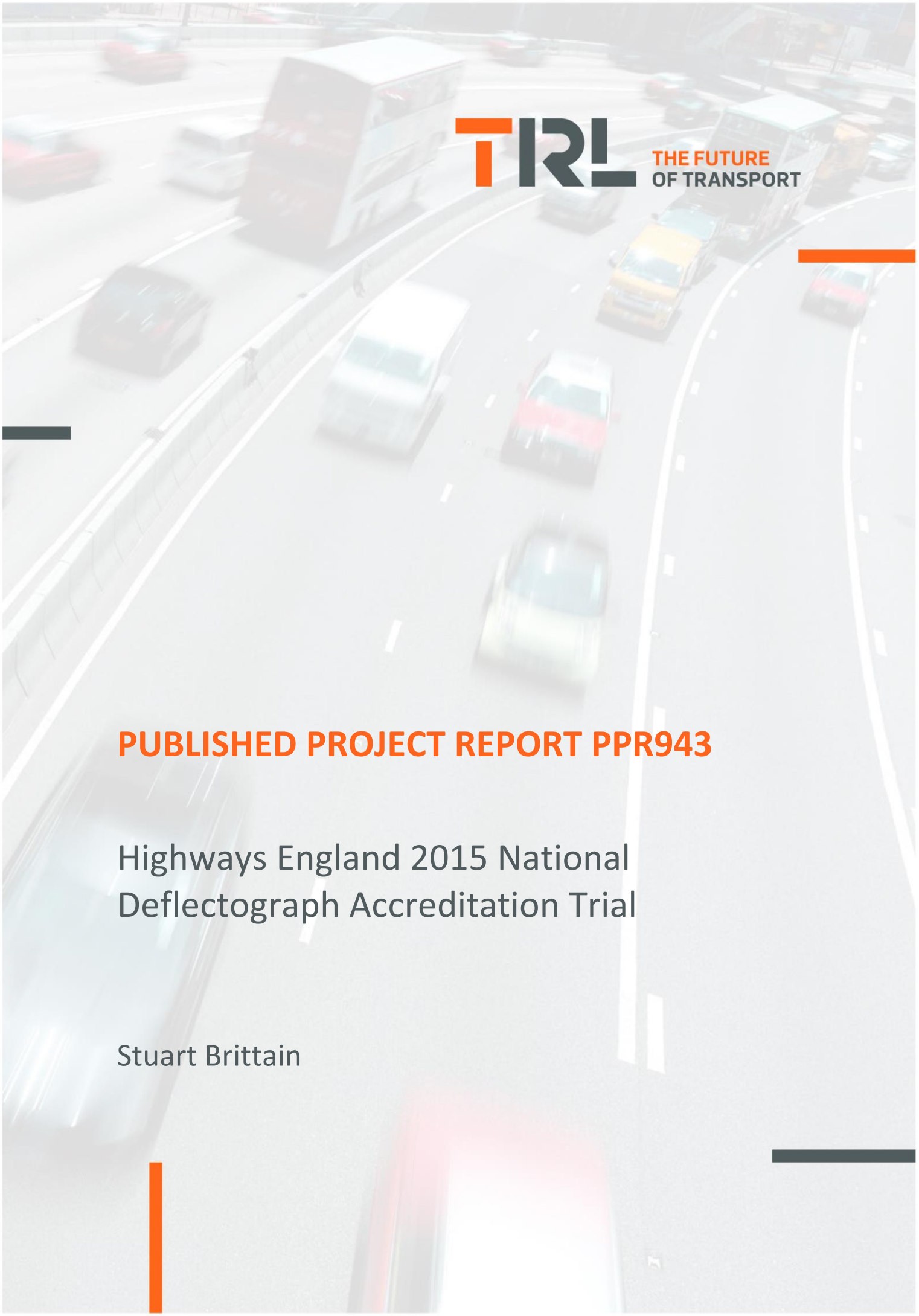

THE FUTURE OF TRANSPORT

PUBLISHED PROJECT REPORT PPR943

Highways England 2015 National Deflectograph Accreditation Trial

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Report details

Report prepared for:	Highways England		
Project/customer reference:	422/4/45/12 - PAAQA		
Copyright:	© Transport Research Laboratory		
Report date:	09/01/2020		
Report status/version:	1.01		
Quality approval:			
Stuart Brittain (Project Manager)	**Stuart Brittain**	Brian Ferne (Technical Reviewer)	**Brian Ferne**

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Contents amendment record

This report has been amended and issued as follows:

Version	Date	Description	Editor	Technical Reviewer
1.00	18/05/2015	Version supplied to Highways England for comment.	S Brittain	B Ferne
1.01	05/09/2016	Issued version	S Brittain	B Ferne
1.02	09/01/2020	Converted to published report for historic continuity	S Brittain	B Ferne & P Langdale

Document last saved on:	09/01/2020 15:41
Document last saved by:	Brittain, Stuart

Executive summary

Deflectograph accreditation trials are held annually by TRL on behalf of the Highways Agency. 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 2015 trials were held during the period 3rd to 4th March 2015. The site used was the twin horizontal straights of the MIRA proving ground. This was the twentieth year in which TRL took full responsibility for the planning and running of the trials. Ten machines attended the trial.

The format of the 2015 trial was broadly consistent with that of recent years, comprising two scheduled days of testing and one contingency day. The 2015 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 not required for the 2015 trial.

All ten machines that participated in the March 2015 accreditation trial met the deflection requirements of the HA's annual accreditation trial and can therefore be considered for approval to survey the HA's strategic road network.

All ten machines provided temperature data and these were found to be of acceptable quality.

Five machines had front axle weights that exceeded the published limits. This excess weight (on the front axle) seems to have shown no measurable effect over a number of accreditation trials. This matter was reviewed by TRL and HA following the 2004 trial. It was decided that, while revising the standard tolerances may be considered at an appropriate point in the future, for the time being the weight difference would be noted but the machines would continue to be regarded as acceptable.

Contents

1 Introduction

Deflectograph accreditation trials are held annually by TRL on behalf of the Highways Agency. The objective is to monitor the performance of all Deflectographs operating on the Highways Agency'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 2015 trials were held during the period 3rd to 4th March 2015. The site used was the twin horizontal straights of the MIRA proving ground which is further discussed in section 2. This was the twentieth year in which TRL took full responsibility for the planning and running of the trials but was the fourth full trial at MIRA. Ten machines attended the trial.

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 the Highways Agency, 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 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 the Highways Agency arranged for a length of the nearside lane on one of the straights to be reconstructed, producing three sections of different constructions/strength levels. These three sections were identified for use in the accreditation of Deflectographs. These sections are referred to as HACP_01, HACP_02 and HACP_03 (Highways Agency Calibration Pavement) during this report. The sections are all 70m in length (however we exclude the beginning and end 5m to help avoid alignment issues resulting in 60m sites) and the layout and test route is shown in Figure C.1 in Appendix C. Nominal construction details of the test sections can be found in Appendix D.

In order to demonstrate the suitability of the sections identified at MIRA, a transitional trial was held on the 12th and 13th September 2011. 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 proposed new procedures and sections at MIRA. The work demonstrated that the MIRA site was suitable for the accreditation of Deflectograph machines. As well as the trial process, the accreditation criteria were reviewed following this trial.

The trial process and the criteria used for the 2015 trial are discussed in sections 3 and 4 respectively.

2.2 Variability of NS deflections on HACP_02

During the transitional trial it was found that there was a localised high deflection point on the NS wheel path for section HACP_02. This high deflection point was traversed in some but not all runs and only affected the NS wheel path of section HACP_02. This is illustrated in Figure 2.1 which is a plot of some of the data collected at the transitional trial.

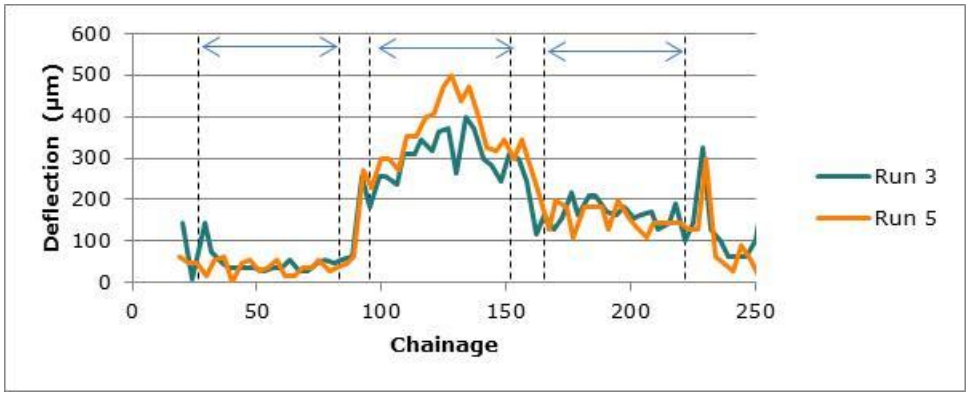

Figure 2.1 Example plot of nearside deflections for MIRA test sections observed during the transitional trial

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, so that any deviation in the test line would cause a cone to be knocked over (as shown in Figure 2.1).

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 section 2. It was therefore decided that these cones will be placed along HACP_02 for future trials in order to reduce this variability.

3 Trial format

The format of the 2015 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 repeated in the trials since.

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. The advance inspections were supplemented by a spot-check inspection of one or more machines by TRL staff during the 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 was 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' temperature probes are collected up so that they can be 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 used to carry out 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.

After completion of the first lap the crew are asked to perform a static calibration (the first lap of day 2 is always disregarded and is used to warm-up the machines). The machines are then cleared to conduct the main running trials. After completion of the main running trials the crews are asked to perform another static calibration.

Deflection measurements are made over the three test sections, and temperature measurements are collected from two pre-drilled holes (40mm depth) located near section 1 and 3. 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.

The Design Manual for Roads and Bridges in HD29/08 (The Highways Agency et al, 2008b) sets a **maximum rate of temperature increase of 2.5ºC per hour** at 40mm for deflection testing. This requirement is intended to ensure that temperature corrections used to correct deflections to a standard temperature of 20ºC 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 for sections HACP_01 and HACP_03 at 40 and 100mm depths to inform any conclusions drawn. Automatic data-loggers are used to provide a record every minute during the running period.

While the machines are running, TRL staff made inspections of the conspicuity and 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

4.1 Wheel weights

The running weight of a Deflectograph inevitably varies during a period of testing depending on the amount of fuel carried and the number (and weight) of crew members on board. For this reason, crews are asked to arrive with the fuel tank approximately half full and the machines are weighed with the crew who normally work the machine in their usual positions on the vehicle. The wheel weights were measured simultaneously on all four wheels using calibrated weigh-pads. The permitted weights for the vehicle plus crew are stipulated in HD 29/08 (The Highways Agency et al, 2008a) as 4275kg-4725kg on the front axle and 2857kg-3493kg on each of the rear wheel assemblies.

4.2 Deflection criteria

As discussed previously, the criteria used for the assessment of Deflectographs were reviewed during the transitional trial held in September 2011. A primary focus of this review was to determine accreditation criteria which could be used for all three of the test sections (rather than for just on the reference section as in previous trials).

These test sections cover a range of deflections, and it was found that the coefficient of variation (CoV is calculated by dividing the standard deviation by the mean) varied considerably between the sections. Therefore the approach used in previous years for the assessment of fleet variability, based on the CoV of one section with medium deflections, was not suitable for use on three test sections with a range of deflections.

Analysis of the data from the transitional trial suggested that a criterion which varied with deflection level and was based on the between Equipment standard deviation (BESD) should be used.

The criteria used for the identification of outliers used in previous years were found to be suitable for use with multiple test sections and did not need to be modified.

Therefore, the following criteria were used for this accreditation trial:

1. In order to limit the overall variability of the fleet, a restriction is placed upon the maximum between Equipment standard deviation (BESD) allowed on the three test sections (HACP_01, HACP_02 and HACP_03). The maximum BESD is dependent on the fleet mean deflection level for the section and is given in equation 4.1 below. This criterion must be met on both wheel paths of all three test sections.
2. Individual machines must fall within three times the BESD criteria of the overall mean on both wheel paths of all three test sections (HACP_01, HACP_02 and HACP_03). Any that lie between 2 and 3 times the BESD criteria will be investigated in detail to see whether their mean result was affected by any external factor, such as an inconsistent run, but the machine may be rejected unless very close to the cut-off.

$$Maximum\ BESD(\mu m) = 0.0257\ \times Fleet\ mean\ deflection\ (\mu m) + 9.88 \qquad \textbf{4.1}$$

It will be necessary to keep the criteria under review and to apply them in full consideration of the data for a particular trial and in the light of experience over several trials. There may also be circumstances when it is clear that a minor infringement on one of the section wheel paths is clearly a statistical random error not reflected as a general bias shown on other sections.

4.3 Distance criteria

The distance check is not a formal requirement for accreditation. However the need for the check had been identified during the transitional trial as a means of assisting in aligning the data and to provide an additional diagnostic tool in the event of unexpected variations in the measured deflections on the trial sections. The procedure involves setting out a marked length and asking the Deflectograph crews to record the length using their Deflectograph.

In Deflectograph data, markers are attached to the nearest deflection reading (rather than recording the elapsed distance between the starting of the recorder and the marker point). Deflection readings are spaced between three and four metres apart and therefore an error of up to 4m could be expected. The criteria used to assess the machines are given in Table 4.1.

Table 4.1 Distance Criteria

	Test Criteria
High	80% within 5m of reference
Medium	80% within 7.5m of reference
Low	80% within 10m of reference
Very Low	Otherwise

4.4 Temperature criteria

The Deflectograph operators are asked to record temperatures from pre-drilled holes on each survey lap so that the quality of their temperature data can be assessed. The pre-drilled holes are on section HACP_01 and HACP_03 and are 40mm deep.

This data is assessed by comparing the results to the values recorded by the data loggers. The criteria used to assess the machines are given in Table 4.2.

Table 4.2 Temperature Criteria

	Test Criteria
High	80% of the measurements are within 1^{o}C of the reference
Medium	50% of the measurements are within 1ºC of the reference
Low	15% of the measurements are within 1ºC of the reference
Very Low	Otherwise

5 Results – Inspection day (3rd March 2015)

5.1 Inspections

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

5.2 Wheel weights

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

Machines 2, 5, 9, 10 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 HA 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.

Table 5.1 Deflectograph weight distributions from 3 March 2015

Machine	Weight distribution including crew (kg)						
	Front NS	Front OS	Total Front	Rear NS	Rear OS	Total Rear	Total Machine
2	2305	2680	**4985***	3315	3250	6565	11550
3	2395	2310	4705	3335	3455	6790	11495
5	2360	2390	**4750***	3395	3270	6665	11415
8	2175	2320	4495	3450	3250	6700	11195
9	2380	2430	**4810***	3155	3210	6365	11175
10	2340	2465	**4805***	3305	3415	6720	11525
12	2240	2225	4465	3440	3240	6680	11145
14	2270	2380	4650	3275	3400	6675	11325
15	2425	2510	**4935***	3310	3470	6780	11715
16	2290	2275	4565	3275	3255	6530	11095

* Exceeds tolerance defined in HD29/08 (see comment in section 5.2)

5.3 Warm-up lap

Following the processing of data from the warm-up lap it was found that the spread of machines was larger than expected. Some machines were identified for investigation and were re-tested. Following re-testing the variation of the fleet was in line with previous years' performances from one run.

5.4 Temperature probes

The operator's temperature probes were collected up and allowed to stabilise at the same temperature (using a bucket of water). From this testing it was identified that all but two probes were within ±0.5˚C of the average. The operators for these machines had additional temperature probes which were within ±0.5˚C of the average and were used for the testing on the main trial day.

6 Results – Main trial day (4th March 2015)

6.1 Calibrations

After the warm-up lap on the main trial day each crew carried out a static calibration of their machine. A further calibration was requested following the main running trials. No machines were identified to TRL as not meeting the limits specified in HD29/08 (The Highways Agency et al, 2008a).

6.2 Distance check

A distance check length was set up on the track to assess the distance measurement systems on the machines. This length was modified part way through testing (without notifying the operators) to a different length. The two lengths used were 575m and 545m. The difference between the measured length from each machine and the references, along with the overall performance are given in Table 6.1. The differences are highlighted to indicate the performance bands given in section 4.3.

Table 6.1 Distance checks

Machine	Difference between measured length and the reference (m)					Performance band
	1	2	3	4	5	
2	-4.1	-4.1	-3.1	-3.2	-5.2	High
3	-1.1	-1.1	-0.1	-6.2	-3.2	High
5	2.9	4.9	3.9	-4.2	1.8	High
8	-1.1	-1.1	-2.1	-2.2	-3.2	High
9	3.9	2.9	5.9	7.8	3.8	Medium
10	3.9	3.9	-0.1	1.8	-1.2	High
12	2.9	0.9	-1.2	-1.2	-2.2	High
14	4.9	3.9	-2.1	-1.2	-1.2	High
15	0.9	-0.1	-2.1	-2.2	0.8	High
16	4.9	4.9	4.9	2.8	0.8	High

On examination of Table 6.1 it can be seen that 9 of the 10 machines achieved the high performance criterion for distance measurement and the remaining one (Machine 9) met the medium performance criterion for distance measurement.

6.3 Temperatures

6.3.1 Temperature pattern shown by the data loggers

The temperatures recorded at one-minute intervals by the data-loggers are shown (in separate graphs for the two sections monitored) in Figure 6.1 and Figure 6.2. These graphs also indicate the approximate periods during which the machines began each test run.

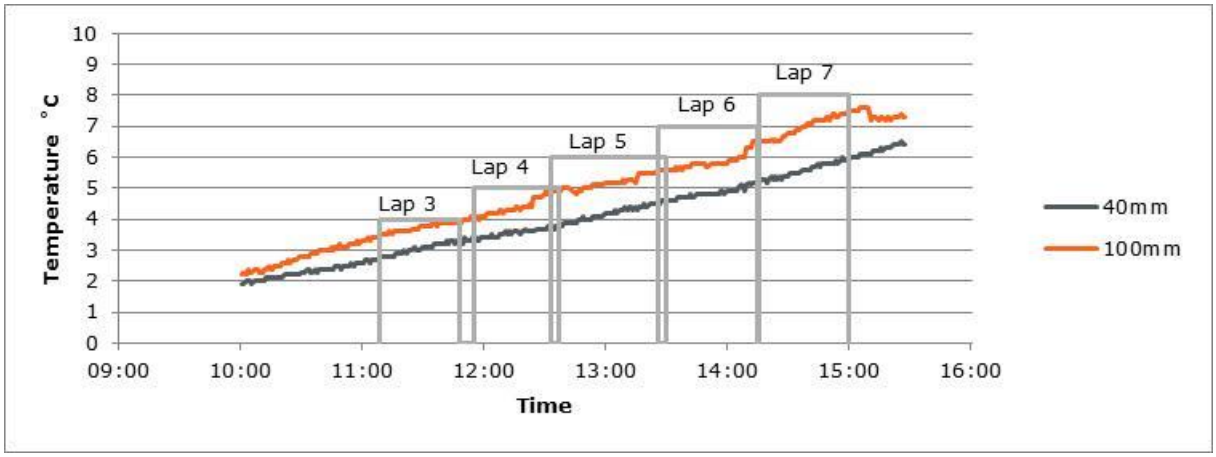

Figure 6.1 Temperatures for HACP_01 for the main trial day

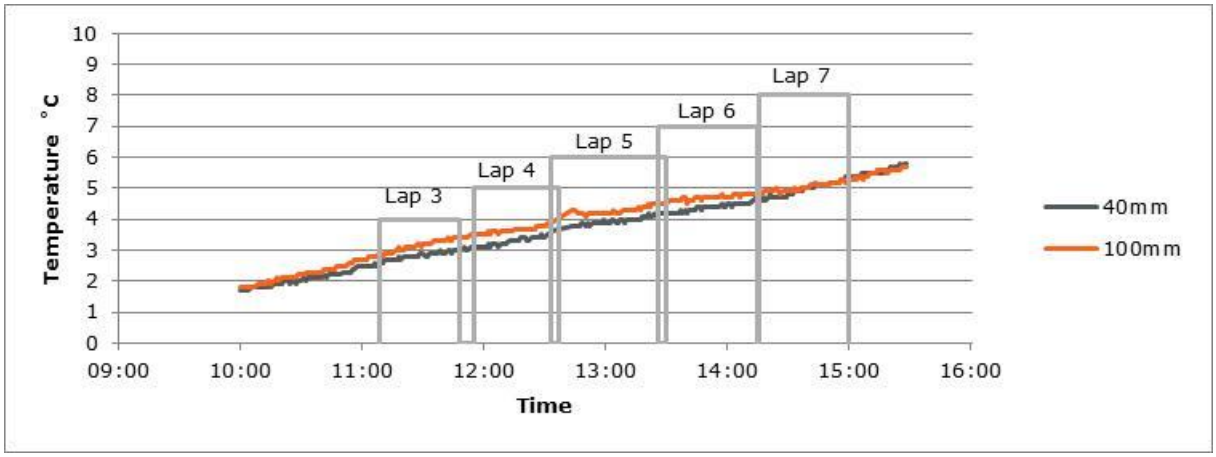

Figure 6.2 Temperatures for HACP_03 for the main trial day

The graphs show the temperatures rising on both sections during the day, with small differences between the depths as would be expected (at low temperatures you would expect the 40mm and 100mm values to be reasonably similar).

As discussed in section 3.2 HD29/08 sets a maximum rate of temperature increase of 2.5ºC per hour at 40mm for deflection testing. The variation of the rate of temperature change (at 40mm) calculated over 10 minute intervals with time is shown in Figure 6.3.

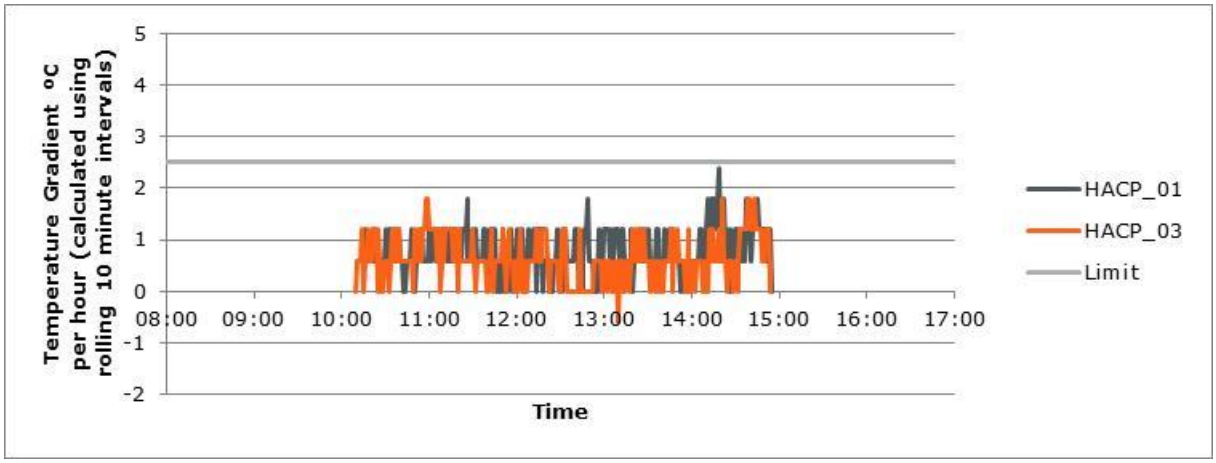

Figure 6.3 Temperature changes at 40mm depth (rolling 10 minute intervals) for the main trial day

The rate of temperature change with time at 40mm (using 10 minute intervals) remains within the suggested limit during all of the testing.

6.3.2 Temperatures recorded by operators

The Deflectograph crews made measurements of temperature from sections HACP_01 and HACP_03 at a 40mm depth. When this data was plotted it was found that the results from the Deflectograph crews were consistent with each other, but significantly different from the values obtained by the data loggers discussed above in Section 6.3.1 (the values supplied by the operators were higher than the values seen by the loggers). If the crews' results were compared to the results of the loggers then all of the operators would have been assigned either a low or very low performance for the measurement of temperature. This is unrealistic, especially given the observed clustering of the operators' measurements and the performance of these devices during the inspection day (see section 5.4). It is believed that the loggers might be producing lower values due to being kept in shadow (under a cone). This procedure should be reviewed for future trials.

Therefore, as for the deflection measurements, the average of the operator's measurements was used as the reference. This reference data is shown in Figure 6.4 and Figure 6.5 as continuous solid orange lines with a summary of the data in Table 6.2. Cells are highlighted in red and bold text if the value is not within 1ºC of the reference.

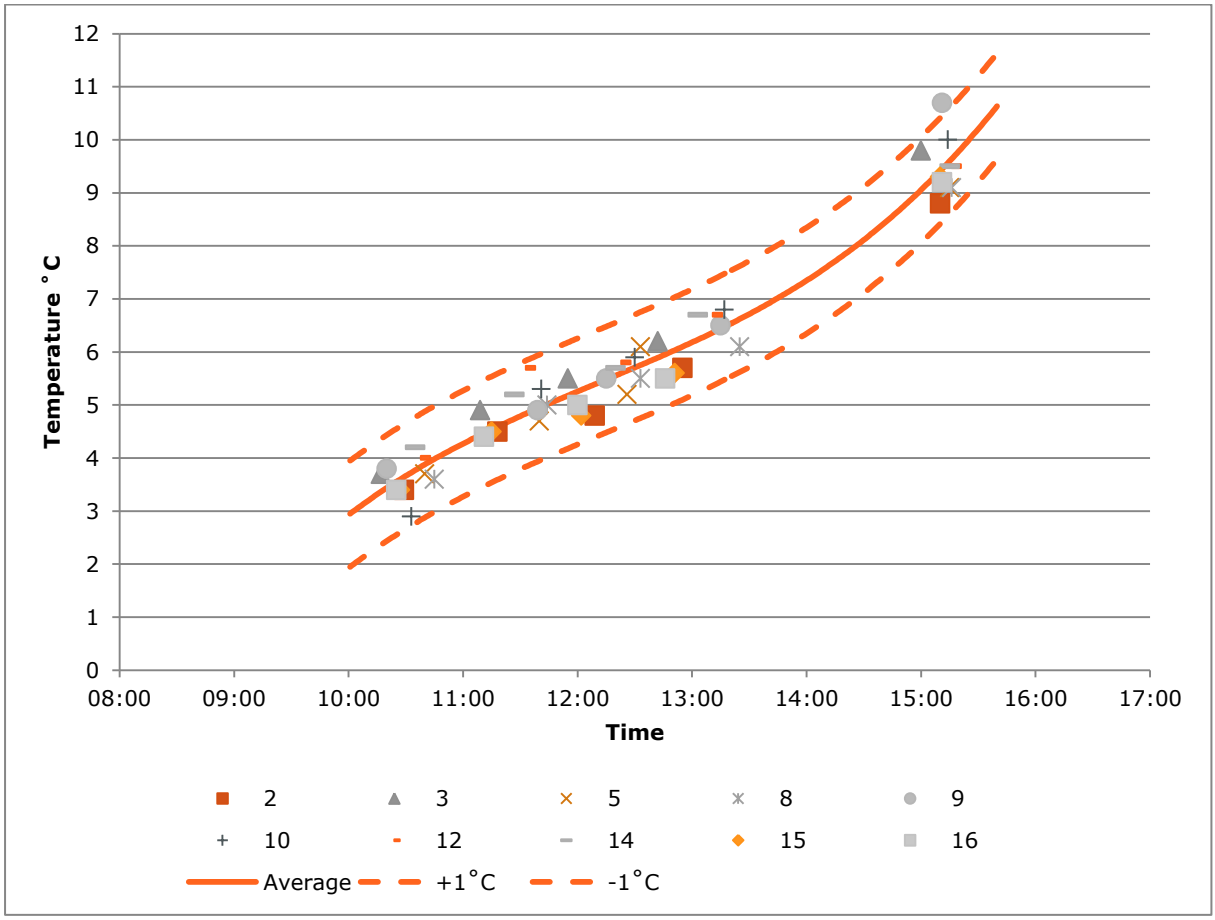

Figure 6.4 Comparison of crew's measurements against reference – Section HACP_01 main trial day

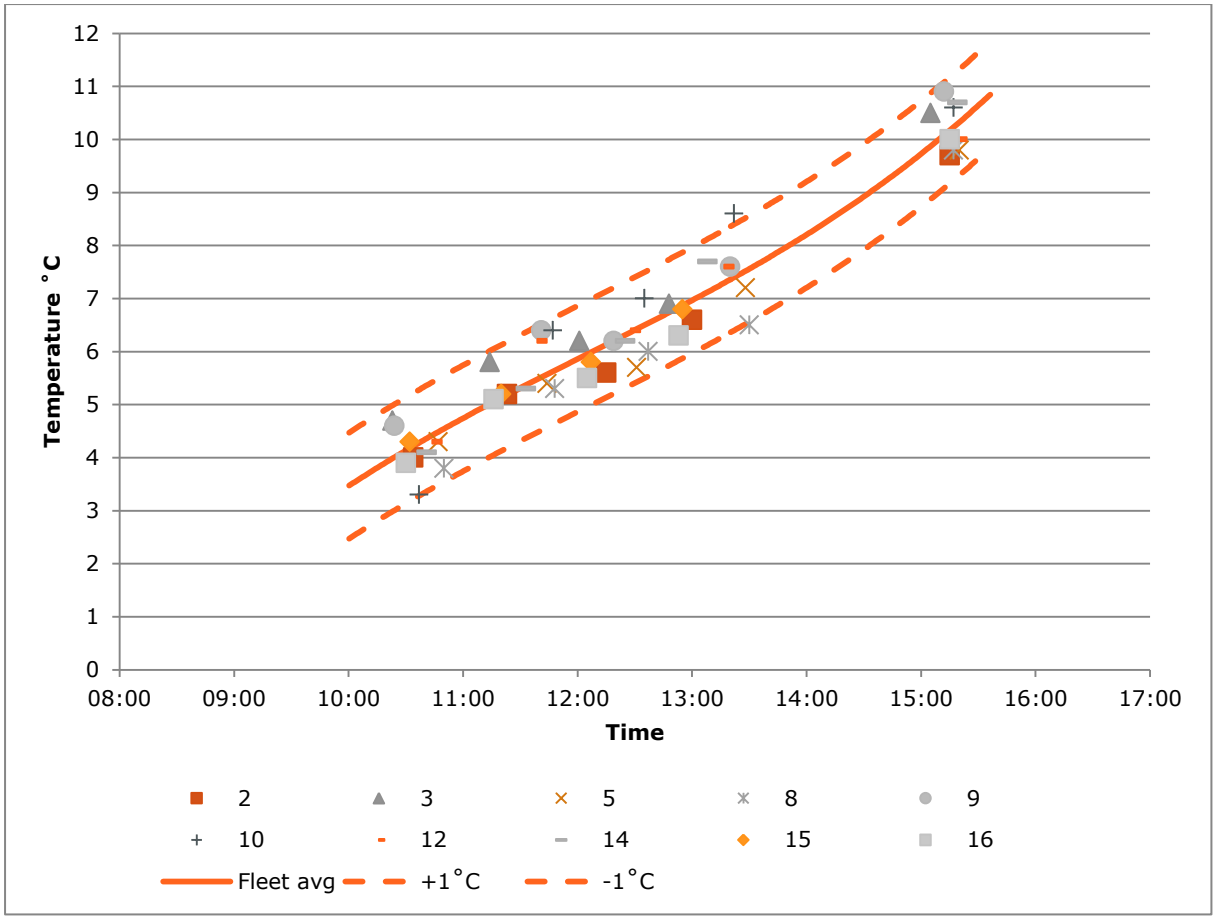

Figure 6.5 Comparison of crew's measurements against reference – Section HACP_03 main trial day

Table 6.2 Difference between operators measured values and the reference on HACP_01 and HACP_03

Machine	Difference between measured temperature and reference (ºC) on day 2, at 40mm									
	Test 1		Test 2		Test 3		Test 4		Test 5	
	S1	S3	S1	S3	S1	S3	S1	S3	S1	S3
2	-0.24	-0.20	-0.09	0.03	-0.59	-0.52	-0.40	-0.35	-0.60	-0.45
3	0.34	0.73	0.47	0.80	0.32	0.33	0.31	0.17	0.75	0.65
5	-0.17	-0.17	-0.25	-0.16	-0.44	-0.71	0.35	-0.30	-0.49	-0.50
8	-0.38	-0.73	-0.01	-0.33	-0.25	-0.52	-0.52	**-1.05**	-0.53	-0.41
9	0.37	0.61	-0.03	0.90	0.02	0.01	0.07	0.26	**1.26**	0.84
10	-0.82	-0.97	0.34	0.79	0.20	0.51	0.33	**1.22**	0.45	0.39
12	0.17	-0.11	0.87	0.73	0.20	0.04	0.34	0.32	-0.13	-0.27
14	0.43	-0.25	0.46	-0.06	0.15	-0.10	0.47	0.59	-0.09	0.43
15	-0.19	0.14	-0.04	0.09	-0.48	-0.18	-0.43	-0.06	-0.10	-0.15
16	-0.15	-0.22	-0.07	0.06	-0.25	-0.44	-0.45	-0.52	-0.24	-0.15

In order to meet the high performance criteria (given in section 4.4) at least 8 out of the 10 measurements need to be within 1 ºC of the reference. We can see that although there are

a few instances where the data is more than 1 ºC away from the reference, all of the machines met this criterion.

6.4 Deflection readings

On the main trial day the first lap (lap 1) is always disregarded as it is used to warm-up the machines prior to undertaking a beam calibration check. During Laps 1 and 2 machine 5 was found to be reading too high and machine 9 was found to be reading too low. The operators of these machines were notified and given the opportunity to investigate their machines before undertaking lap 3. The data from lap 3 onwards was then collected and analysed. The results from these laps (lap 3 onwards) is discussed below.

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 6.3.

Table 6.3 Between run standard deviation (runs 3-7) for the main running day (day 2)

Machine number	HACP_01		HACP_02		HACP_03	
	NS	OS	NS	OS	NS	OS
2	1.9	4.7	21.5	12.1	8.7	3.8
3	2.3	3.7	18.6	13.4	9.9	11.9
5	4.1	2.8	16.3	20.9	7.6	6.4
8	3.6	2.5	9.5	16.4	9.1	10.3
9	6.2	5.6	22.6	24.8	16.2	11.7
10	2.2	3.0	18.5	16.4	14.0	10.3
12	2.9	2.7	17.4	18.3	8.0	8.9
14	4.7	5.0	14.7	14.2	2.2	7.4
15	4.1	2.1	19.5	12.9	6.7	4.9
16	2.3	4.2	14.7	15.5	12.2	16.5

It can be seen from Table 6.3 that no machine was significantly more variable than the others.

6.4.2 Mean deflection values

Table 6.4 shows the mean deflections recorded on each section (for runs 3 to 7), together with summary statistics. Table 6.5 shows the deviations from the overall mean and these are highlighted if further than 2 or 3 times the BESD criteria, for each of the three sections.

Table 6.4 Mean deflection (µm) by section for the main running day (day 2)

Machine number	HACP_01		HACP_02		HACP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	NS
2	61	56	242	208	155	158	153	141
3	38	36	205	156	139	126	127	106
5	65	42	254	187	169	142	162	124
8	44	41	220	197	144	149	136	129
9	26	23	200	159	134	129	120	104
10	45	48	232	191	145	146	141	128
12	46	38	237	174	152	131	145	114
14	55	51	240	200	165	158	153	136
15	46	45	221	172	149	137	139	118
16	39	45	230	200	155	156	141	133
Mean	46	42	228	184	151	143	142	123
BESD	11.4	9.0	16.9	18.2	11.0	12.2	12.6	12.6
BESD criterion	11.1	11.0	15.7	14.6	13.8	13.6	13.5	13.0
CoV	24.5%	21.3%	7.4%	9.9%	7.3%	8.5%	8.9%	10.2%

Table 6.5 Deviation (µm) from overall mean deflection by section for the main running day (day 2)

Machine number	HACP_01		HACP_02		HACP_03		Average	
	NS	OS	NS	OS	NS	OS	NS	NS
2	14.3	13.4	14.3	23.4	4.4	15.4	11.0	17.4
3	-8.7	-6.4	-23.5	-28.6	-11.8	-17.4	-14.7	-17.5
5	18.2	-0.5	25.9	2.7	18.2	-1.5	20.8	0.2
8	-2.0	-1.8	-8.4	12.8	-7.0	6.1	-5.8	5.7
9	-20.4	-19.2	-27.8	-25.0	-16.3	-14.0	-21.5	-19.4
10	-1.2	5.9	3.8	6.4	-6.1	2.8	-1.2	5.0
12	-0.7	-4.7	8.9	-10.8	1.0	-12.4	3.0	-9.3
14	8.6	8.7	12.0	15.7	14.8	14.6	11.8	13.0
15	-0.5	2.7	-7.0	-12.5	-1.8	-6.1	-3.1	-5.3
16	-7.5	2.1	1.9	15.8	4.7	12.6	-0.3	10.2
2x BESD criterion	22.1	21.9	31.5	29.2	27.5	27.1	27.0	26.1
3x BESD criterion	33.2	32.9	47.2	43.9	41.3	40.7	40.6	39.1

It can be seen from these two tables that criteria for the spread of mean deflection values is not met on the NS wheel path for HACP_01 and on both wheel paths for HACP_02. This would typically mean that we would look to remove an outlier to improve the distribution of the fleet so that these criteria are met on all sections and all wheel paths (see section 4.2). However, when examining the deviations (Table 6.5) it can be seen that no machine is more than 2 x BESD away from the fleet mean. On further examination of the distributions of the machines (more clearly seen in the figures in Appendix B) it can be seen that the fleet is more spread out than in previous years rather than containing specific outliers. Considering

this, in combination with the fact that the machines meet the criteria for the average of the sections, means that all ten machines are considered as meeting the trial criteria for deflection measurement.

7 Conspicuity

The Regulations on conspicuity and signage for mobile works vehicles is covered in the "Traffic Signs Manual" (Chapter 8) and the "Safety at Street Works and Road Works - A Code of Practice", sometimes known as the "Red book" (It should be noted that the Red book was amended in 2014). To ascertain if the current Deflectograph fleet meet the current requirements a review of the conspicuity and signage of the Deflectograph fleet was undertaken at the trial. The review was conducted for information purposes and does not affect the outcome of the trial.

To review the conspicuity and signage of the Deflectograph fleet, a questionnaire was put together which was used as a check sheet to assess each machine. The results of these assessments are given in Appendix E.

8 Conclusions

The 2015 National Deflectograph accreditation trials were held on the MIRA proving grounds by TRL on behalf of the Highways Agency in March 2015. Ten of the machines in the current UK fleet attended the trial.

All ten of the machines that participated in the March 2015 accreditation trial met the requirements of the HA's annual accreditation trial with regards to deflection results and can therefore be considered for approval to survey the HA's strategic road network. It should be noted that this report may not be representative of the current accreditation position of the UK Deflectograph fleet. Changes may occur in accreditation status due to additional trials or machine failure since the time of the trials reported here.

Nine of the ten machines achieved a high performance rating for the measurement of distance; the remaining one achieved a medium performance rating.

All ten machines provided temperature data and the results were found to be within acceptable limits.

Machines 2, 5, 9, 10 and 15 had front axle weights over the limits defined in the DMRB. 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.

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 work described in this report was carried out in the Infrastructure division of the Transport Research Laboratory. The author is grateful to Brian Ferne who carried out the technical review and auditing of this report.

Appendix A Machine identification

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

Appendix B Mean deflections on Reference Sections – Main trial day

B.1 HACP_01

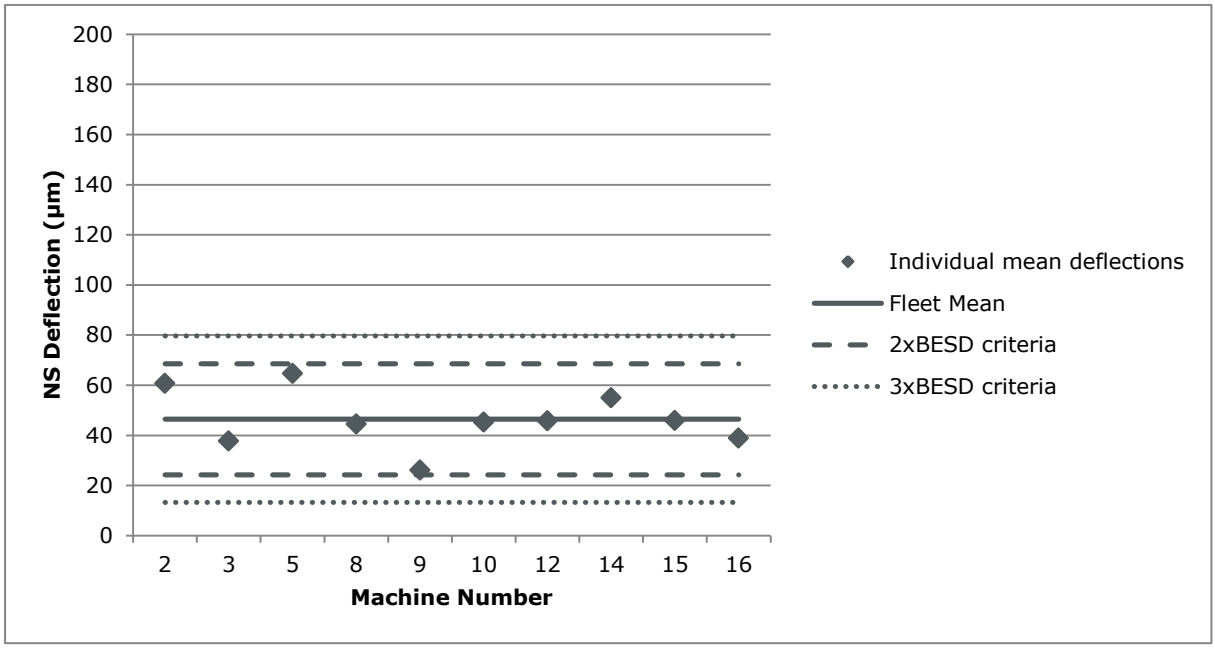

Figure B.1 All machine mean and individual mean deflections for the NS beam on HACP_01 for the main trial day

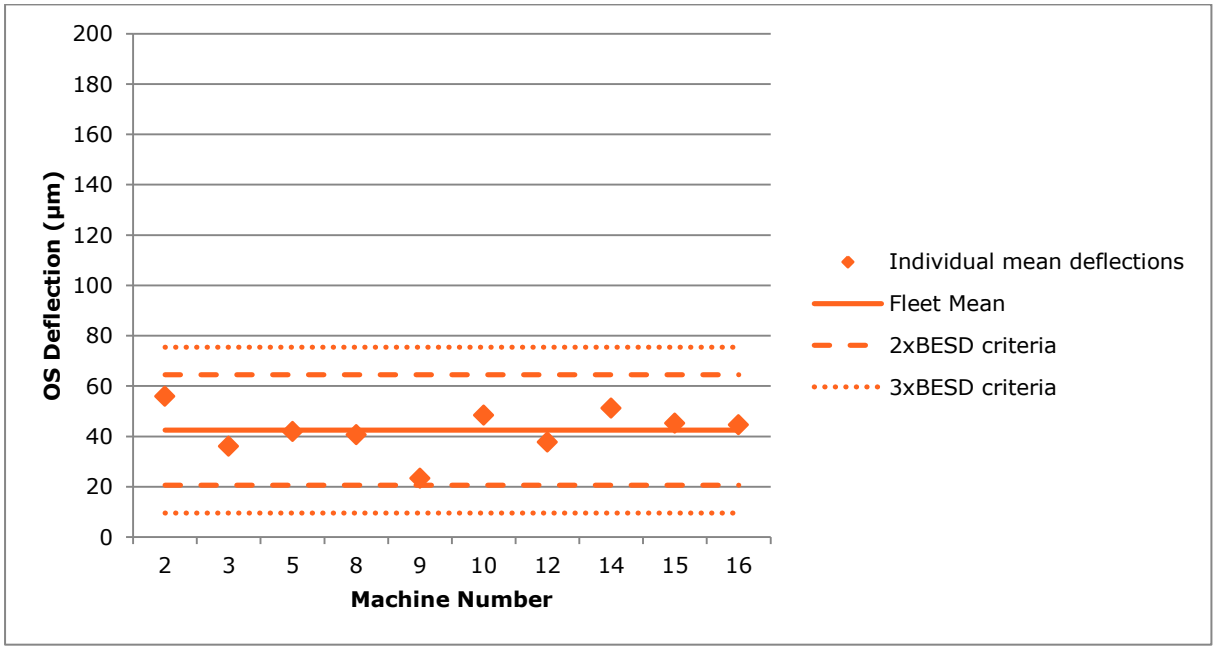

Figure B.2 All machine mean and individual mean deflections for the OS beam on HACP_01 for the main trial day

B.2 HACP_02

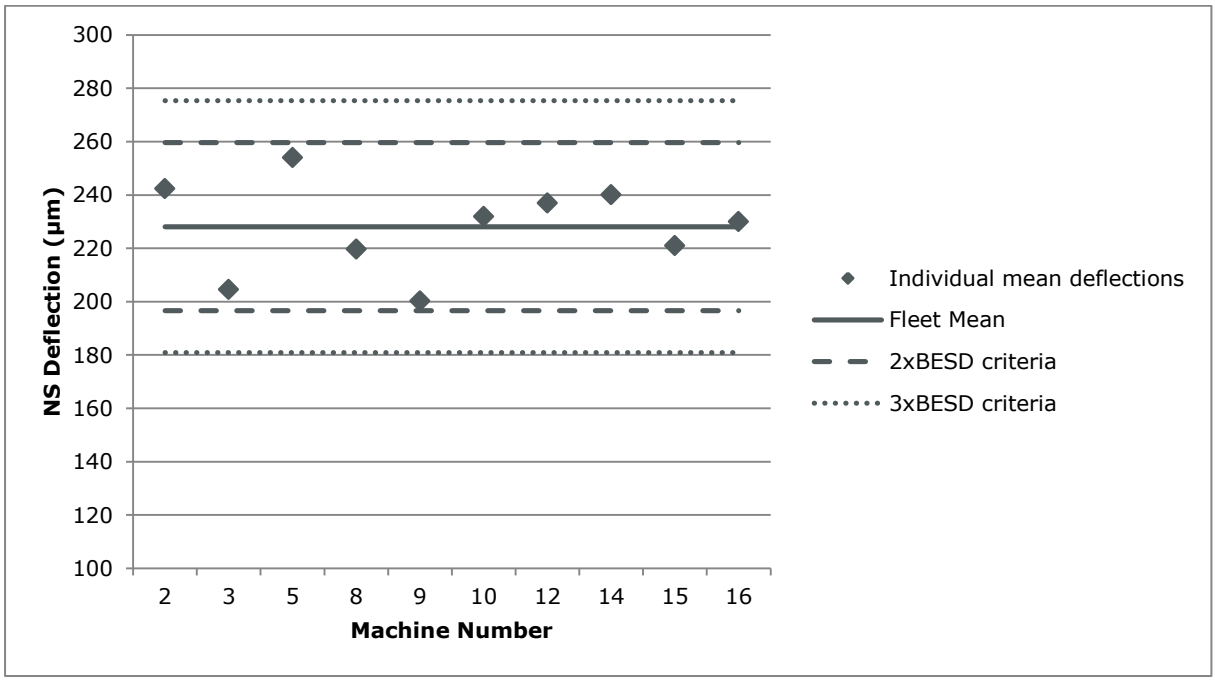

Figure B.3 All machine mean and individual mean deflections for the NS beam on HACP_02 for the main trial day

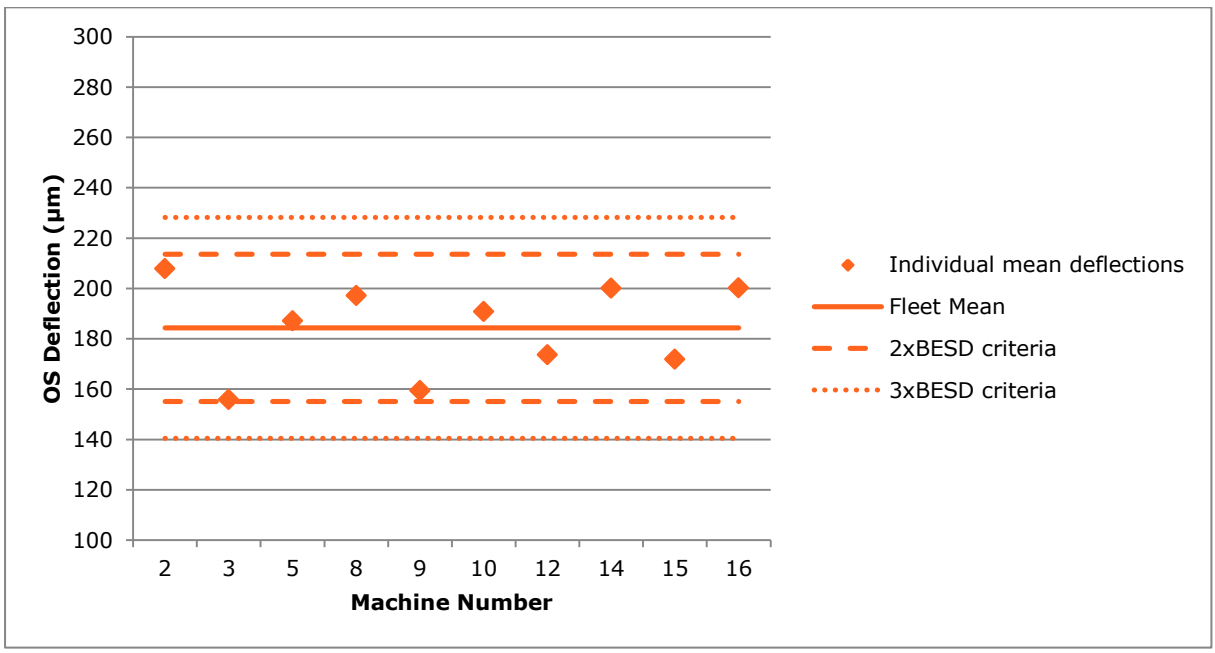

Figure B.4 All machine mean and individual mean deflections for the OS beam on HACP_02 for the main trial day

B.3 HACP_03

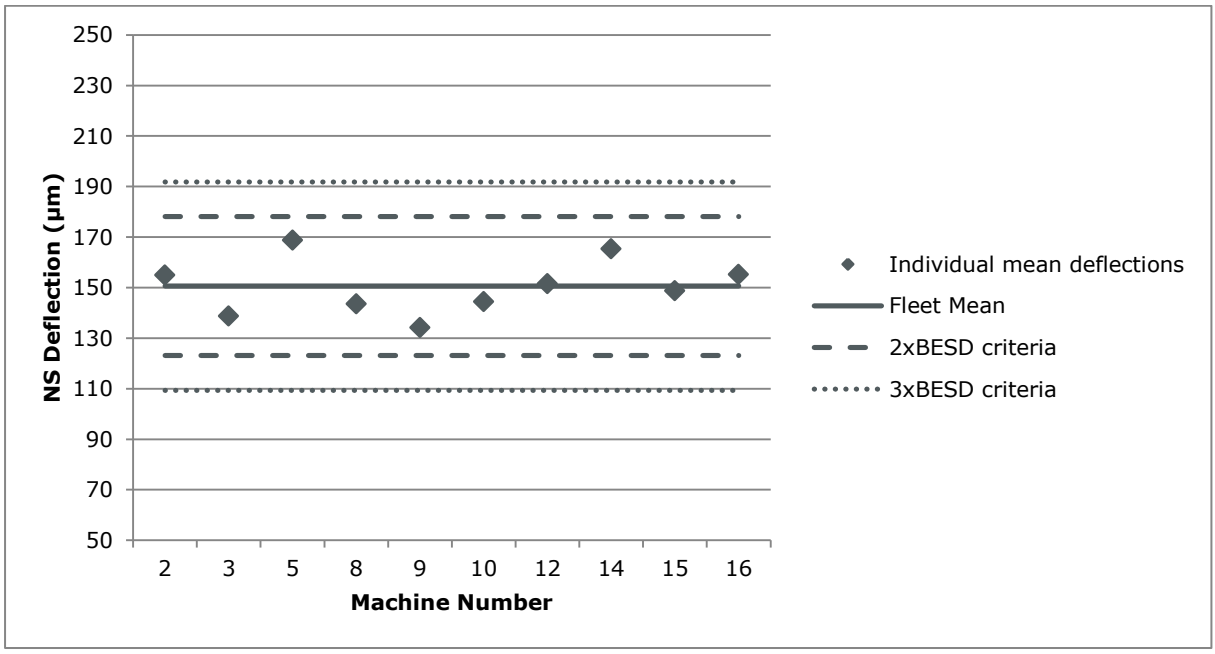

Figure B.5 All machine mean and individual mean deflections for the NS beam on HACP_03 for the main trial day

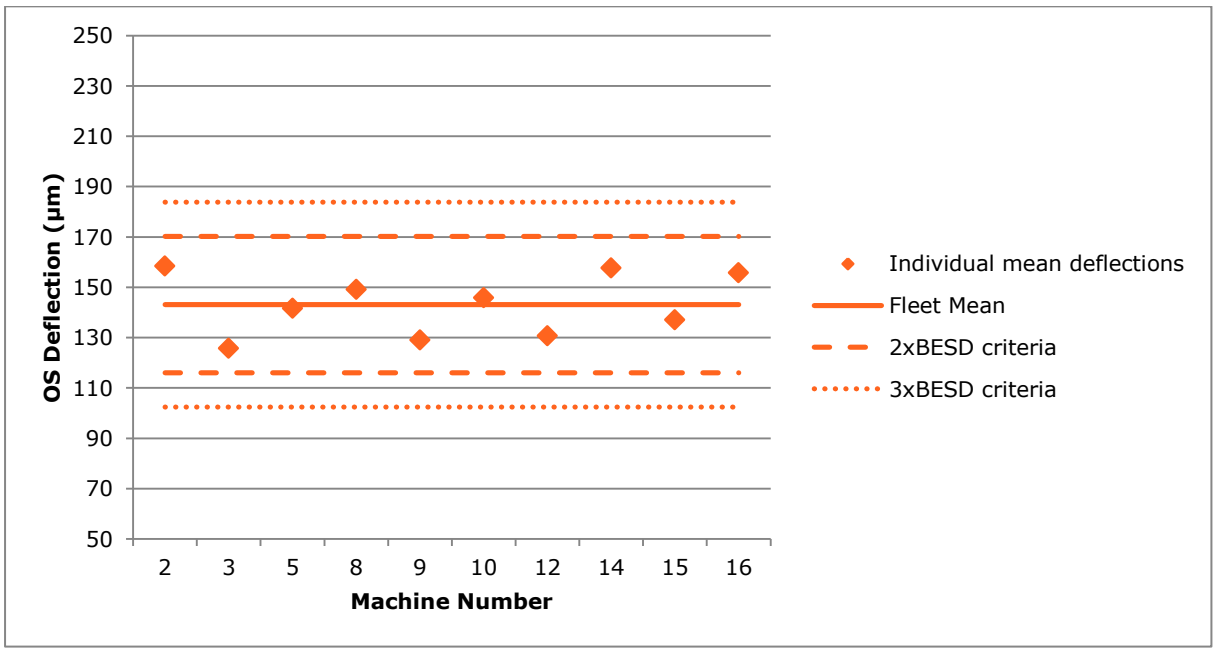

Figure B.6 All machine mean and individual mean deflections for the OS beam on HACP_03 for the main trial day

Appendix C Layout of test sections at MIRA

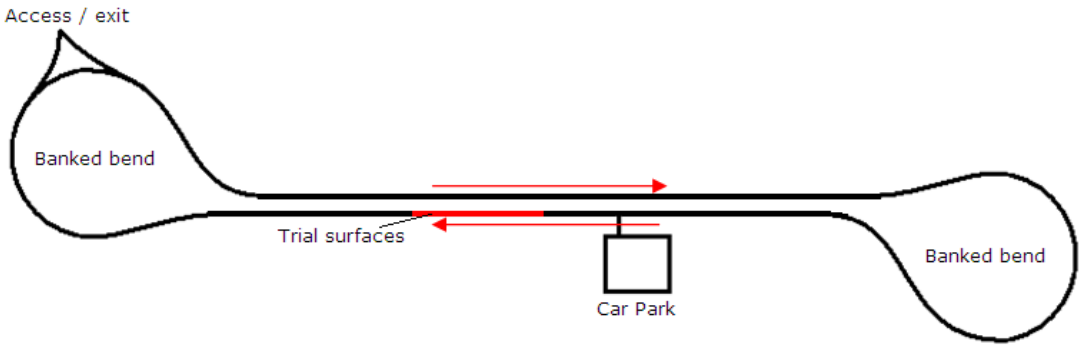

Figure C.1 Test route on the MIRA twin straights

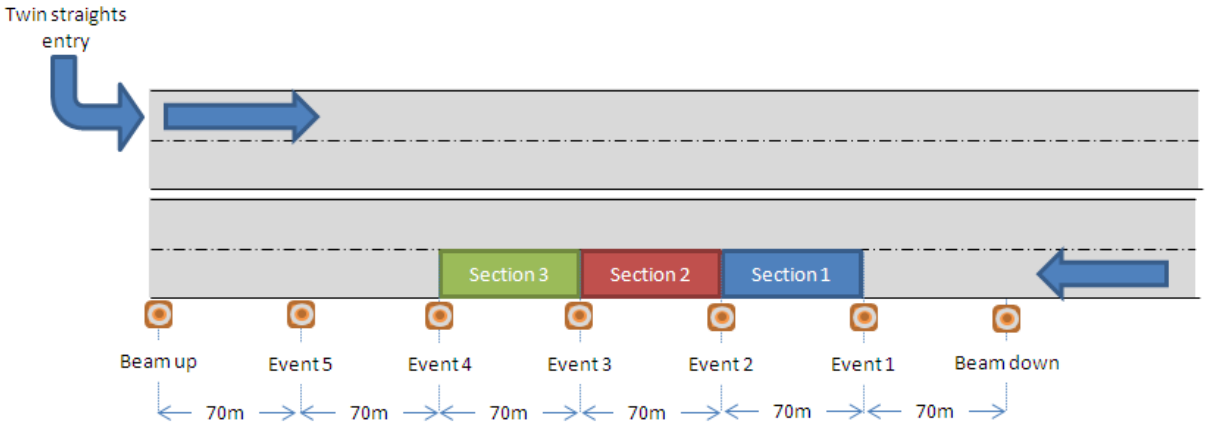

Figure C.2 Location of cones and test sections on MIRA twin straights

Appendix D Construction details for MIRA test sections

Table D.1 Design construction of MIRA site

Section	Nominal construction details and material type) (mm)			
	Surface course	Binder course	Total asphalt thickness [mm]	Sub-base
HACP_01	30 TSC	235 EME2	270	200mm C8/10 HBM
HACP_02	35 TSC	170 DBM	200	250mm 6F1 granular capping material
HACP_03	30 TSC	170 EME2	200	200 Type 1 granular material
Notes	TSC = Cl 942 Thin Surface Course EME2 = Enrobé à Module Élevé, DBM = Dense Bitumen Macadam, HBM = Hydraulically Bound Material, 6F1 = Selected granular capping.			

Table D.2 Construction details for MIRA site from cores

Section	Post Construction Results from cores (mm)			
	Surface course	Binder/ Binder+ base courses	Total asphalt thickness [mm]	Base (mm)
HACP_01	42 TSC	228	270	217 (HBM)
HACP_02	37 TSC	158	192	-
HACP_03	35 TSC	191	226	-
Notes	TSC = Cl 942 Thin Surface Course EME2 = Enrobé à Module Élevé, DBM = Dense Bitumen Macadam, HBM = Hydraulically Bound Material			

Table D.3 Construction details for MIRA site from GPR

Section	Post Construction layer information results from GPR (in mm)			
	Minimum	Average	Maximum	Material
HACP_01	192	242	272	Asphalt
	166	188	215	HBM
	388	431	468	Total bound thickness
HACP_02	167	192	240	Asphalt
HACP_03	167	199	240	Asphalt
Notes	HBM = Hydraulically Bound Material			

Appendix E Conspicuity results

	Machine ID									
	2	3	5	8	9	10	12	14	15	16
Do you carry out surveys where the “red book” is applicable?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Do you carryout surveys where “Chapter 8” is applicable?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Is the main body of the vehicle a conspicuous colour (Yellow or white)?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Is the vehicle clean?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Are there high visibility florescent yellow reflective strips of at least 50mm wide along the side of the vehicle?	N	Y	Y	Y	Y	N	N	Y	N	N
Do you have a roof-mounted flashing amber light bar (comprising at least two independent light sources) or two independent vehicle roof-mounted flashing amber beacons, visible through 360°?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Is the vehicle marked with high visibility rear chevron markings comprising alternate strips of fluorescent orange or red retro-reflective material and fluorescent yellow non-retro-reflective material, of not less than 150 mm width each, inclined at 45–60° to the horizontal and pointing upwards?	Y	Y*	Y	Y	Y	Y	N	Y	N	Y
Is the vehicle marked with a solid block of fluorescent orange-red retro-reflective material?	Y	N	N	N	Y	N	Y	Y	N	N
Is there red reflective tape on rear facing edges of doors, guardrails?	Y	Y	Y	N	Y	N	Y	Y	N	Y
Is a Highway Maintenance sign fitted?	Y	N	Y	Y	Y	Y	Y	Y	N	Y
Is a Motorway Maintenance sign fitted?	N	Y	N	N	N	N	N	N	N	N
Do you have a keep right arrow with 4 flashing amber beacons fitted for use on roads with a speed limit is less than 50mph?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Can this sign be hidden for travelling to/from site?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Can the sign be hidden/revealed whilst in motion?	N	N	N	N	N	N	N	Y	Y	Y

* Only at edge

Highways England 2015 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 2015 accreditation trial run by TRL and held on the Horiba-MIRA proving ground between 3rd and 4th March 2015.

Other titles from this subject area

CPR 1845 Highways Agency 2014 National Deflectograph Accreditation Trial. S Brittain. 2014

CPR 1619 Highways Agency 2013 National Deflectograph Accreditation Trial. S Brittain. 2013

CPR 1449 Highways Agency 2012 National Deflectograph Accreditation Trial. S Brittain. 2012

CPR 1447 Highways Agency 2011 National Deflectograph Correlation Trial. S Brittain. 2011

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ISSN 2514-9652

ISBN 978-1-913246-29-7

PPR943