

**2022 MnDOT Inertial Profiler Certification Program**  
**1/27/2022**

**1. Introduction**

Inertial Profilers (IP) shall be certified, as required by the contract, before evaluating final mainline smoothness on MnDOT bituminous or concrete paving projects.

The International Roughness Index (IRI) is used for smoothness measurement of pavement surfaces. The segment Mean Roughness Index (MRI)—an average of left and right wheel path IRI values—is used to determine pavement smoothness pay adjustments. IRI shall be calculated according to ASTM E 1926-98 (Reapproved 2003) Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements.

Certification does not eliminate the need for daily calibration of the IP on the project.

For purposes of this certification, an IP is defined as a device that uses accelerometers, height sensors, and a distance measuring instrument to measure pavement smoothness. All IP must be equipped with a minimum of two height sensors and be capable of simultaneously collecting profile data in both the left and right wheel paths. Moreover, all IP must be capable of producing Keyhole Markup Language (KML) files. These GPS files consist of the geographic location of the pavement surface data collected by an IP.

For purposes of this certification, the calculation of distance, IRI, and cross-correlation values for all the test sections shall constitute one test. Any IP that requires a retest shall repeat the entire certification procedure.

Due to the high volume of IP that are tested each year, certifications are restricted to devices with scheduled or anticipated work in MN during the calendar year. Companies may have up to three IP tested for certification without a charge. Additional IP testing beyond three per company shall be charged \$1,000.00 per initial certification test. Checks shall be made payable to: Commissioner of Transportation. Checks shall be due prior to having a fourth device tested.

The preferred method of check delivery is to submit payment to the MnDOT representative conducting the certification at the test site. An alternate method of check delivery is to mail payment to:

Glenn Engstrom  
Director  
Minnesota Department of Transportation  
Office of Materials and Road Research  
1400 Gervais Avenue  
Maplewood, MN 55109

## 2. Associated Documents and Requirements

- Minnesota Standard Specifications for Construction
- Specification – 2399 Pavement Surface Smoothness
- Class I requirements of ASTM E950
- AASHTO R56-14: Standard Practice for Certification of Inertial Profiling Systems

## 3. General Information/Expectations

The Inertial Profiler Certification Program is not a training program. **It is expected that all participating operators be well-versed in the operation of their IP.** MnDOT staff will serve as technical experts, and may provide guidance during the certification process, but will not be responsible or accountable for the training of IP operators.

MnDOT staff will not make any corrections or modifications to devices. It is not the role of MnDOT to repair, maintain, or calibrate IP. If repairs or modifications are necessary, the owner/operator of the device must contact the manufacturer. MnDOT will not initiate contact with any manufacturer on behalf of an IP owner/operator.

The owner/operator of the IP will be responsible for transporting the device to the certification site and assuring the device is in proper working condition. The owner/operator of the IP is responsible for having the machine in proper working order at the test site.

The owner/operator of the IP shall make all repairs and adjustments as needed before taking measurements at the test site. The owner/operator of the IP shall have all tools and components necessary to adjust and operate the IP according to the manufacturer's instructions and recommendations. All equipment manufacturer specifications and manuals must accompany the IP to be certified.

## 4. Scheduling

MnDOT will designate three weeks, in the spring of each year, to conduct the Inertial Profiler Certification Program. MnDOT will attempt to provide the dates of certification testing to all contractors with an IP. However, it is the responsibility of the owner/operator of the IP to contact MnDOT for scheduling.

## 5. Site Location

Certification testing will take place at the MnROAD research facility near Albertville, Minnesota. When arriving for a scheduled certification appointment, please report to the main building. A MnDOT employee must be present as an escort during the entire visit to the MnDOT facility.

## 6. DMI and Smoothness Test Sections

MnDOT will establish, designate, and maintain a section 1,000 feet in length to use for Distance Measuring Instrument (DMI) testing. The DMI test section will include ample lead-in distance to

ensure the IP can safely attain the desired data collection speed and lead-out distance to allow the IP to safely and gradually slow to a halt.

Two additional test sections, each at least 528 feet in length, will be established, designated, and maintained by MnDOT for the purpose of verifying the IP's pavement surface smoothness data. MnDOT will determine daily IRI values for the smoothness test sections. The results of MnDOT's International Cybernetics SurPRO Profiler will serve as the baseline for the test sections' IRI values.

Due to frequent reconstruction of MnROAD test cells, some years it might not be possible to evaluate IP on two test sections. If reconstruction precludes the use of two test sections, one test section will be used for the entirety of that year's certification program.

Cones and/or other appropriate material will be used to define the start and end locations of all test sections.

MnDOT will assure that the intended test paths are clear of loose material and foreign objects.

## **7. Software Settings**

The operator of the IP must set the high- and low-pass filters to "zero" or "none." Additional settings should be set according to equipment manufacturer specifications. Once an IP is certified, its settings will be recorded and posted to MnDOT's Smoothness Program webpage: [www.dot.state.mn.us/materials/smoothness.html](http://www.dot.state.mn.us/materials/smoothness.html). The operator of a certified IP must use the same software settings on MnDOT projects that were used during the Inertial Profiler Certification Program.

## **8. Height Sensor Identification**

Each of the IP's height sensors must possess a unique identification number that is prominently displayed on the box in which the sensor is housed.

## **9. Data Collection**

IP operators are required to perform all necessary start-up procedures as specified by the manufacturer.

All IP must be equipped with an auto-start, auto-stop feature. Any hardware needed to activate/deactivate the IP's auto-start, auto-stop mechanism (such as cones and/or reflective tape) shall be supplied by the IP operator.

All IP must be equipped with a GPS or wheel-mounted DMI. Three runs must be made at the lowest and highest speeds that the IP will collect smoothness data. At the end of each run, the deviation from the actual distance will be measured. In order for the IP to be certified, the mean absolute deviation from the actual distance must not exceed 0.15% (zero point one five percent).

The actual length of the test sections will be determined using a steel tape and verified with MnDOT's reference profiler.

Five pavement runs must be made on each test section at the maximum desired certification speed; another five runs must be made on each test section at the minimum desired certification speed. If the maximum desired certification speed is the same as the minimum desired certification speed, five runs will be made per test section. During each run, data must be collected simultaneously in both the left and right wheel paths.

IP data must be collected on all test sections.

For each required pass, the operator of the IP shall perform the following:

- Position the IP at a location from which testing speed can be reached before data collection commences.
- Check that all software and hardware are ready to collect data.
- Activate the IP far enough in advance of the beginning of the test section to ensure proper collection of the required data.
- Collect data throughout the test section, maintaining a uniform speed.
- Deactivate the IP far enough beyond the end of the test section to ensure proper data collection.

## 10. Acceptance Criteria

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

Test values shall be reported to one digit right of the decimal in accordance with conventional rounding procedures.

IRI shall be calculated using a quarter-car simulation as outlined in NCHRP Report 228.

Provide a USB flash drive with **unfiltered** longitudinal profiles in PPF format for all the certification runs. Each file shall be clearly labeled so that MnDOT personnel can easily analyze the data.

For each test section, in each wheel path, all the IP's longitudinal runs will be compared against the corresponding reference profile to verify statistical validity and against one another to verify statistical reliability.

For each wheel path in each test section, the IP's mean IRI value must be within 5% (five percent) of the reference IRI value. The mean of all the contractor-vs.-agency correlations must be at least 90% (ninety percent). In addition, the mean of all the contractor-vs.-contractor correlations must be at least 92% (ninety-two percent).

All statistical comparisons will be performed by MnDOT using the FHWA's Profile Viewing and Analysis (ProVAL) software, with a 250-mm filter applied to IP data, but not applied to reference

profile data. For contractor-vs.-agency cross-correlation analyses, the reference profile will be set as the “basis.”

## **11. Required Minimum Test Data Reporting**

At a minimum, the following information must be printed in either the header or footer of each run’s summary printout.

- 1) Date and time
- 2) Operator identification
- 3) Height sensor identification
- 4) Test section description
- 5) Unique run number
- 6) Software name and version
- 7) Profiler settings: high- and low-pass filters, accelerometer constants, etc.
- 8) IRI and MRI values

All required data must be submitted to a MnDOT representative at MnROAD before exiting the facility.

## **12. Results from MnDOT**

MnDOT will provide the operator of the IP with results on the day of the certification test. For passing devices, an official certification letter will be sent to the owner/operator of the IP at a later date.

## **13. Decals**

IP with acceptable test results will be furnished a 2022 Inertial Profiler Certification decal for each of its passing height sensors. The date of acceptance, sensor identification number, vehicle identification number, device manufacturer, operational system software version, and signature of a MnDOT representative will be denoted on the decal. The decal shall be affixed to the corresponding height sensor box by a MnDOT representative. Removal of the decal by the IP operator/owner will result in decertification of the device.

If, for any reason, the IP is recertified during the same year, updated decals will be issued. If, for any reason, an IP certification is revoked, the decals shall be removed by MnDOT.

## **14. Software Changes**

**The owner/operator of a certified IP must report any software changes within seven days of the change to Tom Nordstrom, Pavement Research Scientist (612-346-9195).**

If a change in software affects raw data collection, the IP will be decertified.

If a change in software affects IRI computation, but not raw data collection, new IRI values shall be computed with the new version of the software. If the recomputed IRI values satisfy the Acceptance Criteria, the certified IP will remain certified, but be issued new decals that contain the updated software version. If the recomputed IRI values do not satisfy the Acceptance Criteria, the certified IP will be decertified.

Before use on a MnDOT project, all decertified IP must be recertified at MnROAD.

## **15. Major Component Failure**

The major components of an IP include, but are not limited to, the accelerometer and its associated hardware, the height sensor and its associated hardware, and any printed circuit board necessary for the collection of raw sensor data or the processing of profiles.

If a major component of an IP fails, repairs/replacements must be completed before any further profiling is allowed.

If a major component is repaired/replaced during a MnDOT project, the Project Engineer will decide if a formal MnROAD recertification is required or if it is acceptable to temporarily allow the IP to continue data collection on the project.

Recognizing that there may not be adequate time to schedule a formal MnROAD recertification in the event of a major component repair/replacement, it is recommended that a 528-foot test strip with no traffic be set up at the onset of all projects. It is recommended that the test strip be located adjacent to the project; however, if this is not possible, another location that is acceptable to the Project Engineer may be designated.

The same IP that is planned for use on the project shall collect profile data on the test strip. Prior to any profiling on the project, the Project Engineer shall be given a summary printout containing a composite MRI value for the test strip.

If a major component of an IP is repaired/replaced during the project, the test strip shall be rerun by the same IP. In order to continue using the IP on the project, the rerun composite MRI value must be within 5% (five percent) of the initial recorded value.

Before use on any subsequent MnDOT projects, all IP that experience a major component failure or undergo major component repairs/replacements must be recertified at MnROAD.

## **16. Certification Follow-Up**

Each certified IP shall undergo a mid-season, side-by-side comparison with a MnDOT high speed IP. This comparison shall be conducted on a current MnDOT construction project on which the contractor IP will collect profile data or at an alternate site such as MnROAD. A test section, between 500 and 1,000 feet in length, shall be designated by MnDOT. In order to pass the side-by-side comparison, the contractor IP's left wheel path and right wheel path IRI values must be within

10% (ten percent) of those of the MnDOT high speed. Any IP that fails to meet this criterion, will be decertified by MnDOT and required to pass a certification retest at MnROAD.

### **17. Length of Certification**

Regardless of when an IP is certified, the certification will be valid only for the remainder of the same calendar year.

### **18. Records**

MnDOT will maintain records of the results of the certification program. The owner, unique identification number, make of device, software version, and the date of acceptance or failure will be included in these records.

### **19. Department Contacts**

The Inertial Profiler Certification Program is directed and administered by the Minnesota Department of Transportation, Office of Materials and Road Research, Maplewood, Minnesota.

To request additional information on this program or to schedule an IP certification testing date, contact Tom Nordstrom, Pavement Research Scientist (612-346-9195), or Rob Golish, Assistant Concrete Engineer (651-366-5576).