Guide to LTPP Profiler Comparison Resource

November 2014

U.S. Department of Transportation
Federal Highway Administration

LTPP Team
Office of Infrastructure R&D

TABLE OF CONTENTS

LTPP PROFILER COMPARISON STUDIES

Profile data collection on LTPP test sections is performed by four Regional Support Contractors (RSCs). Inertial profilers are operated by the RSC to measure longitudinal pavement profile at test sections and weigh-in-motion (WIM) sites within their geographical regions. The profile measurement equipment was purchased by the LTPP program in batches to reduce equipment variability.

Over time, the LTPP program has changed the profile measurement equipment due to equipment fatigue and to keep up with technological advancements. From 1989 until 1996, LTPP operated DNC 690D inertial profilers with incandescent height sensors manufactured by K.J. Law Engineers. In late 1996, LTPP purchased K. J. Law model T-6600 inertial profilers with infrared height sensors. In September 2002, LTPP purchased International Cybernetics Corporation (ICC) MDR 4086L3 inertial profilers with laser height sensors. In 2013 LTPP took delivery of four Ames Engineering, Inc. profilers with laser height sensors.

Comparison studies of these profilers have been conducted at regular intervals. For each study, multiple test sections were established and reference profile elevation measurements in each wheel path performed using a manually operated Dipstick manufactured by the Face Company. Repeat measurements were then performed on the test sections by the inertial profilers. The primary method for checking if the profilers were functioning accurately was to compare the IRI values computed from Dipstick data with the values computed from the data obtained from the profilers. The repeatability of the profilers was evaluated by analyzing the standard deviations of the IRI from the repeat runs. Since 1998, the measured profile elevations were also evaluated to assess profiler repeatability and reproducibility.

Whenever FHWA purchased new profilers, these devices underwent rigorous testing to ensure that they met the requirements that were specified in the contract documents. After each RSC took delivery of a new profiler, a comparison of the new profiler and the old profiler was performed in each region prior to collecting data with the new profiler. The purpose of these verification tests was to compare the measurement output between old and new profilers.

Table 1 provides a listing of the LTPP profiler comparison studies by test year, location, profilers evaluated, and availability of data and evaluation report in this package.

The following portions of this document describe each LTPP profiler comparison study and provide details of the data and report contained in this package.

Table 1. List of LTPP Profiler Comparison Studies

Year	Location	Profile Devices*							Available?	
		690D	T6600	MDR L3	Ames	DS	R&L	SP	Data	Report
1990	Austin, TX	X				X			No	No
1991	Ann Arbor, MI	X				X			No	Yes
1992	Ames, IA	X				X	X		Yes	Yes
1996	LTPP Regions	X	X			X			Yes	Yes
1998	Urbana, IL		X			X			Yes	Yes
2000	College Station, TX		X						Yes	Yes
2002	LTPP Regions		X	X					Yes	Yes
2003	MnROAD, MN		X	X		X			Yes	Yes
2007	MnROAD, MN		X	X		X			Yes	Yes
2010	MnROAD, MN			X		X		X	Yes	Yes
2013	LTPP Regions			X	X				Yes	Yes

*690D identifies the DNC 690D profilometers. T6600 identifies the T-6600 profilometers. MDR L3 identifies the MDR 4086L3 profilers. Ames identifies the Ames profilers. DS identifies data collected by the Dipstick. R&L identifies data collected using the rod and level, or elevation survey. SP identifies data collected using the SurPRO rolling profiler.

1990 PROFILER COMPARISON

This comparison was conducted by the SHRP P-001 contractor when LTPP was administered by the National Academy of Sciences. The data and report from this study are not available at this time.

1991 PROFILER COMPARISON

The 1991 comparison study between the four LTPP profilers was held in Ann Arbor, Michigan. Each profiler was used to collect data on a total of eight test sections. These eight sections include four asphalt-surfaced sections and four portland cement concrete-surfaced sections. The profilers were operated at two speeds, 64 and 80 km/hr, for data collection.

For this study, only the report is available. The report is stored under the report subdirectory.

1992 PROFILER COMPARISON

The comparison study between the four LTPP profilers held in 1992 was located in Ames, Iowa. Eight test sections were established for this comparison study. Each profiler tested each test section at two speeds, 64 and 80 km/h. Dipstick measurements as well as rod and level measurements were obtained at each test section.

Subdirectories and File Naming Convention

Report

The report documenting the test procedures and results from the testing is included in this subdirectory.

Dipstick

The subdirectory 'Dipstick' contains the Dipstick data. The files are named according to the following file naming convention:

1992DSITE*AB*.ERD

Where,

- *A* Site number
- *B* Measurement set. At one site only one set of measurements was obtained. At six sites, two sets of measurements were obtained, while at one site four sets of measurements were obtained.

The data collected along the two wheelpaths at a test section are included in each file.

Rod & Level

The subdirectory 'Rod & Level' contains the rod and level data collected at the test sites. Rod and level data were collected at all sites, but at some sites data were collected only along one wheelpath. The files are named according to the following file naming convention:

RL*AB*.ERD

Where,

- *A* Site number
- *B* Test paths. L – left wheelpath data are contained in the file, R – right wheelpath data are contained in the file, B – data for both wheelpaths are contained in the file

N. Atlantic, N. Central, Southern, and Western

Each of these subdirectories contains the data collected by each regional profiler. The files are named according to the following file naming convention:

RRAB.ERD

Where,

RR	Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, and WE – Western
A	Site number
B	Run number. The profilers obtained multiple runs at a site, and this digit indicates the run number.

Each data file contains data collected along the left and right wheelpaths.

1996 REGIONAL PROFILER COMPARISONS

In 1996, the FHWA purchased four new K.J. Law T-6600 profilers to replace the K.J. Law DNC 690 profilers. After the regional contractors took delivery of the K.J. Law T-6600 profiler, each regional contractor performed a comparison between the DNC 690 profiler and the T-6600 profiler. Each regional contractor established four test sections to perform testing: a smooth asphalt section, a smooth concrete section, a rough asphalt section, and a rough concrete section. Dipstick measurements were performed at each of these sections. Profile data were collected at all sections using both the DNC 690 and the T-6600 profiler. Each profiler performed testing at two speeds, 64 and 80 km/h. At each section, three test sequences were performed, with each sequence being performed on a separate day. Each regional contractor prepared a report that described the results of the testing.

Subdirectories and File Naming Convention

Data for each region are contained in separate subdirectories. The following subdirectories are contained under each region.

Report

Each regional contractor prepared a report describing procedures followed during testing and results from the testing. The report is included in this subdirectory.

Dipstick

The Dipstick data are contained in this subdirectory. The files are named according to the following file naming convention:

*RR*DSITE*A*.ERD

Where,

RR	Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, and WE – Western
A	Site number, site numbers range from 1 to 4

These data files contain data collected along the left and right wheelpath.

DNC690

The data collected by the K.J. Law DNC 690 profiler are included in this subdirectory. This profiler collected data at 25.4-mm intervals and then applied a 304.8-mm moving average on the data and saved the data at 152.4-mm intervals. Hence the data in the files are at 152.4-mm intervals. The files are named according to the following file naming convention:

*RR*D*EFG*.ERD

Where,

RR	Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, and WE – Western
E	Site number, ranges from 1 to 4
F	Test sequence, A – First sequence, B – Second sequence, C – Third sequence
G	Run number. The profilers obtained multiple runs at a site and this digit indicates the run number.

This data file contains data collected along the left and the right wheelpath.

T6600_25mm

The 25-mm interval profile data collected by the K.J. Law T-6600 profiler are included in this subdirectory. The files are named according to the following file naming convention:

*RR*25T*EFG*.ERD

Where,

RR	Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, and WE – Western
E	Site number, ranges from 1 to 4

F	Test sequence, A – First sequence, B – Second sequence, C – Third sequence
G	Run number. The profilers obtained multiple runs at a site and this digit indicates the run number.

Note: 25-mm interval data for sites 1 and 2 are not available in the North Atlantic Region.

Each file has three data columns, with the first, second, and the third columns containing the data for the left wheelpath, center of the lane, and right wheelpath, respectively.

T6600_150mm

The ProQual processed 25-mm interval profile data collected by the K.J. Law T-6600 profiler are included in this subdirectory. ProQual is a program that is used in the LTPP program to process profile data. This program applies a 300-mm moving average to the 25-mm interval profile data and extracts data points at 150-mm intervals. Hence, the data in these files are at 150-mm intervals. The files are named according to the following file naming convention:

*RR*T*EFG*.ERD

Where,

RR	Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, and WE – Western
E	Site number, ranges from 1 to 4
F	Test sequence, A – First sequence, B – Second sequence, C – Third sequence
G	Run number. The profilers obtained multiple runs at a site and this digit indicates the run number.

Each data file has data for the left and the right wheelpaths.

1998 PROFILER COMPARISON

The 1998 comparison study between the four LTPP K.J. Law T-6600 profilers was held in Urbana, Illinois. Four test sections were established for this comparison study. Each profiler tested each test section at a speed of 80 km/h. Dipstick measurements were obtained at each test section.

Subdirectories and File Naming Convention

Data for each region are contained in separate subdirectories. The following subdirectories are contained under each region.

Report

The report documenting the test procedures and results from the testing is included in this subdirectory.

Dipstick

The subdirectory 'Dipstick' contains the Dipstick data. The files are named according to the following file naming convention:

1998DSITE*A*.ERD

Where,

A Site number

Each data file contains the data collected along the left and the right wheelpaths.

N. Atlantic, N. Central, Southern, and Western

The data collected by each regional contractor are contained in each of these subdirectories. There are two subdirectories under each regional contractor, 25 mm and 150 mm. The subdirectory 25 mm contains the 25-mm interval data collected by the profilers, while the subdirectory 150 mm contains the ProQual processed data files.

The following file naming convention was used for the data files:

RR#AB.ERD

Where,

RR Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, and WE – Western
The interval of the longitudinal profile data contained in the data file, 25 – for the 25-mm interval data and 150 for the ProQual processed data files
A Site number
B Run number. The profilers obtained multiple runs at a site, and this digit indicates the run number.

The 25-mm interval data are not available for: (1) site 3 for N. Central, N. Atlantic, and Western profilers, (2) site 2 for Southern profiler. Each ERD containing the 25-mm profile data includes data collected along the left wheelpath, right wheelpath, and center of the lane corresponding to the first, second, and third data columns contained in the files. The site 2 data files for the Western profiler also have data collected along three

paths, but the first, second, and the third data columns correspond to the left, center, and right wheelpath.

The 150-mm interval data are not available for the Southern profiler at site 2. The ERD files for the 150-mm interval data contain data collected along the left and right wheelpaths in the first and second columns, respectively.

2000 PROFILER COMPARISON

In 2000, a comparison test between the four K.J. Law T-6600 profilers was held at College Station, Texas. Five test sections were used in the comparison. The IRI values obtained from the data collected by the Australian Road Research Board (ARRB) walking profiler were available for two of the sections. However, the elevation data collected by the ARRB walking profiler at these two sections are not available. (Texas DOT uses these two sections to certify inertial profilers and these data are not available to the public.) Profile measurements using a reference device (e.g., Dipstick) were not obtained at the other three sites.

Subdirectories and File Naming Convention

Data for each region are contained in separate subdirectories. The following subdirectories are contained under each region.

Report

The report documenting the test procedures and the results from the testing are included in the 'Report' subdirectory.

N. Atlantic, N. Central, Southern, and Western

The 25-mm interval data collected by each regional contractor are contained in each of these subdirectories. The following file naming convention is used for the profile data:

RRMatlAB.ERD

Where,

RR	Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, and WE – Western
Matl	Identifies the surface type, AC – asphalt concrete, PCC – portland cement concrete
A	Site number
B	Run number. The profilers obtained multiple runs at a site, and this digit indicates the run number.

The data collected at sites AC-1 and AC-2 are not included in this package because these two sites are used by Texas DOT to certify inertial profilers. It is believed the North Central profiler collected data on AC-3 with the sensor covers in place. All data files have three columns, with the first, second, and third columns containing data collected in the left wheelpath, center, and the right wheelpath, respectively.

2002 REGIONAL PROFILER COMPARISONS

The FHWA purchased four new profilers from International Cybernetics Corporation (ICC) to collect data at LTPP test sections in 2002. These profilers replaced the K.J. Law T-6600 profilers that were used to collect profile data for the LTPP program. Each RSC took delivery of an ICC profiler in July 2003. After taking delivery of the profiler, each RSC performed a comparison test between their K.J. Law profiler and their ICC profiler. The FHWA requested each RSC to test a minimum of five sites, such that the following criteria were satisfied:

1. AC section with IRI < 1.6 m/km (Smooth AC)
2. PCC section with IRI < 1.6 m/km (Smooth PCC)
3. AC section with IRI > 2.2 m/km (Rough AC)
4. PCC section with IRI > 2.2 m/km (Rough PCC)
5. Chip seal section

No Dipstick testing was performed at any of these sections.

Each RSC processed the collected profile data with the ProQual software to compute IRI values. Each RSC prepared a report that documented the results of the comparison test and submitted the report to the FHWA. The LTPP Technical Support Services Contractor (TSSC) performed an overall analysis of the data submitted by the RSCs and prepared a report documenting the results of the analyses.

Subdirectories and File Naming Convention

Overall Report

This subdirectory contains the overall report for the comparisons prepared by the TSSC.

N. Atlantic, N. Central, Southern, and Western

The following subdirectories are contained under each region.

Report

This subdirectory contains the report prepared by the RSC.

ICC

This subdirectory contains the 25-mm interval profile data collected by the ICC profiler. The data files collected by the Southern profiler could not be converted to obtain the 25-mm interval data, and are not included in the CD. The following file naming convention is used for the profile data:

*SSSHRP*I*B*.ERD

Where,

SS	State code
SHRP	SHRP ID of the test section
B	Run number. Each profiler obtained multiple runs at each site.

The data collected by the North Atlantic ICC profiler at sites 360802 and 360859 are not available. Each data file has data collected along the left wheelpath, right wheelpath, and center of the lane as contained in the first, second, and third data columns, respectively.

T-6600

This subdirectory contains the data collected by the K.J. Law T-6600 profiler. The following file naming convention is used for the profile data files:

*SSSHRP*K*B*.ERD

Where,

SS	State code
SHRP	SHRP ID of the test section
B	Run number. Each profiler obtained multiple runs at each site.

The data collected by the Southern K.J. Law profiler at site 485283 were not available. Each data file has data collected along the left wheelpath, right wheelpath, and center of the lane. Due to differences in the methods used to generate the data files, the order of the data columns is not consistent between the data files and these should be reviewed to determine the appropriate order.

2003 PROFILER COMPARISON

The 2003 comparison test between the four ICC profilers used by the LTPP regional contractors was held at the MnROAD facility in Albertville, Minnesota. This was the first comparison between the four ICC profilers. One of the K.J. Law T-6600 profilers was still operational in July 2002 and participated in this study. Five test sections were used for the profile comparison.

Subdirectories and File Naming Convention

Report

The report documenting the test procedures and results from the testing are included in the 'Report' subdirectory.

Dipstick

The subdirectory 'Dipstick' contains the Dipstick data. The files are named according to the following file naming convention:

2003DSITE*A*.ERD

Where,

A Site number

Each data file contains the data collected along the left and the right wheelpaths.

N. Atlantic, N. Central, Southern, T-6600, and Western

The data collected by each regional contractor are contained in each of these subdirectories. The T-6600 subdirectory contains the data collected by the K.J. Law T-6600 profiler. There are two subdirectories under each regional contractor, 25 mm and 150 mm. The subdirectory 25 mm contains the 25-mm interval data collected by the profilers, while the subdirectory 150 mm contains the ProQual processed data files.

The following file naming convention was used for the data files:

RR#AB.ERD

Where,

- *RR* Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, T-6600 – K.J. Law T-6600 profiler, and WE – Western
- *#* The interval of the longitudinal profile data contained in the data file, 25 – for the 25-mm interval data and 150 for the ProQual processed data files
- *A* Site number
- *B* Run number. The profilers obtained multiple runs at a site, and this digit indicates the run number.

The 25-mm ERD files contain the data collected along the left wheelpath, right wheelpath, and center of the lane in the first, second, and third data columns, respectively. The K.J. Law profiler used an incorrect setting during data collection

causing a 300-mm moving average to be applied onto the 25-mm interval data before the data was saved. In the correct operational mode, a moving average is not applied to the 25-mm data.

The 150-mm ERD files contain the data collected along the left wheelpath and the right wheelpath in the first and second columns, respectively.

2007 PROFILER COMPARISON

The 2007 comparison test between the four ICC profilers used by the LTPP regional contractors was held at the MnROAD facility in Albertville, Minnesota. One of the K.J. Law T-6600 profilers was still operational and participated in this study. Five test sections were used for the profile comparison.

Subdirectories and File Naming Convention

Report

The report documenting the test procedures and results from the testing are included in the 'Report' subdirectory.

Dipstick

The subdirectory 'Dipstick' contains the Dipstick data. The files are named according to the following file naming convention:

2007DSITE*A*.ERD

Where,

A Site number

Each data file contains the data collected along the left and the right wheelpaths.

N. Atlantic, N. Central, Southern, T-6600, and Western

The data collected by each regional contractor at the 25-mm interval are contained in each of these subdirectories. The T-6600 subdirectory contains the data collected by the K.J. Law T-6600 profiler.

The following file naming convention was used for the data files:

RRAB.ERD

Where,

RR Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, T-6600 – K.J. Law T-6600 profiler, and WE – Western
A Site number
B Run number. The profilers obtained multiple runs at a site, and this digit indicates the run number.

The 25-mm ERD files contain the data collected along the left wheelpath, right wheel path, and center of the lane in the first, second, and third data columns, respectively.

2010 PROFILER COMPARISON

The 2010 comparison test between the four ICC profilers used by the LTPP regional contractors was held at the MnROAD facility in Albertville, Minnesota. Six test sections were used for the profile comparison.

Subdirectories and File Naming Convention

Report

The report documenting the test procedures and results from the testing are included in the 'Report' subdirectory.

Dipstick

The subdirectory 'Dipstick' contains the Dipstick data. The files are named according to the following file naming convention:

2010DSITE*A*.ERD

Where,

A Site number

Each data file contains the data collected along the left and the right wheelpaths.

SurPRO

The subdirectory 'SurPRO' contains the data collected using the SurPRO at 25-mm intervals. The files are named according to the following file naming convention:

SP*ABC*.ERD

Where,

- *A* Site number
- *B* Run number. The device was used to obtain multiple runs at a site and this digit indicates the run number.
- *C* Test paths. L – left wheelpath data are contained in the file, R – right wheelpath data are contained in the file

N. Atlantic, N. Central, Southern, and Western

The data collected by each regional contractor at the 25-mm interval are contained in each of these subdirectories.

The following file naming convention was used for the data files:

RRAB.ERD

Where,

- *RR* Regional contractor, NA – North Atlantic, NC – North Central, SO – Southern, and WE – Western
- *A* Site number
- *B* Run number. The profilers obtained multiple runs at a site, and this digit indicates the run number.

The 25-mm ERD files contain the data collected along the left wheelpath, right wheel path, and center of the lane in the first, second, and third data columns, respectively.

2013 REGIONAL PROFILER COMPARISONS

The FHWA purchased four new profilers from Ames to collect data at LTPP test sections in 2013. These profilers replaced the ICC MDR profilers that were used to collect profile data for the LTPP program. After taking delivery of the profiler, each RSC performed a comparison test between their Ames profiler and their ICC profiler, with one exception. The ICC MDR profiler operated by the Southern region was no longer operational; therefore, no comparison could be performed.

Subdirectories and File Naming Convention

Report

The report documenting the test procedures and results from the testing are included in the ‘Report’ subdirectory.

Northern and Western

The data collected by each regional contractor at the 25-mm interval are contained in each of these subdirectories.

The following file naming convention was used for the data files:

RRASSMB.ERD

Where:

RR Regional contractor, NO – Northern regions and WE – Western region

A Site Number,
1 = smooth AC
2 = rough AC
3 = rough PCC 1
4 = rough PCC 2

SS Speed of data collection, 35 mph, 50 mph, or 65 mph

M Manufacturer, I – ICC, A – Ames

B Run Number