

Inertial Profiler Certification: 17 Years of Experience

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Acknowledgement

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Matthew Turo	MassDOT (Deceased)

Outline

- Background
- Certification Site Selection
- Certification Site
- Certification Site Layout
- Certification Procedure
- Certification Requirements
- Reference Device
- Inertial Profilers
- Lessons Learned
- Future Steps

Background

- The first certification in Massachusetts was conducted in 2006.
- Inertial profiler measurements are required for Quality Assurance (QA) projects.
- Profile measurements collected by the paving contractor & MassDOT are compared.
- Certification of contractor & MassDOT devices are used to verify accuracy and repeatability of all inertial profiling devices.

Certification Site Selection

Critical factors in the site selection process:

- ✓ Access and traffic control capabilities
- ✓ Pavement type & condition (roughness)
- ✓ Geometry (grade, curvature)
- ✓ Adequate length for test sections per AASHTO R56 specifications including lead-in & deceleration zones
- ✓ Area for a separate Distance Measuring Instrument (DMI) check site

Certification Site (2006 - 2022)

Located at the New Bedford Regional Airport on Taxiway Bravo

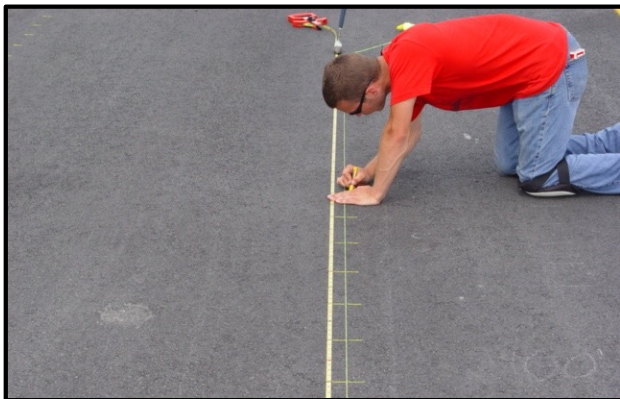


- Two certification test sections (smooth & medium-smooth)
- Each test section 528 ft in length per AASHTO R56
- Separate DMI check sites located on an adjacent municipal roadway

Certification Site Layout



- Two wheel paths per section, each located approximately 70 inches apart.
- Each wheel path was surveyed in 50-foot increments and marked with a PK nail.
- Paint dots every 9.5 inches along the section length.



Certification Site (2006 - 2022)



Certification Site (2006 - 2022)

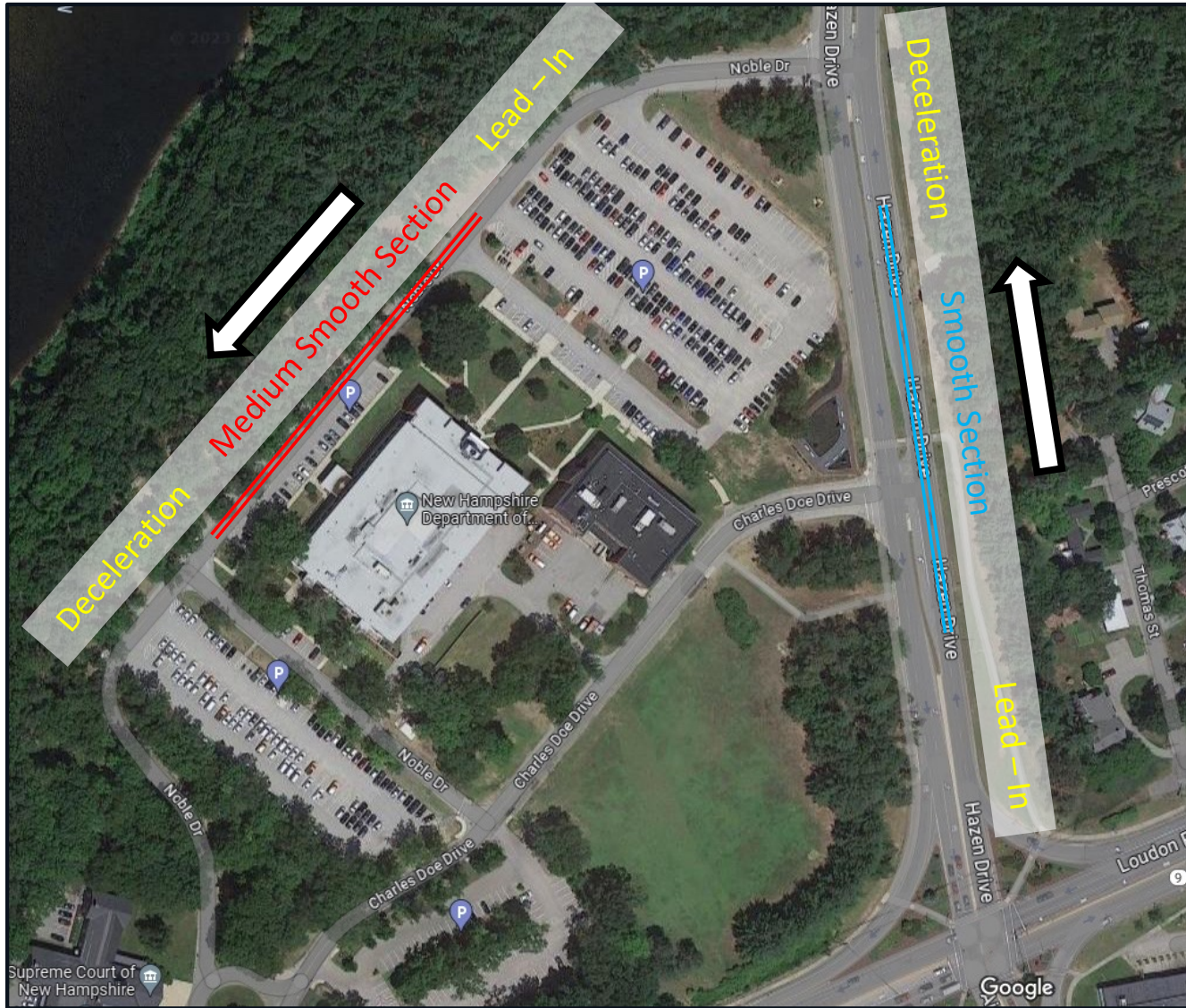


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NHDOT Certification Site (2023)



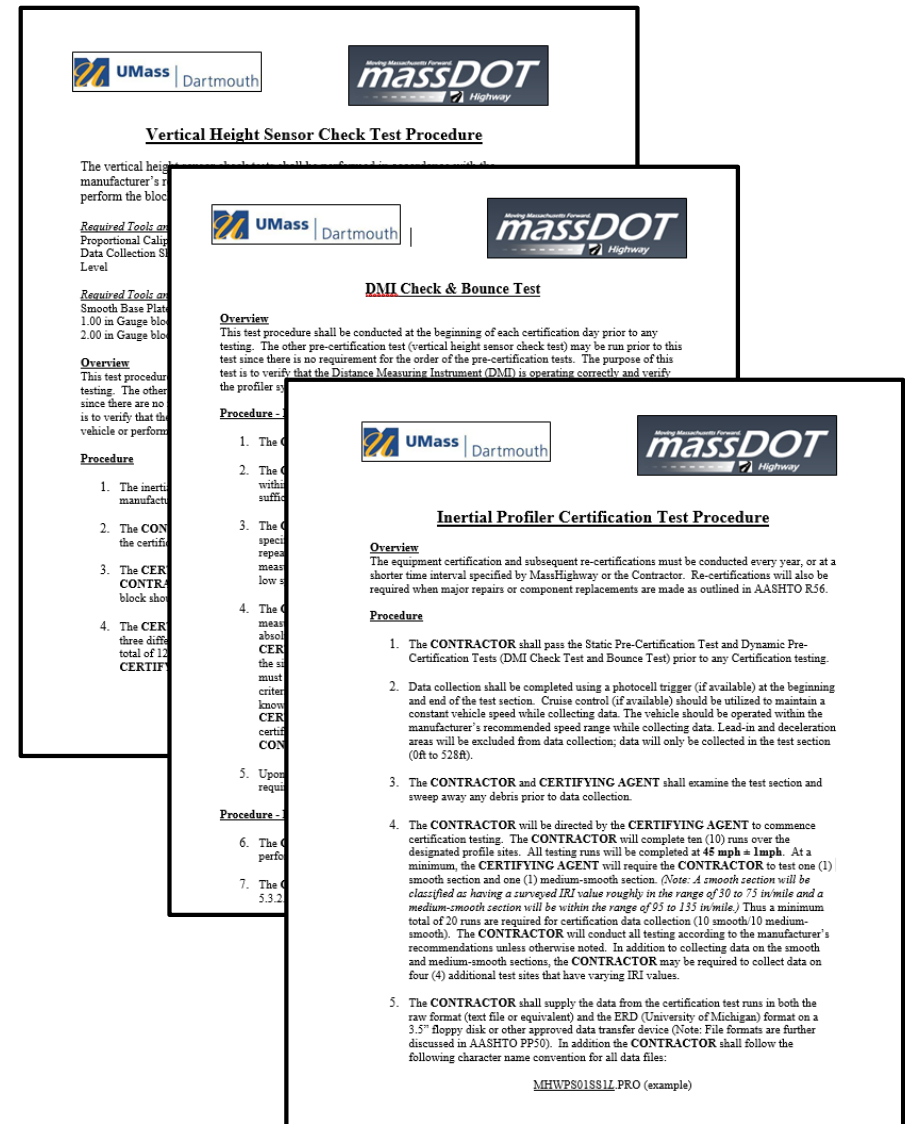
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Certification Procedure

- Developed based on AASHTO PP49 (Now AASHTO R56)
- Pre-certification tests include vertical sensor check (block test), DMI check test, and bounce test.
- Certification data analyzed to determine computed ride statistics (International Roughness Index or IRI), equipment repeatability, and equipment accuracy to reference device.
- Cross-correlation used for repeatability and accuracy using FHWA recommended ProVAL software.



Certification Testing

- Only profilers passing all pre-certification tests are allowed to participate in certification testing
- 10 repeat runs on smooth section
- 10 repeat runs on medium-smooth section
- Data collection speed approximately 45 mph
- Photocell triggers for data acquisition at the beginning & end of each section (0 ft. to 528 ft.)

Certification Requirements

Pre-certification Tests

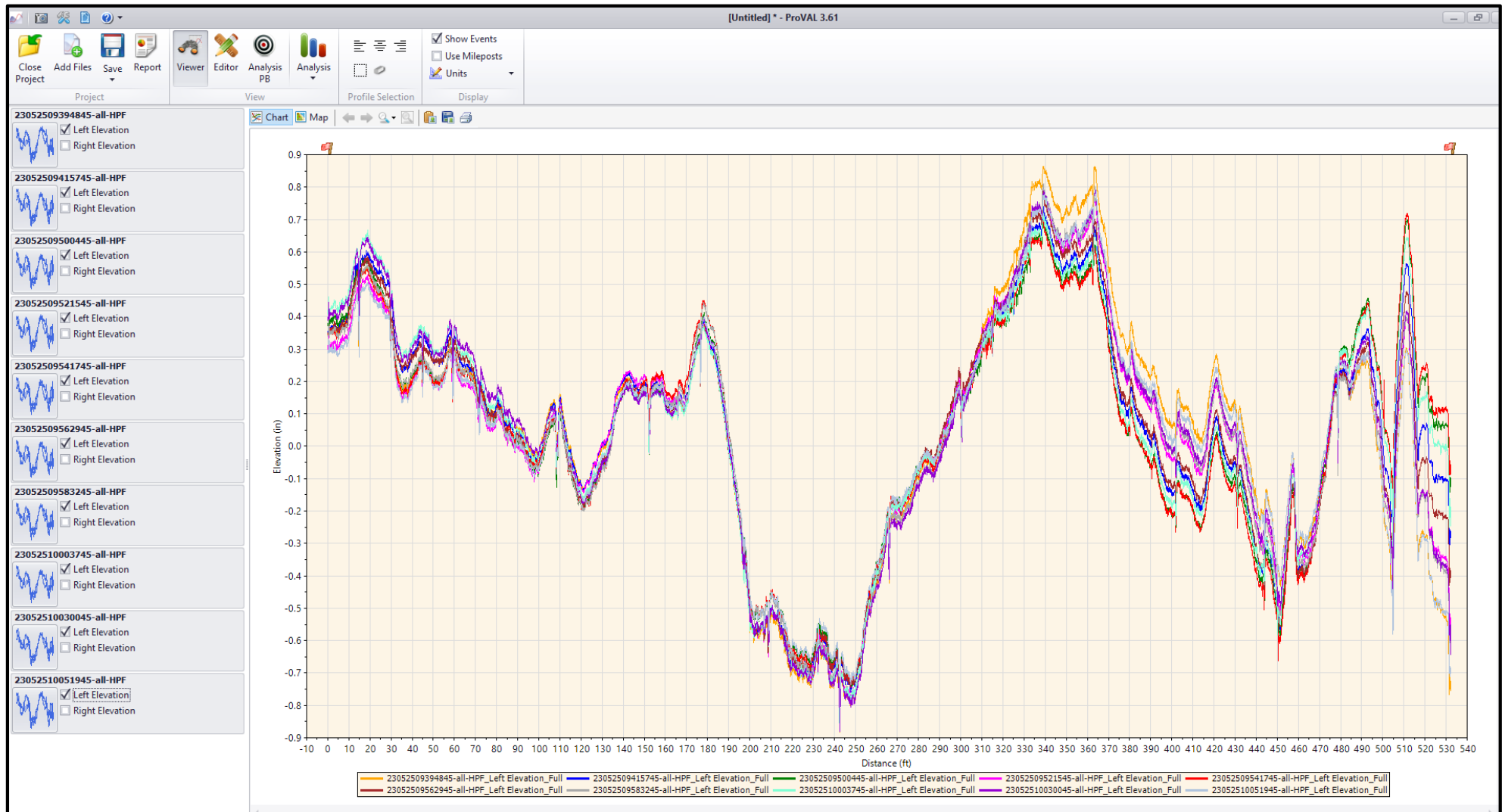
- ❑ Inertial profiler must pass all pre-certification tests (block test, DMI check test, and bounce test) prior to collecting certification data.
-

Certification Data Analysis

Based on 10 runs of certification data collected for each site:

- ❑ The absolute difference in IRI value between the reference device and the mean value of the 10 runs obtained by the inertial profiler must be within ± 6 in/mile
- ❑ For equipment repeatability, an average cross-correlation “score” $\geq 90\%$ between the 10 inertial profiler runs
- ❑ For equipment accuracy, an average cross-correlation “score” $\geq 80\%$ for the 10 inertial profiler runs as compared to the profile collected by the reference device

Cross-Correlation in ProVAL



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Cross-Correlation in ProVAL - PCM

Hazen_SURPRO REF Profiles * - ProVAL 3.61

Close Project | Add Files | Save | Report | Viewer | Editor | Analysis PCM | Analysis | Profile Selection | Display | Units | Template

Profiler Certification: Inputs

Analyze | Navigate

File	Profiles	Basis	Run	Sample Interval (in)
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run05 T1_T2	Left + Right	<input type="checkbox"/>	10	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run07 T1_T2	Left + Right	<input type="checkbox"/>	9	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run08 T1_T2	Left + Right	<input type="checkbox"/>	8	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run09 T1_T2	Left + Right	<input type="checkbox"/>	7	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run10 T1_T2	Left + Right	<input type="checkbox"/>	6	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run11 T1_T2	Left + Right	<input type="checkbox"/>	5	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run14 T1_T2	Left + Right	<input type="checkbox"/>	4	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run15 T1_T2	Left + Right	<input type="checkbox"/>	3	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run16 T1_T2	Left + Right	<input type="checkbox"/>	2	1.00
<input checked="" type="checkbox"/> 20230525_MassDOT_Site 2_Run17 T1_T2	Left + Right	<input type="checkbox"/>	1	1.00
<input checked="" type="checkbox"/> HAZEN_LWP_002	Left	<input checked="" type="checkbox"/>		0.25
<input checked="" type="checkbox"/> HAZEN_RWP_001	Right	<input checked="" type="checkbox"/>		0.25

Cross-Correlation in ProVAL - PCM

Hazen_SURPRO REF Profiles * - ProVAL 3.61

Close Add Files Save Report Viewer Editor Analysis PCM Analysis Profile Selection Display Analysis

Project View Profile Selection Display Analysis

Statistics

Statistic	Repeatability - Left	Repeatability - Right	Accuracy - Left	Accuracy - Right
Comparison Count	45	45	10	10
% Passing	100.00	100.00	100.00	100.00
Mean	98.79	98.25	93.02	90.91
Minimum	97.29	95.79	91.74	87.42
Maximum	99.56	99.66	94.48	92.63
Standard Deviation	0.5	1.0	0.8	1.5
Grade	Passed	Passed	Passed	Passed

Accuracy			Repeatability - Left Correlations (%)										Repeatability - Left Offsets (ft)										Repeatability - Right Correlations (%)										Repeatability - Right Offsets (ft)									
Run	Left	Right	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10	Run	2	3	4	5	6	7	8	9	10
1	92.12	90.75	1	98.98	99.14	98.87	98.99	98.63	98.95	98.27	98.18	99.01	1	0.0	0.0	0.1	-0.1	0.0	0.0	-0.2	0.0	0.0	1	99.05	98.20	98.81	98.88	97.48	99.08	98.12	99.18	98.88	1	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	0.0	0.0
2	92.15	91.28	2	99.27	99.25	98.91	98.33	99.44	99.07	98.39	99.40		2	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.2	-0.1	0.0	2	98.81	98.41	98.68	96.52	99.66	98.80	98.73	98.17	2	0.0	0.0	0.0	-0.1	0.0	0.0	-0.2	-0.1	0.0	
3	91.74	92.63	3			98.68	98.54	98.10	99.24	98.78	98.16	99.02	3			0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	3			97.19	97.41	95.79	98.74	99.07	97.70	97.29	3			0.0	-0.1	0.0	0.0	-0.2	-0.1	0.0
4	93.10	90.26	4				98.99	98.31	99.41	98.81	98.81	99.48	4				-0.1	0.0	-0.1	-0.2	-0.1	-0.1	4			99.30	97.56	98.43	97.37	99.11	99.53	4				-0.1	0.0	0.0	-0.2	0.0	0.0	
5	93.48	90.78	5					99.00	98.80	98.68	98.18	99.02	5					0.1	0.1	-0.1	0.1	0.1	5				97.21	98.80	98.01	99.40	99.06	5					0.1	0.1	-0.1	0.0	0.1	
6	94.48	87.42	6						98.30	98.30	97.29	98.79	6						0.0	-0.2	0.0	0.0	6				96.60	96.13	96.66	98.43	6						0.0	-0.1	0.0	0.0		
7	92.74	91.92	7							99.11	98.77	99.56	7							-0.1	0.0	0.0	7					99.01	99.01	98.42	7							-0.1	0.0	0.0		
8	93.45	92.49	8								98.42	99.18	8								0.1	0.2	8						98.16	97.57	8								0.1	0.1		
9	93.63	91.46	9									98.70	9									0.0	9																	0.0		
10	93.35	90.12																																								

Reference Device



Walking Profiler (2006)



SurPRO (2007 - Present)

Inertial Profilers

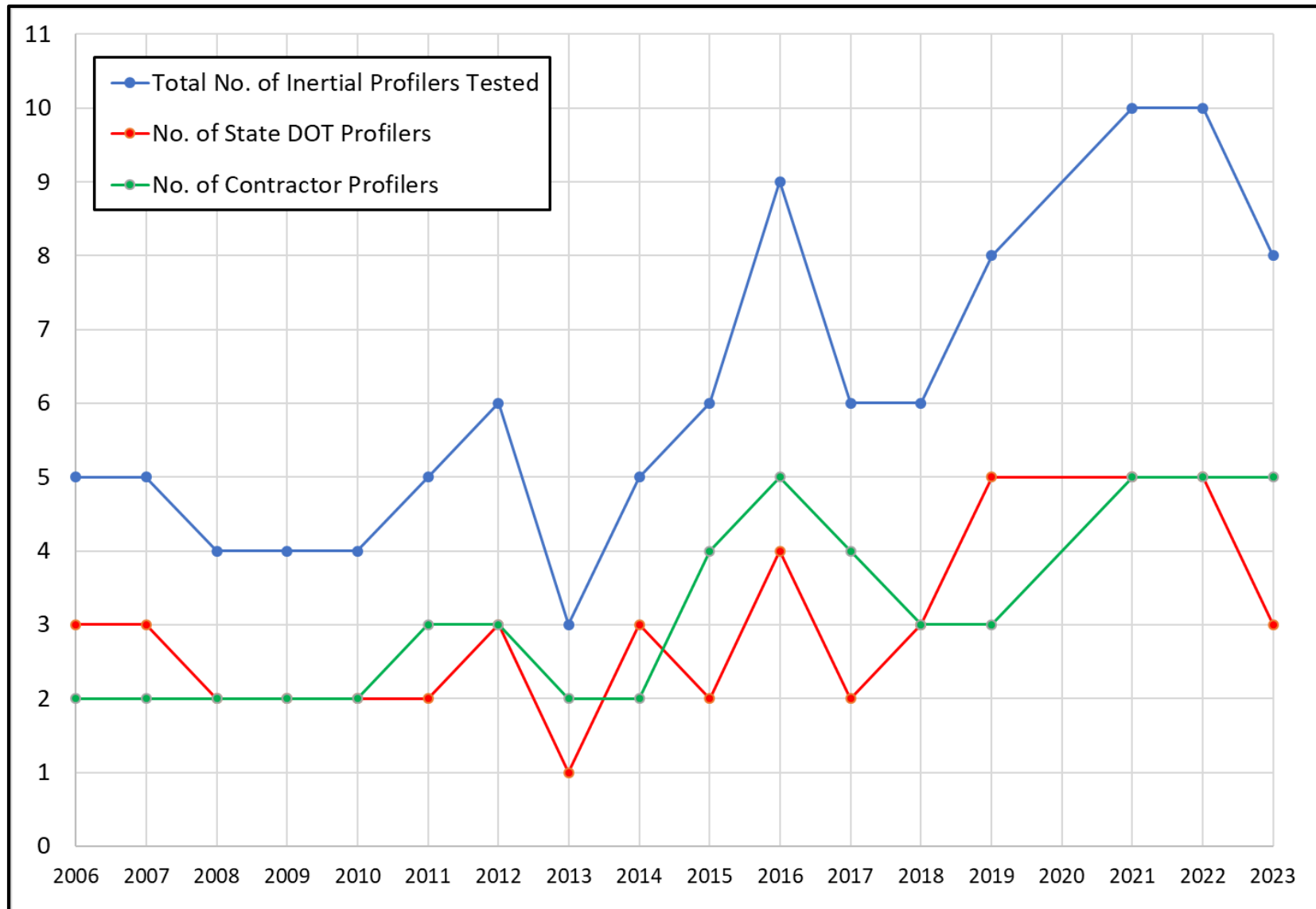


Project Level
(Bumper Mounted)

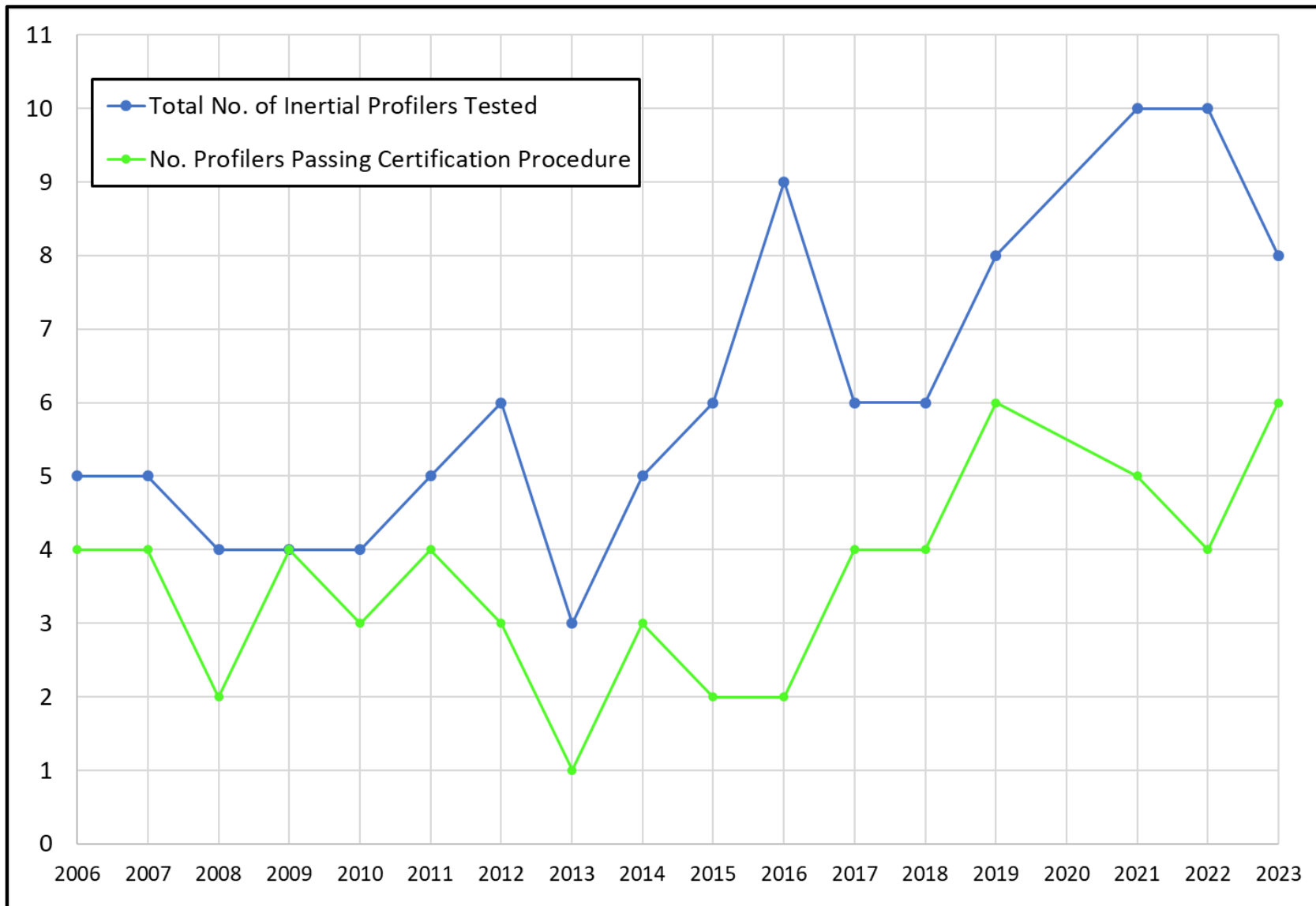


Network Level

Number of Inertial Profilers Tested



Number of Inertial Profilers Passing



Lessons Learned

- Limited access to certification sites, limited time on the sites, traffic, and needing FAA tower approval to use sites all posed significant challenges in efficiently conducting certification operations. A stand-alone site with greater access is recommended.



Lessons Learned

- Certification procedure does not currently include operator certification. This is being investigated as gaps in operator understanding of data reduction and analysis has been noted.
- Typically multiple data collection attempts (re-tests) were required to pass certification, especially for novice participants in the certification process.
- Collection of reference profiles on the day of certification led to better cross-correlation agreement with inertial profilers for the equipment accuracy determination.

Lessons Learned

- Roughness of the sites increased with time, so correspondingly maintenance and reconstruction must be considered to maintain roughness in accordance with AASHTO R56 recommended levels.

	Driver's Side Wheel Path IRI		Passenger's Side Wheel Path IRI	
	2006	2022	2006	2022
Smooth Site	74.7	96.9	74.5	94.4
Medium-Smooth Site	93.8	102.1	77.9	105.8

IRI values in in/mile

Lessons Learned

- Unfiltered profiles are needed for determining equipment accuracy. These unfiltered profiles are combined with the unfiltered reference device profile and then filtered using the same IRI filter within ProVAL. This helps eliminate any errors do the use of different filters.

Future Steps

- MassDOT is currently searching for a new location to set up certification sites for 2024.
- MassDOT acquired a SurPRO 5000 to use as a reference device for certification.

Thank you



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