

LIGHT WEIGHT PROFILING SYSTEM

Calibration Verification & Operator Certification Program Manual



DEPARTMENT OF TRANSPORTATION
BUREAU OF MAINTENANCE AND OPERATIONS
ASSET MANAGEMENT DIVISION
ROADWAY INVENTORY AND TESTING UNIT

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INTRODUCTION

Prior to 2000, PennDOT's pavement smoothness specifications had been based on the measurement of Profile Index (PI). Devices called California Type Profilographs were used to measure PI, and Pennsylvania Test Method (PTM) #424 defined which devices were acceptable and described how to perform the measurements.

In order to ensure that pavement smoothness specifications resulted in a product that provides a smooth ride for the motoring public, PennDOT began to base pavement smoothness specifications on the International Roughness Index (IRI), rather than PI, in 2000. Whereas PI is a measure of the profile and the deviations from a smooth plane, IRI simulates a vehicle's response to the deviations. Therefore, IRI is an expression of the "rideability" of the roadway, as vehicle passengers experience it. IRI was developed as a reference measure by The World Bank and is based on a quarter-car simulation as described in NCHRP Report 228.

Rather than the profilographs used to measure PI, IRI is determined with devices called "profilers." Profilers are mounted with laser sensors and computers and may either be vans that travel at highway speeds, which PennDOT has been using for over a decade, or "Light Weight Profiling" (LWP) devices. An LWP is an off-road utility vehicle that can be easily used within a construction project's confines due to its limited size and weight, and added maneuverability.

PTM #428, (found [here](#) at PennDOT's Roadway Management & Testing website [website](#)) defines the method in which to measure pavement profile and determine pavement ride quality for acceptance and payment using an LWP device. This PTM is provided in Appendix A. Unlike PTM #424, a list of acceptable models is not included. That is for two reasons: 1) the profiling technology is rapidly expanding, and it is not in PennDOT's best interest to publish a PTM that may continuously need to be updated to include new LWP manufacturers and/or models; and 2) PennDOT wants to be assured that each individual LWP device is operated proficiently and provides accurate and precise results, and not make "blanket approvals" based on type. With this second reason in mind, a program has been developed to verify that all LWP devices are calibrated and operating properly.

The second aspect of the program is to certify that LWP operators are competent and capable of operating the device, as well as collecting, analyzing, and reporting accurate results. The certification program ensures control of the use of LWP devices, promotes competence, proficiency, and professionalism, and increases confidence in the test data. Operator certification is necessary because PennDOT offers no training for LWP operation. The vendors that supply LWP devices may provide training, but the extent and quality of training is beyond PennDOT's control and will vary depending on the vendor, device type, and software of each LWP device.

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PENNDOT CONTACTS

The LWP Calibration Verification and Operator Certification Program is directed and controlled by PennDOT's Bureau of Maintenance and Operations (BOMO), Asset Management Division, Roadway Inventory and Testing Unit (RITU).

CERTIFICATION

All correspondence concerning equipment or operator certifications should be made to the Roadway Inventory and Testing Unit by contacting:

Roadway Inventory and Testing Unit
Attn: LWP & Operator Certifications
Pennsylvania Department of Transportation
907 Elmerton Avenue
Harrisburg, Pennsylvania 17110
Phone: (717) 787-7291 or (717) 783-6857

To schedule a certification contact:
(717) 787-7291

DATA ANALYSIS

Questions or concerns pertaining to profile data may be directed to:

(717) 783-6857 or (717) 783-0172

ADMINISTRATION OF CERTIFICATION PROGRAM

Questions or concerns on policies or direction of PennDOT's Light Weight Profiler Calibration Verification and Operator Certification Program should be directed to:

Manager, Pavement Evaluation and Testing (717) 787-7294

Appointments will not be made prior to March 20th of each year. Please leave a message with a name and call back number and we will return your call.

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SCHEDULING

RITU will begin operating the LWP Calibration Verification and Operator Certification program in the spring of each year, typically mid-May. Most verifications/certifications are done in May, June, and July; however, they may also be performed throughout the summer and early fall*. The latest date for completing a certification is October 15th. It is the responsibility of the LWP device owner to contact RITU for scheduling.

To schedule an LWP Calibration Verification and Operator Certification, please contact:
(717) 787-7291

- **When scheduling verifications/certifications, state how many operators are to be certified during the session. Do not send additional operators to the appointment without prior RITU approval.**
- **If time constraints arise, RITU reserves the right to deny the opportunity to certify all operators during a given day.**
- **If you schedule a certification and do not show, or if you fail to cancel a scheduled certification by 3:00 PM the day before the certification, you may be billed \$200.00.**

In some cases, devices may need to be “reverified” during the year. Reasons for this include:

- LWP devices that were not accepted based on their initial tests.
- New operators that need to be certified.
- LWP devices or operators requested to be reverified by PennDOT personnel, due to questionable results and/or practices on a construction project.
- LWP devices that fail to provide results that match those derived by RITU in a follow-up analysis (see below).
- LWP devices that have been repaired and/or hardware or software that has been replaced. **The owner/operator of a certified LWP must report any software changes within seven days of the change to (717) 783-0172 or (717) 783-6857.**

Regardless of when an LWP device is verified, it will only be valid through June 30th of the following year. Operator certifications are valid through June 30th of the third year after issuance; for example, an operator certification issued in 2018 is valid through June 30th, 2021.

*Note that verifications/certifications will not be performed during the late fall and winter; reference values for the site may not be accurate during this time. New reference values will be determined by RITU each year prior to the start of the springtime verification/certification period; these reference values will be checked through the summer and fall as necessary.

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RESTRICTIONS

The Light Weight Profiling System Calibration Verification and Operator Certification Program is not a training program. It is expected that all participating operators are well versed in the operation of the LWP device to be verified. The RITU staff will serve as technical experts and may provide guidance during the verification/certification process, but will not be responsible or accountable for the training of LWP operators, even if they are PennDOT employees.

Furthermore, RITU staff will verify the calibration of LWP devices, but cannot and will not be responsible for making corrections or modifications to devices. Assistance and guidance may be provided, but it is not the role of RITU to repair, maintain, or calibrate LWP devices. If repairs or modifications are necessary, the owner of the device must contact the manufacturer.

Successful completion of the certification program does not eliminate the need for daily calibration of the LWP on the project site (i.e., vertical, horizontal, etc.).

Profiling technology is rapidly expanding, and the number of manufacturers is expected to increase. As stated previously, PTM #428 does not include a list of previously accepted models. Therefore, RITU may not have prior experience, or the necessary software, for all LWP devices required to be verified. It is the responsibility of the owner/operator to assure that RITU is informed of the LWP device type and software version, and that RITU has the required software and/or file format, prior to the scheduled calibration verification.

RITU must also be provided the methodology and/or software necessary to convert raw (unfiltered) profile data to "ERD" or "PPF" file format. ERD and PPF are standard file formats used by ProVAL, an engineering application utilized to view and analyze longitudinal pavement profiles. ProVAL was developed for the Federal Highway Administration (FHWA) under DTFH61-01-P-00159.

RITU reserves the right to analyze raw profile data with ProVAL and compare the IRI results to those produced by the device's software. If the results of this analysis are not acceptable, the LWP device's verification will be revoked or withheld.

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- **RITU will disqualify any individual, manufacturer, or device owner that attempts to collect any type of profile data from the Newville test course without prior permission or notification given by/to PennDOT.**
- **RITU will not initiate contact with any manufacturer on behalf of an LWP device owner/operator.**
- **RITU will not schedule a calibration/verification for an LWP device that uses an unrecognized file format, unknown software, or cannot produce output that can be converted to ERD or PPF file format.**
- **RITU will not accept an LWP device which cannot analyze and produce IRI results equal to the results of ProVAL.**
- **RITU will not accept an LWP device that allows users to define or edit sensor or accelerometer constants. All such constants or factors must be automatically stored during calibration/verification procedures.**
- **RITU will not accept an LWP device that cannot meet the requirements of PTM #428, or ASTM E950/E950M.**
- **RITU will not accept results that are not based on a quarter-car simulation as described in NCHRP Report 228.**
- **RITU recommends that all equipment manufacturer specifications and manuals accompany the LWP device to be verified.**
- **RITU will not accept or certify contractor owned LWP devices that utilize more than one type of laser.**
- **Certification does not eliminate the need for daily calibration of the LWP on the project site (i.e., vertical, horizontal, etc.).**

In addition to reverifying LWP devices, RITU is also available to perform analysis of any data collected by a previously verified device. LWP operators, or PennDOT personnel, may send raw profile data to RA-PDIRIDATACOLLECT@pa.gov. When submitting the data, specify the LWP device type used to collect the data, the software version the device uses, parameters of test area, and a contact to receive the results.

If the RITU analysis results in an IRI value that differs from the IRI value provided by the LWP device that collected the data, that device's acceptance will be revoked and a reverification must be performed.

- **RITU will not analyze data collected by LWP devices that have not participated in the same year's calibration verification program. Furthermore, RITU will not analyze data collected by an LWP operator who does not have a valid Pennsylvania certification in the same year as the data was collected.**

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REQUIREMENTS

1. All LWP devices used by PennDOT, or by contractors, must be verified each year prior to use on PennDOT construction projects. Furthermore, all operators of LWP devices must be certified prior to using the LWP devices on such projects each year. The owners of the LWP devices will be responsible for the transport of the device(s) to the verification/certification site, and for assuring that all necessary personnel are certified.
2. All LWP devices must meet the definitions and requirements of PTM #428 – Method of Test for Measuring Pavement Profile Using A Light Weight Profiler, provided as Appendix A. The devices and operators must be capable of providing results accordingly and in the defined formats.
3. During verification/certification, there may be exposure to hazardous materials, operations, and equipment. It is the responsibility of the operator to establish and address all appropriate safety and health precautions prior to commencement.
4. All operators must be well versed in the operation of the LWP device to be verified and be able to perform all tasks associated with the verification/certification procedure.
5. All LWP operators will be required to supply PennDOT with ERD (.erd) or PPF (.ppf) files for all passes made during certification. These files will be analyzed using ProVAL. PennDOT uses ProVAL to compare multiple runs of a profiler (i.e., repeatability test) and compare those repeats with a reference profile (i.e., accuracy test). The computation of cross-correlation will be based on the guidelines stated in the AASHTO R 56-14. ProVAL is available, free of charge, from the Federal Highway Administration.

See their website at:

<http://www.roadprofile.com> for more information.

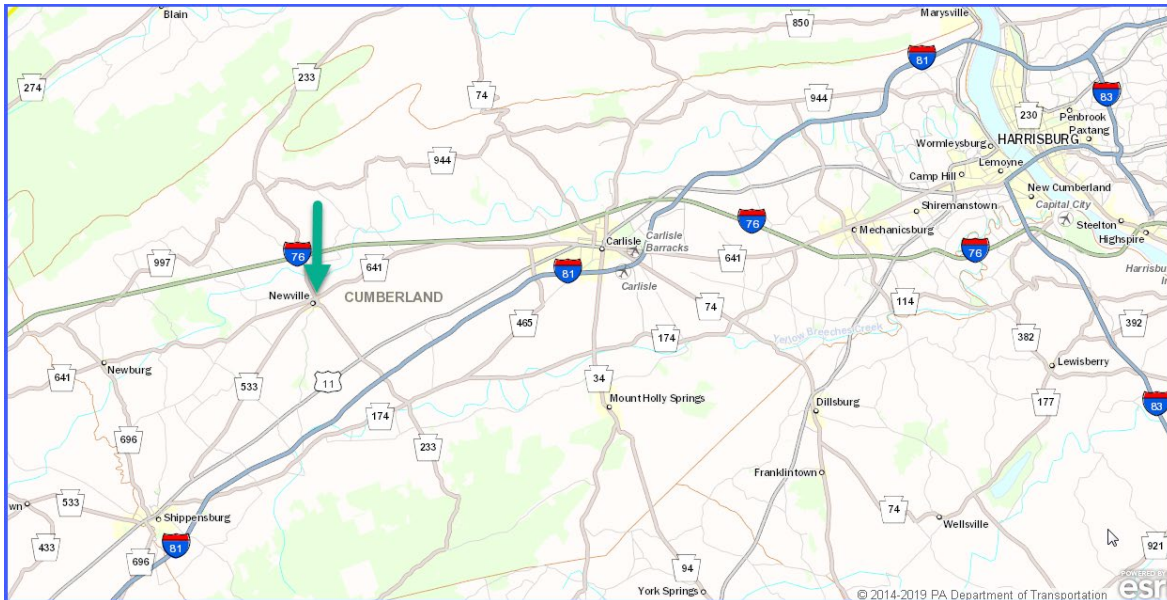
Information about the ERD files can be found on the UMTRI website:

http://www.umtri.umich.edu/erd/software/erd_file.html, or by contacting your LWP manufacturer.

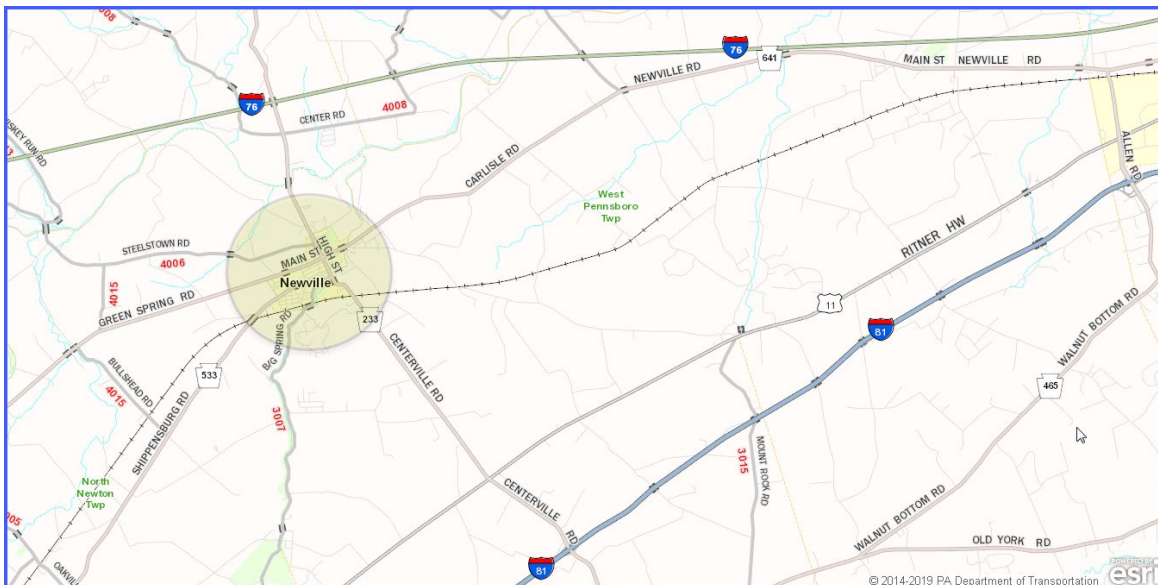
Profile repeatability must be > 92% and accuracy must be > 90% for the LWP to meet certification requirements.

VERIFICATION/CERTIFICATION CENTER

LWP calibration verification and operator certification is performed at a site located in Newville, PA. The site, constructed for PennDOT along a “rails to trails” property, has two one-tenth mile sections constructed of bituminous pavement, and two one-tenth mile sections constructed of plain cement concrete pavement. Each section was constructed to be at distinct IRI values, to assure that the LWP devices can produce accurate results over a range of roughness levels and textures.

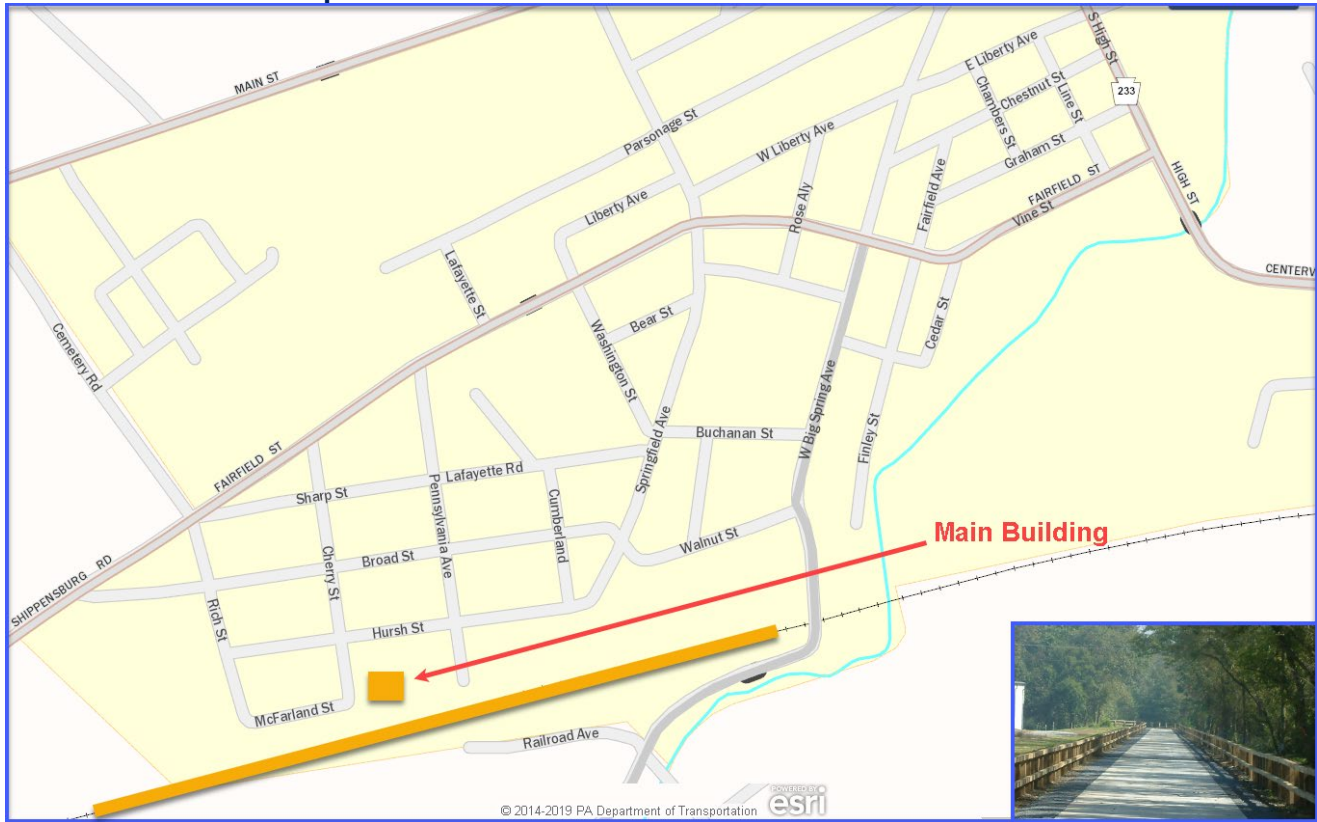


From I-81, Exit 37, follow SR 233 North into Newville. Turn left onto SR 533 West (Vine Street). Turn left on Cherry Street. The parking lot and office for the site are located on the left, at the end of Cherry Street.



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Newville Area Map



PennDOT LWP Certification Building

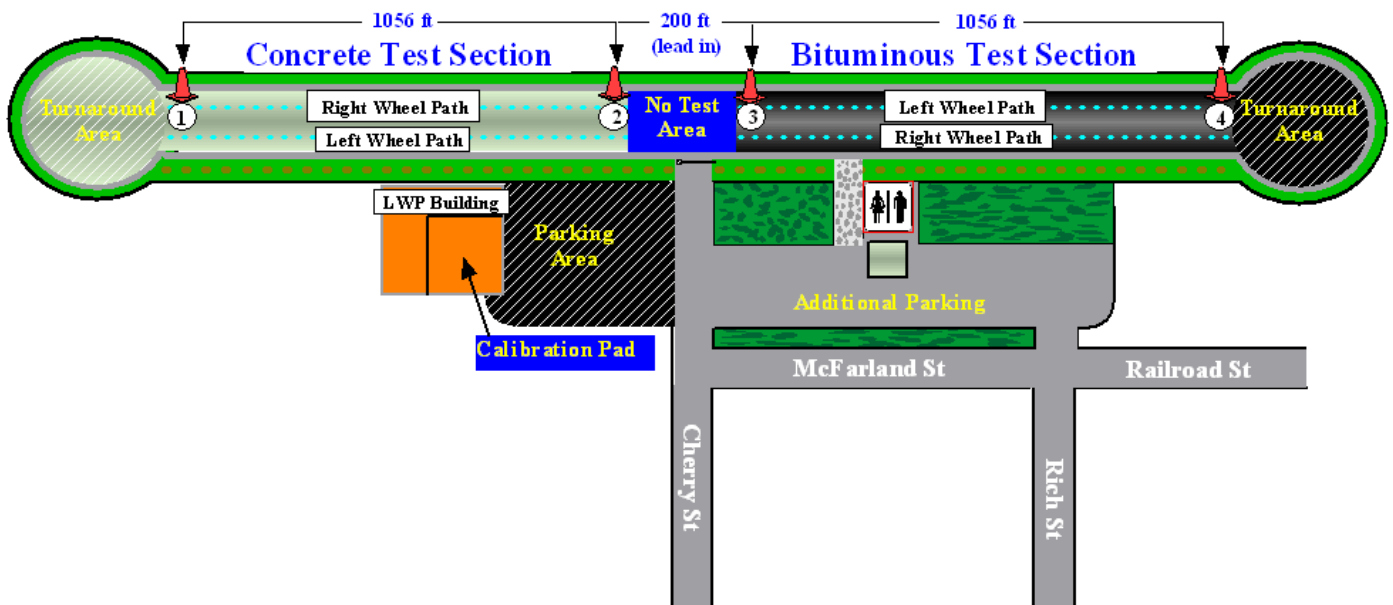


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REFERENCE VALUE DETERMINATION

RITU will annually establish reference IRI values for each 528' test section as follows:

1. RITU will make five passes with a "reference device," such as the SurPRO 3500 Rolling Surface Profiler.
2. If the standard deviation of the five IRI values, determined by the reference device, are within a tolerable percentage of their mean, then RITU will make five passes with its LWP device.
3. If the standard deviation of the five IRI values, determined by the LWP, is within a tolerable percentage of their mean, and the "LWP" mean is within a tolerable percentage of the reference device mean, then the reference device mean will be established as the test section reference value.
4. This procedure is repeated for each wheel path for each section.



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VERIFICATION/CERTIFICATION PROCEDURE

1. RITU will assure that the intended LWP test path is clear of all loose material and foreign objects.
2. Perform all necessary start up procedures, and allow for the minimum acceptable warm-up period, as per manufacturer specifications.
3. Set system displays and test results to English units (inches/mile), or as requested.
4. Perform all necessary profile system (sensor and accelerometer) calibration procedures, as per equipment manufacturer specifications. Save all values. Check that all sensor positions are displaying correctly, and verify that sensor collection rates are properly set. RITU will not accept an LWP device that allows users to define or edit sensor or accelerometer constants. All such constants or factors must be automatically set and stored during calibration/verification procedures. The following must be successfully completed during the profile system calibration:
 - a. Laser height verification (block test) must be performed in accordance with AASHTO R 57-14 or the manufacturer's recommended procedures.
 - b. Vertical verification (bounce test) or the manufacturer's equivalent must be performed in accordance with AASHTO R 57-14.
 - c. Accelerometer verification must be performed in accordance with the manufacturer's recommended procedures.
5. For LWP devices equipped with two sensors, the horizontal sensor spacing must be 69", +/- 1.5". If the sensor spacing is not correct and cannot be corrected, or if the left sensor results are not acceptable, then the device must be considered and accepted as a single sensor device based on the right sensor. (The acceptance decal will reflect this.) If the right sensor results are not acceptable, then the device will not be accepted at all.
6. Check all tire pressures and verify that equipment manufacturer specifications are met.
7. Perform all necessary distance sensor calibration procedures, as per equipment manufacturer specifications, to determine and/or verify the calibration factor necessary to perform the operational distance measurements. Save all values. The operator must use feet or miles as the distance measurement units, and not make any calculations to determine the calibration factor.
8. After determining the distance calibration factor, one pass of at least 1056', is required to verify the distance measurement accuracy. Submit results. 5' per mile (or 1' per 0.2 miles) accuracy is required.
9. Collect, process, and submit pavement profile and roughness data for five passes for both wheel paths for each 528' test section.
10. If the operator believes that a particular pass is invalid, the operator may choose to not save the results and make an additional pass. However, no more than eight passes may be made in order to obtain the five to be submitted.

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11. Printouts and a CD or flash drive containing the IRI value calculated for each pass must be submitted. Provide values in English units, or as requested. The CD or flash drive must be formatted so that it can be analyzed by RITU. All required data must be submitted to a PennDOT representative on the day of certification before leaving the facility.

A summary of this procedure has been developed, as well as a Customer Information Form. These documents are attached as Appendix B.

ACCEPTANCE

1. The results of each pass for each 528' length will be compared to the corresponding reference value in order to determine acceptance. Likewise, results for each wheel path will be compared separately. For example, if four 528' lengths are tested, and both wheel paths in each length are tested, then there will be a total of eight precision and bias comparisons in order to determine acceptance.
2. Each of the passes shall be clearly labeled so that PennDOT personnel can easily analyze the file data.
3. Reporting (for each pass): As a minimum, the following information must be printed. The operator must be able to define, interpret, and describe all of the information, and demonstrate data entry capabilities for all appropriate parameters:
 - a. Date and time of day.
 - b. Operator and equipment identification.
 - c. Weather conditions: temperature, cloud cover, and wind.
 - d. Surface description: type of pavement and condition.
 - e. Location and description of section: Job ID, lot, lane, wheel path, beginning and ending stationing, and direction measured.
 - f. Lot Length.
 - g. Software version: the version number or identification of the LWP device operational system.
 - h. Data filter settings. High-pass filter setting = 100' (30 m).
 - i. IRI value(s).
4. RITU reserves the right to process the raw profile data obtained from the LWP device using ProVAL software. This requires the ability to convert the raw profile data to ERD file format. As stated on page 4, it is the responsibility of the owner/operator to assure that RITU has the methodology and/or software to convert the raw profile data to ERD file format. Reasons for RITU opting to perform this analysis include: unfamiliarity with the LWP device's software and analysis methodology, or a change/upgrade to an LWP device's software. If the results of this analysis are not acceptable, the LWP device's verification will be revoked or withheld.
5. All LWP devices with acceptable test results will be designated with a decal. Denoted on the decal will be a device identifier, the date of acceptance, the date of expiration, the number of sensors, and the device type/operational system software version. This decal must be displayed at all times that the device is present on a PennDOT construction project. **PennDOT reserves the right to remove the decal if the LWP device's acceptance is revoked.**

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6. All certified LWP operators will be provided a certification card. The name of the operator, employer, date of certification, date of expiration, and LWP device type will be denoted on the card. Certified operators may operate LWP devices other than the one used during certification, but only those that are of the same type, owned by the same employer, and designated with a valid verification decal. This card must be carried at all times that the operator employs an LWP device on a PennDOT construction project. Operator certification is typically valid for three years.
7. If more than one individual is to be certified to operate the same LWP device, then all individuals must perform the entire procedure separately. Each operator will be certified based upon their own acceptance.
8. If for any reason, an LWP device is reverified during the same year, an updated decal may be applied.
9. If for any reason, an LWP device's acceptance is revoked, the decal will be removed and all applicable operator certification cards will become invalid. The LWP device will be removed from PennDOT's Approved Certification list.
10. If a device is required to be reverified for any reason, only one operator must return the device for the retest. All other previously certified operators do not need to return for recertification until their three-year certification period ends. As long as the device reverification is successful, the other operators' certification will remain valid.
11. Previously purchased LWP devices do not automatically become invalid if the manufacturer's business status changes (i.e. goes out of business, is sold, etc.). If the business status of an LWP device manufacturer changes, all previously approved devices of that type, and all applicable operator certifications, remain valid through the previously established expiration dates. When the device is reverified and is accepted, an updated verification decal and certification cards will be issued. If the device fails, the decal will be removed, and all applicable certification cards become invalid until there is a subsequent acceptable reverification.
12. If a certified LWP operator changes employer, that operator's certification is no longer valid. (RITU will make no efforts to revoke the certification card from the individual. Since the card states an employer that is no longer valid, PennDOT's construction personnel will disallow the individual from operating an LWP device.) However, if the operator's new employer owns a LWP device that is the same type as that for which the operator was certified, and the device has a valid verification decal, the operator does not need to be recertified. Upon notification from their employer, RITU will send an updated certification card for the operator, at no charge. The updated certification card will expire at the same time as the previously issued certification; it will not be valid for three years from the point that the new card is reissued.
13. RITU will maintain records of the results of the verification/certification program. The owner, LWP device type, the name of the operator(s), and the date of acceptance or failure will be included in these records. RITU will provide this information on the internet by way of a spreadsheet file found on PennDOT's Bureau of Maintenance and Operations' website:
<https://www.penndot.gov/ProjectAndPrograms/ResearchandTesting/RoadwayManagementandTesting/Documents/LWP%20Certified%20Operators.pdf>.

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PAYMENT

The following describes the costs that will be charged to customers for LWP calibration verification and operator certification, and how the charges will be applied. These costs are based on the expense incurred by PennDOT to perform the verification/certification. All PennDOT-owned LWP devices and PennDOT operators are excluded from these charges, but verification/certification is still required.

COST FOR LWP VERIFICATION AND ONE OPERATOR CERTIFICATION: \$450.00

Breakdown:		
RITU Manpower (2 employees):	5 hours x \$26.50 + 5 hours x \$26.50 =	\$265.00
Salary Overhead:	\$265.00 x 0.666920* =	\$176.73
Decal & Card:		\$8.27

EACH ADDITIONAL OPERATOR, SAME DAY+: \$200.00

Breakdown:		
RITU Manpower (2 employees):	2.20 hour x \$26.50 + 2.20 hours x \$26.50 =	\$116.60
Salary Overhead:	\$116.60 x 0.666920* =	\$77.76
Card:		\$5.64

* Salary overhead rate for Fiscal Year 2020-2021.

+ Due to time constraints, RITU may limit the number of additional operators scheduled to be certified per day. If more operators are to be certified than can be accommodated in one day, then the additional operators will be scheduled for a different day. For each additional day, the initial \$450.00 cost will be charged for the first operator and an additional \$200.00 will be charged for each additional operator.

Payment preferred prior to the verification/certification procedure. Credit card payments can be made at www.pay.penndot.gov/web. Checks to be made payable to: "COMMONWEALTH OF PENNSYLVANIA." The costs listed above are applied "pass" or "fail," with the following exceptions and restrictions:

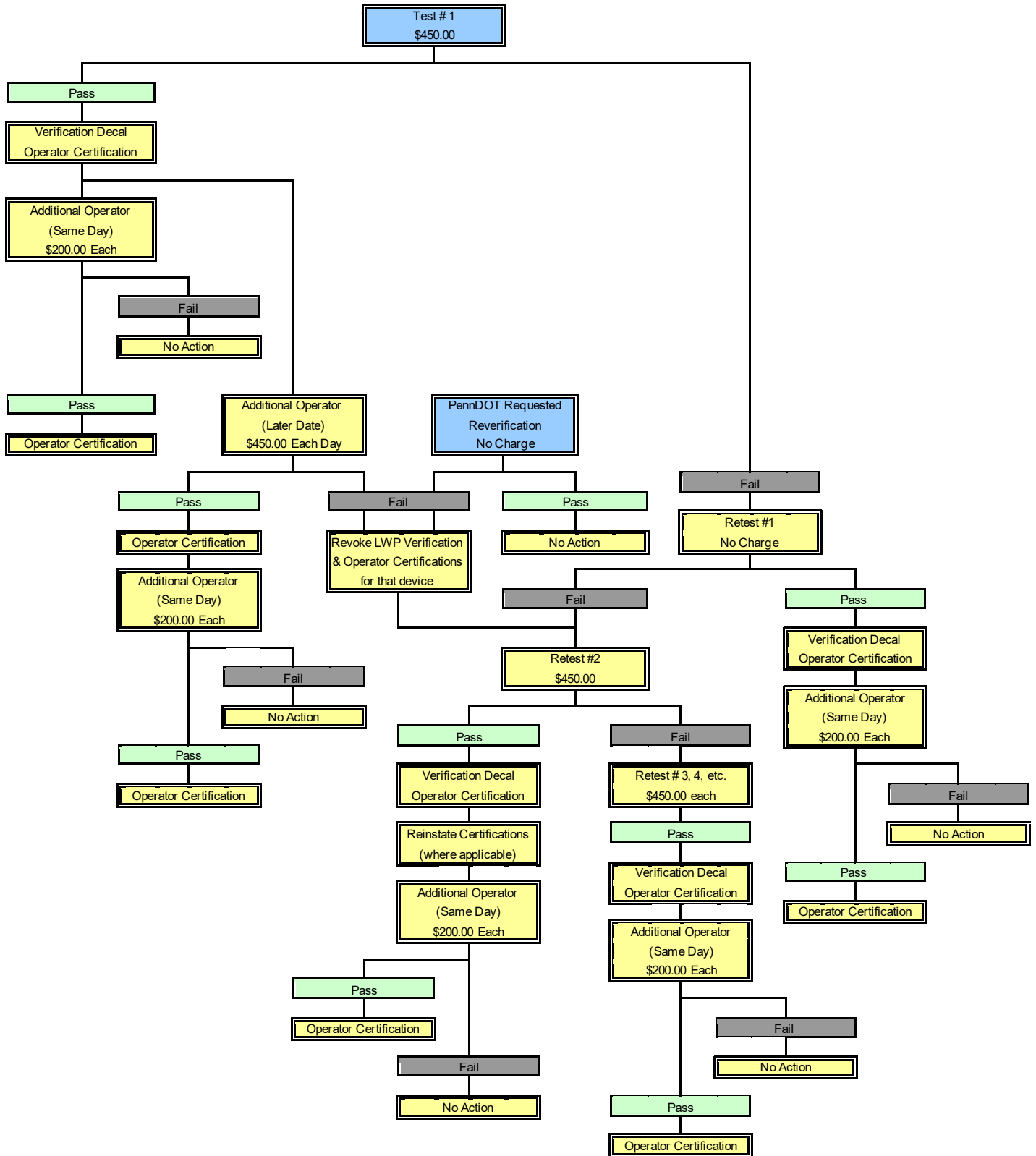
1. When scheduling a certification with more than one operator to be certified, in the same day, and you are paying with a check, provide separate checks with the appropriate amounts. One check, for the LWP device with 1 operator and one check for each additional operator(s) as listed above.
2. If a contractor/vendor/etc. returns its LWP device at a later date in order to certify additional operators, the \$450.00 will be charged. If the new operator fails to certify, then the LWP device's acceptance decal will be revoked and any previously certified operators will no longer be approved to operate the device. This is because we cannot determine if the discrepancies are due to operator error or a change in the device. (Therefore, in order to keep costs down and avoid a later revoking, it behooves a contractor/vendor/etc. to send all potential operators at the same time. If any of the operators pass, then the LWP device will be approved; the passing operators will be certified, but the others will not be certified.)

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3. If a device (and associated operator) fails initially, and then returns for recertification during the same year, no charge will be applied. However, if the individual/device fails the second time, then all subsequent recertifications will be charged the \$450.00 cost.
4. If a contractor/vendor/etc. owns two or more LWP devices, each device must be certified. Even if all devices are certified the same day, the \$450.00 will be applied to each device. If all devices are of the same type, each operator that is certified to operate any of the devices will automatically be certified to operate them all. No charge will be applied in addition to the operator's initial certification.
5. If a PennDOT employee, such as a construction inspector, requires that a verified/certified device and operator retest, there will be no charge for the retest. However, the same operator must perform the retest.
 - a. That device is not permitted to operate on any PennDOT project by any operator until it passes a retest. Additionally, that operator is not permitted to operate a LWP device on a PennDOT project until they pass a retest.
 - b. If the device and operator pass, the appropriate PennDOT personnel will be notified that the device verification and operator certification are still valid.
 - c. If the device and/or operator fail, the previously granted verification/certification will be revoked.
 - d. If/when the revoked device and operator returns for retesting (during the same year), it will be treated as a new verification/certification, and \$450.00 will be charged.
 - e. If the subsequent test is performed by a different operator than the one that failed, then upon passing, the operator that performed the successful retest will be certified, and the device will have its verification reinstated. Any other previously certified operators will be permitted to operate the device on PennDOT projects again. The operator that caused the revocation, however, will not be recertified unless they subsequently pass a certification. (The charge will be \$450.00 unless this retest is the same day as the test that reinstated the device, in which case the charge will be \$200.00.)
6. When you are scheduled for a certification and don't show or if you don't cancel a scheduled certification by 3:00 PM the day before the certification, you may be charged \$200.00.

The flow chart on the next page further illustrates the application and amount of the costs to be charged.

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REFERENCED DOCUMENTS

1. NCHRP Report 228
2. PA Test Method No. 428 Method of Test for Measuring Pavement Profile Using A Light Weight Profiler
(<https://www.penndot.gov/ProjectAndPrograms/ResearchandTesting/RoadwayManagementandTesting/Documents/Ptm-428.pdf>)
3. PTM #424 Method of Test for Measuring Pavement Profile Using A Profilograph
4. ASTM E950/E950M Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
5. AASHTO R 56-14 (2018) Standard Practice for Certification of Inertial Profiling Systems
6. AASHTO R 57-14 (2018) Standard Practice for Operating Inertial Profiling Systems

APPENDIX A:

Pennsylvania Test Method (PTM) No. 428

Method of Test for

Measuring Pavement Profile Using a Light Weight Profiler

ASSET MANAGEMENT DIVISION

Method of Test for

MEASURING PAVEMENT PROFILE USING A LIGHT WEIGHT PROFILER

1. SCOPE

- 1.1. This test method covers the measurement of pavement profile and roughness using a Light Weight Profiler by driving the profiler longitudinally over the pavement.
- 1.2. This test method covers the determination of the pavement ride quality from the longitudinal profile, in the form of the International Roughness Index (IRI), for acceptance and payment.
- 1.3. This test method covers the calibration verification procedures and it outlines the procedures for collecting Light Weight Profiler data on paving projects.
- 1.4. This test method covers the submission requirements for projects with a ride quality specification.

2. REFERENCED DOCUMENTS

- 2.1. NCHRP Report 228 Calibration of Response-Type Road Roughness Measuring Systems
- 2.2. ASTM Standards
 - E950/E950M Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
 - E1926 Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements
 - E2560 Standard Specification for Data Format for Pavement Profile
- 2.3. AASHTO Standards
 - R 56 Standard Practice for Certification of Inertial Profiling Systems
 - R 57 Standard Practice for Operating Inertial Profiling Systems
- 2.4. PennDOT Publications and Forms
 - Publication 408, Specifications
 - Publication 589, Light Weight Profiling System Calibration Verification and Operator Certification Program Manual

- Publication 2, Project Office Manual, Section B.6.23, Verification Process for Ride Quality of Newly Constructed Pavements
- Form M-7, Contractor IRI Data Collection Form

3. TERMINOLOGY - DESCRIPTION OF TERMS SPECIFIC TO THIS PTM

- 3.1. International Roughness Index (IRI) - A scale for roughness based on the response of a generic motor vehicle to roughness of the road surface. IRI was developed as a reference measure by The World Bank, and is based on a quarter-car simulation as described in NCHRP Report 228. IRI is determined by obtaining a suitably accurate measurement of the profile of the road, processing it through an algorithm that simulates the way a reference vehicle would respond to the roughness inputs, and accumulating the suspension travel.
- 3.2. Excluded Area - An area that is not included in the measurement, used to determine lot payment.
- 3.3. Light Weight Profiler System (LWP) - An inertial profiler that is relatively lightweight (golf cart, ATV, etc.) compared with high-speed profilers. It is often operated much more slowly than prevailing traffic speed.
- 3.4. Raw (Unfiltered) Binary Data – Inertial profiler output files that have not been filtered and are saved in binary, encrypted form. Profiler manufacturers use various file extensions to save the profile, speed and elevation data which are required for the data to be reprocessed as the user needs. Refer to your profiler’s manufacturer for questions regarding your equipment’s raw binary output files.
 - 3.4.1. Engineering Research Division (ERD) – A file format developed within the Engineering Research Division of the University of Michigan Transportation Research Institute (UMTRI). ERD is the standard file format used by ProVAL, an engineering software application that allows users to view and analyze longitudinal pavement profiles.
 - 3.4.2. Pavement Profile Standard File Format (PPF) – A binary based file format created for ProVAL, an engineering software application that allows users to view and analyze longitudinal pavement profiles. The ASTM International profile data file specification, E2560, is based on this format.

4. APPARATUS

- 4.1. The Light Weight Profiling System must be an all-terrain or golf-cart type vehicle equipped with various hardware and software that together allow the measurement and recording of the longitudinal profile of a traveled wheel track and the reference distance traveled along the traveled wheel track.
- 4.2. The equipment and software will produce an IRI in English units (inches/mile) for 0.10 mile intervals conforming to ASTM E1926 and meet the requirements of Appendix A, Generic Specification for Light Weight Profiling System.
- 4.3. Must be certified for use on PennDOT projects described in Section 6.

5. REPAIR AND ADJUSTMENT OF LIGHT WEIGHT PROFILER

- 5.1. Major component repairs or replacement that would require recertification of the inertial profiler include, but are not limited to, the following:
 - 5.1.1. the accelerometer and its associated hardware,
 - 5.1.2. the non-contact height sensor and its associated hardware,
 - 5.1.3. the distance measuring instrument, or
 - 5.1.4. any printed circuit board necessary for the collection and processing of raw sensor data of the LWP and IRI.

6. ACCEPTANCE

- 6.1. This section provides minimum certification requirements for LWP devices and operators.
 - 6.1.1. Prior to testing, the LWP device will be checked to verify that it has been calibrated and is operating properly.
 - 6.1.1.1. Verification/certification will be done in accordance with Publication 589.
 - 6.1.1.2. Accepted profilers are designated with a decal that is valid until June 30 of the following calendar year provided no changes are made to the equipment or software. The decal must adhere to the outside of the LWP in clear view.
 - 6.1.1.3. Additional reverification/recertification of profilers or operators may be required, due to repairs, replacements, and/or upgrades to the profiler's

hardware or software, or questionable results and/or practices on a construction project.

- 6.1.2. The LWP operator must be certified. Certified operators will receive individual certification cards that are valid for up to three calendar years.
- 6.1.3. The operator of a certified LWP must use the same software version and settings on PennDOT projects that were used during the profiler certification. A copy of these settings may be obtained by contacting the Roadway Inventory and Testing Unit or by viewing the Roadway Inventory and Testing Unit's website at <http://www.penndot.gov/ProjectAndPrograms/ResearchandTesting/RoadwayManagementandTesting/Pages/Light-Weight-Profiler-Certifications.aspx#.VmsrSqMo670>.
- 6.1.4. Changes to the software version may result in the need for reverification or recertification of the profiler.

7. PROJECT SITE VERIFICATION

- 7.1. The Department shall certify all light weight profilers and operators prior to testing.
- 7.2. The Project Engineer (or designee) will approve the operator and equipment for project level testing by verifying the equipment and software information on the PennDOT issued decal and by verifying the operator has a current PennDOT issued certification card. The operator and equipment information shall be documented by the Project Engineer (or designee) on the Form M-7. A list of approved contractor operators and approved equipment is posted on the Bureau of Maintenance and Operations, Asset Management Division, Pavement Testing and Asset Management Section, Roadway Inventory and Testing Unit's webpage.
- 7.3. The following daily verification procedure is required for all testing. Although the specific steps to complete the verifications will vary in accordance with the manufacturer's recommendations, the basic procedures will not change. The results of the verification checks shall be documented in a log. The Project Engineer (or designee) shall verify the profiler meets the following requirements:
 - 7.3.1. Longitudinal Verification (Distance)
 - 7.3.1.1. The longitudinal calibration will be a straight roadway test section at least 528 feet in length. This distance shall be measured accurately within +/-0.1 % using a steel measurement tape or electronic measuring device.
 - 7.3.1.2. Verify the tire air pressure on the wheels of the apparatus daily and maintain per the vehicle manufacturer's recommendations.

- 7.3.1.3. Warm up the LWP's tires and electronic systems in accordance with the manufacturer's recommendations.
 - 7.3.1.4. If the LWP's distance measuring subsystem measures the length of the test section to within 0.1% of its actual length, no additional verification is necessary.
 - 7.3.1.5. If the LWP's distance measuring subsystem fails to measure the length of the test section to within 0.1% of its actual length, the calibration shall be adjusted according to the manufacturer's guidelines and the longitudinal verification repeated.
 - 7.3.1.6. No more than one single certified operator is to occupy the profiler during verification/calibration.
 - 7.3.1.7. If the LWP fails to meet these requirements, the LWP will be deemed to be not certified and prohibited from use on PennDOT projects until it is recertified.
 - 7.3.1.8. A printed copy of the distance calibration must be submitted to the PennDOT representative each day prior to taking any measurements.
- 7.3.2. Laser Height Verification (Block Test)
- 7.3.2.1. Laser height verification must be performed in accordance with AASHTO R 57-14 or the manufacturer's recommended procedures each day the LWP device is in use.
 - 7.3.2.2. The block sensor tests are run after the profiler has reached operational stability as defined and specified by the manufacturer. This test should be performed on a flat level area. Its purpose is to check the height measurements, in inches, from the height sensor(s) of the LWP using blocks of known heights. During the test, do not lean on the LWP or cause it to move in any way. At a minimum, two base plate and three varying measurement plate (typically 0.25, 0.5 and 1 inch) readings will be needed. The absolute difference should be less than or equal to 0.01 inch for each gauge block.
 - 7.3.2.2.1. Center the base plate under the height sensor of the LWP and allow the system to take height measurements.
 - 7.3.2.2.2. Center a 0.25 inch block underneath the height sensor on top of the base plate and record the height measurement.

- 7.3.2.2.3. Replace the 0.25 inch block from the base plate with a 0.50 inch block and record the height measurement.
- 7.3.2.2.4. Replace the 0.50 inch block from the base plate with a 1.0 inch block and record the height measurement.
- 7.3.2.2.5. Remove the 1.0 inch block leaving only the base plate and record the height measurement. The profiler's height measurement subsystem returns to zero.
- 7.3.2.2.6. If the tests fail to meet these requirements, the LWP will be deemed to be not certified and prohibited from use on PennDOT projects until it is recertified.
- 7.3.2.2.7. A printed copy of the laser height verification results must be submitted to the PennDOT representative each day prior to taking any measurements.

7.3.3. Vertical Verification (Bounce Test)

- 7.3.3.1. A bounce test in accordance with AASHTO R 57-14 or manufacturer's equivalent must be performed each day the LWP device is in use, prior to taking any measurements.
- 7.3.3.2. With the base plates in position simultaneously under both wheel path sensors, place the LWP in an operating mode that simulates longitudinal movement and initiate profile data collection. Allow the profiler to collect a minimum of 828 feet (includes a 300 foot lead-in) of static profile with the LWP as motionless as possible.
- 7.3.3.3. Sensor(s) should be moved vertically for a total displacement of approximately 1 to 2 inches keeping the sensors as close to perpendicular to the surface as possible during this movement. The bouncing must continue until a minimum of 528 feet of simulated distance has been traveled.
- 7.3.3.4. After a minimum of 528 feet of bounce profile is collected, allow the profiler to collect an additional minimum of 828 feet (includes a 300 foot lead-out) of static profile with the LWP as motionless as possible.
- 7.3.3.5. When reviewing the analysis results, the first and last (static) 528 foot segments shall not exceed 3 inches per mile, while the IRI for the middle (bouncing) segment shall not exceed 8 inches per mile for the bounce test.

If the computed IRI values exceed 3 inches per mile for the static test and/or exceed 8 inches per mile for the bounce test, then the manufacturer's recommendations for performing sensor operational checks shall be followed. The static bounce test shall be repeated.

7.3.3.6. If the tests fail to meet these requirements, the LWP will be deemed to be not certified and prohibited from use on PennDOT projects until it is recertified.

7.3.3.7. A printed copy of the bounce test results must be submitted to the PennDOT representative each day prior to taking any measurements.

7.3.4. Accelerometer Verification

7.3.4.1. Accelerometer verification must be performed in accordance with the manufacturer's recommended procedures each day the LWP device is in use, prior to taking any measurements. The tolerance for the accelerometer verification must meet the manufacturer's requirements.

7.4. The operator will check that all sensor positions are displaying correctly, and verify that sensor collection rates are properly set. All such constants or factors must be automatically set and stored during calibration/verification procedures.

7.5. A calibration verification log, in accordance with AASHTO R 56, is to be kept with the inertial profiler to provide a verification of calibration history. The results of the routine bounce tests, block checks, accelerometer and distance verification runs shall also be included in this log. If the log is electronic, a backup copy shall be kept in a secure location.

8. PROCEDURE

8.1. Startup and initialization.

8.1.1. Clean the roadway path of all debris and other loose material before measuring.

8.1.2. Perform all necessary start up procedures.

- 8.1.3. Verify that distance measurement, sensors, and accelerometers are properly calibrated. Perform all necessary calibration procedures, as specified in Section 7, and as per equipment manufacturer procedures. Save all values.
- 8.1.4. Check that all sensor positions are displaying correctly, and verify that sensor collection rates are properly set.
- 8.1.5. Enter the location identification information (all data collected must have this information printed on all output files), and define the direction of traffic for the pavement to be tested.
- 8.1.6. Collect measurements in the direction of traffic. When using a LWP that collects a single wheel path per pass, take care to ensure that the measurements from each wheel path in a travel lane start and stop at the same longitudinal locations.

8.2. Sampling

- 8.2.1. Pavement profiles must be taken in the wheel paths of each lane. The first profile must be approximately 3 feet from and parallel to the outside edge of pavement, and the second profile must be approximately 5.75 feet from the first profile, or as directed by the Project Engineer.
- 8.2.2. Measure profiles to the limits of the pavement areas, as specified. As per Publication 408, sampling areas must be designated as lots, and excluded areas must be defined and measured separately (measure profiles of the excluded areas to their limits).
- 8.2.3. Only a single certified operator is to occupy the profiler during sampling. The weight of additional passengers, including Department personnel, may adversely affect results and is not permissible.

8.3. Data collection

- 8.3.1. Position the LWP to a point where the testing speed can be reached before testing begins. A 100 foot lead-in section of roadway is required to eliminate all error through filtering in the program that processes the data. This lead-in section should be located immediately before the section of pavement being tested. When this is not possible, then crop the beginning of the run until the LWP has reached testing speed and the systems have had a chance to stabilize, or add a minimum of 100 foot lead-in and/or lead-out through the report program to account for speed adjustments and system stabilization.
- 8.3.2. Verify that all software and hardware is ready to collect data. Start the data collection system.

- 8.3.3. The LWP shall remain stationary for approximately 1 minute for the system filters to stabilize.
- 8.3.4. Start the LWP moving and initiate testing when the LWP reaches testing speed.
- 8.3.5. If targeting is used, allow the target to reset the system at test start and finish.
- 8.3.6. Continue testing at a consistent speed until the test end point is passed. A lead-out may be used in accordance with the profiler manufacturer's operating requirements.
- 8.3.7. Terminate the test after the test end point is passed, or allow targeting to terminate the test.
- 8.3.8. End data collection and save the file. It is recommended to save all data, and then delete unwanted data later, rather than abort the file save mode.
- 8.3.9. If applicable, mark where the total file may be broken into smaller files for analysis.
- 8.3.10. Upon completion of a sampling path, make ending notations and review the test for reasonableness. Repeat the procedure, driving the LWP in the same direction for successive sampling paths for a given section of pavement. Test each sampling path only once. Additional profiles may be taken to define the limits of an out-of-tolerance surface variation.
- 8.3.11. Measure IRI for excluded areas separately.

9. WEATHER LIMITATIONS

- 9.1. Collect data only when the temperature and weather conditions are within the operating range recommended by the manufacturer of the light weight profiler.
- 9.2. Data collection is not permitted during precipitation.
- 9.3. Data collection is not permitted when standing water is present on the pavement.

10. SUBMITTALS

- 10.1. All test results shall be reported in English units (inches/mile).

- 10.2. Test values shall be reported to one digit to the right of the decimal in accordance with conventional rounding procedures.
- 10.3. Provide a summary printout of the IRI value calculated for each pass as generated by the equipment performing the test, within 24 hours of the conclusion of each test. IRI shall be calculated using a quarter-car simulation as outlined in NCHRP Report 228.
- 10.4. As a minimum, the following information must be printed from the inertial profiler for the interpreted output:
- (1) Date and time of day
 - (2) Operator and equipment identification
 - (3) Weather conditions: temperature, cloud cover, and wind
 - (4) Surface description: type of pavement and condition
 - (5) Location and description of section: Job ID, lot, lane, wheel path, beginning and ending stationing, and direction measured
 - (6) Lot length
 - (7) Software version: both the LWP and the reporting software
 - (8) Data filter settings
 - (9) High-pass filter setting = 100 feet
 - (10) Lot IRI value: the average of the IRI values for the two wheel paths for each lot will be the IRI for the lot
 - (11) IRI values for excluded areas
- 10.5. Supply the necessary raw (unfiltered) binary data files, PennDOT Form M-7, and a copy of the operator's certification card for all projects. Provide a USB flash drive or CD that contains the raw (unfiltered) binary data for each wheel path, so that PennDOT may perform verification analysis. Each pass shall be clearly labeled to include county, state route, project number, lot number, and wheel path. The data file must be in ERD or PPF format.

End of PTM 428

APPENDIX A

GENERIC SPECIFICATION FOR LIGHT WEIGHT PROFILING SYSTEM

The purpose of this specification is to define the requirements for a Light Weight Profiling (LWP) System that can be used to collect roadway surface data for determining the roughness and profile of roads. The following items are required:

1. The computer based system, with its profile sensing system described must be capable of the following:

- (1) interfacing with the operator
 - (2) controlling the tests
 - (3) measuring the necessary resultant test signal data
 - (4) recording the resultant test data on USB flash memory drive, Compact Disc (CD) or Digital Versatile Disc (DVD)
 - (5) calculating and storing profile, roughness, and distance values
 - (6) displaying the stored data
 - (7) printing the stored data upon operator request
2. The LWP operational system must be an all-terrain or golf-cart type vehicle equipped with various hardware and software that together allows the measurement and recording of the longitudinal profile of a traveled wheel track and the reference distance traveled along the traveled wheel track. The longitudinal profile must be measured using a concept where three transducers are used. These transducers include:
 - (1) non-contact height measurement (sensor) subsystems, capable of measuring the height from the mounted sensor face to the surface of the pavement under test.
 - (2) an inertial reference (accelerometer) subsystem, capable of measuring the movement of the LWP vehicle as it traverses the pavement under test.
 - (3) a distance measuring subsystem which provides a reference measurement of the vehicle as it traverses the pavement, verified accurate to within 1 foot per 0.20 mile of actual distance traveled.
3. The data must be saved and recorded so that road profiles obtained with this system must be independent of the measuring speed and the type of vehicle used. The LWP must:
 - (1) include hardware and software capable of producing and storing inertial profiles by combining the data from the inertial referencing subsystem, the distance subsystem, and the height measurement subsystem.
 - (2) be capable of measuring and storing profile elevations at 1 inch intervals or less and outputting in ERD or PPF format.
 - (3) have the capability of summarizing the profile elevation data into summary roughness statistics over a section length equal to 0.1 mile (the summary roughness statistic is the International Roughness Index (IRI) for each longitudinal path profiled). In addition, profile plots must be capable of being displayed and printed during post processing.
 - (4) have design to allow field calibration and verification of calibration for the distance measurement (horizontal) subsystem and the height measurement (vertical) subsystem as required by agency standards.
4. The roughness value must be calculated using the standardized International Roughness Index (IRI). In addition to the normal IRI unit value the system must also provide an "inches/mile" statistic. The IRI was developed as a reference measure by The World Bank,

and is based on a quarter-car simulation as described in NCHRP Report 228. This value must conform to the requirements of ASTM E950/E950M. IRI measures obtained from this system must match those obtained from other valid profilometers, and also IRI measures obtained using agency approved ground truth devices. A plot of roughness using any base length for averaging must also be reproducible. The above roughness results must be displayable on the system screen, printed on a printer or written into an electronic file format for processing.

5. The profile system hardware and software for collecting and processing the data obtained in real time in conjunction with the post processing software must have as a minimum the following capabilities:
 - (1) profile computation
 - (2) IRI computation
 - (3) high-pass filtering
 - (4) low-pass filtering (smoothing)
 - (5) height sensor error checking
6. The system must be capable of calculating, displaying, and storing the average roughness value obtained from the stored data. Additionally, the system must be capable of putting the accumulated roughness test results through mathematical equations and printing results when enabled by the operator. These options must be done in real time or in post processing. The system must be capable of performing all required post processing operations.
7. The test software must activate the testing using the timing and control parameters stored by the test control setup software.
 - (1) The operational system through the Distance/Data Acquisition Subsystem (DAS) must provide all interfaces to collect data to derive distance, speed, and profile from the transducers mounted on the vehicle; activate the tests; derive distance and location information from the transmission mounted distance transducer; process operator inputs from the keyboard signaling that the test vehicle has encountered a significant feature; and pass information on about the feature and its location to the processing unit for display and logging.
 - (2) The software must monitor the signals to verify that the testing is being performed properly and indicate detectable errors.
 - (3) The test software must receive, display, and store raw data received from the vehicle mounted transducers at corresponding distances and test speeds.
8. An optical encoder must be mounted on the vehicle to produce a pulse for units of distance traveled by the vehicle on the roadway. The DAS must accept these pulses and, in combination with the DAS software, must determine the distance traveled and vehicle speed.

9. The operational system software must allow the operator to perform a distance sensor calibration and use the calculated Distance Calibration Factor (DCF) to perform the operational distance measurements. The calibration software must also allow the operator to save the calculated DCF. The operator must only enter the distance traveled in feet, meters, kilometers, or miles and not make any calculations to determine the DCF. Five feet per mile (or 1 foot per 0.20 mile), accuracy is required.
 - (1) The calibration software must also allow the operator to perform a profile system calibration. The values determined in calibration must be stored and recorded as above for use in the calculation.
10. The reference height of the vehicle above the pavement must be obtained through a laser or infrared module as required. The sensor must be totally enclosed in a case that may be sealed during bad weather or when not in use. The sensor must be formed in a manner so that it may be mounted on a vehicle approximately 1 foot above the pavement surface. The laser or infrared module shall be equivalent to a Selcom sensor, which has a resolution of 0.001 inch. The sensor must provide continuous coverage of the roadway. The sensor module must send an infrared beam to the pavement and sample the height value at a rate of 16,000 times per second. The sample data must be averaged and stored referenced to time and/or distance so that the data may be processed into transverse profile data or aligned with the accelerometer data to provide a longitudinal profile.
11. The displacement of the vehicle in the vertical direction used to calculate position shall be sensed using an accelerometer. The DAS must provide hardware and software to amplify and filter/integrate the signal as required to obtain the data required for storage and for further post processing of the required data.
12. The vehicle will be equipped with infrared sensors to allow the operational system to perform system functions (start test, end test, reset DMI value, etc.) without operator intervention when using roadside targets.

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APPENDIX B:

Procedure Summary

& Customer Information Form

PROCEDURE SUMMARY

- ✓ Check that the test path is clear of all loose material and foreign objects.
- ✓ Document the company/agency name, address, operator name(s), device type, and device identifier.
- ✓ Check that all necessary start up procedures, and minimum warm-up periods, are followed.
- ✓ Check that all profile system calibration verification procedures are performed and properly set, sensor positions are correct, sensor collection rates are properly set, and all tire pressures are adequate.
- ✓ Check that pavement markings are clear and targets, if used, are properly positioned 1056' apart.
- ✓ Laser height verification (block test) must be performed in accordance with AASHTO R 57-14 or the manufacturer's recommended procedures.
 - This test should be performed on a flat level area.
 - Check the height measurements, in inches, from the height sensor(s) of the LWP using blocks of known heights. At a minimum, two base plate and three varying measurement plate (typically 0.25, 0.5 and 1") readings will be needed. The absolute difference should be less than or equal to 0.01 inch for each gauge block.
 - If the tests fail to meet these requirements, the LWP will be deemed to be not certified and prohibited from use on PennDOT projects until it is recertified.
 - A printed copy of the laser height verification results must be submitted to the PennDOT representative.
- ✓ Accelerometer verification must be performed in accordance with the manufacturer's recommended procedures. The tolerance for the accelerometer verification must meet the manufacturer's requirements.
- ✓ Vertical verification (bounce test) must be performed in accordance with AASHTO R 57-14 or manufacturer's equivalent.
 - With the base plates in position simultaneously under both wheel path sensors, place the LWP in an operating mode that simulates longitudinal movement and initiate profile data collection. Allow the profiler to collect a minimum of 828 feet (includes 300-foot lead-in) of static profile with the LWP as motionless as possible.
 - Sensor(s) should be moved vertically for a total displacement of approximately 1 to 2 inches keeping the sensors as close to perpendicular to the surface as possible during this movement. The bouncing must continue until a minimum of 528 feet of simulated distance has been traveled.
 - After a minimum of 528 feet of bounce profile is collected, allow the profiler to collect an additional minimum of 828 feet (includes 300-foot lead-out) of static profile with the LWP as motionless as possible.
 - The first and last (static) 528 feet segments shall not exceed 3 inches per mile, while the IRI for the middle (bouncing) segment shall not exceed 8 inches per mile for the bounce test. If the computed IRI values exceed 3 inches per mile for the static test and/or exceed 8 inches per mile for the bounce test, then the manufacturer's recommendations for performing sensor operational checks shall be followed. The static bounce test shall be repeated.
 - A printed copy of the bounce test results must be submitted to the PennDOT representative.
- ✓ Check that distance sensor calibration procedures are performed, and that the calibration is verified with at least 1 pass. 5' per mile (1' per 1056') accuracy is required.
 - If the LWP's distance measuring subsystem fails to measure the length of the test section to within 0.1 percent of its actual length, the calibration shall be adjusted per the manufacturer's guidelines and the longitudinal verification repeated.

- No more than one single certified operator is to occupy the profiler during verification/calibration.
 - If the LWP fails to meet these requirements, the LWP will be deemed to be not certified and prohibited from use on PennDOT projects until it is recertified.
 - A printed copy of the distance calibration must be submitted to the PennDOT representative.
- ✓ Instruct the operator that pavement profile and roughness data must be collected, processed and submitted for five passes for both wheel paths for each 528' test section, and that no more than 8 passes may be made. If targets are to be used during testing, instruct the operators that they are responsible for the placement.
 - ✓ Collect the necessary raw (unfiltered) binary data files.
 - The operator will provide a USB flash drive or CD that contains the raw (unfiltered) binary data for each wheel path. Each pass shall be clearly labeled to include surface type, lot number, and wheel path.
 - The operator will provide a USB flash drive or CD that contains the raw (unfiltered) ERD or PPF files.
 - ✓ Collect the necessary hardcopy reports.
 - Printouts must be collected for each wheel path.
 - As a minimum, the printed reports must include the parameters outlined in #3 of the Acceptance section (p.12). One of the printed reports must include an extended header.
 - The light weight profiler must be capable of printing the stored data upon operator request.
 - ✓ Check that all required information is provided on the printouts.
 - ✓ Check that the high-pass filter length is set to 100'.
 - ✓ Check the resultant precision of the device, based on each submitted pass (minimum of 5) for each baseline.
 - ✓ Check the resultant bias of the device, based on each submitted pass (minimum of 5) for each baseline.
 - ✓ Check that the operator is competent and generally capable in the device operation, data processing and other associated tasks.
 - ✓ If all checks meet requirements, complete and apply a calibration verification decal to the device. If the device is equipped with two sensors, and both sensors meet requirements, denote the decal as such. If only the right sensor meets requirements, denote the decal as a 1 sensor system. If the right sensor does not meet requirements, do not approve the device and apply no decal.
 - ✓ If all checks meet requirements and payment is confirmed, issue a permanent operator certification card.
 - ✓ Repeat the complete process for additional operators.
 - ✓ Confirm credit card payment receipt or collect a check, made payable to: "COMMONWEALTH OF PENNSYLVANIA" with the provided invoice number and the proper amount. If payment is not made at the time of verification/certification, inform the operator(s) that that a 30-day temporary operator certification card will be issued and a permanent certification card will not be issued until payment is received. If the device is not approved, inform the operator(s) that recertification will not be performed without prior payment.
 - ✓ If a previously approved device does not meet all requirements, remove the decal.

CUSTOMER INFORMATION FORM

Date: _____

Company/Agency Name: _____ Company Phone: _____

Company Address: _____ Company Contact: _____

_____ Company Email: _____

The above information will be made public at:
<http://www.penndot.gov/ProjectAndPrograms/ResearchandTesting/RoadwayManagementandTesting>

Operator 1 Name: _____

Address: _____

Phone: _____ Cell: _____

E-mail: _____

Send Operator Card To: Home or Office

Certified: Yes _____ No _____

Comments: _____

Operator 2 Name: _____

Address: _____

Phone: _____ Cell: _____

E-mail: _____

Send Operator Card To: Home or Office

Certified: Yes _____ No _____

Comments: _____

Operator 3 Name: _____

Address: _____

Phone: _____ Cell: _____

E-mail: _____

Send Operator Card To: Home or Office

Certified: Yes _____ No _____

Comments: _____

Operator 4 Name: _____

Address: _____

Phone: _____ Cell: _____

E-mail: _____

Send Operator Card To: Home or Office

Certified: Yes _____ No _____

Comments: _____

OFFICIAL USE

LWP Device Type: _____ PennDOT LWP ID Number: _____

Profiler Software Version: _____ Analysis Software Version: _____

SN#1: _____ SN#2: _____ Verified: Yes _____ No _____

Comments: _____

Accelerometer Calibration Block Check Bounce Check Distance Calibration