THE FUTURE OF TRANSPORT

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Highways England 2019 national accreditation trial for sideway-force skid resistance devices

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Contents

Executive Summary

The national accreditation trials for sideway-force skid resistance devices are organised annually by TRL, on behalf of Highways England. The purpose of the trials is to verify the performance of all sideway-force skid resistance devices operating on the UK trunk roads so that consistency is maintained throughout the fleet. The measurements by these machines are used to monitor the skid resistance of the motorway and trunk road network in support of Highways England standard HD28/15 (Design Manual for Roads and Bridges, 2015). By examining the results from the machines operating on specified test sections it is possible to assess the performance of individual machines and the consistency of the whole UK fleet.

The 2019 accreditation trial was held during the week beginning 25th March 2019. The trial followed a similar format to one that has been used successfully by TRL in previous years. Eighteen machines attended, including two machines from the Republic of Ireland that sometimes carry out surveys in the UK and two machines that have/will be testing in the USA.

The following principal conclusions were drawn in relation to the mandatory tests and assessments.

- Seventeen of the eighteen machines were found to be satisfactory with regards to the machine being in good general mechanical order and test wheel weight. One machine was identified as requiring additional investigation to confirm the suitability of the vertical load cell and wheel assembly weight.
- Seventeen of the eighteen machines met the criteria for the skid resistance measurements.
- Seventeen of the eighteen machines met the criteria for vehicle speed.
- Seventeen of the eighteen machines met the criterion for distance measurement.
- All eighteen machines provided satisfactory water flow rate and direction.

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

- Sixteen machines were assessed for measurement of OSGRs. Fourteen machines achieved a high performance and two machines a low performance.
- Sixteen machines were assessed for measurement of Altitude. Eleven machines achieved a high performance, four a medium performance and one a low performance.

Overall, the trials demonstrated that the UK fleet continues to perform at a level suitable for use in supporting skid resistance standards.

1 Introduction

The 2019 accreditation trial for sideway-force coefficient routine investigation machines was held on the HORIBA-MIRA proving ground (referred to as MIRA in the rest of this report) and the Longcross test track, on behalf of Highways England.

The purpose of the trial is to verify the performance of all sideway-force skid resistance devices operating on the UK trunk road network so that consistency is maintained throughout the fleet. This is important because the results of measurements by these machines are used to monitor the motorway and trunk road network in support of the Highways England standards (set out in the Design Manual for Roads and Bridges Vol.7, Section 3, HD28).

By examining the results from the machines operating on specified test sections it is possible to assess the performance of individual machines and the consistency of the whole UK fleet.

TRL has been responsible for planning and running the trials since 1995 and the 2019 exercise followed a similar format to one that has been successfully used for several years.

The trial comprised six general stages:

1. **Preparations**: During the days immediately preceding the trial, the test track, documentation and support facilities were checked and made ready.
2. **Inspection day (MIRA)**. On this day, the incoming machines are inspected and a series of static tests are made to verify vertical wheel weights, force transducer calibration and water flow control. This day also includes surveys of the network route.
3. **Main running trials day 1 (MIRA)**. This is the first main test day, in which all the machines that proved satisfactory in the initial checks run extensive dynamic tests and the results are reviewed as the data are collected.
4. **Main running trials day 2 (MIRA)**. Following the testing on the main trials day 1, survey crews are notified if their machine appears to be an outlier with regards to skid resistance measurement and given an opportunity to investigate their machine. After this investigation time, additional dynamic tests are conducted.
5. **3 Dimensional positional system assessments (Longcross)**. The assessments of the 3 dimensional positional systems are conducted at Longcross. This part of the assessment is only conducted by machines which have 3 dimensional positional systems fitted and are seeking accreditation for those systems. The assessment of the 3 dimensional positional systems also incorporates the survey data collected on the network route (conducted on the inspection day at MIRA).
6. **Follow-up tests**. Sometimes machines are unable to attend the main trial, or problems are identified that cannot be resolved during the main trial. If machines fail to pass the main trial sponsored by Highways England, any necessary modifications and follow-up tests are arranged by and carried out at the expense of the machines' owners. Depending upon the issues that need to be addressed, these may include a repeat accreditation trial.

The results from the testing described above 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.ukroadsliaisongroup.org/en/asset-condition/road-condition-information/data-collection/skid-resistance/Sideway_force_skid_resistance_survey_devices/index.cfm.

The 2019 trial was held during the week beginning 25th March 2019. Sixteen machines based in the UK and Ireland and two machines based in the USA attended.

For convenience, throughout this report machines are referred to using the running number assigned at the trial. For ease of comparison, machines usually retain the same running numbers from one year to the next. To avoid confusion with earlier vehicles, when a machine is replaced or re-built on a new chassis, the new vehicle is assigned a new running number in sequence when it first appears at the trials. Appendix A lists all the machines, their running numbers (ID) and their operating organisations as they were in March 2019.

2 Trial Format

2.1 Pre-trial preparation

Although it has been found generally to not be a large source of variation, small variations in skid resistance measurements can be caused by differences between test tyres fitted to different machines. The tyres purchased for this work were scrubbed in prior to the trial and the data produced was checked for consistency and found to be suitable for the trial.

The parts of the MIRA proving ground used in the trial are prepared on the days leading up to the trials. The reference points at the start of each test length are identified using cones and the track was visually inspected.

There is always an element of variability in the measurements that is a result of drivers following different test lines. This manifests itself both in variation between runs with the same driver and in different general lines followed by different drivers. For this reason, the test line to follow is explicitly identified on appropriate parts of the test track. This was achieved by placing cones either side of the lane to create a corridor for the machines to travel within. However, the cones have to enable testing with the largest vehicle and also some leeway so that cones are not hit on a regular basis. Therefore although this may reduce the driving line variability, some may still remain.

2.2 Inspection day – MIRA

The inspection day is used to conduct the following inspections and calibrations of the machines attending the trial, along with a survey of the network route (a horizontal calibration is conducted for each machine on each day of the trial):

1. Water flow checks
2. Wheel weight checks and vertical calibration
3. Distance calibration

2.3 Main running trial days – MIRA

The main running trials are designed to test, firstly, whether individual machines are operating consistently and, secondly, whether different machines obtain comparable readings over a range of skid resistance levels.

Each crew is given instructions and a copy of the planned running order and organisation of the machines, so that they know approximately when they are running, with which tyre, and with which other machines. Due to unexpected events such as minor problems with vehicles or operating errors this running order is occasionally amended in situ.

All machines are operated with the dynamic vertical load measurement system turned on, which is part of the requirements given in HD28/15 (Design Manual for Roads and Bridges, 2015). In addition, the machines are set up to report the average skid readings at 10m intervals. After each set of tests the data is collected and checked to verify that the location referencing codes have been inserted correctly by the operator.

2.4 3 Dimensional positional system assessment – Longcross and network route

The 3 dimensional positional systems are assessed on the Longcross test track and on a network route near MIRA. The Longcross assessment determines whether the machines identify the correct position of section marker points (identified with retro-reflective markers or push buttons), in addition to accurately plotting the route between these markers. The Longcross test track site was introduced in 2015 because it contains test sections of poor GPS availability. The Longcross test track is heavily tree-lined and can be used to assess the accuracy of the measurement system when there is poor GPS coverage. This type of scenario is not available at the MIRA test site as it is a large open area with excellent access to the open sky (and hence good GPS coverage).

The Longcross test track is a closed environment (i.e. no road traffic), it is therefore possible to assess these devices to a high degree of accuracy. However, it is not truly representative of the real world use of these devices. Therefore the devices are also assessed on the network route. The network route assessment provides the same assessment but in a real world usage (with slightly looser criteria due to the impact of traffic).

3 Test sections

The trial uses two areas of the MIRA proving ground (the Twin Straights and the Straight Line Wet Grip Area), along with a network route in the surrounding area. In addition the Longcross test track is also used for the machines which are undergoing the 3 dimensional positional systems assessment.

3.1 Twin straights

This area is used for distance calibration, the location referencing tests (including speed measurement), and for skid resistance testing. The overview of the Twin Straights and the position of the marker points A-G are given in Figure 3.1.

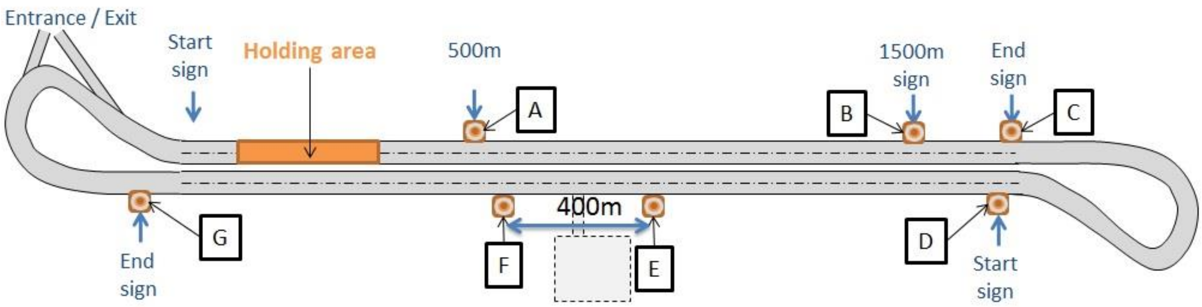

Figure 3.1: Overview of Twin Straights and position of marker points

The skid resistance data is assessed on the length between markers E and G, and utilises the Highways England calibration site. Six sections on this length have been selected for analysis. The position of these sections is shown in Figure 3.2. Details of the surfaces are given in Table 3.1.

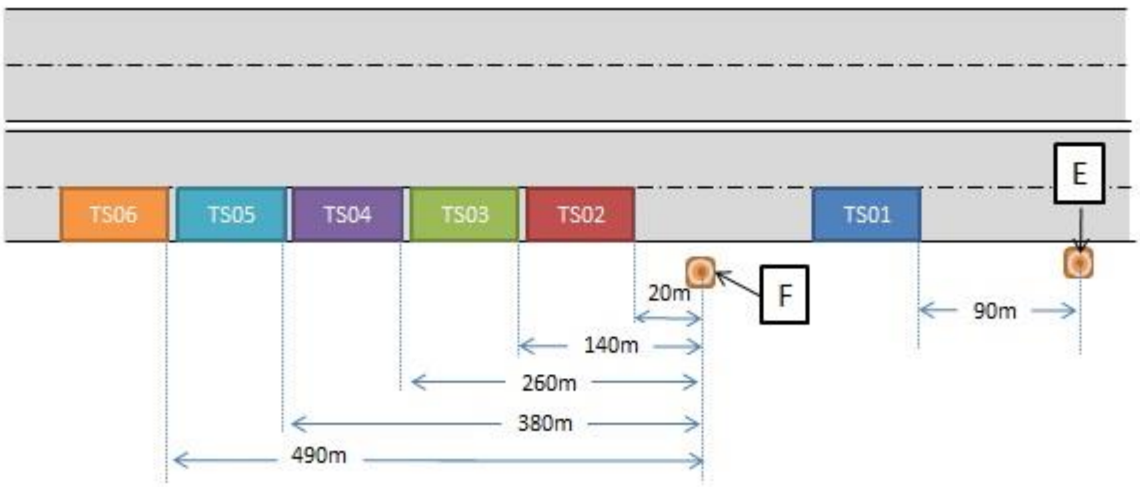

Figure 3.2: Skid resistance test sections on Twin Straights

Table 3.1: Skid resistance test sections on Twin Straights

Section	Length (m)	Surface description
TS01	130	Normal track surface, thin surfacing applied in October 2013.
TS02	100*	A proprietary thin surfacing material using 6 mm coarse aggregate and polymer-modified bitumen. The small-size particles are closely packed and the texture is formed by large numbers of relatively narrow and shallow gaps between them. This type of surfacing generates very low levels of traffic noise but it has a relatively lower texture depth (compared with other thin surfacings with coarser aggregates). Laid in October 2010.
TS03	100*	A proprietary thin surfacing material using 10 mm coarse aggregate and a fibre-reinforced bitumen. This is typical of low-noise asphalt materials laid on many roads. Laid in October 2010.
TS04	100*	A proprietary thin surfacing material using 14 mm coarse aggregate. It has a rather more open grading, and hence greater texture depth, than the surfacings with the smaller aggregate. Laid in October 2010.
TS05	50*	A hot-rolled asphalt mat into which 20 mm chippings that have been lightly pre-coated with bitumen are rolled while the asphalt is still hot. This is the "traditional" material used commonly on UK main roads until the introduction of thin surfacings from about 1990. Laid in October 2010.
TS06	100	Normal track surface, thin surfacing applied in October 2013.

* The trial lengths on the Calibration Site did not include the full length of each surfacing in order to exclude the transitions between the different surfaces.

3.2 Straight Line Wet Grip area

The Straight Line Wet Grip area on the MIRA proving ground is utilised to provide lengths with low skid resistance levels. The position of the sections are given in Figure 3.3 and details of the sections are given in Table 3.2

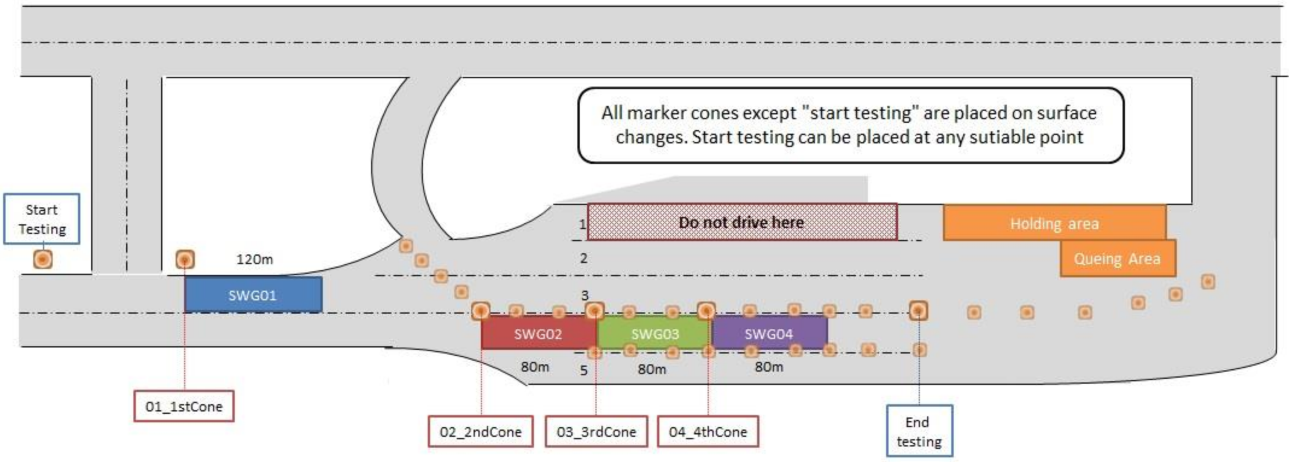

Figure 3.3: Skid resistance test sections on the Straight Line Wet Grip area

Table 3.2: Skid resistance test sections on the Straight Line Wet Grip area

Section	Length (m)	Surface description
SWG01	100	Transverse grooved Portland cement concrete
SWG02	60*	Worn bitumen macadam
SWG03	60*	Bridport gravel (with quartzite) exposed aggregate concrete
SWG04	60*	Smooth asphalt concrete
* The trial lengths on the wet grip area did not include the full length of each surfacing in order to exclude the transitions between the different surfaces.		

3.3 Network route to Sheepy Magna

A network route is included in the accreditation trial to provide supporting data for the assessment of skid resistance and location referencing. The first marker of the route is at the entrance of MIRA, the route then loops round to Sheepy Magna and returns to MIRA as shown in Figure 3.4 (Contains Ordinance Survey data © Crown copyright and database right 2019). Details of the route are given in Table 3.3.

Figure 3.4: Network route to Sheepy Magna

Table 3.3: Details of network route, including marker positions

Survey distance (km)	Section length (m)	Markers	Marker position	Driving Instructions
n/a	n/a	**NSMsmmttrr**	Entry to MIRA roundabout	Turn right at the MIRA exit roundabout (A5 WB)
0	1260	**01_RBTExt**	Node at exit of MIRA roundabout	Continue on A5, testing in Lane 1
1.26	192	**02_A444JnS**	Node at entry to gyratory at junction with A444 south	Continue on A5
1.45	1454	**03_A444JnN**	Node at exit of gyratory at Junction with A444 North	Continue on A5
2.91	1379	**04_WdfrdLn**	Node at centre of Junction with Woodford lane (has sign for Dobbie's Garden world)	Continue on A5
4.28	543	**05_StDuals**	Start of duals	Dual carriageway commences. Take right lane and continue to second exit on to A5 Atherstone by-pass towards Tamworth.
4.83	1199	**06_Bypss80**	Mancetter circulatory system exit	Return to testing on Lane 1 for exit of circulatory system on to A5.
6.03	1249	**07_Bridge**	Centre of 1st road bridge going over A5	Continue on A5
7.28	178	**08_EndDC50**	Node at end of dual carriageway	Continue testing for approx 200m on approach to roundabout
7.45	128	**09_RBTEnt**	Entry to roundabout junction with B4116	Test roundabout as per HD28
7.58	147	**10_RBTNode**	Roundabout "Node"	Continue survey of roundabout
7.73	111	**11_RbtNode**	Roundabout "Node"	7.73
7.84	640	**12_RBTExt**	Roundabout exit	Take exit, B4116 towards Twycross.
8.48	30	**13_RBTEnt**	Roundabout (access to Aldi distribution depot)	Take second exit (straight on)
8.51	836	**14_RbtExt**	Roundabout exit	Continue testing on B4116
9.35	970	**15_B4166Jn**	At T-junction	Turn left and continue testing on B4116 towards Twycross
10.32	1486	**16_B5000Jn**	Junction with B5000 (on left) at the Red Lion	Continue testing on B4116
11.80	1100	**17_RtClffe**	Centre of junction with Ratcliffe Ln (on right)	Continue on B4116 and enter Sheepy Magana
12.90	1333	**18_B585Jn**	At exit of T-Junction	Turn right on to B585 (Mill Lane) towards Market Bosworth.
14.24	2108	**19_Ford**	Centre of junction with sign post for ford.	Continue on B585
16.34	1847	**20_A444Jn**	At junction with A444	Turn right onto A444 towards Nuneaton.
18.19	1910	**21_ShnLnJn**	At Junction with Shenton Lane (signposted Upper Shenton)	Continue on A444
20.10	1476	**22_UptonLn**	At junction with Upton Lane (on left, is sign posted for Upton)	Continue on A444
21.58	1385	**23_FnnLnJn**	At junction with Fenn Lanes (on left, is sign posted for Bosworth Battlefield)	Continue on A444
22.96	n/a	**24_A5Jn**	Centre of A444/A5 Junction	Turn left on to A5 towards Hinkley. Continue along the A5. On dual carriageway in Lane 1 This marks the end of the route.

Fourteen 100m lengths of varying skid resistance levels are selected from the network route for the analysis. These lengths have been selected for homogeneity of skid resistance within the length and low indications of variation due to test line. As parts of the route may be maintained between accreditation trials, the lengths used in the analysis are reviewed in each accreditation trial and modified as necessary. Therefore the locations of these lengths (and the typical skid resistance values) may vary between trials.

3.4 Longcross test track

This site includes more corners and tree coverage than the sites used on the MIRA proving ground, providing a more challenging test environment for the assessment of the 3 dimensional positional systems. The site contains five marker points and four assessment sections (highlighted in red) as shown in Figure 3.5 and detailed in Table 3.4.

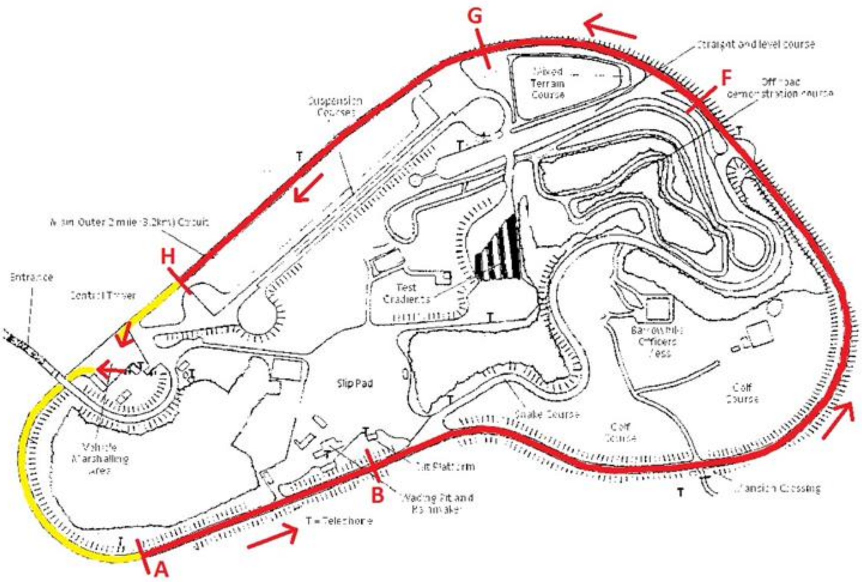

Figure 3.5: Longcross test track site map

Table 3.4: Details of Longcross test track, including marker positions

Section	Length (m)	Easting	Northing	Section identifier
Start to A	>200	N/A	N/A	Run-in
A to B	290.1	498377.2642	165348.1812	AB
B to F	1299.0	498643.7988	165462.5819	BF
F to G	367.0	499150.9436	166034.2452	FG
G to H	472.6	498806.0321	166098.0752	GH
to End	>200	498440.6401	165803.5887	Run-out

4 Assessment criteria

The accreditation trial criteria are specified in “Accreditation and Quality Assurance of Sideways Force Skid Resistance 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 (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 sideway-force measurement system, GPS, distance 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 Equipment will be inspected to ensure that they are in a suitable condition to conduct the tests. Contractors will be provided with an inspection check sheet to complete and provide to the Auditor in advance of the Trial.

E3.2 Inspections will include:

- Water flow System (including verification of flow rate, nozzle alignment and general condition)
- Calibration of the Vertical load System and Horizontal load system
- Verification of the test wheel weight
- checking that a Contractor’s pre-test inspection report has been provided and correctly filled in; and
- Verifying that the Equipment is in good general mechanical order.

E.4 Running Trials

E4.1 **Overview**

E4.1.1 As detailed in 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 **Skid resistance testing – Mandatory Requirement**

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

E4.2.2 Some Equipment may have skid resistance measurement Systems fitted to both the nearside and offside of the Equipment. If fitted then these systems should be assessed independently and given independent Accreditation results. This requires that suitable reference data is collected for both wheel paths or that the Equipment test on offset driving lines so that the test wheel traffics the same part of the test surface. The Auditor may specify that only one side of the Equipment will be assessed.

E4.2.3 The Equipment will undertake laps so that the following criteria are met:

- At least 3 laps are undertaken that comply with the requirements for Reference Data (see Appendix B, App B.3).
- Survey data will be collected at the target test speed.

E4.2.4 The Contractor will supply the skid resistance measurements for their Equipment from each test lap in the file formats specified by the Auditor.

E4.2.5 The Auditor will calculate:

- The mean values for the Equipment for each 100m length test section or the length of the test section if shorter (averaging together the repeat measurements).
- 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 skid resistance values between runs for the Equipment for 100m lengths (or the length of the test section if shorter). 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.

E4.2.6 The BRSD assessment criterion is given in Table 1. Where the BRSD criterion is exceeded, the data will be examined for any obvious error, for example as a result of significant variation in test line and if necessary individual runs on that section may be excluded from subsequent analysis. If Equipment consistently records data with unacceptable between-run standard deviation, the data from that Equipment will be regarded as unacceptable.

E4.2.7 The Trial BESD is acceptable if it is below the criterion given in Table 1. 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 be rejected. Any Equipment that is between two and three times the BESD criterion from the all-Equipment mean will be subject to further investigation.

E4.2.9 The data from any Equipment rejected due to the BRSD, BESD or otherwise identified as an outlier will not be used in the calculation of the Reference Data (App B.3.1).

Table 1 – Acceptance Criteria for Skid resistance measurements

Parameter	Acceptability Limit
Between run standard deviation (BRSD)	Investigate if >3 SR on 100m lengths
Between Equipment standard deviation (BESD) on closed site (e.g. test track)	≤2.7 SR
Between Equipment standard deviation (BESD) on live site (e.g. network route)	≤2.8 SR

E4.3 Vehicle Speed – Mandatory Requirement

E4.3.1 The assessment of vehicle speed is split into two parts:

- The speed recorded by the Equipment compared with the independently measured speed
- The speed recorded by the Equipment compared with the required target survey speed.

E4.3.2 The test will be carried out on at least 3 test laps at each target survey speed

E4.3.3 The acceptance criteria for vehicle speed measurement are given in Table 2.

Table 2 – Acceptance Criteria for Vehicle Speed Measurement

Parameter	Acceptability Limit
Vehicle Speed recorded by the Equipment compared to independent measure	80% within ± 1km/h of the independently measured speed
Vehicle speed recorded by the independent measure compared to the target speed	80% within ± 3km/h of required target speed

E4.1 Location Referencing – Distance Criteria

E4.1.1 The Accreditation of distance measurement will be carried out using at least 6 measurements of distance made using the Equipment.

E4.1.2 There are three mechanisms for recording location referencing points in the survey data during testing:

- Push button entry relies on the survey operator pushing a button to enter the location of the point manually.
- Automatic markers uses a system which automatically detects the markers.
- OSGR fitted utilises the coordinate data to identify the elapsed chainage of the location reference points within the survey data.

E4.1.3 The push button entry approach will include some operator error and therefore it is expected that Equipment using this approach will be less accurate than the other methods. The criteria applied to the test measurements for these two approaches are given in Table 3.

Table 3 – Criteria for measurement of distance travelled for repeatability and reproducibility

Parameter	Push button entry	Automatic markers (where available)	OSGR fitted (where available)
Distance measured	80% within 5m	80% within 2m	80% within 2m

E4.1.4 If the Survey Contractor will be supplying data to a Customer with OSGR fitted location reference points then they must meet the criteria for the OSGR fitted distance measurement.

E4.2 Test wheel weight

E4.2.1 The Accreditation of test wheel weight will be carried out using at least 3 measurements. There can be a tendency for the shaft bearings to stick slightly when the wheel is first lowered (without the shaking action that would be experienced on the moving vehicle at the start of a survey run). For this reason, the assessment will be carried out after the bearings have been released (achieved by applying foot pressure to the wheel arm bearing and “bouncing” the back-plate against the suspension damper and spring). For this assessment the test wheel will be raised/lowered and bounced before each measurement. The measurements made will be averaged together and the criteria applied are given in Table 4.

Table 4 – Criteria for test wheel weight

Parameter	Acceptability Limit
“Bounced” test wheel weight	200±8kg

E4.3 Water flow

E4.3.1 The water delivery system will be inspected and checked to confirm that the Equipment is delivering water at an acceptable rate and to the correct position on the road surface. The water flow delivery system should achieve a target water film thickness of 0.5mm at 50km/h. Due to differences in design (e.g. position of the nozzle) the target flow rate to achieve this will differ between Equipment. The target flow rate for each Equipment should be determined (through consultation between the Auditor and the Developer). Each Equipment will then be tested to confirm that the flow rate supplied is within the criteria given in Table 5. In the cases where the Equipment incorporates a speed controlled water flow system, the flow rate will be assessed using 50km/h and 80km/h test pulses.

Table 5 – Criteria for water flow rate

Parameter	Acceptability Limit
Water flow rate	Within 10% of the target flow rate

E.5 Additional Tests

E5.1 **Overview**

E5.1.1 This sub-section describes the additional criteria which are assessed to provide additional information on the capabilities of the Equipment. These criteria are assessed as High, Medium and Low levels of performance. These criteria typically include the assessment of Systems not fitted to all Equipment and/or tests which are not as mature as the mandatory assessments. In future revisions to this document some or all of these criteria 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 **Location Referencing – OSGR data**

E5.2.1 As noted in E4.1.2 there are two mechanisms for recording the location of location referencing points. The differences in these approaches results in different criteria for OSGR assessment on closed test sections. In addition, data collected on a network or live traffic route may be fitted to network sections using reference OSGR points. These two approaches also have corresponding test criteria. The Auditor should record on the Accreditation Certificates the type of assessment undertaken.

E5.2.2 OSGR data collected from the closed test sections will be assessed using the criteria given in Table 6.

Table 6 – Closed test section: Criteria for OSGR data of individual 10m data points

Performance level	Push button entry	Automatic markers (where available)	OSGR fitted (where available)
High	90% within 5m 95% within 7m 100% within 20m	90% within 2m 95% within 4m 100% within 20m	90% within 2m 95% within 4m 100% within 20m
Medium	80% within 5m 90% within 7m 100% within 20m	80% within 2m 90% within 4m 100% within 20m	80% within 2m 90% within 4m 100% within 20m
Low	80% within 8m 100% within 20m	80% within 5m 100% within 20m	80% within 5m 100% within 20m
Not suitable	Otherwise	Otherwise	Otherwise

E5.2.1 If the Survey Contractor will be supplying data to a Customer with OSGR fitted location reference points then they must meet the criteria for the OSGR fitted data.

E5.2.2 OSGR data collected from a live traffic route will be assessed using the criteria given in Table 7

Table 7 – Live traffic route: Criteria for OSGR data of individual 10m data points

Performance level	Push button entry	OSGR fitted (where available)
High	90% within 12m 100% within 25m	90% within 6m 100% within 20m
Medium	90% within 17m 100% within 25m	90% within 12m 100% within 25m
Low	100% within 25m	100% within 25m
Not suitable	Otherwise	Otherwise

E5.2.3 If multiple test sites are used for the assessment of the OSGR Component of the Equipment, the lowest performance achieved across the sites will be reported by the Auditor.

E5.2.4 If the Survey Contractor will be supplying data to a Customer with OSGR fitted location reference points then they must meet the criteria for the OSGR fitted data.

E5.3 Location Referencing – Altitude data

E5.3.1 Altitude data collected will be assessed using the criteria given in Table 8.

Table 8 –Criteria for Altitude data of individual 10m data points

Performance level	Criteria
High	90% within 2m 95% within 5m 100% within 20m
Medium	80% within 4m 90% within 6m 100% within 20m
Low	100% within 20m
Not suitable	Otherwise

E.6 Checking of file formats

E6.1.1 Some Employers require the production of data in specific data formats, for example Highways England requires data to be produced as Raw Condition Data (RCD) and Base Condition Data (BCD). Where required, Owners will be asked to deliver accreditation data files in the required format. These will be assessed to determine whether the data are being correctly processed.

5 Machine inspections

5.1 Water flow rate checks

After minor adjustments to some machines, it was deemed that all machines had satisfactory water flow rates and direction.

5.2 Left test wheel weight checks

Each machine was weighed and the results are given in Table 5.1.

Table 5.1: Test wheel weights

Machine	Average static wheel weight (kg)							
	"Un-bounced"				"Bounced"			
	Check 1	Check 2	Check 3	Mean	Check 1	Check 2	Check 3	Mean
1	201.5	202.0	202.0	201.8	201.5	201.5	201.5	201.5
3	195.0	195.0	195.0	195.0	198.5	198.5	199.0	198.7
14	205.0	204.0	204.0	204.3	207.0	206.5	206.0	206.5
16	200.5	200.5	200.5	200.5	202.5	204.0	203.5	203.3
17	198.0	198.0	198.0	198.0	202.0	202.5	203.0	202.5
19	196.5	197.0	196.8	196.8	200.0	200.0	200.0	200.0
21	196.6	196.6	196.6	196.6	200.0	200.0	200.0	200.0
22	198.5	199.0	199.0	198.8	200.5	200.5	200.5	200.5
23	197.0	196.0	196.0	196.3	200.0	199.6	199.4	199.7
24	195.5	195.5	195.5	195.5	201.0	200.5	200.5	200.7
25	195.0	195.0	195.5	195.2	199.5	199.5	199.5	199.5
26	197.5	197.5	197.5	197.5	201.5	202.0	201.5	201.7
28	195.6	195.8	196.0	195.8	201.6	202.2	201.8	201.9
29	207.0	207.0	207.0	207.0	207.5	208.0	208.0	207.8
31	194.0	194.0	194.2	194.1	198.0	198.4	198.2	198.2
32	198.0	198.0	198.5	198.2	202.0	201.0	202.0	201.7
33	203.0	203.0	203.0	203.0	204.5	204.0	204.5	204.3
34	197.0	197.0	197.0	197.0	200.5	201.0	200.5	200.7

It can be seen in Table 5.1 that all of the "bounced" mean weights of the machines fell within the tolerances given in section 4.1. There is a noticeable difference in the bounced and un-bounced wheel weight values for some of the machines (e.g. Machine 17, 24, 25, 26, 28 and 31). The owners of these machines should be aware that this may be an indication of some deterioration in the shaft assembly and may cause issues at a future date.

Initially machine 29 produced values outside of the tolerance. It was investigated and reweighed and then found to be just within the tolerance. Due to the variation in the weight, it was decided that it would be reweighed on the first main running trials day. This reweigh found that the machine was now outside of the tolerance. After further inspection it was found that recent work undertaken on the machine had resulted in pipework resting on the test wheel assembly. After this pipework was tied back the machine produced results just within the tolerance (the values shown in Table 5.1). Due to these changes in the measured weight of the wheel assembly, and aspects with skid resistance performance (discussed in section 6) it was agreed that further assessment of this machine would be undertaken after the trial (discussed in section 9).

In 2009, British Standards published a CEN Technical Specification for these devices (BSI, 2009). This is a Draft for Development (DD) document that can be used voluntarily over a period so that experience can be gained before being accepted and introduced (if appropriate) as a full EN (European Norme). This is one of a series of documents for skid resistance measurement devices intended to encourage consistent standards in the use of similar machines in different European countries. It is envisaged that the requirements in this document will eventually supersede those in the current British Standard (BSI, 2006).

This DD was developed from BS 7941-1 so it is already largely consistent with current UK practice. However, some aspects were revised to take account of wider experience of use of similar devices in Europe and one of these is the reduction of the tolerance for static wheel weight to ±1 kg.

All of the machines were within the current ±8 kg tolerance. However, had the CEN TS requirement been applied to the fleet this year, eleven machines would have been outside the ±1 kg tolerance. In future trials it may be appropriate to review this aspect more closely, both in terms of how the weight is measured and the tolerances that are practicably achievable (or necessary where dynamic vertical load is measured), so that the British Standards Committee that deals with these matters can be advised of the practical experience and take this into account in their deliberations and their discussions when the CEN document is due for review.

5.3 Vertical and horizontal load calibration

During the static wheel weight checks, the vertical load calibration check was also carried out, followed by a full vertical load calibration and a further vertical load calibration check. Vertical calibrations were successfully carried out on all machines.

The crews were also asked to conduct a horizontal calibration during the inspection day before conducting the network route tests (and the morning of each subsequent day).

5.4 Distance calibration

All crews undertook a distance calibration of their machine on a defined length at the test site. No issues were reported during this process.

5.5 Speed

The assessment of speed (the attainment of the target speed and the accurate recording of speed in the survey data) was carried out using data collected during the tests on the Twin Straights.

The time taken for the machines to travel between markers E and F on the Twin Straights, along with the distance between these two markers, was used to determine an independent measure of the average speed of the machines over this length. The elapsed time was recorded using a set of timing gates which recorded the time in seconds to 2 decimal places.

The differences between the survey data and the independent measure are shown in Table 5.2. The differences between the independent measure and the target speed are shown in Table 5.3. Instances where the value exceeds the criteria levels in section 4.1 are highlighted in bold red text. It was not possible to record valid independent data on all runs, therefore some data are missing from the tables. Machine 21 did not take part in these tests (due to computer issues) and is therefore excluded from the tables.

Table 5.2: Difference between speed recorded in data and independent measure

ID	Speed recorded in data – independent measure of speed (km/h)										% within criterion
	Target speed 50km/h					Target speed 80km/h					
	Run 1	Run 2	Run 3	Run 4	Run 5	Run 1	Run 2	Run 3	Run 4	Run 5	
1	-0.59	.	-0.47	.	0.03	-0.48	-0.64	-0.68	-0.70	.	100%
3	-0.04	-0.08	-0.26	.	-0.10	-0.04	-0.09	-0.09	-0.09	-0.13	100%
14	0.33	0.31	-0.39	.	0.01	0.06	0.01	-0.07	-0.01	**2.12**	89%
16	-0.42	.	-0.46	-0.47	-0.47	-0.27	-0.36	-0.36	-0.40	.	100%
17	0.22	.	-0.16	0.19	0.19	-0.27	-0.27	-0.31	**1.65**	.	88%
19	.	.	-0.02	.	0.01	-0.21	-0.06	-0.15	-0.14	.	100%
22	-0.06	.	-0.10	-0.81	**1.71**	0.19	0.18	0.18	.	.	86%
23	-0.02	.	0.14	.	0.21	-0.21	-0.22	-0.04	-0.05	.	100%
24	0.08	-0.28	0.00	0.04	-0.13	-0.07	0.19	-0.05	-0.12	.	100%
25	0.12	-0.03	0.04	-0.22	0.05	-0.19	-0.20	-0.04	0.85	.	100%
26	-0.06	0.08	-0.08	-0.07	-0.12	0.01	0.00	-0.12	0.79	.	100%
28	.	.	-0.23	-0.35	-0.37	.	.	0.04	0.04	.	100%
29	-0.62	-0.69	-0.63	-0.81	.	-0.53	-0.49	.	-0.68	.	100%
31	-0.02	-0.05	-0.07	-0.07	-0.10	.	-0.13	**1.01**	.	.	86%
32	0.02	0.17	0.16	0.14	0.12	-0.45	0.18	0.66	.	.	100%
33	0.38	0.37	0.35	0.33	0.31	**1.22**	0.51	0.42	.	.	88%
34	0.05	0.04	**-1.70**	0.00	-0.08	0.05	0.01	-0.03	.	.	88%

Table 5.3: Difference between independent measure and target speed

ID	Independent measure of speed- target speed (km/h)										% within criterion
	Target speed 50km/h					Target speed 80km/h					
	Run 1	Run 2	Run 3	Run 4	Run 5	Run 1	Run 2	Run 3	Run 4	Run 5	
1	-1.58	.	-1.24	.	-1.43	-1.57	-1.82	-1.95	-2.37	.	100%
3	-0.50	-0.58	0.26	.	-0.29	0.04	0.09	0.09	0.09	0.13	100%
14	0.67	0.69	1.39	.	0.99	-0.13	0.40	0.31	0.76	-0.44	100%
16	0.42	.	0.46	0.47	0.47	0.27	0.36	0.36	0.40	0.40	100%
17	-0.22	.	0.16	-0.19	-0.19	0.27	0.27	0.31	-1.65	.	100%
19	-0.97	.	-0.34	.	-0.26	-1.23	-0.75	-1.27	-2.79	.	100%
22	-0.94	.	-0.90	-0.19	-2.71	0.81	-0.18	-0.18	.	.	100%
23	-1.47	.	-1.43	.	-1.45	-0.79	0.22	-2.66	-2.95	.	100%
24	-0.10	0.33	-0.17	0.28	-0.77	-0.40	0.13	0.00	0.00	.	100%
25	0.83	-0.70	0.87	0.00	0.51	0.31	-0.27	-1.74	-0.92	.	100%
26	-1.04	-1.37	-1.14	-0.62	-0.17	-0.97	-0.70	-0.44	-0.79	.	100%
28	-0.68	1.08	-0.65	-0.65	-0.63	-0.13	-0.09	-0.04	-0.04	.	100%
29	0.28	-0.02	-0.17	-0.19	.	-1.23	-0.88	.	-1.23	.	100%
31	0.02	0.05	0.07	0.07	0.10	.	0.13	-1.01	.	.	100%
32	-0.02	-0.17	-0.16	-0.14	-0.12	0.45	-0.18	-0.66	.	.	100%
33	0.62	0.63	0.65	0.67	0.69	-0.22	0.49	0.58	.	.	100%
34	-1.05	-1.04	0.70	-1.00	-0.92	-1.05	-1.01	-0.97	.	.	100%

From these tables it can be seen that all seventeen machines that took part in this testing achieved at least 80% of their data within the criteria. Therefore all machines are deemed acceptable with regards to measurement of survey speed.

6 Skid resistance measurements

Skid resistance measurements were taken on three sites (Twin Straights, Straight Line Wet Grip, and the network route). The assessment of skid resistance measurements falls into two parts; machine repeatability and variation between machines (see section 4.1).

6.1 Amendments to survey machines

The data from the network route testing is partially processed on the track during the inspection day and any significant anomalies are communicated to corresponding survey crews. However, the first instance where a robust analysis can be carried out and reviewed is the end of the main running trials day 1 when the network route and SLWG data is available. Therefore at the end of the main running trials day 1, survey crews are given preliminary feedback using a red/amber/green scale on the performance of their machines based on the results from the first set of tests on the Straight Line Wet Grip area. They are then given an opportunity to investigate their machines before additional testing takes place. These categories are defined as:

- **Green** – the machine is producing skid resistance values within the required criteria for skid resistance based on the current fleet average.
- **Amber** – the machine is producing skid resistance values within the required criteria but close to the thresholds based on the current fleet average.
- **Red** – the machine is producing skid resistance values outside of the criteria for accreditation for skid resistance based on the current fleet average.

Prior to the network route tests on the inspection day, one machine (21) suffered from computer problems and was unable to take part in the rest of the trial.

At the end of main running trials day 1, one machine (Machine 29) was identified as being in the red category and one machine (Machine 33) was identified as being in the orange category.

As previously mentioned (see section 5.2) when the wheel assembly of Machine 29 was initially weighed it was found to be outside of the permitted tolerance. This was further investigated on the inspection day, and reweighing produced values just within the tolerance. This machine then produced suitable results on the network route testing (discussed below). On the 1st main trial day the Straight Line Wet Grip testing identified that the machine was now no longer producing skid resistance values consistent with the fleet. Further investigation found that the vertical check values had varied during the course of the two days, and a subsequent reweigh showed that the wheel assembly was again outside of the tolerance. This was investigated by the survey crew and they found some pipework resting on the wheel assembly which they believed was increasing the wheel weight and may have also interfered with the vertical calibrations. This pipe work was tied back and the device went on to take part in the rest of the trial. Due to these variations in the performance of this device it was decided that this machine would be subject to additional investigations after the trial. These additional investigations are discussed in section 9.

The crew for Machine 33 examined their machine and found that the calibration was slightly out and recalibrated before the last day of testing.

Skid resistance data collected prior to these changes should be disregarded for these two machines. Therefore as the data from the network route is used in the assessment of skid resistance these two machines were required to retest the network route after the above changes were made. The Twin Straights testing is used primarily for distance and speed assessments, and as such Machine 33 which underwent changes for its skid resistance measurements did not need to repeat this testing (Machine 29 underwent its changes before this testing).

6.2 Machine repeatability

The between run standard deviation (BRSD) data for the survey data is given in Appendix B. On examination of the between run standard deviation and plots of the individual runs the following conclusions were made:

- For the network route, Machine 16 was higher than the BRSD criterion for the average for the route.
- The data from the tests on the Straight Line Wet Grip area shows a higher BRSD on SWG04. It has been found from previous trials that the BRSD is typically higher for SWG04. For the first set of tests Machines 1, 16 and 34 were higher than the BRSD criterion for the average of the SLWG site. For the second set of tests Machines 14, 29 and 34 were higher than the BRSD criterion for the average of the SLWG site.
- During the 50km/h testing on the Twin Straights Machine 28 was above the criterion for the average of the site. During the 80km/h testing no machines were above the criterion for the average of the site.

No machine consistently exceeds the BRSD guidance criterion during the trial. Following investigations where the threshold was exceeded all machines were deemed to be performing acceptably with regards to between run variation.

6.3 Variation between machines

The average SR values produced by the machines for each of the test sites are shown in the tables below (Table 6.1 to Table 6.7). At the base of each table is the average calculated for the trial indicated as “Trial mean”, and the Between Equipment Standard Deviation for the trial indicated as “Trial BESD”.

Two machines (Machine 32 and Machine 34) taking part in the trial were not accredited during the previous year. As such these two machines cannot be considered as part of the reference dataset. Therefore in addition to the mean and BESD for the trial (all machines), the tables below also show the mean and BESD for the reference machines.

Machine SR values are highlighted in green if they lie within 2 times the BESD criterion (see section 4.1) of the reference mean, in orange if they lie between 2 and 3 times the BESD criterion, and in red if they are greater than 3 times the BESD criterion. The “Ref BESD” and “Trial BESD” values are highlighted in green if they are below the BESD criterion, in orange if they are below 1.5 times the BESD criterion and in red if they exceed this value.

6.3.1 *Inspection day tests*

As noted in section 6.1, Machines 29 and 33 retested the network route following the alterations made to those machines. The final values for each machine at the trial are shown in Table 6.1. During this repeat testing, the batteries for the measurement system on Machine 29 lost power and they were only able to complete two laps. Machine 16 suffered some computer problems which caused invalid data in the first lap, which was not discovered until after the trial. As such these two machines (16 and 29) only have two laps of data for the network route testing. The owners of Machine 29 have since updated the batteries on their machine, and the owners of Machine 16 have developed a process to detect when their issue occurs so that data can be invalidated and a resurvey scheduled.

For information, the data from the original network route surveys for Machines 29 and 33 are shown in Table 6.2.

Table 6.1: Average SR from the network route surveys

ID	Average SR for network route sections														
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	Avg
1	68.7	94.2	85.4	85.3	84.7	59.0	75.9	86.6	70.5	59.8	76.3	54.0	47.9	60.8	72.1
3	63.5	86.6	82.8	83.0	84.4	61.3	73.4	85.4	72.8	59.6	76.5	59.1	55.6	65.7	72.1
14	63.5	88.4	83.7	83.2	83.8	60.5	75.7	83.3	70.3	58.5	76.3	53.5	47.4	65.4	71.0
16	63.2	87.3	84.1	82.3	84.6	62.7	76.5	85.5	69.6	57.0	76.6	52.4	43.5	62.5	70.6
17	59.6	87.9	78.9	79.7	81.7	59.0	74.2	79.9	69.1	55.9	73.9	53.7	49.0	61.4	68.8
19	57.7	83.6	79.3	78.8	79.8	58.3	71.4	80.0	67.5	56.0	74.6	53.7	47.2	63.7	68.0
22	60.8	84.7	79.5	78.5	78.9	57.8	69.7	79.0	67.8	55.9	76.7	51.6	45.9	59.7	67.6
23	64.0	90.3	82.8	86.0	84.4	63.4	75.0	80.8	73.1	59.0	78.1	58.6	53.9	66.6	72.6
24	60.1	87.1	82.3	81.5	82.9	59.5	72.3	81.2	69.1	57.9	75.4	53.6	46.0	63.2	69.4
25	64.7	94.0	84.6	90.9	86.6	64.1	77.1	83.6	72.4	60.6	77.7	58.7	49.7	67.2	73.7
26	63.2	88.7	81.3	82.1	82.4	59.6	75.2	82.1	74.3	58.0	76.8	59.9	46.7	65.3	71.1
28	58.0	85.0	77.7	77.7	79.3	58.2	70.2	79.5	70.9	56.9	73.5	53.1	50.5	63.1	68.1
29	64.1	90.1	86.7	85.8	90.6	61.2	75.1	83.7	66.4	53.0	74.1	53.6	52.3	66.0	71.6
31	60.3	84.3	79.8	80.1	81.3	57.9	73.4	78.0	68.4	54.9	76.0	53.8	48.7	64.2	68.6
32	59.0	83.1	80.0	79.3	80.4	57.2	72.8	79.2	66.9	56.0	73.6	51.3	44.2	64.1	67.6
33	65.6	89.5	85.0	84.0	84.7	63.3	77.9	84.9	72.0	57.5	74.6	53.7	52.3	68.3	72.4
34	68.5	90.4	83.9	85.1	85.8	65.0	77.4	86.6	71.2	61.1	80.0	54.4	50.2	65.5	73.2
Ref mean	62.5	88.1	82.3	82.6	83.3	60.4	74.2	82.2	70.3	57.4	75.8	54.9	49.1	64.2	70.5
Ref BESD	3.00	3.19	2.73	3.50	3.02	2.16	2.47	2.68	2.31	2.04	1.39	2.71	3.29	2.47	1.94
Trial mean	62.6	88.0	82.2	82.6	83.3	60.5	74.3	82.3	70.1	57.5	75.9	54.6	48.9	64.3	70.5
Trial BESD	3.30	3.29	2.65	3.43	2.99	2.46	2.47	2.84	2.32	2.15	1.75	2.68	3.32	2.33	2.07

Table 6.2: Average SR from the original network route surveys for Machines 29 and 33

ID	Average SR for network route sections														
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	Avg
29	63.8	86.9	78.7	79.6	80.0	55.8	69.7	76.4	61.8	53.3	71.2	53.5	48.8	67.1	67.6
33	67.5	94.7	88.9	89.1	88.9	66.2	79.9	87.6	74.2	66.7	85.3	59.9	54.6	70.0	76.7

On examination of the data collected on the network route (Table 6.1) we can see that both the Ref BESD and the Trial BESD for the average of all the sections meet the criterion for the network route (see Section 4.1).

6.3.2 Main running trial day 1 tests

The results from the 1st set of tests on the Straight Line Wet Grip are shown in Table 6.3.

Table 6.3: Average SR from the 1st set of tests on the Straight Line Wet Grip

ID	Average SR on Straight Line Wet Grip				
	SWG01	SWG02	SWG03	SWG04	Avg
1	69.4	93.6	28.4	66.7	65.2
3	67.5	92.0	28.2	59.4	62.6
14	67.5	89.8	26.0	58.0	61.3
16	69.5	93.5	26.7	57.0	62.8
17	64.9	89.1	25.2	54.4	59.3
19	66.0	90.3	26.3	54.9	60.4
22	62.6	86.8	23.9	51.5	57.1
23	65.5	90.0	25.4	56.3	60.2
24	64.2	89.0	24.4	55.4	59.1
25	66.7	93.2	27.2	56.3	61.7
26	66.2	88.2	24.5	55.6	59.7
28	61.1	85.4	23.2	51.6	56.2
29	55.7	74.4	22.3	51.5	51.6
31	61.6	85.4	22.7	50.5	56.0
32	63.3	86.3	24.2	51.8	57.4
33	71.3	96.2	30.3	61.3	65.7
34	68.2	91.9	27.4	62.7	63.4
Ref mean	65.3	89.1	25.6	56.0	59.9
Ref BESD	3.92	5.13	2.27	4.24	3.68
Trial mean	65.4	89.1	25.7	56.2	60.0
Trial BESD	3.78	4.90	2.20	4.43	3.60

The first set of tests on the Straight Line Wet Grip area (Table 6.3) show that the trial BESD is not met for the average of the site. One machine (Machine 29) is more than 3 times the BESD criterion away from the reference mean for the average of the site. This means that this machine would need to be rejected from the fleet (clause E4.2.8 see section 4.1). In addition one machine (Machine 33) is between 2 and 3 times the BESD criterion away from the reference mean and would therefore be subject to additional investigation. However it is noted that if Machine 29 is removed from the dataset then Machine 33 falls within 2 times the BESD criterion from the updated reference mean.

After removing these machines the trial BESD has dropped but is still just outside of the criterion, this is shown in Table 6.4.

Table 6.4: Summary of 1st set of tests on the Straight Line Wet Grip after exclusion of Machine 29 and 33

ID	Average SR on Straight Line Wet Grip				
	SWG01	SWG02	SWG03	SWG04	Avg
Ref mean	65.6	89.7	25.5	56.0	60.1
Ref BESD	2.67	2.82	1.79	4.12	2.68
Trial mean	65.6	89.6	25.6	56.1	60.1
Trial BESD	2.64	2.82	1.77	4.37	2.73

This would ordinarily require additional machines to be excluded in order to move the Trial BESD to be within the criterion. However, none of the remaining machines are more than 2 times the BESD criterion away from the reference mean for the average of the site and therefore no machine has been identified as a potential outlier for removal. This suggests that although the standard deviation is higher than the criterion, the overall spread of the remaining machines is suitable.

Directly after this testing (and before the Twin Straights testing), Machine 29 was reweighed and the pipework resting on the wheel assembly was identified. The pipework was tied back and the vertical calibration was redone before taking part in the Twin Straights testing.

The results from the 50km/h tests on the Twin Straights are shown in Table 6.5.

Table 6.5: Average SR from the 50km/h tests on the Twin Straights

ID	Average SR for 50km/h tests on Twin Straights						
	TS01	TS02	TS03	TS04	TS05	TS06	Avg
1	75.8	88.2	80.8	80.4	78.7	69.5	78.8
3	72.4	87.6	80.7	78.6	76.9	68.3	77.2
14	75.4	87.9	80.3	78.2	77.2	68.3	77.8
16	74.1	87.4	80.1	78.7	79.3	67.3	77.5
17	70.6	86.0	79.0	76.9	75.5	67.3	75.7
19	70.5	85.6	77.4	76.3	75.0	64.9	74.7
22	68.0	82.5	75.1	74.1	72.9	63.5	72.4
23	70.3	86.4	80.0	78.6	75.9	69.8	76.6
24	66.5	80.7	75.4	74.2	73.1	64.2	72.0
25	70.1	85.9	81.7	79.9	77.8	69.3	77.1
26	68.2	84.5	77.7	75.8	74.4	65.4	74.0
28	70.7	83.5	76.0	74.4	72.6	63.4	73.4
29	73.9	86.2	80.0	80.4	79.6	71.4	78.3
31	65.7	78.0	72.9	72.0	70.1	60.6	69.7
32	66.3	80.7	74.6	74.5	72.7	64.2	71.8
33	83.1	94.4	86.3	84.5	81.9	72.4	83.9
34	71.1	86.4	79.7	79.5	77.6	68.4	76.8
Ref mean	71.7	85.6	78.9	77.5	76.0	67.0	75.9
Fleet BESD	4.39	3.74	3.28	3.20	3.15	3.31	3.44
Trial mean	71.3	85.4	78.7	77.5	75.9	66.9	75.7
Trial BESD	4.31	3.70	3.25	3.13	3.09	3.19	3.37

On examination of the data collected from the 50km/h Twin Straights tests (Table 6.5) we can see that the Trial BESD for the average of the sections exceeds the criterion (see Section 4.1). During the SLWG testing it was observed that Machines 29 and 33 were outliers in the data. From the 50km/h testing on the Twin Straights Machine 29 no longer appears to be an outlier, suggesting the pipework fix and recalibration had improved the results for this machine.

The 50km/h testing on the Twin Straights suggests that Machines 31 and 33 might be outliers (as they are between 2 and 3 times the BESD criterion away from the fleet mean). However, historically it has been found that the data from the Twin Straights are more variable than those for the Straight Line Wet Grip site. This is due to the fact that the site has not had much traffic since it was laid. The data for this site has improved, however, as it stands, it is currently used only to provide supporting information for the skid resistance measurement part of the accreditation process.

The results from the 80km/h tests on the Twin Straights are shown in Table 6.5.

Table 6.6: Average SR from the 80km/h tests on the Twin Straights

ID	Average SR for 80km/h tests on Twin Straights						
	TS01	TS02	TS03	TS04	TS05	TS06	Avg
1	68.7	82.6	75.1	76.3	74.2	63.9	73.2
3	64.5	80.7	76.3	76.6	75.5	65.1	72.5
14	64.9	79.0	73.4	73.5	71.3	61.4	70.3
16	67.8	84.5	80.9	80.2	79.8	67.8	76.2
17	62.9	79.2	74.5	75.1	73.0	63.3	70.8
19	62.7	79.3	74.3	74.3	73.2	62.7	70.5
22	61.1	76.6	72.2	72.5	71.2	60.7	68.5
23	62.6	80.0	75.6	75.1	73.7	63.8	71.2
24	63.6	79.4	73.7	74.2	72.6	62.1	70.4
25	68.2	85.6	78.0	78.2	76.8	66.0	75.0
26	64.0	80.6	75.5	75.6	73.6	62.3	71.4
28	58.9	73.6	68.9	68.4	67.1	57.3	65.3
29	69.2	82.9	78.5	78.8	75.3	66.6	75.0
31	59.4	74.5	70.4	69.8	67.3	57.5	66.1
32	62.1	80.0	74.1	74.4	73.0	62.4	70.4
33	73.0	88.7	83.3	83.5	80.7	70.7	79.6
34	65.8	83.6	78.2	78.1	77.0	66.4	74.2
Ref mean	64.8	80.5	75.4	75.5	73.7	63.4	71.7
Fleet BESD	3.92	4.01	3.74	3.83	3.78	3.59	3.74
Trial mean	64.7	80.6	75.5	75.6	73.8	63.5	71.8
Trial BESD	3.73	3.83	3.59	3.66	3.63	3.44	3.57

The data from the 80km/h tests on the Twin Straights (Table 6.6) shows a similar performance as seen for the 50km/h tests. With Machines 28, 31 and 33 identified as possible outliers (as they are between 2 and 3 times the BESD criterion away from the fleet mean). However as noted above the Twin Straights data is used to provide only supporting information for the skid resistance measurement part of the accreditation process.

At the completion of the testing on the main running trial day 1, Machine 29 was assigned the red category, noting that the fix conducted before the Twin Straights testing may have resolved the issue.

Machine 33 was assigned the amber category due to its performance. This Machine was identified as a potential outlier in Straight Line Wet Grip testing (when Machine 29 is included in the dataset) and was also identified as a possible outlier from the Twin Straights testing.

The remaining machines that took part in the testing were assigned to the green category.

6.3.3 Main running trial day 2 tests

The testing on day 2 is a repeat of the SLWG testing from the morning of day 1. This testing serves two purposes, the first is to confirm that the fleet is stable and the second is to allow any machines which underwent repairs or modifications after the first set of testing to repeat the assessment. The results from this testing are shown in Table 6.7.

Table 6.7: Average SR from the 2nd set of tests on the Straight Line Wet Grip

ID	Average SR on Straight Line Wet Grip				
	SWG01	SWG02	SWG03	SWG04	Avg
1	66.2	91.2	23.5	54.3	59.9
3	67.2	89.3	24.7	50.6	59.3
14	63.7	88.6	23.6	54.6	58.5
16	68.6	96.0	24.4	54.6	62.0
17	62.7	87.2	22.9	49.1	56.5
19	60.7	83.7	22.1	48.0	54.6
22	61.3	85.5	22.7	51.5	56.1
23	64.3	87.9	23.9	50.4	57.7
24	64.6	90.4	22.6	51.0	58.2
25	64.1	89.8	23.0	52.9	58.4
26	64.8	86.4	22.3	48.6	56.9
28	60.6	83.9	21.4	48.8	54.7
29	67.7	92.8	27.3	61.6	63.1
31	59.5	81.9	21.7	46.1	53.3
32	59.4	82.5	21.0	47.4	53.5
33	69.3	93.1	26.6	53.6	61.9
34	64.9	90.9	25.7	60.1	61.0
Ref mean	64.4	88.5	23.5	51.7	58.1
Ref BESD	3.05	3.89	1.67	3.78	2.86
Trial mean	64.1	88.3	23.5	52.0	58.0
Trial BESD	3.10	3.98	1.77	4.24	2.99

The second set of tests on the Straight Line Wet Grip area (Table 6.7) show that again the Trial BESD does not meet the criterion for the average of the site. However, none of the machines are more than 2 times the BESD criterion away from the reference mean for the average of the site and therefore being identified as outliers. Further examination of the data has found that the machine which is producing the highest value is approximately the same distance away from the mean as the one that is producing the lowest value. As noted in the main trial day 1 testing, this suggests that although the BESD criterion has not been met the overall spread of the machines is suitable.

6.4 Summary of skid resistance testing

All machines produced suitable results with regards to repeatability of skid resistance measurement (BRSD criterion, see Section 4.1).

All machines produced suitable results with regards to reproducibility of skid measurement (BESD criterion, see 4.1).

7 Location referencing

7.1 Distance measurement

The assessment of the distance measurement recorded by the machines is complicated because there are a number of different assessment methods possible and potentially up to three different test sites to be used in the analysis. The sites are the Twin straights at HORIBA-MIRA, the Longcross test track and the network route. However, due to the variation in the position of marker entry (as there are no cones set out to clearly identify the points) and the impact of traffic, the network route data is typically only used as supporting information for the assessment of distance. The two different assessment methods are:

1. Physically entering the location of the survey section start and end points into the data as they are driven past by the survey vehicle. However, these can be entered by two different methods:
    - Automatically - using retroreflective markers. This method is generally used for any assessments undertaken in a controlled environment (test track). This is the most accurate method of determining the performance of the system as it removes all other variables.
    - Manually – these are entered by the system operator during the survey. This method is used when the survey device does not have an automatic marker recognition system fitted or the test site does not use reflective markers (e.g. on the network route). The criterion for the push button entry is more lenient to allow for the additional uncertainty added by the reaction times of the operator.
2. Assessment of the system when section start and end points are generated post survey using OSGR fitting software. Using this method can potentially introduce additional errors if these are present in the OSGR measurement system. However, this is the standard fitting method used by Highways England (and other road operators) for routine survey data. It is noted that some devices (and operators) do not have this capability and therefore cannot be assessed against this requirement.

As stated in Section 2.4, the Longcross test track programme is a requirement for all machines requiring an assessment for measurement of their 3 dimensional positional systems (OSGRs). Highways England requires the highest standards from their measurement devices and therefore they state that systems should meet the requirements for both assessment methods (and using automatic markers on the test track sites).

Due to this split in requirements and the differing capabilities of the survey fleet the following assessments have been carried out:

- All machines were assessed for distance travelled measurement on the MIRA Twin Straights site. This is discussed in Section 7.1.1 below.
- The machines requiring assessment of their 3 dimensional positional systems were required to attend the Longcross test site. These devices were then assessed for their distance measurements (using the RCD file format) against the automatic or manual requirements as appropriate. This is discussed in Section 7.1.2 below.

- The machines that attended Longcross that also required an OSGR fitting assessment were then also assessed (using BCD and RCD files) against the OSGR fitting requirements for distance measurement. This is discussed in Section 7.1.2 below.

7.1.1 MIRA Twin Straights

To provide data for the assessment of distance measurement, the survey vehicles performed ten passes of the Twin Straights test site (5 passes at 50km/h and 5 passes at 80km/h), marking positions A-G as shown in Figure 3.1. The data was delivered in the standard 'loc file' output from the system. This data was then assessed against the reference data collected from an optical survey of the site against the push button or automatic marker criteria as required.

The results of this assessment (including the criteria used) are shown in Table 7.1.

Table 7.1: Distance measurement assessment on MIRA Twin straights

ID	Percentage of data within				Assessment criteria used	Met criterion
	1m	2m	5m	10m		
1	54%	78%	98%	100%	Automatic	Fail
3	38%	76%	100%	100%	Push	Pass
14	56%	82%	100%	100%	Push	Pass
16	70%	88%	100%	100%	Automatic	Pass
17	90%	100%	100%	100%	Automatic	Pass
19	72%	98%	100%	100%	Automatic	Pass
22	36%	82%	100%	100%	Push	Pass
23	94%	100%	100%	100%	Automatic	Pass
24	98%	100%	100%	100%	Automatic	Pass
25	86%	100%	100%	100%	Automatic	Pass
26	98%	100%	100%	100%	Automatic	Pass
28	97%	100%	100%	100%	Automatic	Pass
29	52%	78%	88%	100%	Automatic	Fail
31	93%	100%	100%	100%	Automatic	Pass
32	98%	100%	100%	100%	Automatic	Pass
33	68%	92%	100%	100%	Push	Pass
34	70%	100%	100%	100%	Automatic	Pass

From Table 7.1 it can be seen that two machines fail to meet the corresponding criteria, Machine 1 and Machine 29. However, further examination of the data found that although both of these machines have automatic marker detection fitted, some of the markers were not detected automatically and were entered manually instead, thus increasing the error for the system in these cases. Unfortunately, the operators of these systems did not follow the correct procedures in these circumstances. The survey crew should have highlighted the error and repeated the tests until all markers are identified automatically. However, as both of these machines took part in the testing at Longcross they can therefore be further assessed using that dataset.

7.1.2 Longcross

The testing at Longcross comprised of six passes of the track (3 passes at 50km/h and 3 passes at 80km/h), marking positions A, B, F, G and H as shown in Figure 3.5.

Sixteen machines took part in the testing at Longcross (to assess their OSGR systems), of these thirteen machines provided OSGR fitted data. The results for the machines that supplied OSGR fitted data are given in Table 7.2.

Table 7.2: Distance measurement assessment at Longcross (OSGR fitted data)

ID	Percentage of data within				Assessment criteria used	Met criterion
	1m	2m	5m	10m		
1	50%	94%	100%	100%	OSGR Fitted	Pass
17	94%	100%	100%	100%	OSGR Fitted	Pass
19	94%	100%	100%	100%	OSGR Fitted	Pass
22	56%	100%	100%	100%	OSGR Fitted	Pass
23	83%	94%	100%	100%	OSGR Fitted	Pass
24	61%	100%	100%	100%	OSGR Fitted	Pass
25	94%	100%	100%	100%	OSGR Fitted	Pass
26	94%	100%	100%	100%	OSGR Fitted	Pass
28	83%	100%	100%	100%	OSGR Fitted	Pass
29	72%	89%	100%	100%	OSGR Fitted	Pass
31	100%	100%	100%	100%	OSGR Fitted	Pass
32	100%	100%	100%	100%	OSGR Fitted	Pass
34	83%	100%	100%	100%	OSGR Fitted	Pass

From Table 7.2 it can be seen that all of the machines met the OSGR fitted criteria.

However, it has been noted at previous trials that the OSGR fitted data has not always met the requirements for the distance assessment as it incorporates the performance of the OSGR system into the distance assessment. In some cases this may result in some machines failing the distance measurement criteria due to poor OSGR performance. In other cases it might show a machine to meet the criteria because the error in the OSGR system is cancelling out the error in the distance measurement.

To ensure that any device working on the Highways England network is assessed to the highest standards, it is therefore planned that the text in the SKID accreditation and QA specification is updated to state that machines which plan to provide OSGR fitted data will also have the original survey data (i.e. not OSGR fitted) assessed on the automatic markers criteria (regardless of the marker entry method). The Longcross data for these machines has also been assessed using this method. This assessment found that the machines all met these criteria and therefore the proposed changes are achievable by the fleet. As this updated criteria is currently not in the Accreditation and QA specification the certificates for these machines had the following comment added to explain the assessment undertaken:

This machine supplied OSGR fitted data, however the OSGR fitted criteria for distance has been identified as being demanding. Therefore machines are assessed against the automatic markers criteria.

As previously mentioned three machines attended the Longcross testing and did not supply OSGR fitted data. The results for these three machines are given in Table 7.3.

Table 7.3: Distance measurement assessment at Longcross (for machines that only supplied RCD files)

ID	Percentage of data within				Assessment criteria used	Met criterion
	1m	2m	5m	10m		
14	56%	94%	100%	100%	Push	Pass
16	0%	39%	100%	100%	Automatic	Fail
33	44%	94%	100%	100%	Push	Pass

From this assessment it can be seen that one machine (Machine 16) fails to meet the automatic marker criteria on the Longcross test site. However, this machine provided suitable data from the MIRA test site (as discussed above). It was noted that the device always measured the lengths shorter than the reference (on average around 2m shorter). However examination of their distance calibration files (in the 'loc' format) conducted before the Longcross testing and between the surveys of the two sites displayed a good level of accuracy.

It was noted that the operators of machine 16 were experiencing some difficulties in generating the locations of the automatic markers in the RCD files (it should be noted that this is only required for the Longcross and the network route testing). In addition the performance of distance measurement on the network route for this machine was consistent with the rest of the fleet. Therefore it was deemed that the variations seen at Longcross were either:

- Errors introduced into the RCD when generating the positions of the automatic markers
- Incorrect driving lines taken on the Longcross test track

The following recommendations are given to the operators of Machine 16:

- They should investigate their RCD generation software (especially the insertion of automatic markers)
- Keep their device correctly calibrated
- Ensure the correct test lines are taken at future trials.

7.1.3 Summary of distance measurement assessment

For Machine 16:

- The results from the RCD assessment (discussed above) did not meet the requirements- however it is believed that this may be down to file formatting issues.

- The evidence from other sites (and calibrations) indicates the system is behaving as would be expected.
- The system has therefore been deemed acceptable and will be monitored during the QA process.

For Machines 1 and 29 (which exhibited a lower level of performance on the MIRA site) show a good performance on the Longcross site. This evidence supports the theory that the poor performance on the MIRA site was due to detection of the markers (rather than an error in the distance measurement equipment) as discussed above. These two Machines are therefore deemed satisfactory for the measurement of distance travelled.

The awarded performance for distance measurement (and the criteria applied) is shown in Table 7.4. Machines which were deemed to be suitable but had additional comments added to the certificate are awarded a "Pass*" (the additional comments are discussed in the previous sections). Machines which provided OSGR fitted data but were assessed against the Automatic markers criteria are shown as "Automatic*".

Table 7.4: Distance measurement assessment Summary

ID	Assessment criteria used	Distance measurement
1	Automatic*	Pass
3	Push	Pass
14	Push	Pass
16	Automatic	Pass*
17	Automatic*	Pass
19	Automatic*	Pass
22	Automatic*	Pass
23	Automatic*	Pass
24	Automatic*	Pass
25	Automatic*	Pass
26	Automatic*	Pass
28	Automatic*	Pass
29	Automatic*	Pass
31	Automatic*	Pass
32	Automatic*	Pass
33	Push	Pass
34	Automatic*	Pass

7.2 3 dimensional spatial coordinates data

The assessment of 3 dimensional spatial coordinates is mandatory for any device that is to be used on the central Highways England survey contract and optional for the other devices. Sixteen machines took part in these tests.

The assessment is carried out on the Longcross test track and the network route near MIRA. The reference data from the Longcross test track was obtained from a static GPS survey of the site, and the network route reference data was supplied by Highways England's HARRIS survey vehicle.

The results from the OSGR and altitude assessments and the criteria applied are given in Appendix C and are summarised in Table 7.5 and

Table 7.6. All machines would be assessed using the OSGR fitted criteria along with the corresponding marker entry criteria. Data from any machines which did not provide OSGR fitted data, was fitted by TRL using Highways England's MSP software. It is recommended that the Accreditation and QA specification is updated to reflect this amended test procedure. The assessment criteria are given in section 4.1.

Table 7.5: Summary of OSGR assessments

ID	Performance on Network route (OSGR fitted)	Performance at Longcross		Awarded Performance
		OSGR fitted	Marker entry	
1	High	High	High	High
14	High	High	High	High
16	High	High	Low	Low
17	High	High	High	High
19	High	High	High	High
22	High	High	High	High
23	High	High	High	High
24	High	High	High	High
25	High	High	High	High
26	High	High	High	High
28	High	High	High	High
29	High	High	High	High
31	High	High	High	High
32	High	High	High	High
33	High	Low	Low	Low
34	High	High	High	High

Table 7.6: Summary of Altitude assessments

ID	Performance on Network route (OSGR fitted)	Performance at Longcross (Marker entry)	Awarded Performance
1	High	High	High
14	Medium	Low	Low
16	Medium	Medium	Medium
17	High	High	High
19	High	High	High
22	High	High	High
23	High	High	High
24	High	High	High
25	High	High	High
26	High	High	High
28	High	High	High
29	High	Medium	Medium
31	High	High	High
32	High	Medium	Medium
33	Medium	Medium	Medium
34	High	High	High

8 File formats

All of the machines that took part in the skid resistance testing supplied suitable ".S10" and ".loc" files. There is a mandatory requirement that any device that is to be used on the central Highways England contract shall provide RCD and BCD data.

The following machines provided RCD files:

- Machine 1
- Machine 14
- Machine 16
- Machine 17
- Machine 19
- Machine 22
- Machine 23
- Machine 24
- Machine 25
- Machine 26
- Machine 28
- Machine 29
- Machine 31
- Machine 32
- Machine 33
- Machine 34

The following machines provided BCD files:

- Machine 1
- Machine 17
- Machine 19
- Machine 22
- Machine 23
- Machine 24
- Machine 25
- Machine 26
- Machine 28
- Machine 29
- Machine 31
- Machine 32
- Machine 34

Examination of the supplied RCD and BCD found that the data formatting was in general suitable. However, Machine 16 provided RCD files with incorrectly formatted section data. This may be a unique problem for the trials as it is required to enter section data for the survey. Often on network surveys section data is not required to be entered. The owner has been notified of these formatting issues.

9 Additional investigations into Machine 29

9.1 Measurements made at trial and issue identified

As part of the inspection day the test wheel assembly is weighed on each machine and a vertical calibration is undertaken and checked. The process for this is:

1. The survey crew undertakes a vertical check (this provides the weight that the vertical load system on the machine believes the wheel assembly to weigh).
2. The survey crew then carries out a calibration of the vertical load system.
3. The wheel assembly is then weighed using a weigh pad. There can be a tendency for the shaft bearings to stick slightly when the wheel is first lowered (without the shaking action that would be experienced on the moving vehicle during a survey). Therefore the assembly is weighed in an “un-bounced” and a “bounced” (where foot pressure has been applied to the wheel arm bearing to bounce the back plate). Three pairs of “un-bounced” and “bounced” measurements are taken.
4. The survey crew undertakes a second vertical check.

For this process the bounced measurements in step 3 are required to be 200±8 kg. In addition the final vertical check should be similar to this value.

For Machine 29 the first run through of this process produced the following results:

Vertical check (kg)	191.0					
	Un bounced			Bounced		
	1	2	3	1	2	3
Weight (kg)	209.0	208.6	208.6	209.0	208.6	208.6
Avg weight (kg)	208.7			208.7		
Vertical check (kg) - after calibration	204.4					

From this it can be seen that the bounced weight (208.7) is outside of the tolerance set. It was also noted that vertical check values were markedly different before and after the vertical calibration (suggesting that the machine did not arrive at the trial in a calibrated state or the system is variable). After the survey crew examined their machine two sets of reweighs and vertical checks (no recalibrations) were undertaken, with the following results:

	Un bounced			Bounced		
	1	2	3	1	2	3
Weight (kg)	206.8	207.4	206.8	207.0	207.6	207.4
Avg weight (kg)	207.0			207.3		
Vertical check	202.6					

	Un bounced			Bounced		
	1	2	3	1	2	3
Weight (Kg)	206.6	206.2	206.4	207.4	207.6	207.2
Avg weight	206.4			207.4		
Vertical check	199.3					

From this it can be seen that the weight has dropped to being just within the criteria. However there appears to be a downward trend on the vertical check values. This was concerning as the vertical calibration should be undertaken on a monthly interval; i.e. it is expected that the calibration will hold for this period.

Due to concerns with this device it was decided that it should repeat the whole weighing and vertical calibration process on the first main trial day (Wednesday). Prior to this reweighing, the machine took part in the tests on the Straight Line Wet Grip (see section 6.3.2) and was found to be an outlier. This reweigh produced the following results:

	Un bounced			Bounced		
Vertical check (kg)	195.1					
	1	2	3	1	2	3
Weight (Kg)	208.0	209.0	209.0	209.5	209.0	208.5
Avg weight (kg)	208.7			209.0		
Vertical check (kg) -after calibration	206.6					

This shows that the vertical check before and after the calibration was again inconsistent and the bounced wheel weigh was again outside of the threshold. The survey crew undertook further investigation of their machine and found that the high wheel assembly weight was likely due to some pipework resting on it. The survey crew tied this pipework back so that it would not interfere with the wheel assembly and repeated the vertical check and weighing process; this produced the following results:

	Un bounced			Bounced		
Vertical check (kg)	203.4					
	1	2	3	1	2	3
Weight (Kg)	207	207	207	207.5	208	208
Avg weight (kg)	207			207.8		
Vertical check (kg) - after calibration	205.4					

This can now be seen to be just within the wheel weight tolerance, and the vertical check values are more consistent before and after the calibration. This machine then went on to take part in the Twin Straights testing (see section 6.3.2) and the final day of testing on the Straight Line Wet Grip (see section 6.3.3). This machine was not identified as an outlier in these remaining tests.

The final set of testing for this machine suggests that it is capable of producing skid resistance values consistent with the fleet. However, the data collected raises some concerns with the weight of the wheel assembly (which varied during the trial and was only just within the criteria at the end of the trial). In addition (and possibly a related issue) the vertical load cell calibration did not appear to be performing correctly.

9.2 Plan for determining suitability of machine

Due to the concerns raised at the trial for this machine (29), it was decided that some additional testing would be carried out after the trial, to confirm whether the wheel weight is within the tolerance and if the vertical load system is behaving consistently. The testing process that was identified:

1. The trial vertical check and weighing procedure would be repeated after the trial.
2. The survey crew would provide TRL with vertical check results from each week day for the three weeks following this re-weigh, without carrying out any vertical calibrations within this time frame.
3. Back to back testing on the network route would be undertaken with an accredited device (providing raw data including the vertical and horizontal loads).

The above steps will be carried out sequentially and if the machine is found to be unsuitable at any stage, the process will stop and the machine will require further investigations. If the machine is found to be suitable through all three stages, then it will receive a back dated accreditation (based on its performance at the trial) noting that the owners should take particular care to check on the vertical calibration throughout the year as part of their QA.

9.3 Results of reweighs after the trial

Machine 29 was reweighed at TRL on 13th May 2019, producing the following results:

Vertical check (kg)	204.0					
	Un bounced			Bounced		
	1	2	3	1	2	3
Weight (Kg)	206.5	206.5	206.5	206.0	207.0	205.5
Avg weight (kg)	206.5			206.2		
Vertical check (kg) - after calibration	206.1					

The machine was also reweighed back at the survey contractor's offices on the 14th May 2019, producing the following results:

Vertical check (kg)	205.9					
	Un bounced			Bounced		
	1	2	3	1	2	3
Weight (Kg)	206.5	207.0	206.5	207.0	207.0	206.5
Avg weight (kg)	206.7			206.8		
Vertical check (kg) - after calibration	205.7					

The weight values measured are within the weight criteria and are consistent between the two days (and the values measured at last year's trial). In addition the vertical check appears to be remaining constant over this time frame.

9.4 Ongoing work

This machine will undergo further monitoring of the vertical load cell via a daily check of the vertical calibration values for three weeks, followed by back to back testing on the network route with an accredited device to confirm the performance. At the end of this work if no issues have arisen with the data then a certificate recommending its use will be issued. This work is outside the scope of the accreditation trial and is therefore not included in this report.

10 Conclusions

The 2019 sideway-force skid resistance accreditation trials were held during the week commencing 25th March 2019. The trials were held on and around the MIRA proving ground and at the Longcross test track. Eighteen machines attended.

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

(i) General condition

One machine appeared to have some inconsistencies in the performance of the vertical calibration during the trial and will be subject to ongoing monitoring not covered in this report. Another machine suffered from computer failure and did not take part in the majority of the testing (and was therefore not assessed).

(ii) Skid resistance measurement

Seventeen of the eighteen machines met the criteria for the measurement of skid resistance at the trial.

(iii) Vehicle Speed attainment and recording

Seventeen of the eighteen machines met the criteria for vehicle speed attainment and recording.

(iv) Distance measurement

Seventeen of the eighteen machines met the criteria with regards to the measurement of distance.

(v) Left test wheel weight

All eighteen machines met the current ±8 kg tolerance for test wheel weight. However, one machine only achieved this following adjustments to the device.

It is noted that there is a draft for development CEN technical specification for these devices which would tighten the tolerance to ±1 kg. Eleven of the seventeen machines meet this tighter tolerance.

(vi) Water flow

All eighteen machines were found to provide satisfactory water flow and direction.

The following conclusions were drawn in relation to the various additional tests and assessments (note: OSGR and Altitude is mandatory for machines operating on the central Highways England survey contract and optional for others):

(vii) Measurement of OSGRs

Sixteen machines fitted with 3 dimensional spatial coordinate systems were assessed for the measurement of OSGRs. Fourteen machines achieved a high performance and two a low performance.

(viii) Measurement of Altitude

Sixteen machines fitted with 3 dimensional spatial coordinate systems were assessed for the measurement of altitude. Eleven machines achieved a high performance, four a medium performance and one a low performance.

(ix) File formats

Seventeen of the eighteen machines supplied suitable .s10 and .loc files. Sixteen machines provided suitable RCD files and thirteen machines provided suitable BCD files.

A summary of the machines that attended the 2019 accreditation trial and the criteria that they met can be found in Appendix A.

References

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Appendix A Machine identification and performance

Table A.1: Machine identification and performance summary

ID	Current Owner	Registration number	Performance Summary								
			Skid resistance	Speed	Distance travelled[1]	Weight and vertical cal.	OSGR	Altitude	S10 and loc file	RCD file	BCD file
1	PTS Ltd	W965 SVG	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
3	DRDNI	IKZ 2203	Pass	Pass	Pass	Pass			Satisfactory	-	-
14	PMS	01 KK 1138	Pass	Pass	Pass	Pass	High	Low	Satisfactory	Satisfactory	-
16	Saber	S66 HSL	Pass	Pass	Pass*	Pass	Low	Medium	Satisfactory	Satisfactory	-
17	WDM Ltd	S800 WDM	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
19	WDM Ltd	S900 WDM	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
21	Surrey CC	KX07YXH	-	-	-	Pass			-	-	-
22	PTS Ltd	KX07YVH	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
23	WDM Ltd	S11 WDM	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
24	WDM Ltd	S12 WDM	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
25	WDM Ltd	S13 WDM	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
26	WDM Ltd	S14 WDM	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
28	Operated by TRL on behalf of Highways England	WX60 AXN	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
29	PTS Ltd	YD02 XSN	Pass	Pass	Pass	TBC	High	Medium	Satisfactory	Satisfactory	Satisfactory
31	WDM Ltd	S16 WDM	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
32	Virginia Tech Transport Institute	DOT 45158	Pass	Pass	Pass	Pass	High	Medium	Satisfactory	Satisfactory	Satisfactory
33	PMS	17 2G 1777	Pass	Pass	Pass	Pass	Low	Medium	Satisfactory	Satisfactory	-
34	WDM Ltd	WDM SM1	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory

[1] Machines are assessed on different criteria for distance travelled depending on the equipment fitted. Please see the corresponding part of this report or the test certificate for the machine to see which criteria were applied for the assessment.

Appendix B Between run standard deviation

Values that are within the BRSD criteria (see section 4.1) are shaded in green. Values up to 1 standard deviation greater than the criteria are shaded in orange, values greater than this are shaded in red.

Table B.1: Machine repeatability for the Network route (final runs)

ID	Between run SD														
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	Avg
1	3.60	4.79	2.77	1.59	0.70	2.03	0.96	2.08	1.37	1.77	2.14	2.71	1.27	1.41	2.47
3	3.56	1.91	1.89	1.51	1.19	0.74	1.22	1.74	1.21	0.81	1.51	2.92	3.62	1.20	1.75
14	1.79	2.40	1.11	2.34	0.85	0.70	1.39	1.13	2.50	2.13	2.10	1.45	2.67	1.68	1.76
16	2.20	2.67	2.12	0.07	0.31	0.13	1.49	4.34	1.38	3.32	1.58	0.97	0.54	2.60	2.25
17	2.01	3.33	1.25	2.12	1.43	0.93	1.40	0.18	1.10	0.72	0.42	1.33	1.11	0.61	1.67
19	0.77	2.81	1.21	2.14	2.70	1.70	1.50	1.40	0.74	0.30	1.36	0.36	2.63	0.55	1.72
22	2.97	2.28	1.45	2.22	2.56	1.50	1.14	2.01	1.84	1.34	3.03	0.67	0.67	2.49	2.01
23	0.59	3.50	2.17	4.76	2.76	0.90	1.11	1.26	2.78	2.04	1.97	0.83	2.04	1.24	2.51
24	1.34	2.06	2.47	0.80	1.03	0.58	1.31	2.01	1.22	1.69	1.85	0.16	0.98	1.90	1.56
25	1.12	3.19	2.21	1.35	1.35	1.71	1.96	1.18	3.13	2.94	1.41	1.84	2.43	3.45	2.16
26	0.97	3.62	2.90	2.38	2.24	2.54	1.78	2.28	2.28	2.40	2.33	8.00	1.84	4.45	2.43
28	0.08	2.70	1.71	1.93	2.01	0.23	1.62	1.56	1.71	1.13	1.79	0.79	1.25	2.22	1.65
29	0.96	0.89	0.57	2.60	4.02	0.14	3.94	0.50	1.24	1.39	0.10	0.54	2.83	4.05	2.10
31	0.54	2.10	2.50	3.09	1.84	0.72	1.37	1.47	1.67	3.88	3.42	2.37	0.34	1.20	2.15
32	0.95	1.05	2.62	2.87	1.99	2.24	0.97	1.18	2.90	2.57	1.26	0.95	1.25	2.07	2.08
33	2.24	1.68	0.79	0.84	0.68	0.94	1.69	1.71	1.19	0.70	0.99	2.40	0.88	0.21	1.35
34	1.82	2.16	0.90	0.82	1.79	1.71	0.54	2.82	1.97	2.48	1.24	0.88	1.27	0.42	1.84
Avg	1.91	2.71	1.94	2.23	1.96	1.35	1.65	1.92	1.91	2.10	1.86	2.47	1.86	2.22	2.00

Table B.2: Machine repeatability for original tests of the Network route

ID	Between run SD														
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	Avg
29	0.51	1.01	0.61	0.93	2.42	3.00	3.21	2.91	0.75	1.94	1.07	3.29	2.19	2.36	2.01
33	3.30	1.02	1.65	2.31	1.50	2.75	1.60	1.28	0.14	1.19	1.35	0.40	1.24	1.60	1.88

Table B.3: Machine repeatability for the 1st set of tests on the Straight Line Wet Grip

ID	Between run SD				
	SWG01	SWG02	SWG03	SWG04	Avg
1	2.27	1.19	2.86	6.85	3.73
3	1.26	1.17	1.08	3.51	1.94
14	2.05	1.53	1.65	3.86	2.40
16	4.07	1.16	1.83	3.20	3.02
17	1.52	1.21	1.12	4.50	2.40
19	1.74	1.82	1.22	2.01	1.72
22	0.77	1.69	1.62	3.56	2.03
23	0.82	1.06	1.51	4.71	2.39
24	0.62	1.39	0.93	1.65	1.15
25	0.47	1.10	0.84	2.80	1.47
26	1.42	1.34	2.26	3.49	2.19
28	1.25	1.23	1.15	4.27	2.25
29	1.67	0.77	1.45	3.34	1.99
31	1.23	1.66	0.99	3.97	2.17
32	1.16	2.08	1.26	2.96	1.90
33	1.01	2.13	0.91	2.80	1.79
34	0.53	1.19	2.00	6.90	3.38
Avg	1.63	1.44	1.55	4.03	2.32

Table B.4: Machine repeatability for the 2nd set of tests on the Straight Line Wet Grip

ID	Between run SD				
	SWG01	SWG02	SWG03	SWG04	Avg
1	1.29	1.40	0.38	3.65	1.97
3	1.00	1.60	0.51	2.10	1.38
14	1.17	1.44	1.29	6.20	3.08
16	1.11	1.63	0.53	3.60	1.96
17	1.26	0.90	0.45	2.32	1.39
19	1.15	0.85	0.62	3.33	1.76
22	0.82	0.79	0.52	2.90	1.50
23	0.44	0.95	0.41	2.21	1.16
24	2.06	0.92	0.54	2.27	1.69
25	1.42	0.81	0.51	3.80	2.00
26	1.09	0.52	0.60	1.64	1.06
28	2.41	1.40	0.78	2.08	1.88
29	0.69	3.16	2.33	10.63	5.26
31	1.79	1.60	0.94	2.96	1.94
32	1.16	2.03	1.03	4.75	2.54
33	1.94	1.61	0.38	1.75	1.61
34	1.75	2.55	1.65	7.68	3.96
Avg	1.42	1.57	0.94	4.42	2.37

Table B.5: Machine repeatability for the 50k/h tests on the Twin Straights

ID	Between run SD						
	TS01	TS02	TS03	TS04	TS05	TS06	Avg
1	2.07	0.81	0.84	0.54	1.43	0.71	1.22
3	1.99	1.18	1.27	0.80	0.76	2.00	1.49
14	2.79	2.19	0.74	0.64	2.97	1.79	2.02
16	2.19	3.05	1.76	1.56	2.67	1.58	2.17
17	0.97	2.03	1.23	0.42	0.86	2.02	1.40
19	4.66	1.66	1.05	0.71	0.51	0.30	2.35
22	2.14	1.77	0.91	0.55	0.27	0.58	1.34
23	2.40	0.67	0.53	0.85	0.65	1.96	1.49
24	1.82	1.24	0.66	0.74	1.03	0.48	1.14
25	1.88	2.33	1.94	1.62	0.79	0.90	1.73
26	0.89	1.86	1.88	0.81	0.72	1.22	1.34
28	6.08	5.53	3.99	3.43	3.18	4.11	4.69
29	2.02	1.65	1.18	0.80	2.26	1.69	1.64
31	0.46	1.60	2.43	1.86	1.80	1.27	1.64
32	1.56	0.48	0.35	0.15	0.62	0.32	0.80
33	3.62	3.88	1.90	2.00	1.42	0.96	2.67
34	2.14	1.45	0.49	0.32	1.20	0.34	1.26
Avg	2.69	2.30	1.62	1.31	1.62	1.60	1.98

Table B.6: Machine repeatability for the 80km/h tests on the Twin Straights

ID	Between run SD						
	TS01	TS02	TS03	TS04	TS05	TS06	Avg
1	0.43	1.58	0.71	1.05	0.80	0.26	0.90
3	0.94	1.30	0.69	0.58	0.69	0.78	0.88
14	0.99	0.76	1.29	0.74	0.87	0.57	0.91
16	1.66	0.73	1.95	1.35	2.19	1.52	1.58
17	0.80	0.50	0.41	0.91	0.39	0.64	0.66
19	0.82	0.60	0.39	0.31	1.19	0.23	0.63
22	1.42	1.16	0.89	0.58	0.50	0.16	0.95
23	0.44	0.51	1.90	0.35	0.36	0.42	0.88
24	0.57	1.24	0.78	0.53	0.70	0.31	0.74
25	1.60	1.68	1.01	0.61	1.27	0.08	1.20
26	1.41	1.86	1.17	1.99	0.97	0.68	1.45
28	0.20	0.15	0.64	0.41	0.63	0.21	0.40
29	1.04	2.75	2.95	3.37	1.58	2.12	2.45
31	1.04	1.02	1.21	1.99	0.98	0.57	1.22
32	0.59	1.70	1.04	0.56	1.05	0.38	0.97
33	1.67	2.47	2.03	2.32	0.74	1.55	1.94
34	0.79	1.20	0.59	0.51	0.84	0.36	0.76
Avg	1.06	1.42	1.34	1.36	1.02	0.84	1.20

Appendix C Assessment of 3 dimensional spatial coordinates data

C.1 OSGR data

Table C.1: OSGR measurements against the reference: Network route –OSGR fitted data

ID	10m data points Network route: % within							Performance level
	3m	6m	12m	17m	20m	25m	30m	
1	99%	100%	100%	100%	100%	100%	100%	High
14	98%	100%	100%	100%	100%	100%	100%	High
16	97%	99%	100%	100%	100%	100%	100%	High
17	100%	100%	100%	100%	100%	100%	100%	High
19	100%	100%	100%	100%	100%	100%	100%	High
22	100%	100%	100%	100%	100%	100%	100%	High
23	100%	100%	100%	100%	100%	100%	100%	High
24	100%	100%	100%	100%	100%	100%	100%	High
25	100%	100%	100%	100%	100%	100%	100%	High
26	100%	100%	100%	100%	100%	100%	100%	High
28	99%	100%	100%	100%	100%	100%	100%	High
29	99%	100%	100%	100%	100%	100%	100%	High
31	99%	100%	100%	100%	100%	100%	100%	High
32	100%	100%	100%	100%	100%	100%	100%	High
33	88%	94%	97%	100%	100%	100%	100%	High
34	100%	100%	100%	100%	100%	100%	100%	High

Table C.2: OSGR measurements against the reference: Longcross –OSGR fitted data

ID	10m data points on test track: % within							Performance level
	2m	4m	5m	7m	8m	20m	25m	
1	97%	100%	100%	100%	100%	100%	100%	High
14	99%	100%	100%	100%	100%	100%	100%	High
16	95%	100%	100%	100%	100%	100%	100%	High
17	100%	100%	100%	100%	100%	100%	100%	High
19	99%	100%	100%	100%	100%	100%	100%	High
22	100%	100%	100%	100%	100%	100%	100%	High
23	98%	100%	100%	100%	100%	100%	100%	High
24	99%	100%	100%	100%	100%	100%	100%	High
25	99%	100%	100%	100%	100%	100%	100%	High
26	98%	100%	100%	100%	100%	100%	100%	High
28	98%	100%	100%	100%	100%	100%	100%	High
29	92%	100%	100%	100%	100%	100%	100%	High
31	98%	100%	100%	100%	100%	100%	100%	High
32	100%	100%	100%	100%	100%	100%	100%	High
33	41%	85%	94%	100%	100%	100%	100%	Low
34	98%	99%	100%	100%	100%	100%	100%	High

Table C.3: OSGR measurements against the reference: Longcross –Push button or automatic marker data

ID	10m data points on test track: % within							Marker entry type	Performance level
	2m	4m	5m	7m	8m	20m	25m		
1	97%	100%	100%	100%	100%	100%	100%	Automatic	High
14	62%	96%	100%	100%	100%	100%	100%	Push	High
16	76%	90%	100%	100%	100%	100%	100%	Automatic	Low
17	97%	100%	100%	100%	100%	100%	100%	Automatic	High
19	99%	100%	100%	100%	100%	100%	100%	Automatic	High
22	85%	100%	100%	100%	100%	100%	100%	Push	High
23	95%	100%	100%	100%	100%	100%	100%	Automatic	High
24	99%	100%	100%	100%	100%	100%	100%	Automatic	High
25	100%	100%	100%	100%	100%	100%	100%	Automatic	High
26	98%	100%	100%	100%	100%	100%	100%	Automatic	High
28	97%	100%	100%	100%	100%	100%	100%	Automatic	High
29	91%	100%	100%	100%	100%	100%	100%	Automatic	High
31	99%	100%	100%	100%	100%	100%	100%	Automatic	High
32	100%	100%	100%	100%	100%	100%	100%	Automatic	High
33	5%	28%	47%	72%	80%	100%	100%	Push	Low
34	98%	99%	100%	100%	100%	100%	100%	Automatic	High

C.2 Altitude data

Table C.4: Altitude measurements against the reference: Network route – OSGR fitted data

ID	10m data points on Network route Section start and end points on test track: % within					Performance level
	2m	4m	5m	6m	20m	
1	96%	100%	100%	100%	100%	High
14	3%	89%	100%	100%	100%	Medium
16	36%	100%	100%	100%	100%	Medium
17	99%	100%	100%	100%	100%	High
19	99%	100%	100%	100%	100%	High
22	99%	100%	100%	100%	100%	High
23	100%	100%	100%	100%	100%	High
24	100%	100%	100%	100%	100%	High
25	99%	100%	100%	100%	100%	High
26	100%	100%	100%	100%	100%	High
28	100%	100%	100%	100%	100%	High
29	96%	100%	100%	100%	100%	High
31	98%	100%	100%	100%	100%	High
32	99%	100%	100%	100%	100%	High
33	77%	100%	100%	100%	100%	Medium
34	100%	100%	100%	100%	100%	High

Table C.5: Altitude measurements against the reference: Test track –Push button or automatic marker data

ID	10m data points on test track: % within					Marker entry type	Performance level
	2m	4m	5m	6m	20m		
1	93%	100%	100%	100%	100%	Automatic	High
14	3%	76%	89%	99%	100%	Push	Low
16	79%	100%	100%	100%	100%	Automatic	Medium
17	90%	100%	100%	100%	100%	Automatic	High
19	100%	100%	100%	100%	100%	Automatic	High
22	100%	100%	100%	100%	100%	Push	High
23	100%	100%	100%	100%	100%	Automatic	High
24	99%	100%	100%	100%	100%	Automatic	High
25	99%	100%	100%	100%	100%	Automatic	High
26	100%	100%	100%	100%	100%	Automatic	High
28	97%	100%	100%	100%	100%	Automatic	High
29	88%	100%	100%	100%	100%	Automatic	Medium
31	100%	100%	100%	100%	100%	Automatic	High
32	80%	100%	100%	100%	100%	Automatic	Medium
33	65%	95%	100%	100%	100%	Push	Medium
34	100%	100%	100%	100%	100%	Automatic	High

Highways England 2019 national accreditation trial for sideway-force skid resistance devices

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

This report covers the 2019 trial run by TRL and held in the week beginning the 25th March 2019.

Other titles from this subject area

PPR935	Highways England 2018 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020
PPR936	Highways Agency 2017 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020
PPR937	Highways Agency 2016 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020
PPR938	Highways Agency 2015 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020

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