

PUBLISHED PROJECT REPORT PPR941

Highways England 2017 National
Deflectograph Accreditation Trial

S Brittain

Report details

Report prepared for:	Highways England		
Project/customer reference:	SPATS 1-123 PAAQA 2		
Copyright:	© Transport Research Laboratory		
Report date:	09/01/2020		
Report status/version:	1.01		
Quality approval:			
Stuart Brittain (Project Manager)	Stuart Brittain	David Gershkoff (Technical Reviewer)	David Gershkoff

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Contents amendment record

This report has been amended and issued as follows:

Version	Date	Description	Editor	Technical Reviewer
1.00	27/04/2017	Version supplied to Highways England for comment.	S Brittain	D Gershkoff
1.01	09/01/2020	Converted to published report for historic continuity	S Brittain	D Gershkoff & P Langdale

Document last saved on: 09/01/2020 15:48

Document last saved by: Brittain, Stuart

Executive summary

Deflectograph accreditation trials are held annually by TRL on behalf of Highways England. The objective is to monitor the performance of all Deflectographs operating on UK trunk roads. By examining and monitoring the results from the machines operating on specified test sections of the reference site, the performances of individual machines, and the whole UK fleet, are assessed.

The 2017 trial was held during the period 28th February to 1st March 2017. The site used was the twin horizontal straights of the Horiba-MIRA proving ground. This was the twenty-second year in which TRL took full responsibility for the planning and running of the trials. Ten machines attended the trial.

The format of the 2017 trial was broadly consistent with that of recent years, comprising two scheduled days of testing and one contingency day. The 2017 trial included checks on the distance calibration first added to the 2012 trial. The first day of the trial was dedicated to static inspections and calibration checks, with the second day used for the main running trials. The reserve day was used for additional assessments. The accreditation trial criteria are specified in “Accreditation and Quality Assurance of Deflectograph survey devices” (TRL, 2016).

After some additional testing, all ten machines that participated in the March 2017 accreditation trial met the mandatory requirements of the trial (wheel weight, deflection measurement and distance measurement) and can therefore be considered for approval to survey Highways England’s strategic road network.

Eight of the machines achieved a high performance rating and two a medium performance rating with regards to the measurement of pavement temperature at depth.

For the 2017 trial, participants were also asked to provide air and surface temperature measurements (if they had the equipment fitted). Although this data was not formally assessed, it was used to review the criteria set and develop a future test procedure for assessing participants performance in relation to these requirements. Based on the results obtained it is recommended that air and surface measurements should be formally assessed at the next accreditation trial.

The results from the trial are discussed in this report and are provided in the accreditation certificates issued to the trial participants. These certificates are also accessible at:

<http://www.ukroadsliasongroup.org/en/asset-condition/road-condition-information/data-collection/deflectograph/index.cfm>

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1 Introduction

Deflectograph accreditation trials are held annually by TRL on behalf of Highways England. The objective is to monitor the performance of all Deflectographs operating on Highways England's strategic road network. By examining and monitoring the results from the machines operating on specified test sections, the performances of individual machines, and the whole UK fleet, are assessed.

The 2017 trial was held during the period 28th February to 1st March 2017. The site used was the twin horizontal straights of the Horiba-MIRA proving ground which is further discussed in Section 2. This was the twenty-second year in which TRL took full responsibility for the planning and running of the trials and the fifth full trial at Horiba-MIRA. Ten machines attended the trial. The accreditation trial criteria are specified in "Accreditation and Quality Assurance of Deflectograph survey devices" (TRL, 2016).

For convenience, throughout this report, the machines are referred to by their running numbers rather than by the Operator. For ease of record keeping, running numbers are retained from year to year with new machines being assigned new numbers. By agreement with Highways England, Appendix A lists the machines, operating authorities and performance at the trial. Historically, this was also agreed with the ADEPT (formerly CSS) Deflectograph Operators Group before it disbanded.

2 Test site

2.1 Details of the test site

The twin horizontal straights area of the Horiba-MIRA Proving Ground comprises two lengths of straight and essentially level track just over 1.5km long joined by banked bends at either end. During October 2010 Highways England arranged for a length of the nearside lane on one of the straights to be reconstructed, in order to produce three sections of different constructions/strength levels. These three sections were designed specifically for use in the accreditation of Deflectographs and other pavement deflection measuring devices. These sections are referred to as HECP_01, HECP_02 and HECP_03 (Highways England Calibration Pavement) during this report. The sections are each 70m in length (however the beginning and end 5m are excluded in the analysis to help avoid alignment issues, resulting in 60m sections) and the layout and test route is shown in Figure B.1 in Appendix B. Nominal construction details of the test sections can be found in Appendix C.

In order to demonstrate the suitability of the sections identified at Horiba-MIRA, a transitional trial was held on the 12th and 13th September 2011 (Brittain & Sanders, 2012). This trial compared a sub-set of the UK Deflectograph fleet, initially following the traditional approach using the historic test sections of the TRL track and then moving to follow the proposed new procedures and sections at Horiba-MIRA. The work demonstrated that the Horiba-MIRA site was suitable for the accreditation of Deflectograph machines. As well as the trial process, the accreditation criteria were reviewed following the 2011 transitional trial.

The trial process and the criteria used for the 2017 trial are discussed in Sections 3 and 4 respectively.

2.2 Variability of NS deflections on HECP_02

During the transitional trial it was found that there was a localised high deflection area in the NS wheel path of section HECP_02. This high deflection area was traversed in some but not all runs and only affected the NS wheel path of section HECP_02. This is illustrated in Figure 2.1 which is a plot of some of the data collected at the transitional trial over the three test sections.

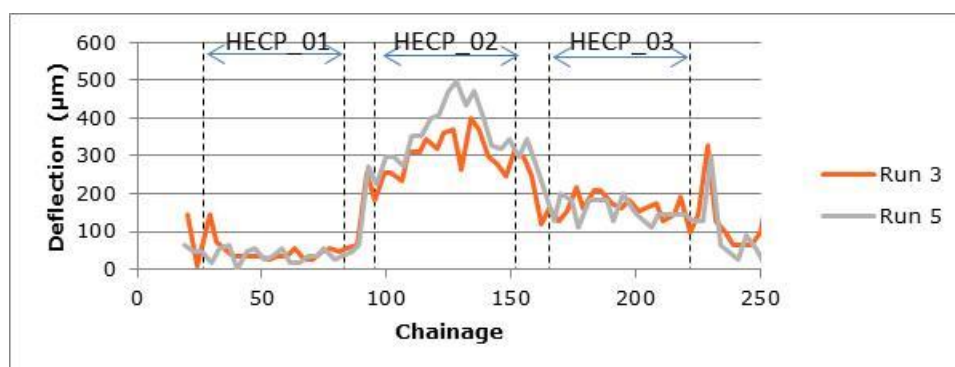


Figure 2.1 Example plot of nearside deflections for Horiba-MIRA test sections observed during the transitional trial

In order to try and reduce this effect for the 2013 trial, small cones were placed on the test track to mark the survey test line for the whole test site. These cones were placed either side of the machine's test path (as shown in Figure 2.2), so that any deviation in the test line would cause a cone to be knocked over and thereby any deviation could be recorded.



Figure 2.2 Image illustrating cone positions during testing

During the analysis of the 2013 trial it was found that this approach reduced the variability of the deflections for the NS wheel path of HECF_02. It was therefore decided that these cones will be placed along HECF_02 for future trials in order to reduce this variability.

3 Trial format

The format of the 2017 trial was kept broadly the same as that of recent years, with two scheduled days of testing and one contingency day. The review of the accreditation trial procedure following the transitional trial recommended that checks on the distance calibrations of the machines should be included. This was incorporated into the 2012 trial and has been repeated in all subsequent trials.

Each crew carried out a machine inspection in advance of the trials and a certified checklist was submitted before the machine could be included in the running trials.

3.1 Day 1

The first day is dedicated to static inspections, distance calibrations and a warm-up lap to help identify any major issues.

On arrival, each machine is inspected followed by a measurement of the machine's wheel weights. The wheel weight values are then used in the trial software to allow corrections for rear wheel weight to be applied to the deflection data.

The operators' thermometers are collected and are compared against each other in a stabilised environment.

The machines are then taken to the test track where the survey crew perform a distance calibration followed by a single lap of the test circuit to provide some preliminary data to try and identify any machines which have any significant issues.

3.2 Day 2 and day 3

The second day is the main running trials. This includes repeat measurements of deflection, temperature and distance. If bad weather or, other unforeseen circumstances arise then the contingency day (day 3) allows for additional time to conduct these tests.

On arrival at the test track the crews are asked to perform a static calibration before undertaking laps of the test sections.

Deflection measurements are made over the three test sections, and temperature measurements are collected from two pre-drilled holes (40mm depth) located before and after the deflection test sections. The distance check involves the crews surveying a length between two cones (separated by more than 400m) and comparing the resulting data to the reference measurement of the cone separation.

The machine running order is randomly determined before testing begins, with all machines running in convoy to cover all the sections in a single circuit. Each machine is required to complete a minimum of five measurement runs. Data from the survey machines is handed in after each run and real-time data processing enables collated measurements to be available for review as the trials proceed.

In order to improve the alignment of data, at the start of each run crews are asked to stop their machines and align the deflection beam frame to the forward-most position of the cycle with the truck wheels at a defined "beam down" point.

HD29/08 (Design Manual for Roads and Bridges, 2008) sets a maximum rate of temperature increase of 2.5°C per hour at 40mm for deflection testing on the trunk road network. This requirement is intended to ensure that temperature corrections used to adjust deflections to a standard temperature of 20°C stay within the validity of the equations.

Although temperature corrections are not carried out in analysing data from the accreditation trial, the temperature is monitored at the same location as the operator temperature measurements (i.e. before and after the deflection test sections) at 40 and 100mm depths to inform any conclusions drawn. Automatic data-loggers are used to provide a record every minute during deflection testing.

While the machines are running, TRL staff made inspections of the dynamic operation of each machine, including a timed section to verify that operating speeds are acceptable.

4 Criteria for acceptability and the transitional trial

The accreditation trial criteria are specified in “Accreditation and Quality Assurance of Deflectograph Survey Devices” (TRL, 2016). This document is a live document (i.e. is subject to change) and the July 2016 version of the document was used for the trial. The relevant section of the document is reproduced verbatim below in Section 4.1. Note in the text below, “Equipment” is a defined term and refers to the overall machine being assessed, incorporating the measuring systems and the survey vehicle. “System” refers to an individual measurement system installed on the Equipment e.g. the NS deflection measurement system, temperature measurement system etc. “Employer” refers to the organisation that commissions the Survey Contractor to complete a survey and will generally be the final user of the data provided. “Owner” refers to the organisation or individual to which Equipment belongs and to whom Accreditation Certificates are awarded.

4.1 Trial criteria from the Accreditation and QA document

E.3 Equipment inspection

- E3.1 Contractors will be provided with an inspection check sheet to complete and provide to the Auditor in advance of the Trial. The Contractors will also be asked to supply evidence that the required Calibrations have been performed (see section C.4).
- E3.2 Equipment will also be inspected at the trial to ensure that they are in a suitable condition to conduct the tests. This will include verifying that the Equipment appears to be in good general mechanical order.
- E3.3 Equipment will be weighed so that Load normalisation of the survey data can be carried out. The Equipment should be within the limits given in Table 1.

Table 1 – Criteria for wheel weights

Parameter	Acceptability Limit
Front Axle ¹	4500 kg ±5%
Twin rear wheel	3175 kg ±10%

- E3.4 A simple of assessment of the temperature measurement System should be carried out to make sure that it is producing consistent results.

¹ It has been the experience in the Accreditation Trials that Equipment falling within approximately 10% of target limit for the front axle has performed acceptably with regards to deflection measurements. This matter has been investigated by TRL and Highways England. It has been concluded that, while consideration may be given to revising the specification limits at an appropriate point in the future, for the time being Equipment falling within this approximate front axle range would continue to be regarded as acceptable provided that they performed satisfactorily in the dynamic tests.

E.4 Running Trials

E4.1 Overview

E4.1.1 As detailed in Appendix B, trials will be carried out on a test site separated into test stations, and laid out such that “laps” of the set of test sections can be undertaken by the Fleet for the purposes of repeating the measurements.

E4.2 Deflection testing – Mandatory Requirement

E4.2.1 The assessment for Deflection measurements is described below, and a worked example is provided in Appendix C

E4.2.2 The Equipment will undertake laps so that the following criteria are met:

- At least 5 laps are undertaken that comply with the requirements for Reference Data (see Appendix B, App B.3)
- Survey data will be collected at a target test speed of 2.4 km/h. Equipment will be checked by measuring the time taken to travel a known length. If the Equipment is found to be surveying more than 0.1km/h from this target, the survey operator will be asked to adjust their speed accordingly.
- The pavement temperature measured at a depth of 40mm must not change by more than $\pm 2.5^{\circ}\text{C}$ during the test lap.

E4.2.3 The Contractor will supply the deflection measurements for their Equipment from each test lap in the file formats specified by the Auditor.

E4.2.4 The Auditor will calculate:

- The load corrected mean for the Equipment for each wheel path and test section.
- The standard deviation of these mean values for the Fleet and for all of the Equipment at the trial, referred to as the Fleet between-Equipment standard deviation (BESD) and the Trial BESD. These values will be used to assess the consistency of the Equipment at the Trial.
- The standard deviation of the deflection values between laps for the Equipment for each wheel path and test section. This data is referred to as the between-run standard deviation (BRSD). These values will be used to assess the repeatability of each individual Equipment.

E4.2.5 The BRSD will be used in the initial assessment of each Equipment. During the Tests, the BRSD values will be affected by the variability of pavement temperatures during the course of the testing. Therefore the performance will be assessed by comparison against the performance of the other Equipment undertaking the Re-accreditation/Accreditation Tests.

E4.2.6 Where the BRSD values of the Equipment are significantly higher than the BRSD values of other individual Fleet Equipment, the data from the Equipment will undergo further investigation by the Auditor to determine if the Equipment is suitable for Accreditation.

E4.2.7 The Trial BESD is acceptable if it is below the criterion given in Table 2. If the trial BESD exceeds this criterion then the data will be further examined to identify

outlying Equipment. This will include examining the Fleet BESD and data from individual Equipment. Outlying Equipment will be rejected and the data reassessed until the performance is acceptable.

- E4.2.8 In addition, any Equipment that deviates by more than 3 times the BESD criterion from the Fleet Mean will fail Accreditation. Any Equipment that is between two and three times the BESD criterion from the Fleet mean will undergo further investigation by the Auditor to determine if the Equipment is suitable for Accreditation.
- E4.2.9 The data from any Equipment rejected due to BRSD, BESD or otherwise identified as an outlier will not be used in the calculation of the Reference Data (App B.3.1).

Table 2 – Criterion for Deflection measurements

Parameter	Acceptability Limit
Between Equipment standard deviation (BESD)	$\leq 0.0257 * \text{Reference Data} + 9.88 \text{ (}\mu\text{m)}$

E4.2.10 The performance will be assessed for both wheel paths separately. To achieve Accreditation the Equipment must meet the requirements for both the NS wheel path and the OS wheel path.

E4.3 Location Referencing (Distance) – Mandatory Requirement

E4.3.1 Accreditation of an Equipment's ability to measure distance is carried out by comparing its measurements of a test length with the Reference Data (App B.3.2), repeated at least five times. The criteria applied to the test measurements are given in Table 3. Note: the tolerance allows for the basic method by which events are recorded in Deflectograph Survey Data.

Table 3 – Criteria for Measurement of Distance travelled

Parameter	Acceptability Limit
Distance measured	80% within 5m

E.5 Additional Tests

E5.1 Overview

E5.1.1 The criteria in this sub-section are specified as High, Medium and Low levels of performance. This reflects the lower level of maturity of this test. In future revisions to this document these may become mandatory criteria.

E5.1.2 Some Employers may require a specific level of performance in some or all of these additional tests to carry out Accredited Surveys on their Network.

E5.2 Temperature measurement – temperature sensor for measurement at depth

E5.2.1 If undertaking this test, the Contractor will be required to make measurements from holes supplied by the Auditor (40mm depth) so that at least eight

measurements are taken during the course of the test laps. The criteria for the assessment of temperature measurement at depth are given in Table 4.

Table 4– Criteria for temperature measurement at depth

Performance level	Measurement of temperature
High	80% of the measurements are within 1°C of the reference
Medium	50% of the measurements are within 1°C of the reference
Low	15% of the measurements are within 1°C of the reference
Not Suitable	Otherwise

E5.3 Temperature measurement – temperature sensor for surface measurement

E5.3.1 If undertaking this test, the Contractor will be required to make measurements of the surface temperature so that at least eight measurements are taken during the course of the test laps. The criteria for the assessment of surface temperature measurement are given in Table 4.

Table 5– Criteria for surface temperature measurement

Performance level	Measurement of temperature
High	80% of the measurements are within 1°C of the reference
Medium	50% of the measurements are within 1°C of the reference
Low	15% of the measurements are within 1°C of the reference
Not Suitable	Otherwise

5 Results – Inspection day (28th February 2017)

5.1 Inspections

All ten machines arrived with completed inspection checklists and in good condition.

5.2 Wheel weights

The weights recorded for each machine are given in Table 5.1.

Table 5.1 Deflectograph weight distributions from 28 February 2017

Machine	Weight distribution including crew (kg)						Total Machine
	Front NS	Front OS	Total Front	Rear NS	Rear OS	Total rear	
2	2385	2645	5030*	3190	3350	6540	11570
3	2325	2460	4785*	3405	3350	6755	11540
5	2345	2315	4660	3305	3320	6625	11285
8	2225	2520	4745*	3230	3200	6430	11175
9	2400	2410	4810*	3310	3035	6345	11155
10	2295	2445	4740*	3270	3405	6675	11415
12	2200	2420	4620	3395	3210	6605	11225
14	2315	2445	4760*	3210	3425	6635	11395
15	2350	2540	4890*	3440	3340	6780	11670
16	2335	2325	4660	3245	3235	6480	11140

* Exceeds tolerance defined in HD29 (see comment in Section 5.2)

Machines 2, 3, 8, 9, 10, 14 and 15 exceeded the published front axle limits. Machines 2 and 15 have exceeded the published limit since their introduction into the fleet. However, ever since Machine 2 (and, subsequently Machine 15) was introduced, there has been no measurable effect from the heavier front axle weight. This matter was reviewed by TRL and Highways England following the 2004 trials. It was concluded that, while consideration may be given to revising the specification limits at an appropriate point in the future, for the time being the differences will be noted but the affected machines would continue to be regarded as acceptable provided that they performed satisfactorily in the dynamic tests.

5.3 Warm-up lap

Following the processing of data from the warm-up lap it was found that the spread of machine results was larger than the criteria. This is typically the case when there is only data from one lap available, however machines 9 and 12 were identified as clear outliers from the rest of the fleet on both the NS and OS wheel paths (producing significantly lower deflection values). After removal of these two machines from the reference dataset, it was also identified that Machine 3 was an outlier on the OS (also producing lower values than the rest of the fleet). The owners of these machines were notified so that they could investigate their machines prior to the main trial day.

5.4 Temperature probes

The operators' thermometers were collected up and the probes allowed to stabilise at the same temperature (using a bucket of water). From this testing it was identified that one device was clearly faulty, producing values approximately 3.5 °C above the average of the other devices. After removal of this device, the majority of the measurements were within $\pm 0.5^{\circ}\text{C}$ of the average, with two devices being within 0.6°C of the average. The owner of the faulty device was notified and they used a spare device (which was found to be suitable) during the main trial day.

6 Results – Main trial day (1st March 2017)

6.1 Calibrations

At the start of the day each crew carried out a static calibration of their machine. No machines were identified to TRL as not meeting the limits specified in HD29/08.

6.2 Distance measurement

A distance check length was set up on the track to assess the distance measurement systems on the machines. The reference length used was 433m. The difference between the measured length from each machine and the reference, along with the overall performance are given in Table 6.1. The differences between the machine and the reference are highlighted in red bold text if it exceeds the threshold for the criteria as given in Section 4.1.

Table 6.1 Distance measurement

Machine	Difference between measured length and the reference (m)					Performance
	1	2	3	4	5	
2	1	4	2	2	3	Pass
3	2	3	2	0	3	Pass
5	2	6	4	5	6	Fail
8	1	0	1	-1	-1	Pass
9	-11	-4	0	0	2	Pass
10	-	-	-	-	-	Not tested
12	2	2	1	-1	1	Pass
14	2	8	2	1	1	Pass
15	2	3	2	1	0	Pass
16	4	2	1	5	6	Pass

On examination of Table 6.1 it can be seen that eight machines passed the distance measurement criteria on the main trial day. Machine 5 failed to meet the criteria, and Machine 10 was unable to take part in the testing (further discussed in Section 6.4).

6.3 Temperatures

6.3.1 Temperature pattern shown by the data loggers

An issue with the temperature loggers meant that automatic recording of the data was not achieved during the majority of the main trial day. To mitigate the effects of a failure of the logging equipment, manual records of the temperatures recorded by the data logging system are made roughly every hour during the trial. This is not comprehensive enough to perform the assessment of the data collected by the operators, but does provide independent data on the variation of temperatures during the course of the day.

To assess the data collected by the operators they have been compared to the average of the fleet which was found to be consistent with the manual logger measurements.

As discussed in Section 3.2, HD29/08 sets a maximum rate of temperature increase of 2.5°C per hour at 40mm for deflection testing. The temperature measurements recorded and the corresponding rate of change per hour are given in Table 6.2 and Table 6.3.

Table 6.2 Manual record of data logger measurements at 40mm

Point 1 (before deflection test sections)			Point 2 (after deflection test sections)		
Time	°C	Rate of change per hour	Time	°C	Rate of change per hour
11:30	6.3	-	11:30	6.2	-
12:00	6.1	-0.4	12:00	6.4	0.4
12:30	6.6	1.0	12:30	6.7	0.6
13:10	7.4	1.2	13:10	7.1	0.6
17:00	6.8	-0.2	17:00	6.7	-0.1

Table 6.3 Manual record of data logger measurements at 100mm

Point 1 (before deflection test sections)			Point 2 (after deflection test sections)		
Time	°C	Rate of change per hour	Time	°C	Rate of change per hour
11:30	4.7	-	11:30	4.6	-
12:00	4.9	0.4	12:00	4.9	0.6
12:30	5.3	0.8	12:30	5.2	0.6
13:10	5.8	0.8	13:10	5.6	0.6
17:00	6.8	0.3	17:00	6.6	0.3

It can be seen that the rate of temperature change with time at 40mm remained within the suggested limit during testing.

6.3.2 Temperatures at depth, recorded by operators

The Deflectograph crews made measurements of temperature from the two temperature test points at a 40mm depth. This data is shown below in Figure 6.1 and Figure 6.2.

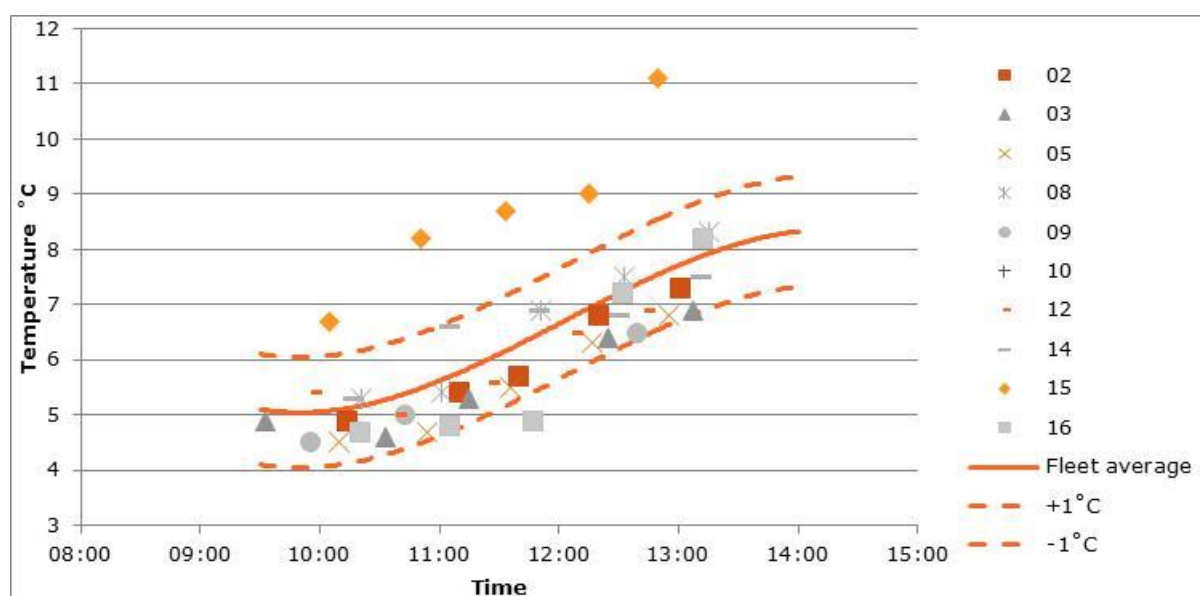


Figure 6.1 Comparison of crews' measurements against reference – Temperature test point 1, main trial day

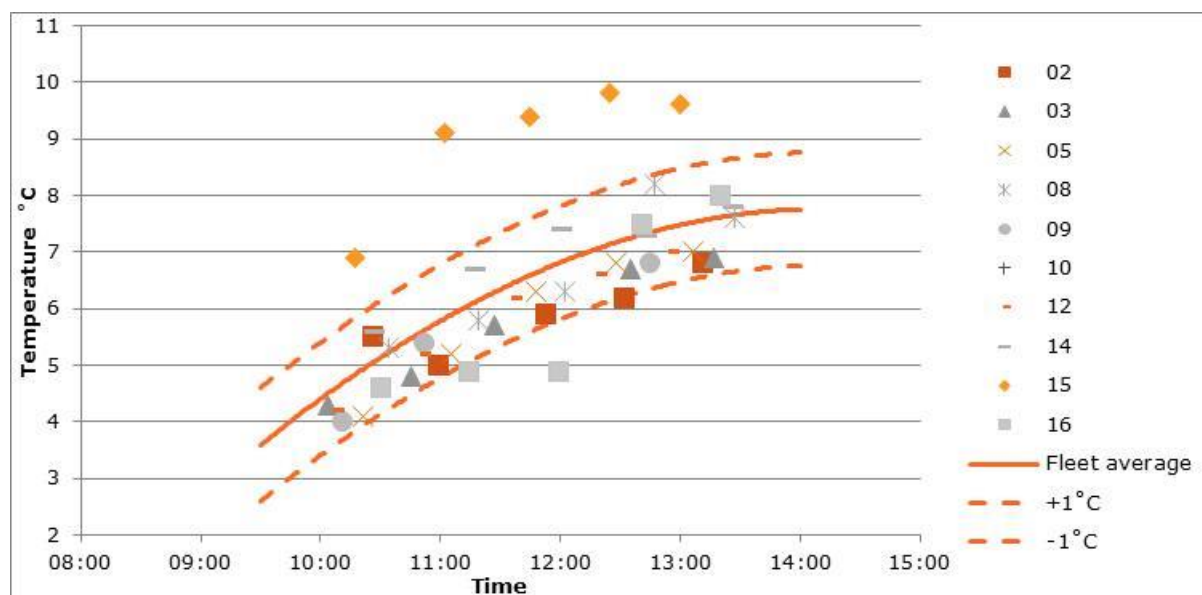


Figure 6.2 Comparison of crews' measurements against reference – Temperature test point 2, main trial day

The difference between the operators' measured values and the reference and the awarded performance are shown in Table 6.4. If the value is more than 1°C away then it is highlighted in bold red text. For more details on this criteria see E5.2.1 in section 4.1.

Table 6.4 Difference between operators measured values and the reference

Machine	Difference between measured temperature and reference (°C)										Performance band
	Test 1		Test 2		Test 3		Test 4		Test 5		
	1	2	1	2	1	2	1	2	1	2	
2	-0.2	0.5	-0.4	-0.7	-0.6	-0.8	-0.2	-1.0	-0.4	-0.8	High
3	-0.2	-0.2	-0.7	-0.6	-0.5	-0.6	-0.7	-0.5	-0.9	-0.7	High
5	-0.6	-0.8	-0.8	-0.7	-0.7	-0.3	-0.7	-0.4	-0.8	-0.5	High
8	0.1	0.1	-0.2	-0.3	0.4	-0.5	0.3	0.8	0.4	0.0	High
9	-0.5	-0.7	-0.4	-0.2	.	.	.	.	-0.8	-0.5	Incomplete dataset
10	.	.	.	.	.	.	.	.	.	.	Not tested
12	0.4	-0.4	-0.3	-0.4	-0.4	-0.2	-0.3	-0.4	-0.5	-0.4	High
14	0.2	0.6	0.9	0.6	0.5	0.6	-0.4	0.0	-0.4	0.2	High
15	1.6	2.1	2.7	3.3	2.6	2.8	2.1	2.7	3.6	2.1	Not Suitable
16	-0.5	-0.5	-0.9	-1.1	-1.5	-1.9	0.0	0.2	0.3	0.4	Medium

Six machines achieved a high performance on the main trial day, one achieved a medium and one was deemed not suitable. Two machines (machines 9 and 10) either did not test or provided an incomplete dataset, this is further discussed in Section 6.4.

6.3.3 Air and Surface temperatures, recorded by operators

Methodologies for estimating pavement temperature from measurements of air and surface temperatures have been developed for use with deflection surveys. It is anticipated that the next version of HD29 will give survey contractors the option to supply air and surface temperatures instead of pavement temperatures along with the deflection survey

data. Anticipating this change, the Accreditation and QA specification (TRL, 2016) was amended to include criteria for the assessment of pavement surface temperatures measured using an infrared temperature probe mounted on the Deflectograph. Criteria for air measurements using a thermometer device mounted on the Deflectograph will be included in a future version of the document.

To help develop the assessment method and test the criteria, survey contractors were asked to supply air and surface measurements (if they had the equipment fitted) from the test laps on the main trial day. This data would be used to get a general picture of the performance of the equipment and to help develop the methodology for assessing the performance of the devices. The data would not be formally assessed to provide a performance rating for these devices.

At the trial, data was supplied from three machines. However, as we had not provided a specific box on the run log sheets (users were asked to add the data in the comments box on the sheet) it is possible that this equipment is fitted to more machines but they forgot to supply the data.

Data collected from the temperature test point 1 (near the beam down position) from the logger and the data supplied from the operators is shown in Figure 6.3 and Figure 6.4.

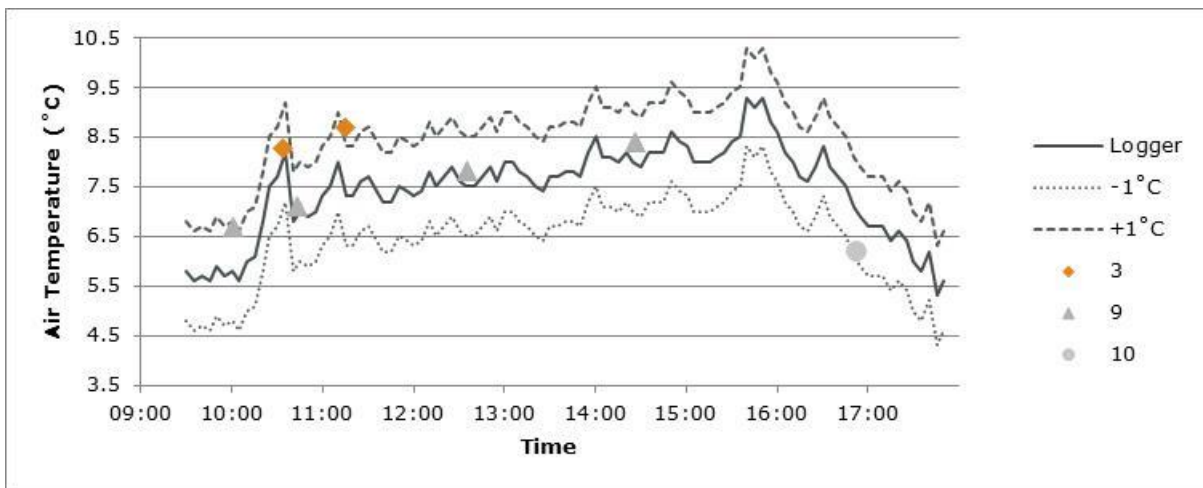


Figure 6.3 Air temperatures – Temperature test point 1, main trial day

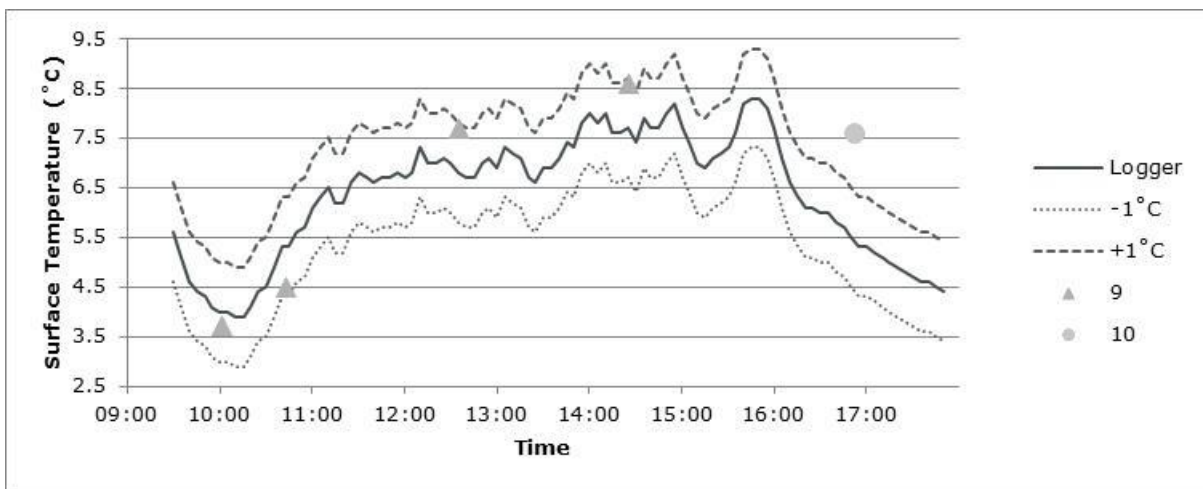


Figure 6.4 Surface temperatures – Temperature test point 1, main trial day

Although there were only a few air and surface temperature measurements provided by the participants, it can be seen that the data supplied was around the same levels as the thresholds ($\pm 1^{\circ}\text{C}$). Therefore it is recommended that at the next trial the air and surface temperature sensors are formally assessed using this criteria and loggers set-up at the same locations as the 40mm temperature stations (i.e. near the beam down and beam up positions) so that two sets of measurements are made each lap. The run log sheets provided to the operators should be amended to include specific boxes for the entry of the air and surface temperature measurements (along with the existing boxes for the 40mm measurements).

6.4 Deflection readings – Main trial day

During the inspection day three machines were identified as outliers (Machines 3, 9 and 12). These machines underwent repairs prior to the main testing with the winches being changed on Machines 9 and 12 and a new tow cable fitted to Machine 3.

During the initial laps it was found that Machine 3 and 9 were still outliers from the fleet. The settings on the OS amplifier board on Machine 3 were modified (and the machine recalibrated). Machine 9 was continuously worked on during this period with different winches tried on the machine. In addition, during the first lap Machine 10 developed a software issue which meant that it was unable to take part in the main testing.

As these machines (3, 9 and 10) did not have a complete set of tests in this period (with the same configuration) they are excluded from the tables in this section. These machines undertook some additional laps at the end of the main trial day, with a selection of machines from the rest of the fleet to act as a reference. These additional laps and the results are discussed in Section 6.5.

6.4.1 *Between run standard deviation for deflection values*

No criteria are set relating to the between run standard deviation of each machine. It is, however, useful to consider this aspect when investigating anomalies in the behaviour of machines in case an individual machine's mean result has been unduly influenced by variations between runs, perhaps as a result of a significant variation from the expected test line. The variation between runs is indicated by the between-run standard deviation for each machine, as shown in Table 6.5.

Table 6.5 Between run standard deviation for main running day (day 2)

Machine number	HECP_01		HECP_02		HECP_03	
	NS	OS	NS	OS	NS	OS
2	1.1	1.1	7.1	7.6	8.3	9.2
8	2.9	3.9	6.4	5.8	9.8	6.4
9	1.2	2.7	3.0	7.3	9.4	11.1
14	2.5	3.2	6.5	4.6	7.6	9.6
15	3.1	2.7	5.2	5.1	9.0	9.7
16	1.1	5.5	3.6	4.2	10.0	9.9

It can be seen from Table 6.5 that no machine was significantly more variable than the others.

6.4.2 Mean deflection values

Table 6.6 shows the mean deflections recorded on each section, together with summary statistics. Instances where the between equipment standard deviation (BESD) is within the criterion are highlighted in green and instances where the criterion are not met in red. Table 6.7 shows the deviations from the overall mean and these are highlighted if they are further than 2 or 3 times the BESD criteria (orange and red respectively). For more details on this criteria see E4.2 in section 4.1.

Table 6.6 Mean deflection (μm) by section: Main running day (day 2)

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
2	57	54	225	185	149	140	143	126
5	51	47	213	179	151	140	138	122
8	48	44	202	165	139	123	130	111
12	46	44	206	161	136	126	129	111
14	65	60	233	198	151	150	149	136
15	53	60	211	185	142	154	135	133
16	51	54	217	184	140	138	136	125
Mean	53	52	215	180	144	139	137	123
BESD	6.2	6.8	10.8	12.7	6.1	11.3	7.2	9.9
BESD criterion	11.2	11.2	15.4	14.5	13.6	13.4	13.4	13.1
CoV	11.7%	13.1%	5.0%	7.1%	4.2%	8.1%	5.2%	8.0%

Table 6.7 Deviation (μm) from overall mean deflection by section: Main running day (day 2)

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
2	3.8	1.5	9.5	5.8	4.8	1.2	6.0	2.8
5	-2.0	-4.5	-2.1	-0.5	6.7	1.2	0.9	-1.3
8	-4.7	-7.8	-13.7	-15.0	-4.6	-15.4	-7.6	-12.7
12	-6.7	-7.7	-9.0	-18.2	-8.2	-12.7	-8.0	-12.9
14	11.9	7.8	17.5	17.9	6.8	11.1	12.1	12.3
15	-0.3	8.3	-4.5	5.8	-1.7	15.3	-2.2	9.8
16	-2.0	2.4	2.2	4.3	-3.8	-0.8	-1.2	2.0
2x BESD criterion	22.5	22.4	30.8	29.0	27.2	26.9	26.8	26.1
3x BESD criterion	33.7	33.7	46.2	43.5	40.7	40.3	40.2	39.2

It can be seen from these two tables that the criteria for the spread of mean deflection values is met in all cases. Therefore these seven machines are considered as meeting the trial criteria for deflection measurement.

6.5 Deflection readings – Main trial day additional tests

As discussed in Section 6.4, Machines 3, 9 and 10 were unable to conduct a complete set of laps (with the same configuration) during the main set of testing. At the completion of the main testing it was possible to carry out some additional test laps (with a reduced fleet to speed up the lap times). At this point of the testing Machine 3 had already undertaken two laps with the rest of the fleet (after the modification to the OS amplifier board) and

therefore only required three more laps for a full dataset (with the same configuration). Machine 9 was ready for retesting following further modifications. Machine 10 was still suffering software issues.

6.5.1 Main trial day additional test lap results

It was therefore decided that Machines 3 and 9 would undertake some additional laps with a selection of other machines (Machines 5, 15 and 16) to provide a cross comparison to the earlier testing. In the first of these additional laps it was clear that Machine 9 was still an outlier, and therefore did not undertake a full set of laps. The results from the five laps for Machine 3 and the corresponding data for the reference devices are given below.

Table 6.8 Between run standard deviation for main running day additional laps (day 2)

Machine number	HECP_01		HECP_02		HECP_03	
	NS	OS	NS	OS	NS	OS
3	3.6	1.7	7.2	4.4	6.3	6.7
5	3.9	4.2	8.0	7.5	10.7	11.7
15	7.2	5.0	11.2	5.5	7.2	9.9
16	2.4	3.0	9.1	6.9	4.0	9.3

From Table 6.8 it can be seen that the between run standard deviation is comparable for these devices.

Table 6.9 Mean deflection (μm) by section: Main running day additional laps (day 2)

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
3	41	37	198	157	117	101	119	98
5	49	47	201	172	135	128	128	115
15	50	63	215	186	137	150	134	133
16	49	52	217	173	133	124	133	116
Mean	47	50	208	172	130	126	129	116
BESD	4.2	11.1	9.6	12.1	9.4	19.9	7.1	14.3
BESD criterion	11.1	11.2	15.2	14.3	13.2	13.1	13.2	12.9
CoV	8.8%	22.3%	4.6%	7.0%	7.2%	15.8%	5.5%	12.3%

Table 6.10 Deviation (μm) from overall mean deflection by section: Main running day additional laps (day 2)

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
3	-6.2	-13.0	-9.7	-15.2	-13.8	-24.6	-9.9	-17.6
5	1.9	-2.8	-6.8	-0.1	4.7	1.9	-0.1	-0.3
15	2.6	13.7	7.5	14.4	7.0	24.0	5.7	17.3
16	1.8	2.1	8.9	0.8	2.2	-1.3	4.3	0.5
2x BESD criterion	22.2	22.3	30.4	28.6	26.5	26.2	26.4	25.7
3x BESD criterion	33.3	33.5	45.7	42.9	39.7	39.3	39.6	38.6

It can be seen from Table 6.9 and Table 6.10 that the criteria is not met for the OS wheel path for the average of the site (or for HECP_03). This would typically mean that we would

look to remove an outlier to improve the distribution of the fleet so that the criteria are met for the average of the site (and if possible each section). However, Machine 3 (the machine being assessed in this case) is within the 2x BESD criterion of the mean (see Table 6.10). In addition this is a subset of the fleet, and the nature of the criteria means that it is harder to meet it for smaller machine numbers. Therefore it is necessary to combine this dataset with the earlier test data to fully assess this machine.

6.5.2 Combined main trial day data

In order to combine the data from the two datasets, the average deflection values for the machines that acted as the reference in the second set of tests (Machines 5, 15 and 16) was calculated for each section and wheel path for the two datasets. The ratio between the two datasets was then calculated and applied to the data from Machine 3 collected in the second dataset, to estimate the likely measurements it would have achieved if it operated in its new configuration at the start of the main trial day. The average from the two datasets for the machines acting as reference and the calculated ratio is shown in Table 6.11.

Table 6.11 Reference data values and estimation ratio

	HECP_01		HECP_02		HECP_03	
	NS	OS	NS	OS	NS	OS
Average dataset 1	52	54	214	183	144	144
Average dataset 2	49	54	211	177	135	134
Ratio	1.05	1.00	1.01	1.03	1.07	1.07

The estimated value for Machine 3 and the updated fleet statistics are shown in Table 6.12 and Table 6.13.

Table 6.12 Mean deflection (μm) by section: Estimated values for Machine 3 and resulting fleet statistics

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
3	43	37	201	162	125	109	123	102
Mean	52	50	213	177	141	135	136	121
BESD	6.8	8.3	11.2	13.3	8.8	14.8	8.4	11.8
BESD criterion	11.2	11.2	15.4	14.4	13.5	13.3	13.4	13.0
CoV	13.0%	16.6%	5.3%	7.5%	6.2%	11.0%	6.2%	9.8%

Table 6.13 Deviation (μm) from overall mean deflection by section: Estimated values for Machine 3 and resulting fleet statistics

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
3	-8.9	-13.4	-12.7	-15.5	-16.9	-26.2	-12.8	-18.3
2x BESD criterion	22.4	22.3	30.7	28.9	27.0	26.7	26.7	26.0
3x BESD criterion	33.6	33.5	46.1	43.3	40.5	40.0	40.1	39.0

It can be seen from Table 6.12 and Table 6.13 that the BESD criterion is now met for both the NS and OS wheel paths for the average. In addition Machine 3 is always within 2x BESD criterion of the fleet mean. Therefore Machine 3 can be considered as meeting the trial criteria for deflection measurement.

6.6 Decision on use of the reserve day

The original plan for the trial was to only use the reserve day where it was not possible to conduct all of the testing on the main trial day due to bad weather or other unforeseen circumstances (e.g. a “stop testing” call from track control due to an emergency).

During the testing of Machine 3, the software issue for Machine 10 was resolved and it managed to carry out a single test lap which appeared to be consistent with the rest of the fleet. However, at this stage of the day it was not possible to conduct a full set of five laps for this machine (with reference devices). As it appeared likely that Machine 10 would meet the trial criteria if it could undertake the laps, it was agreed that the reserve day would be used to assess this machine. This additional testing would also be used to provide Machine 5 the opportunity to be reassessed for distance, and Machines 15 and 16 to try and improve their performance in the temperature at depth assessment. As test laps would be undertaken it was also agreed that Machine 9 would be also given the opportunity for another attempt on the deflection criteria.

7 Results – Reserve day

7.1 Distance measurement

On the reserve day Machine 10 was assessed for distance measurement and Machine 5 was reassessed for distance measurement (following a distance recalibration). The results from this assessment are given in Table 7.1. The differences between the machine and the reference are highlighted in red bold text if it exceeds the threshold for the criteria as given in Section 4.1.

Table 7.1 Distance measurement – reserve day

Machine	Difference between measured length and the reference (m)					Performance
	1	2	3	4	5	
5	2	5	7	2	3	Pass
10	3	5	1	4	2	Pass

7.2 Temperatures at depth, recorded by operators

The issue with the temperature loggers was resolved prior to the reserve day, and this data was used as the reference to assess the temperature measurement for Machine 10, to reassess the performance for Machines 15 and 16, and provide additional test points for Machine 9 to undertake the assessment. The data is shown below in Figure 7.1 and Figure 7.2.

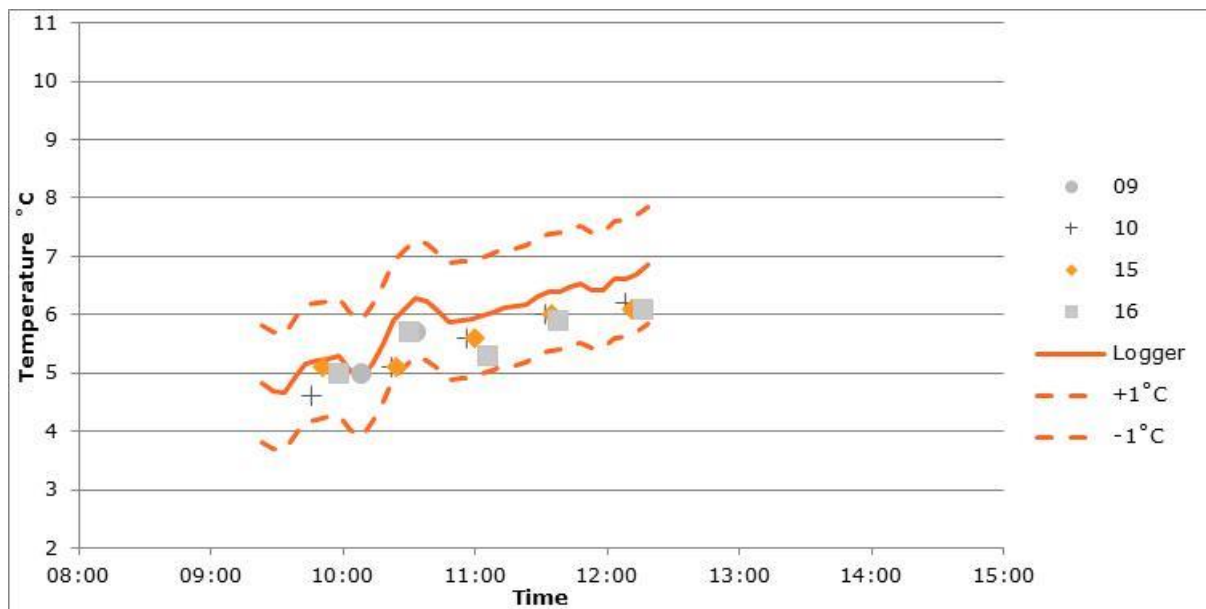


Figure 7.1 Comparison of crews' measurements against reference – Temperature test point 1, reserve day

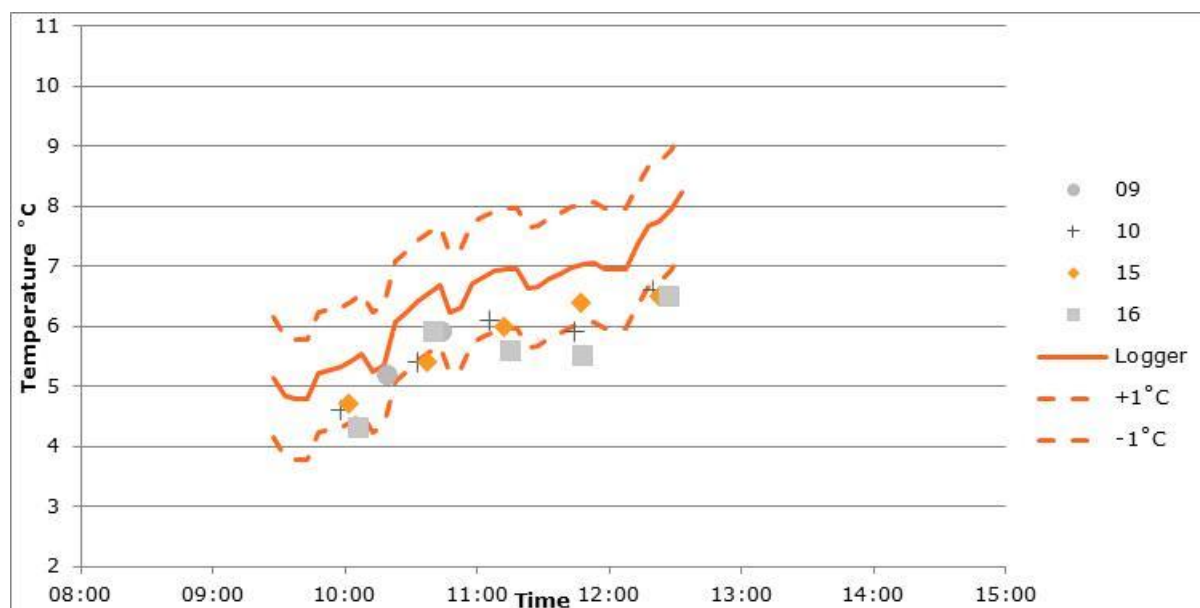


Figure 7.2 Comparison of crews' measurements against reference – Temperature test point 2, reserve day

The difference between the operators' measured values and the reference, and the performance band awarded to these machines are shown in Table 7.2 (tests 1, 2 and 3 for Machine 9 are from the main trial day). If the value is more than 1°C away then it is highlighted in bold red text.

Table 7.2 Difference between operators measured values and the reference – reserve day

Machine	Difference between measured temperature and reference (°C)										Performance band
	Test 1		Test 2		Test 3		Test 4		Test 5		
	1	2	1	2	1	2	1	2	1	2	
9	-0.5	-0.7	-0.4	-0.2	-0.8	-0.5	0.0	-0.2	-0.4	-0.8	High
10	-0.6	-0.7	-0.04	-1.0	-0.3	-0.7	-0.3	-1.1	-0.4	-1.1	Medium
15	-0.1	-0.6	-0.8	-1.0	-0.3	-0.9	-0.4	-0.6	-0.5	-1.2	High
16	-0.2	-1.1	-0.4	-0.7	-0.7	-1.4	-0.5	-1.5	-0.6	-1.2	Medium

7.3 Deflection readings

7.3.1 Results from reserve day

The results from the five laps undertaken on the reserve day are given below.

Table 7.3 Between run standard deviation for main running day additional laps (day 2)

Machine number	HECP_01		HECP_02		HECP_03	
	NS	OS	NS	OS	NS	OS
3	1.9	3.5	9.8	7.1	15.1	9.2
5	5.9	3.1	7.8	6.5	9.0	9.0
9	4.0	2.8	15.1	13.1	9.5	12.0
10	0.6	2.1	10.0	5.6	17.0	10.7
15	5.0	1.8	9.1	10.0	11.9	8.2
16	1.7	0.6	7.2	13.4	8.5	11.4

From Table 7.3 it can be seen that the between run standard deviation is comparable for these devices.

Table 7.4 Mean deflection (μm) by section: Reserve day (day 3)

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
3	43	36	201	154	121	111	122	100
5	52	45	214	172	149	135	138	117
9	51	52	228	184	126	127	135	121
10	61	53	228	190	151	136	146	126
15	55	59	228	192	141	142	141	131
16	47	49	215	177	139	133	134	120
Mean	52	49	219	178	138	131	136	119
BESD	6.1	8.0	10.9	14.1	12.0	10.8	8.3	10.6
BESD criterion	11.2	11.1	15.5	14.5	13.4	13.2	13.4	12.9
CoV	11.8%	16.2%	5.0%	7.9%	8.7%	8.3%	6.1%	8.9%

Table 7.5 Deviation (μm) from overall mean deflection by section: Reserve day (day 3)

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
3	-8.4	-13.4	-17.9	-24.2	-16.6	-19.6	-14.3	-19.0
5	0.9	-3.6	-4.9	-6.1	10.9	4.1	2.3	-1.9
9	-0.1	3.2	9.1	5.7	-11.7	-3.7	-0.9	1.7
10	9.1	4.2	8.7	11.5	13.2	5.1	10.3	7.0
15	3.1	9.8	8.8	14.3	3.0	11.9	5.0	12.0
16	-4.6	-0.1	-3.8	-1.2	1.2	2.2	-2.4	0.3
2x BESD criterion	22.4	22.3	31.0	28.9	26.8	26.5	26.8	25.9
3x BESD criterion	33.6	33.4	46.5	43.4	40.2	39.7	40.1	38.8

It can be seen from these tables that the BESD criterion is met on both wheel paths for the average of the site and for all sections. In addition, no machine is more than 2x BESD criterion away from the fleet mean on any section/wheel path.

However, as with the analysis done for Machine 3 (see Section 6.5) it is necessary to combine this dataset with the main trial data to confirm that the fleet distribution is sensible when Machines 9 and 10 are included.

7.3.2 Main trial day and reserve day combined

The average from the two datasets for the machines acting as reference and the calculated ratio is shown in Table 7.6

Table 7.6 Reference data values and estimation ratio

	HECP_01		HECP_02		HECP_03	
	NS	OS	NS	OS	NS	OS
Average main trial day	50	50	211	178	139	135
Average reserve day	49	47	215	174	137	130
Ratio	1.00	1.06	0.98	1.02	1.02	1.04

The combined datasets (main trial day and the reserve day) are shown below in Table 7.7 and Table 7.8.

Table 7.7 Mean deflection (μm) by section: Combined data

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
2	57	54	225	185	149	140	143	126
3	43	37	201	162	125	109	123	102
5	51	47	213	179	151	140	138	122
8	48	44	202	165	139	123	130	111
9	52	55	224	188	128	131	134	125
10	61	56	223	194	153	141	146	130
12	46	44	206	161	136	126	129	111
14	65	60	233	198	151	150	149	136
15	53	60	211	185	142	154	135	133
16	51	54	217	184	140	138	136	125
Mean	53	51	215	180	141	135	136	122
BESD	6.6	7.7	10.8	13.1	9.8	13.3	8.1	10.8
BESD criterion	11.2	11.2	15.4	14.5	13.5	13.4	13.4	13.0
CoV	12.5%	15.0%	5.0%	7.3%	6.9%	9.8%	6.0%	8.9%

Table 7.8 Deviation (μm) from overall mean deflection by section: Combined data

Machine number	HECP_01		HECP_02		HECP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	OS
2	4.2	2.3	9.3	5.3	7.4	4.7	7.0	4.1
3	-9.7	-14.5	-14.7	-18.2	-16.7	-26.4	-13.7	-19.7
5	-1.6	-3.7	-2.3	-1.0	9.3	4.7	1.8	0.0
8	-4.3	-7.0	-13.9	-15.5	-1.9	-11.9	-6.7	-11.5
9	-1.1	3.9	8.3	7.7	-13.4	-3.5	-2.1	2.7
10	8.1	4.9	8.0	13.7	11.8	5.6	9.3	8.1
12	-6.3	-6.8	-9.3	-18.7	-5.6	-9.2	-7.1	-11.6
14	12.3	8.6	17.3	17.4	9.4	14.6	13.0	13.5
15	0.1	9.2	-4.7	5.3	0.9	18.8	-1.2	11.1
16	-1.7	3.2	2.0	3.9	-1.2	2.7	-0.3	3.3
2x BESD criterion	22.5	22.4	30.8	29.0	27.0	26.7	26.8	26.0
3x BESD criterion	33.7	33.6	46.2	43.5	40.5	40.1	40.2	39.1

After combining the datasets it can be seen that the BESD criterion is met for both the NS and OS wheel paths and the deviation from the fleet mean is suitable. Therefore all ten machines are deemed suitable with regards to deflection measurement.

8 Conclusions

The 2017 National Deflectograph accreditation trials were held on the Horiba-MIRA proving grounds by TRL on behalf of the Highways England in February/March 2017. Ten of the machines in the current UK fleet attended the trial.

The following conclusions were drawn in relation to the various mandatory tests and assessments:

(I) Wheel Weights

Seven of the ten machines exceeded the front axle limits defined in (Design Manual for Roads and Bridges, 2008). Following a review of this matter in 2004, machines exceeding the front axle weight limits are regarded as acceptable provided that they perform satisfactorily in the dynamic tests. All of the machines were within the rear wheel weight limits. Therefore all ten machines that participated in the 2017 trial are deemed acceptable with regards to wheel weights.

(II) Deflection measurement

Following additional testing, all ten machines that participated in the 2017 trial met the criteria for deflection measurement.

(III) Distance measurement

Following additional testing, all ten machines that participated in the 2017 trial met the criteria for distance measurement.

The following conclusions were drawn in relation to the various additional tests and assessments:

(IV) Temperature measurement – measurement at depth

At the completion of the trial, eight of the ten machines achieved a high performance with regards to the measurement of temperature at depth. The remaining two machines achieved a medium performance.

A summary of the machines that attended the 2017 accreditation trial and the criteria that they met/performance achieved can be found in Appendix A.

For the 2017 trial, participants were also asked to provide air and surface temperature measurements (if they had the equipment fitted). Although this data was not formally assessed, it was used to review the criteria set and develop the assessment procedure to be used for future determination of performance. Based on the results obtained it is recommended that air and surface measurements should be formally assessed at the 2018 accreditation trial. This would involve amending the run log sheets provided to the operators to include specific boxes for the entry of the air and surface temperature measurements (along with the existing boxes for the 40mm measurements). In addition the air and surface temperature loggers (used for the reference dataset) should be located at the same locations as the 40mm temperature loggers (i.e. near the beam down and beam up positions) so that two sets of measurements are made each lap.

References

Brittain, S., & Sanders, P. (2012). *Deflectograph accreditation transitional trial (CPR1299)*. Crowthorne: TRL.

Design Manual for Roads and Bridges. (2008, May). *Volume 7 Section 3, HD29/08, Data for surface assessment*. London: The Stationery Office.

TRL. (2016). *Accreditation and Quality Assurance of Deflectograph Survey Devices*. <http://www.ukroadsliaisongroup.org/en/asset-condition/road-condition-information/data-collection/deflectograph.cfm>.

Acknowledgements

The author wishes to thank the operators of the Deflectograph devices for their co-operation in the accreditation process. Particular thanks to the operators that took part on day 3 of the trial to aid the assessment of the machines which did not meet the criteria on day 2. The author is also grateful to David Gershkoff who carried out the technical review of this report, and to David Gardiner, Nick Lindley, Phil Morgan and Chris Torkington for their assistance with the trial.

Appendix A Machine identification

Table A.1 Machine identification

ID	Operator at trial date	Registration number	Performance achieved		
			Deflection	Distance	Temperature at depth
2	PTS Ltd	L697 BKR	Pass	Pass	High
3	TRL Ltd	B180 FBL	Pass	Pass	High
5	WDM Ltd	D962 JRU	Pass	Pass	High
8	WDM Ltd	BYW 80V	Pass	Pass	High
9	WDM Ltd	VGW 182X	Pass	Pass	High
10	WDM Ltd	F569 JBB	Pass	Pass	Medium
12	WDM Ltd	EOU 230W	Pass	Pass	High
14	Lincolnshire County Council	B195 CFW	Pass	Pass	High
15	DoE Northern Ireland	ACZ 3268	Pass	Pass	High
16	WDM Ltd	B880 XOY	Pass	Pass	Medium

Appendix B Layout of test sections at Horiba-MIRA

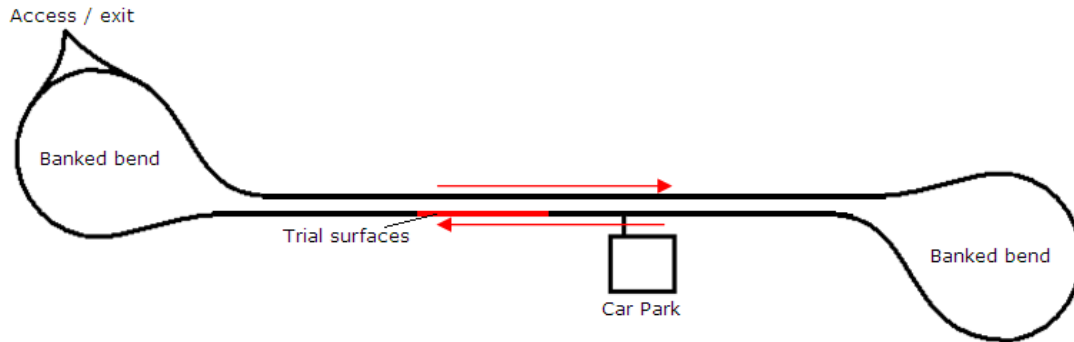


Figure B.1 Test route on the Horiba-MIRA twin straights

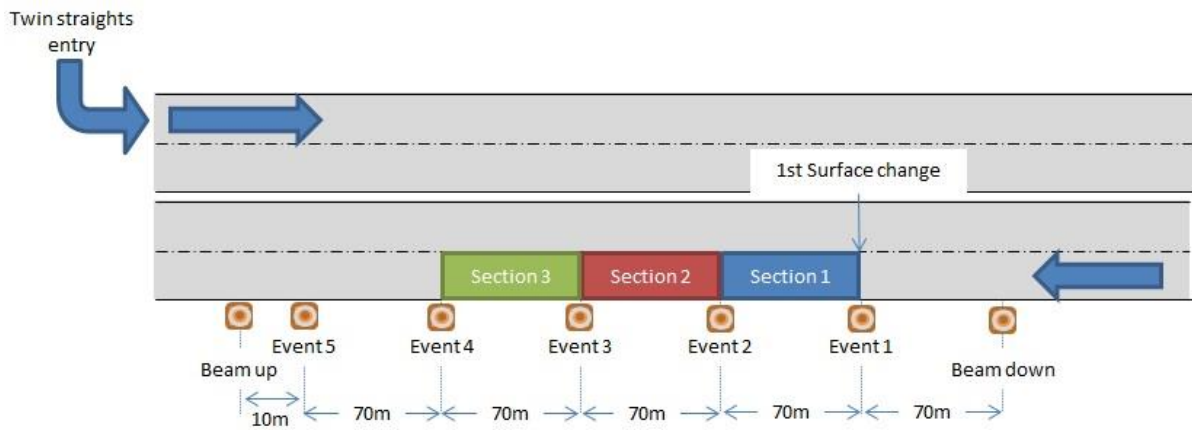


Figure B.2 Location of marker cones and test sections on Horiba-MIRA twin straights

Appendix C Construction details for Horiba-MIRA test sections

Table C.1 Design construction of Horiba-MIRA site

Section	Nominal construction details and material type (mm)			
	Surface course	Binder course	Total asphalt thickness (mm)	Sub-base
HECP_01	30 TSC	235 EME2	270	200mm C8/10 HBM
HECP_02	35 TSC	170 DBM	200	250mm 6F1 granular capping material
HECP_03	30 TSC	170 EME2	200	200 Type 1 granular material

Notes: TSC = CI 942 Thin Surface Course EME2 = Enrobé à Module Élevé, DBM = Dense Bitumen Macadam, HBM = Hydraulically Bound Material, 6F1 = Selected granular capping.

Table C.2 Construction details for Horiba-MIRA site from cores

Section	Post Construction Results from cores (mm)			
	Surface course	Binder/ Binder+ base courses	Total asphalt thickness (mm)	Base (mm)
HECP_01	42 TSC	228	270	217 (HBM)
HECP_02	37 TSC	158	192	-
HECP_03	35 TSC	191	226	-

Notes: TSC = CI 942 Thin Surface Course EME2 = Enrobé à Module Élevé, DBM = Dense Bitumen Macadam, HBM = Hydraulically Bound Material

Table C.3 Construction details for Horiba-MIRA site from GPR

Section	Post Construction Results from cores (mm)			
	Minimum	Average	Maximum	Material
HECP_01	192	242	272	Asphalt
	166	188	215	HBM
	388	431	468	Total bound thickness
HECP_02	167	192	240	Asphalt
HECP_03	167	199	240	Asphalt

Notes: HBM = Hydraulically Bound Material

Highways England 2017 National Deflectograph Accreditation Trial



A key element for the successful maintenance of a road network is accurate, reliable and consistent survey data. To this aim, Highways England commissions annual accreditation trials for the Deflectograph devices supported by ongoing QA for the devices. In order to undertake accredited surveys, the survey devices are required to meet the mandatory criteria of the trial.

This report covers the 2017 accreditation trial run by TRL and held on the Horiba-MIRA proving ground between 28th February and 1st March 2017.

Other titles from this subject area

- PPR 942** Highways England 2016 National Deflectograph Accreditation Trial. S Brittain. 2020
- PPR 943** Highways England 2015 National Deflectograph Accreditation Trial. S Brittain. 2020
- CPR1845** Highways Agency 2014 National Deflectograph Accreditation Trial. S Brittain. 2014
- CPR1619** Highways Agency 2013 National Deflectograph Accreditation Trial. S Brittain. 2013

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ISSN 2514-9652

ISBN 978-1-913246-27-3

PPR941