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Highways England 2015 national accreditation trial for sideway-force skid resistance devices

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Executive Summary

The sideway-force coefficient routine investigation machine accreditation trials 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 standards (HD28/04, 2004). By examining the results from the machines operating on specified test sections it is possible to assess:

- The performance of individual machines.
- The consistency of the whole UK fleet.

The 2015 accreditation trial was held during the week beginning 27th April 2015. The trial followed a similar format to one that has been used successfully by TRL in previous years. The accreditation trial criteria are specified in "Accreditation and Quality Assurance of Sideways Force Skid Resistance Survey Devices" (TRL, 2013). Eighteen machines from the UK fleet attended, including two machines from the Republic of Ireland which sometimes carry out surveys in the UK.

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

- All eighteen of the machines met the criteria for the skid resistance measurements.
- Making allowance for the differences between manual and automatic entry of reference points fifteen machines achieved a high performance for the measurement of distance between fixed points repeatedly and accurately. Three machines achieved a medium performance.
- Fourteen machines fitted with 3 dimensional spatial coordinate systems for the provision of Ordnance Survey Grid Reference (OSGR) and altitude were assessed. Ten machines achieved a high performance for OSGRs, two a medium performance and two a low performance. Four machines achieved a high performance for altitude, eight machines a medium performance and one machine achieved a low performance. A further machine was awarded a fail for the altitude assessment as the data was supplied in the incorrect format (ellipsoid).
- All eighteen machines met the criteria for the measurement and recording of survey speed.

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

- All eighteen machines had satisfactory water flow and direction.
- All eighteen machines were within the tolerance for test wheel weight.

Overall, the trials demonstrated that the UK fleet continues to perform at a level suitable for use in supporting skid resistance standards. The results from the trial are discussed in this report and are provided in the accreditation certificates issued to the trial participants. These certificates are also accessible at:

http://www.ukroadsliaisongroup.org/en/asset-condition/road-condition-information/data-collection/skid-resistance/Sideway_force_skid_resistance_survey_devices/index.cfm

Contents

1 Introduction

The 2015 accreditation trial for sideway-force coefficient routine investigation machines was held on the MIRA proving ground and the Longcross test track by TRL, on behalf of Highways England. This work was conducted under framework arrangement contract 422/4/45/12 Pavement Assessment Accreditation and Assurance (PAAQA).

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, Chapter 3, HD28).

By examining the results from the machines operating on specified test sections it is possible to assess:

- The performance of individual machines.
- The consistency of the whole UK fleet.

TRL has been responsible for planning and running the trials since 1995 and the 2015 exercise followed a similar format to one that has been successfully used for several years. The accreditation trial criteria are specified in "Accreditation and Quality Assurance of Sideways Force Skid Resistance Survey Devices" (TRL, 2013).

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. The results of these tests are reported informally to operators in the week following the tests and are confirmed in this report and in the accreditation certificates issued.
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 seeking accreditation for these systems.
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 2015 main trials were held during the period 27th April to 1st May 2015 and eighteen machines based in the UK and Ireland attended. This included two machines from the Republic of Ireland which sometimes carry out surveys in the UK.

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 May 2015.

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 tests tyres fitted to different machines. For this reason, a set of “matched” tyres were requested from the tyre supplier for use in the trial. These tyres were scrubbed in prior to the trial and the data produced was checked for consistency.

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 marker flags 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.

2.2 Inspection day - MIRA

The inspection day is used to conduct inspections and calibrations of the machines attending the trial along with a survey of the network route:

1. Water flow checks
2. Wheel weight checks and vertical calibration
3. Distance calibration
4. Survey of the network route

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 knew approximately when they would be 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 the default condition in which they operate on the network. 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

The 3-dimensional positional systems are assessed on the Longcross test track. This assessment determines if the machines identify the correct position of section marker points (identified with retro-reflective markers and cones), in addition to accurately plotting the route between these markers. After each test lap the data is collected and checked to verify that the location referencing codes have been correctly identified (either via automatic detection if fitted, or by manual entry if not).

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 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-H are given in Figure 3.1.

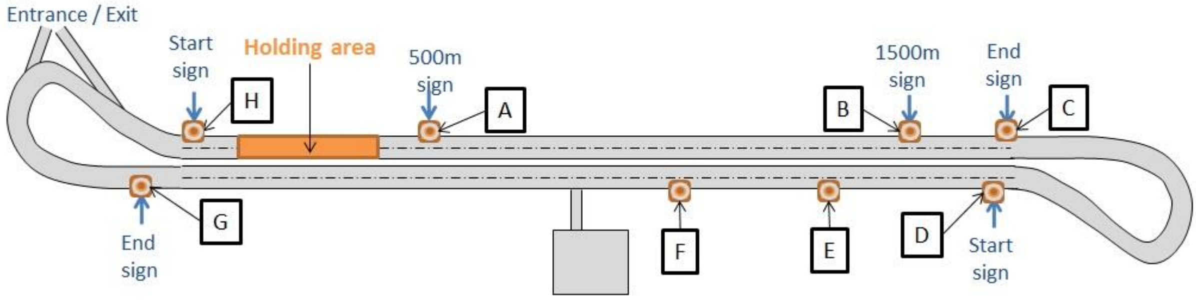

Figure 3.1 Overview of Twin Straights and position of marker points

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.

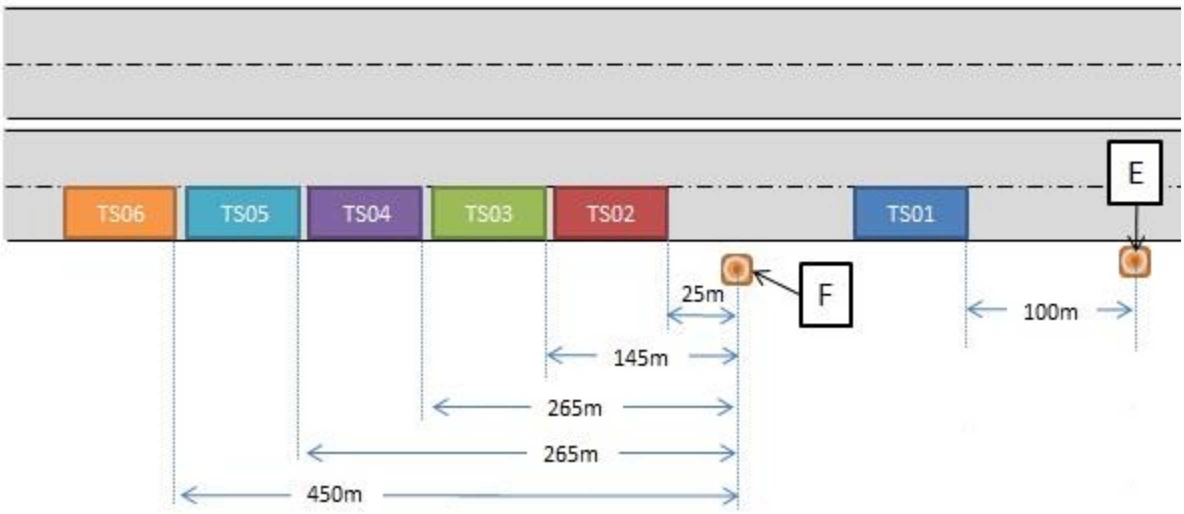

Figure 3.2 Skid resistance test sections on Twin Straights

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

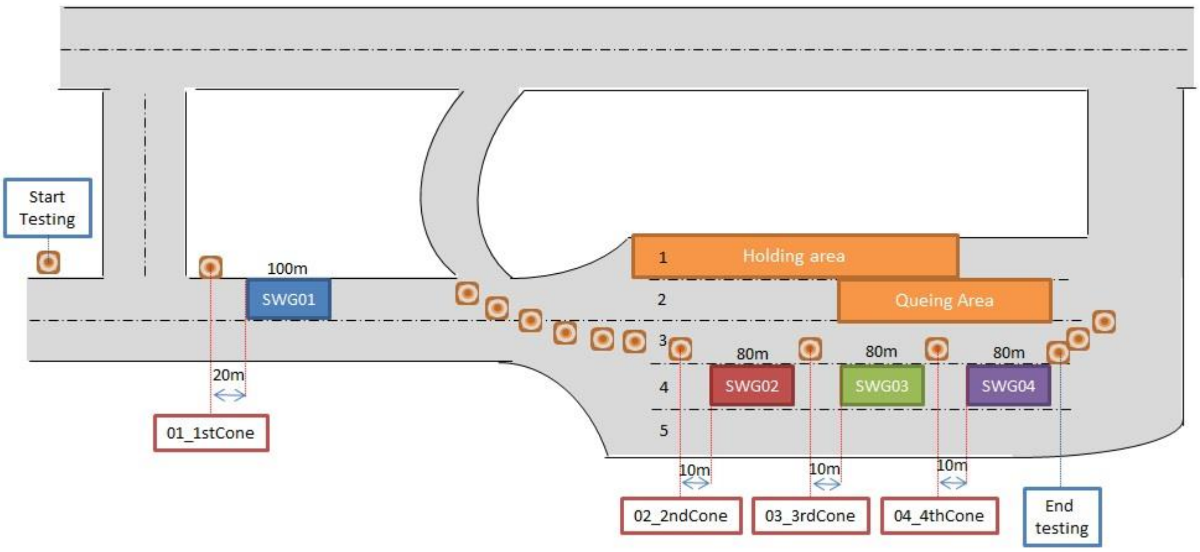

Figure 3.3 Skid resistance test sections on the Straight Line Wet Grip area

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

3.3 Network route to Sheepy Magna

A network has been 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. Details of the route are given in Table 3.3.

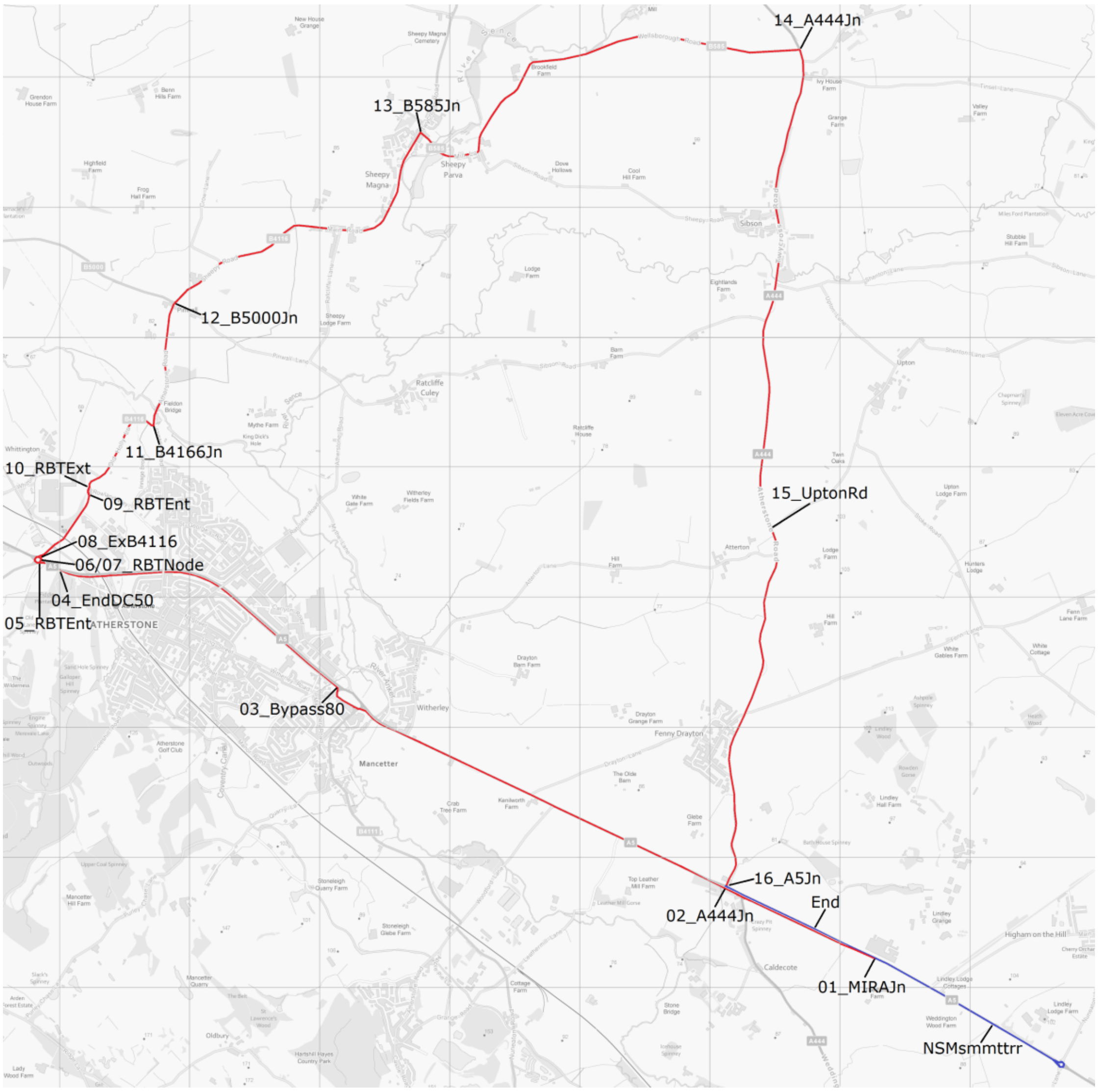

Figure 3.4 Network route to Sheepy Magna

Table 3.3 Details of network route, including marker positions

Approx Km	Location description	Instructions	Markers
-2.8	Exit from MIRA on to A5	Turn left from MIRA Drive on to A5 towards Hinkley	
-1.4	At roundabout	Carry out U-turn using 3rd exit and continue northbound on A5 towards Tamworth. Establish test speed, lower test wheel to warm-up and start recorder	
			NSMsmmttrr
0.0	Centre of junction with MIRA Drive on right	Test route commences. Continue on A5. After about 250m dual carriageway commences with 50mph posted speed limit. Continue testing in Lane 1	Node adjacent to junction: **01_MIRAJn**
1.4	At junction with A444	Continue on A5, testing in Lane 1 After about 200m dual c'way ends. Continue on A5	Node at junction (s/p A444 Nuneaton) to left: **02_A444Jn**
4.8	At Mancetter circulatory system	Dual carriageway commences. Take right lane and continue to second exit on to A5 Atherstone by-pass towards Tamworth. Continue testing in Lane 1 for approximately 1.5 miles	**03_Bypss80**
7.3	End of dual carriageway	Continue testing for approx 200m on approach to roundabout	**04_EndDC50**
7.4	Entry to roundabout junction with B4116	At roundabout take third exit, B4116 towards Twycross.	**05_RBTEnt**
7.5	Roundabout "Node"		**06_RBTNode**
7.7	Roundabout "Node"		**07_RbtNode**
7.8	Roundabout exit	Continue testing at 50 km/h on B4116.	**08_ExB4116**
8.5	Roundabout (access to Aldi distribution depot)	Take second exit and continue testing on B4116	**09_RBTEnt**
8.5	Roundabout exit		**10_RbtExt**
9.3	At T-junction at Pinwall	Turn left and continue testing on B4116 towards Twycross	**11_B4166Jn**
10.2	Junction with B5000 on left at the Red Lion	Follow round right-hand bend and continue testing on B4116	**12_B5000Jn**
11.5	Sheepy Magna	Enter village and continue testing on main road for a futher mile	
12.8	Sheepy Magna village centre	Turn right on to B585 (Mill Lane) towards Market Bosworth. Continue testing on B585 for about 3 miles	**13_B585Jn**
16.3	At junction with A444	Turn right onto A444 towards Nuneaton. Continue testing passing Sibson and Fenny Drayton	**14_A444Jn**
20.0	At junction with Upton Road		**15_UptonRd**
22.9	Centre of A444/A5 Junction	Turn left on to A5 towards Hinkley. Continue along the A5. On dual carriageway in Lane 1	**16_A5Jn**
24.3	Junction with MIRA drive	Return to manoeuvres Area	

3.4 Longcross test track

This site involves more corners than the sties used on the MIRA proving ground. In addition the site has tree coverage providing a more challenging test environment for the assessment of the 3-dimensional positional systems. The site contains eight marker points and five assessment sections (highlighted in red) as shown in Figure 3.5 and Table 3.4.

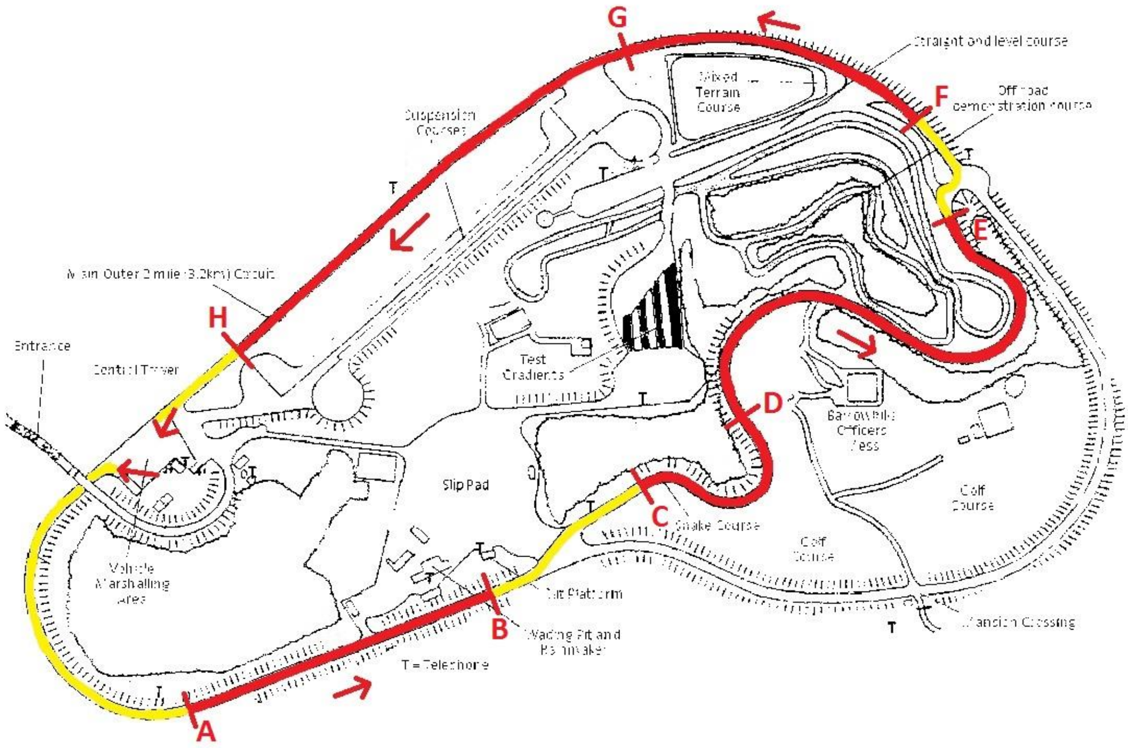

Figure 3.5 Longcross test track site map

Table 3.4 Details of Longcross test track, including marker positions

Section	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 C	240.2	498643.7988	165462.5819	BC
C to D	246.3	498837.211	165596.6619	CD
D to E	637.8	498961.4243	165672.3736	DE
E to F	155.8	499199.0944	165908.341	EF
F to G	367.0	499150.9436	166034.2452	FG
G to H	472.6	498806.0321	166098.0752	GH
H to End	>200	498440.6401	165803.5887	Run-out

4 Assessment criteria

The majority of the accreditation trial criteria are specified in "Accreditation and Quality Assurance of Sideways Force Skid Resistance Survey Devices" (TRL, 2013). The QA document is a live document (i.e. is subject to change) and the December 2013 version of the document was used for the trial. The relevant section of the document is copied verbatim below (section 4.1). Additional criteria not detailed in that document are presented in section 4.2. 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 side-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

A1.1 ***Production of Data in Specific File Formats***

A1.1.1 Some Employers require the production of data in specific data formats, for example the Highways Agency requires data to be produced as Raw Condition Data (RCD) or Base Condition Data (BCD). Where required, Owners will be required to deliver accreditation data files in the required format. These will be assessed to determine whether the data is being correctly processed.

A1.2 ***Skid resistance measurements***

A1.2.1 Measurements will be collected from the test sections at target test speeds of 50 km/h and 80km/h.

A1.2.2 The between-run standard deviation (BRSD) will be used to assess the repeatability of each Equipment. The BRSD is calculated from the average values of 100m lengths (or the length of the test section if shorter). The BRSD criterion is given in Table 5.

A1.2.3 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.

A1.2.4 The between-Equipment standard deviation (BESD) will be used to assess the consistency of the fleet. The BESD is acceptable if it is below the criterion given in Table 5. If the BESD exceeds this criterion then the data will be further examined to identify outlying Equipment. Outlying Equipment will be rejected and the data reassessed until the fleet performance is acceptable.

A1.2.5 In addition, any Equipment that deviates by more than 3 times the BESD criterion from the all-Equipment 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.

A1.2.6 The data from any Equipment rejected due to the BRSD, BESD or identified as an outlier from the all-Equipment mean, will be removed from the calculation of the reference data.

Table 5 – 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)	≤2.7 SR

A1.3 Location Referencing

A1.3.1 The measurement of the locational referencing of data in relation to distance travelled in section and lane will be assessed for accuracy (against a reference) and repeatability (against repeat survey runs) of the measurements of elapsed distance of any given point from a fixed location referencing point (e.g. from a section start point).

A1.3.2 There are two mechanisms for recording location referencing points in the survey data during testing. The first (push button entry) relies on the survey operator pushing a button to enter the location of the point manually. The second (Automatic markers) uses a system which automatically detects the markers. As the push button entry approach will include some operator error, it is expected that Equipment using automatic marker recognition will be more accurate than those using the push button approach.

A1.3.3 There are three levels of performance for the measurement of elapsed distance depending on the capability of the Equipment. The acceptable tolerances for High, Medium and Low levels of performance are shown in Table 6 (note a specific performance level may be requested by some Employers).

A1.3.4 Reference data for the assessment of elapsed distance shall be obtained using a suitable calibrated reference method such as a measurement wheel, measuring tape or a mobile measurement system selected by the Employer (for example the Highways Agency HARRIS vehicle).

Table 6 – Acceptance Criteria for Location Referencing (distance travelled)

Performance level	Push button entry	Automatic markers (where available)
High	80% within 5m	80% within 1m
Medium	80% within 10m	80% within 2m
Low	Otherwise	Otherwise

A1.4 3-Dimensional Spatial Coordinates

A1.4.1 The measurement of 3-Dimensional Spatial Coordinates will be assessed for the accuracy and repeatability of the reported 3-Dimensional Spatial Coordinates against the True 3-Dimensional Spatial Coordinates of that point.

A1.4.2 There are again three levels of performance for the measurement of 3-Dimensional Spatial Coordinates depending on the capability of the Equipment. The acceptable tolerances for High, Medium and Low levels of performance are shown in Table 7 and Table 8 (note a specific performance level may be requested by some Employers).

A1.4.3 Reference data for the assessment of 3-Dimensional Spatial Coordinates shall be obtained using a suitable reference method such as a static dGPS, total station, or a suitable accurate mobile measurement system selected by the Employer (for example the Highways Agency HARRIS vehicle).

Table 7 - Acceptance Criteria for High level performance in measurement of 3 Dimensional Spatial Coordinates

Marker entry method	Test	OSGR	Altitude
Site level tests			
Push Button	Position of Location Referencing Points	80% within 5m 90% within 10m 100% within 20m	80% within 2m 90% within 5m 100% within 20m
Automatic	Position of Location Referencing Points	90% within 2m 95% within 4m 100% within 20m	90% within 2m 95% within 5m 100% within 20m
Push Button	Individual 10m data points	80% within 5m 90% within 10m 100% within 25m	80% within 2m 90% within 5m 100% within 20m
Automatic	Individual 10m data points	90% within 2m 95% within 4m 100% within 20m	90% within 2m 95% within 5m 100% within 20m
Network Level tests			
Push button (or fitting by section length)	Position of Location Referencing Points	95% within 10m 100% within 25m	95% within 6m 100% within 20m
OSGR fitting	Position of Location Referencing Points	95% within 4m 100% within 20m	95% within 6m 100% within 20m
Push button (or fitting by section length)	Individual 10m data points	90% within 12m 100% within 25m	90% within 6m 100% within 20m
OSGR fitting	Individual 10m data points	90% within 6m 100% within 20m	90% within 6m 100% within 20m

Table 8 - Acceptance Criteria for Medium level performance in measurement of 3 Dimensional Spatial Coordinates

Marker entry method	Test	OSGR	Altitude
Site level tests			
Push Button	Position of Location Referencing Points	80% within 10m 90% within 15m 100% within 20m	80% within 4m 90% within 6m 100% within 20m
Automatic	Position of Location Referencing Points	80% within 2m 90% within 4m 100% within 20m	80% within 4m 90% within 6m 100% within 20m
Push Button	Individual 10m data points	80% within 10m 90% within 15m 100% within 25m	80% within 4m 90% within 6m 100% within 20m
Automatic	Individual 10m data points	80% within 2m 90% within 4m 100% within 20m	80% within 4m 90% within 6m 100% within 20m
Network Level tests			
Push button (or fitting by section length)	Position of Location Referencing Points	95% within 15m 100% within 30m	95% within 6m 100% within 20m
OSGR fitting	Position of Location Referencing Points	95% within 8m 100% within 20m	95% within 6m 100% within 20m
Push button (or fitting by section length)	Individual 10m data points	90% within 17m 100% within 30m	90% within 6m 100% within 20m
OSGR fitting	Individual 10m data points	90% within 12m 100% within 25m	90% within 6m 100% within 20m

A1.5 *Vehicle Speed*

A1.5.1 Accreditation of vehicle speed measurement will be based on the speed measured by an independent, calibrated measurement system. The test speed measurement will be carried out 50 and 80km/h target test speeds.

A1.5.2 The assessment will be in 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.

A1.5.3 The acceptance criteria for vehicle speed measurement are given in Table 9.

Table 9 – Acceptance Criteria for Vehicle Speed Measurement

Parameter	Acceptability Limit
Vehicle Speed recorded by the Equipment	± 1km/h of the independently measured speed ± 3km/h of required target speed

4.2 Additional test criteria

4.2.1 Test-wheel weight

Electronic weigh pads are used for checking the static vertical load on the test wheel. Ramped wooden pads are used to raise the vehicle tyres to the same level as the top of the weigh pad so that the test wheel of each machine can be weighed with its tyre and shaft bearings in the normal running position.

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 load is measured both as initially applied and 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). The process of raising and lowering the wheel on to the weigh pad is repeated three times. The results from these three tests are compared to the criteria given in Table 4.10

Table 4.10 Acceptance Criteria for Test wheel weight

Parameter	Acceptability Limit
"Bounced" test wheel weight	200 ± 8kg

4.2.2 Water flow

The water delivery system is inspected (checking for damage to the outlet nozzles, for example), and the flow rate is measured to confirm that the Equipment is delivering water at an acceptable rate.

The flow rate is checked by measuring the quantity of water released during a measured time period. The timed period and volume of water criteria are given in Table 4.11.

Table 4.11 Acceptance Criteria for Water flow

	Acceptability Limit
Without speed control	25 litres±10% in 26 seconds
With speed control	Set at 50km/h: 25 litres±10% in 51 seconds Set at 80km/h: 25 litres±10% in 32 seconds

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 and direction.

5.2 Left test-wheel weight checks

Each machine was weighed when the level of water in its tank was half full. The results of these checks are given in Table 5.1.

Table 5.1 Results of static wheel weight checks

Machine	Average static wheel weight							
	"Un-bounced"				"Bounced"			
	Check 1	Check 2	Check 3	Mean	Check 1	Check 2	Check 3	Mean
1	201.2	197.2	199.2	199.2	201.6	201.2	203.6	202.1
3	200.0	200.5	200.5	200.3	203.0	203.0	202.5	202.8
13	201.6	201.6	201.6	201.6	202.4	202.6	203.0	202.7
14	203.0	203.0	203.0	203.0	204.5	204.5	204.5	204.5
16	202.8	202.8	202.8	202.8	203.0	203.4	205.6	204.0
17	195.0	194.5	194.5	194.7	200.0	200.0	200.0	200.0
18	202.8	203.0	203.6	203.1	205.0	204.0	205.2	204.7
19	198.0	198.0	198.0	198.0	202.0	201.5	201.5	201.7
21	203.5	203.5	203.0	203.3	203.5	203.5	203.5	203.5
22	198.8	198.8	199.2	198.9	200.8	199.6	199.8	200.1
23	197.5	197.5	197.5	197.5	200.0	200.0	200.5	200.2
24	196.5	196.5	196.5	196.5	199.5	199.0	199.0	199.2
25	198.0	199.0	199.5	198.8	202.5	203.0	203.0	202.8
26	195.0	195.5	196.0	195.5	204.0	204.5	205.0	204.5
28	193.0	192.0	192.5	192.5	200.0	200.0	200.0	200.0
29	206.5	206.0	206.0	206.2	206.5	207.0	207.0	206.8
31	195.4	195.2	196.0	195.5	200.0	200.2	200.8	200.3
32	199.0	199.0	199.0	199.0	202.5	202.5	203.0	202.7

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 4.2. There is a noticeable difference in the bounced and un-bounced wheel weight values for some of the machines (e.g. Machine 26 and 28). The owners of these machines should be aware that this may be an indication of some deterioration in shaft assembly and may cause issues at a future date.

In 2009, British Standards published a CEN Technical Specification for these devices (British Standards Institution, 2009). This is a Draft for development 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 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 (British Standards Institution, 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 well within the current ±8 kg tolerance. However, had the CEN TS requirement been applied to the fleet this year, only six machines would have been acceptable at ±1 kg. 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 practically 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. After the crews successfully performed a vertical calibration they were asked to perform a horizontal calibration.

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, 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 recoded 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 appear to be missing from the tables.

Table 5.2 Difference between speed recorded in data and independent measure

Machine	Speed recorded in data – independent measure of speed						Percentage within criteria
	Target speed 50km/h			Target speed 80km/h			
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	
1	.	-0.01	0.06	-0.24	-0.11	-0.15	100%
3	-0.41	.	-0.46	-0.2	.	-0.27	100%
13	-0.16	-0.07	-0.05	-0.07	-0.12	-0.3	100%
14	.	.	-0.34	-0.31	-0.31	-0.31	100%
16	0.05	0.02	0.01	0.1	0.06	0.02	100%
17	.	0.21	0.21	0.02	0.02	-0.1	100%
18	.	-0.1	-0.1	0.61	0.88	0.9	100%
19	0.39	0.39	0.39	-0.26	-0.31	-0.31	100%
21	-0.02	-0.03	-0.05	-0.29	-0.4	-0.49	100%
22	.	-0.25	-0.26	-0.51	-0.72	.	100%
23	0.33	-0.69	.	0	-0.37	-0.46	100%
24	.	-0.91	-0.04	0.12	0.06	-0.05	100%
25	**-1.35**	0.89	-0.1	-0.04	0.19	-0.05	83%
26	.	-0.03	0.1	.	0.12	-0.07	100%
28	-0.05	-0.2	.	0.01	0	-0.08	100%
29	0.46	0.55	0.55	0.55	.	0.75	100%
31	-0.21	-0.23	.	-0.11	-0.26	-0.1	100%
32	0.05	0.02	0.02	0.06	0.01	-0.04	100%

Table 5.3 Difference between independent measure and target speed

Machine	Independent measure of speed – target speed						Percentage within criteria
	Target speed 50km/h			Target speed 80km/h			
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	
1	.	-0.07	0.02	-0.84	-1.27	-1.4	100%
3	0.46	.	0.46	-0.35	.	0.27	100%
13	-0.46	-0.1	-0.4	-2.37	-2.16	-1.7	100%
14	.	.	1.34	0.31	0.31	0.31	100%
16	0.72	0.74	0.76	0	0.04	0.09	100%
17	.	0.79	0.79	-0.44	.	0	100%
18	.	0.1	0.1	0.67	0.72	0.76	100%
19	1.61	1.61	0.63	1.26	1.31	1.31	100%
21	0.02	0.03	0.05	1.17	1.4	1.49	100%
22	.	1.25	0.26	-0.49	-0.31	.	100%
23	-0.33	0.69	.	0.22	-1.48	0.49	100%
24	.	-0.94	-1.76	-0.57	-0.57	-0.27	100%
25	0.33	-1.07	-0.28	-2.66	-1.53	-0.92	100%
26	.	-1.69	-0.7	.	0	0.99	100%
28	-0.6	-0.58	.	-1.01	-0.97	-0.92	100%
29	-0.68	-0.77	-0.97	-1.7	.	-1.65	100%
31	2.21	1.23	.	1.31	1.36	1.4	100%
32	-1.05	-1.02	-1.02	0.94	0.99	1.04	100%

From these tables it can be seen that all machines achieved at least 80% of their data within the criteria and are therefore deemed acceptable.

6 Skid resistance measurements

Skid resistance measurements were taken on three sites (Twin Straights, Straight Line Wet Grip, and on 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

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 value 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.
- Red – the machine is producing skid resistance values outside of the criteria for accreditation for skid resistance.

For the 2015 trial all machines were assigned the green category.

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:

- The data from the first set of tests on the Straight Line Wet Grip shows a few instances where the data is more than 2 times the BRSD criteria. There are no machines where the BRSD is consistently high, and none of the data was more than 2 times the BRSD criteria in the second set of tests. There were also a few instances where the data lies between 1 and 2 times the BRSD criteria, however no machine was consistently high with regards to BRSD and the instaces varied between the two sets of tests.
- The sections on the Twin Straights appear to be more variable in general than the Straight Line Wet Grip surfaces, as seen by the high values recorded for between run standard deviation. This is likely due to the fact that these surfaces have not experienced much traffic and variations in test line. These sections are therefore not used in the formal assessment of SR during this year's trial. Instead the data is used as supporting evidence. It is expected that in future years the variation of these sections will decrease allowing for use in future trials.
- The data from the network route shows several instances where the data lies between 1 and 2 times the BRSD criteria, and a few instances greater than this. However, it is expected that the between run standard deviation will be greater than the thresholds more often on the network route. Examination of the data found no instances where the BRSD is consistently high for a single machine. The BRSD was

however consistently high on section NSM_01. This may be due to the recent changes to the road surfacing and road layout (addition of a roundabout) in this section.

Using the 2nd set of tests on the Straight Line Wet Grip as the main focus and the other data as supporting information, it can be seen that no machine consistently exceeds the BRSD criterion.

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. At the base of each table are the average and standard deviation calculated for the fleet (indicated as “All mean” and “All BESD” respectively). Machine 32 is a new machine and therefore is not considered as part of the reference fleet for the assessment. Therefore the average and standard deviation for the reference fleet (i.e. excluding Machine 32) is also shown at the base of each table (indicated as “Ref mean” and “Ref BESD” respectively)

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

6.3.1 Inspection day tests

Table 6.1 Average SR during the network route

Machine	Average SR for network route sections									
	01	02	03	04	05	06	07	08	09	Length weighted avg
1	82.1	78.5	69.8	67.7	66.1	65.9	77.3	63.4	71.3	71.6
3	75.8	71.5	63.5	63.6	61.2	61.6	72.6	61.0	68.7	66.9
13	71.5	68.8	60.0	59.5	57.1	57.4	71.0	56.2	64.1	63.3
14	80.1	78.5	66.9	65.0	64.3	65.8	76.2	61.3	69.3	70.1
16	68.6	67.7	58.1	57.9	55.9	55.3	65.6	54.8	60.9	60.8
17	71.6	73.2	61.4	63.1	58.8	58.3	70.8	57.6	65.2	64.8
18	79.0	78.1	68.3	66.4	66.3	66.4	78.1	66.5	74.0	72.1
19	75.0	72.7	62.0	58.9	61.4	61.5	74.9	60.5	67.6	66.9
21	75.8	72.9	64.6	64.6	62.4	62.7	75.3	60.5	68.3	67.8
22	73.2	69.7	62.5	61.7	61.1	60.2	71.5	59.3	66.1	65.3
23	72.3	70.7	60.0	62.4	59.9	61.3	70.7	58.4	64.8	64.8
24	74.7	73.6	64.5	62.8	62.5	63.2	74.1	61.1	69.8	68.0
25	75.7	73.8	61.7	62.7	61.3	62.4	73.0	60.6	68.4	67.1
26	74.1	71.7	61.7	62.9	61.5	61.8	74.2	59.7	67.7	66.5
28	74.1	71.4	61.7	60.8	60.9	62.5	72.2	61.0	69.5	66.6
29	73.5	69.3	60.8	61.8	56.6	55.6	65.8	54.4	61.3	62.0
31	69.0	65.6	59.6	56.5	56.7	56.3	68.0	54.6	62.5	61.4
32	70.5	67.8	59.0	57.9	57.2	57.5	69.3	58.3	63.7	63.0
All mean	74.3	72.0	62.5	62.0	60.6	60.9	72.2	59.4	66.8	66.1
All BESD	3.59	3.71	3.20	3.01	3.14	3.47	3.59	3.13	3.52	3.26
Ref mean	74.5	72.2	62.8	62.3	60.8	61.1	72.4	59.5	67.0	66.2
Ref BESD	3.57	3.66	3.17	2.92	3.12	3.47	3.62	3.21	3.54	3.26

On examination of the data collected on the network route (Table 6.1) we can see that the fleet BESD is between 1 and 1.5 times the BESD criteria on all sections and for the average of the sections. Looking at the machine values we can see that there are scattered instances of machines lying between 2 and 3 times the BESD criteria from the mean. This is consistent with the expected level of performance for network tests (in comparison to the more controlled environment test track tests). This suggests that the machines are producing suitable survey data under normal survey conditions and over long test lengths. In addition it appears that there are no major anomalies with any of the machines.

6.3.2 Main running trial day 1 tests

Table 6.2 Average SR during the 1st tests on the Straight Line Wet Grip

Machine	Average SR on Straight Line Wet Grip				
	SWG01	SWG02	SWG03	SWG04	Length weighted avg
1	73.7	92.5	27.6	53.4	62.4
3	74.0	93.1	29.3	55.1	63.5
13	70.8	88.1	25.9	52.2	59.9
14	75.1	96.6	28.1	55.5	64.4
16	65.6	82.0	24.6	50.1	56.1
17	69.2	86.8	25.8	50.6	58.7
18	69.5	91.5	25.1	52.1	60.1
19	68.8	87.6	26.3	51.8	59.1
21	72.0	92.8	28.1	53.8	62.2
22	69.8	89.0	26.6	53.0	60.2
23	69.1	87.6	25.6	53.1	59.4
24	69.3	87.9	29.5	53.8	60.6
25	67.8	86.1	25.7	51.1	58.2
26	67.2	84.7	24.9	50.8	57.4
28	69.9	88.1	25.5	52.8	59.7
29	73.7	91.6	29.9	57.1	63.7
31	65.6	80.9	27.1	51.3	56.7
32	68.2	84.4	24.9	49.2	57.3
All mean	70.0	88.4	26.7	52.6	60.0
All BESD	2.78	4.07	1.70	2.02	2.45
Ref mean	70.1	88.7	26.8	52.8	60.1
Ref BESD	2.83	4.06	1.68	1.89	2.42

The 1st set of tests on the Straight Line Wet Grip area (Table 6.2) show that the fleet BESD is between 1 and 1.5 times the criteria for two of the sections and within the criteria on the other two sections and for the average for the site. On examination of the machine values it can be seen that three machines (machines 14, 16 and 31) are between 1 and 1.5 times the criteria for one of the sections (SWG02).

Table 6.3 Average SR during the 50km/h tests on the Twin Straights

Machine	Average SR for 50km/h tests on Twin Straights						
	TS01	TS02	TS03	TS04	TS05	TS06	Length weighted avg
1	87.2	93.2	88.4	88.1	87.8	70.8	85.8
3	82.1	82.0	84.1	85.0	86.2	69.8	81.2
13	81.2	84.6	82.7	83.8	85.1	68.3	80.6
14	87.6	93.0	89.0	89.7	92.0	77.3	87.8
16	76.1	80.8	77.9	77.5	78.8	64.1	75.7
17	82.6	79.3	83.0	88.5	91.1	76.2	82.8
18	82.7	86.2	84.1	84.0	88.1	71.8	82.4
19	85.6	94.9	88.5	87.8	86.5	69.5	85.4
21	82.9	89.8	86.5	85.6	86.1	68.8	83.0
22	84.5	92.5	86.5	85.1	84.8	68.2	83.5
23	83.4	89.5	79.8	79.4	77.8	62.8	79.0
24	78.0	95.1	88.0	90.3	85.1	70.8	84.2
25	82.8	90.0	82.1	82.2	77.3	66.7	80.5
26	84.7	91.5	83.8	83.1	81.9	65.4	81.9
28	84.9	91.0	82.5	79.9	80.3	64.9	80.8
29	89.8	96.9	88.1	85.9	83.5	68.8	85.8
31	81.0	85.6	82.5	85.1	80.6	65.1	80.0
32	80.2	90.9	81.0	78.6	76.2	61.3	78.3
All mean	83.2	89.3	84.4	84.4	83.8	68.4	82.2
All BESD	3.32	5.10	3.28	3.78	4.64	4.22	3.03
Ref mean	83.4	89.2	84.5	84.7	84.3	68.8	82.4
Ref BESD	3.34	5.24	3.28	3.60	4.36	3.95	2.96

Table 6.4 Average SR(50) during the 80km/h tests on the Twin Straights

Machine	Average SR(50) for 80km/h tests on Twin Straights						
	TS01	TS02	TS03	TS04	TS05	TS06	Length weighted avg
1	81.8	91.9	84.7	84.9	83.0	65.9	81.9
3	80.7	91.4	85.1	82.4	81.3	65.2	81.0
13	80.2	93.1	84.7	81.2	81.2	62.8	80.5
14	90.0	102.0	95.8	98.6	94.0	74.5	92.2
16	71.3	81.2	74.6	75.1	73.9	58.8	72.3
17	85.0	92.2	86.3	86.8	84.5	70.8	84.3
18	80.5	90.7	84.7	82.8	81.0	64.5	80.7
19	77.7	90.9	83.5	82.9	81.0	64.6	79.9
21	78.7	93.5	84.9	82.9	82.2	64.0	80.8
22	78.3	88.6	82.2	81.7	81.4	64.2	79.2
23	77.8	91.4	81.4	78.7	77.7	60.5	78.0
24	78.7	91.1	84.4	83.8	81.5	63.3	80.3
25	74.7	84.1	77.5	79.6	79.8	63.0	76.1
26	76.8	90.1	83.1	81.1	80.1	63.4	78.9
28	75.2	88.8	84.7	85.2	81.9	65.8	79.9
29	80.2	90.1	82.9	82.1	80.0	65.1	80.1
31	68.1	81.8	77.6	76.8	77.9	58.9	72.9
32	78.6	90.0	79.1	77.8	77.7	60.2	77.3
All mean	78.6	90.2	83.2	82.5	81.1	64.2	79.8
All BESD	4.79	4.63	4.49	5.02	4.00	3.84	4.28
Ref mean	78.6	90.2	83.4	82.7	81.3	64.4	79.9
Ref BESD	4.94	4.77	4.51	5.03	4.03	3.82	4.37

Historic data collected for the Twin straights has shown that the skid resistance measurements 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 variable nature of the site is also reflected in the measurements collected during this accreditation trial at 50km/h (Table 6.3) and at 80km/h (Table 6.4).

A few machines (14, 16 and 31) appear to be showing a consistent difference from the rest of the fleet. However, this variation is not reflected in either the network route or the Straight Line Wet Grip site. Therefore this extra variation is likely to be due to variations in test line.

Therefore, all machines were notified that they were in the green category after the first day of tests.

6.3.3 *Main running trial day 2 tests*

Table 6.5 Average SR during the 2nd tests on the Straight Line Wet Grip

Machine	Average SR on Straight Line Wet Grip				
	SWG01	SWG02	SWG03	SWG04	Length weighted avg
1	71.1	92.9	23.2	50.6	60.1
3	69.5	87.7	22.9	48.7	57.9
13	73.7	91.9	24.0	52.3	61.2
14	69.7	91.8	25.3	51.1	60.0
16	64.5	83.4	22.5	48.3	55.2
17	67.5	86.6	22.8	47.3	56.7
18	74.1	98.3	27.9	56.9	64.8
19	67.1	86.6	24.5	50.9	57.8
21	71.4	91.4	26.0	53.5	61.1
22	70.4	90.4	23.1	50.0	59.1
23	66.4	84.1	22.9	48.9	56.1
24	66.2	85.0	25.7	50.9	57.5
25	70.2	89.5	25.9	52.9	60.2
26	67.3	86.5	21.5	49.5	56.8
28	70.4	85.3	22.9	49.7	57.8
29	71.0	90.4	28.3	54.4	61.5
31	66.6	84.5	24.5	50.1	57.0
32	68.8	85.3	21.9	48.0	56.7
All mean	69.2	88.4	24.2	50.8	58.7
All BESD	2.61	3.92	1.95	2.45	2.43
Ref mean	69.2	88.6	24.3	50.9	58.9
Ref BESD	2.69	3.96	1.92	2.42	2.45

The data from the 2nd set of tests on the Straight Line Wet Grip (Table 6.5) show that the fleet BESD is between 1 and 1.5 times the criteria for one of the sections and within the criteria on the other three sections and for the average for the site. One machine (Machine 18) was more than 3 times the BESD criteria from the mean on one section and between 2 and 3 times on another section. With a fleet of 18 machines, it is statistically likely that one machine would be in this bracket.

Therefore all machines are deemed acceptable with regards to the reproducibility of skid measurement.

6.4 Summary of skid resistance testing

The survey data collected from the network route was consistent with the expected level of performance for network tests. This data showed that the machines could produce suitable data under normal survey conditions and for long test lengths (relative to the track tests).

Using the 2nd set of tests on the Straight Line Wet Grip as the main focus and the other data as supporting information, it can also be seen that no machine consistently exceeds the BRSD criterion. Therefore all machines are deemed to be acceptable with regards to repeatability of skid resistance measurement (BRSD criterion, see section 4.1).

In addition all machines are deemed acceptable with regards to the reproducibility of skid measurement (BESD criterion, see section 4.1).

The survey data from the Twin Straights is quite variable (due to low levels of traffic since construction). Although the variability is reducing, it is likely that the Twin straights will not form a formal part of the assessment of Skid Resistance in the next trial. However, it is possible that the data will be suitable for the assessment of skid resistance and this should be reviewed following the collection of the data.

7 Location Referencing

7.1 Distance measurement

To provide data for the assessment of distance measurement the survey vehicles performed six passes of the Twin Straights (3 passes at 50km/h and 3 passes at 80km/h), marking positions A-H as shown in Figure 3.1. This data was then assessed against the reference data collected by the Highways England development machine HARRIS 2. For the repeatability assessment, the first pass at the target speed for each machine provided the reference positions for the section start points. The subsequent runs at this speed were then compared with this run. For the reproducibility tests the section lengths reported by the device were compared to the reference lengths. The same criteria are applied to the repeatability and the reproducibility assessments.

During the assessment of distance travelled it was noted that an increasing number of the machines undergoing the assessment with automatic marker detection report the distance to the nearest metre. This is due to machines being retro fitted with automatic marker detection (i.e. in previous years they were assessed on the push button criteria). For the machines reporting to the nearest metre, the requirement of 80% of the measurements to be within 1m is an unrealistic expectation. We therefore applied the criteria by giving an extra 1m leeway to accommodate this resolution on the automatic marker assessment. To maintain consistency in the assessment this approach (1m leeway) was also applied to the machines which had automatic marker detection and report distances to the nearest 0.1m.

The results from the repeatability and reproducibility tests on distance measurement are summarised in Table 7.1 for machines assessed against the push button criteria and in Table 7.2 for machines assessed against the automatic marker detection criteria.

Table 7.1 Distance measurement assessment: push button entry

Machine	Repeatability	Reproducibility	Overall performance
1	High	High	High
3	High	High	High
13	High	High	High
14	High	High	High
21	High	High	High
22	High	Medium	Medium

Table 7.2 Distance measurement assessment: automatic marker detection

Machine	Repeatability	Reproducibility	Overall performance
16	High	High	High
17	High	High	High
18	High	Medium	Medium
19	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	High	High

It can be seen from these tables that a high repeatability was achieved by all of the devices. The majority of machines achieved a high performance level for reproducibility, with three machines achieving a medium performance.

7.2 3-dimensional spatial coordinates data

The assessment of 3-dimentional spatial coordinates is mandatory for any device that is to be used on the central Highways England contract and optional for the other devices. Fourteen machines took part in these tests: Machines 14, 16-19, 22-26, 28, 29, and 31-32. As with the distance assessment, the OSGR and altitude data were assessed against a reference data set supplied by HARRIS 2. The results from the OSGR and altitude assessments are given in Appendix C and are summarised in Table 7.3 and Table 7.4. If the assessment is based on the more relaxed criteria (i.e. push button entry with no OOSGR fitting) then the colouring is in a lighter shade and the text is in italics and also in a lighter shade (see section 4.1 for the assessment criteria).

Table 7.3 Summary of OSGR assessments

Machine	OSGR reference points		10m data points		Awarded Performance
	50km/h	80km/h	50km/h	80km/h	
14	*High*	*High*	*High*	*High*	*High*
16	High	Low	Low	Low	Low
17	High	High	High	High	High
18	High	Medium	Low	Low	Medium
19	High	High	High	High	High
22	*High*	*High*	*High*	*High*	*High*
23	High	High	High	High	High
24	High	High	High	High	High
25	High	High	High	High	High
26	High	High	High	High	High
28	Low	Low	Low	Low	Low
29	Low	Medium	Low	Low	Medium
31	High	High	High	High	High
32	High	Low	High	Medium	High

Two machines were awarded a low performance, two machines were awarded a medium performance and the remaining machines achieved the high level for OSGR data.

The two machines (machines 18 and 29) awarded medium performance achieved approximately 63% of the data within 2m of the reference. Although this does not strictly meet the criteria for a medium performance (see section 4.1), the two machines achieved 99% and 93% of the data within 4m respectively. They were therefore deemed to have achieved a medium performance level.

Table 7.4 Summary of Altitude assessments

Machine	OSGR reference points		10m data points		Awarded Performance
	50km/h	80km/h	50km/h	80km/h	
14	*Low*	*Low*	*Low*	*Low*	*Low*
16	Medium	Medium	Medium	Medium	Medium
17	Medium	Medium	Medium	Medium	Medium
18	Medium	Medium	Medium	Medium	Medium
19	High	High	High	High	High
22	*Medium*	*Medium*	*Medium*	*Medium*	*Medium*
23	Medium	Medium	Medium	Medium	Medium
24	High	High	High	High	High
25	Medium	Medium	Medium	Medium	Medium
26	High	Medium	High	Medium	Medium
28	Medium	High	Medium	High	Medium
29	Fail	Fail	Fail	Fail	Fail
31	High	High	High	High	High
32	High	Medium	High	Medium	High

Four machines achieved a high performance for altitude, eight a medium performance, and one a low performance. The remaining machine (Machine 29) was awarded a fail for this assessment as they supplied their altitude data in the incorrect format (ellipsoid).

8 File formats

All of the machines 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 data:

- Machine 14
- Machine 17
- Machine 18
- Machine 19
- Machine 22
- Machine 23
- Machine 24
- Machine 25
- Machine 26
- Machine 29
- Machine 31
- Machine 32

The following machines provided BCD data:

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

Examination of the supplied RCD and BCD found that the data formatting was suitable.

9 Conclusions

The 2015 sideway-force skid resistance accreditation trials were held during the week beginning the 27th April 2015. The trials were held on and around the MIRA proving ground and at the Longcross test track. Eighteen machines from the UK fleet attended.

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

(i) Skid resistance measurement

All eighteen of the machines met the criteria for the measurement of skid resistance.

(ii) Distance measurement

Fifteen machines achieved a high performance with regards to the measurement of distance. Three machines achieved a medium performance.

(iii) Measurement of OSGRs

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

(iv) Measurement of Altitude

Fourteen machines fitted with 3 dimensional spatial coordinate systems were assessed for the measurement of altitude. Four machines achieved a high performance, eight machines a medium performance and one machine achieved a low performance. The remaining machine was awarded a fail for this assessment as they supplied their altitude data in the incorrect format (ellipsoid).

(v) Speed measurement and recording

All eighteen machines were deemed to be acceptable with regards to the measurement and recording of survey speed.

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

(vi) Water flow

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

(vii) Left test-wheel weight

All eighteen machines met the current ±8 kg tolerance for test wheel weight. However, it is noted that there is a draft for development CEN technical specification for these devices which would tighten the tolerance to ±1 kg. six of the eighteen machines meet this tighter tolerance.

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

A summary of the machines that attended the 2015 accreditation trial and the criteria that they met can be found in Appendix A.

References

British Standards Institution. (2006). *BS 7941-1. Methods for measuring the skid resistance of pavement surfaces - Sideway-force coefficient routine investigation machine.* London: BSi.

British Standards Institution. (2009). *DD CEN/TS15901-6:2009. Road and airfield surface characteristics. Procedure for determining the skid resistance of a pavement surface by measurement of the sideway force coefficient (SFCS).* BSi.

HD28/04. (2004). *DMRB Volume 7 Section 3, HD28/04, Skid resistance*. London: The Stationery Office.

TRL. (2013). *Accreditation and Quality Assurance of Sideways Force Skid Resistance Survey Devices [online]. [Accessed 1st April 2015].* Available from World Wide Web: http://www.ukroadsliaisongroup.org/en/asset-condition/road-condition-information/data-collection/skid-resistance/index.cfm.

Appendix A Machine identification and performance

Table A.1 Machine identification and performance summary

ID	Current Owner/Operator	Registration Number	Performance summary						
			Skid resistance measurement	Speed	Distance travelled[1]	OSGR[1]	Altitude[1]	RCD file	BCD file
1	PTS Ltd	W965 SVG	Pass	Pass	*High*	-	-	-	-
3	DRDNI	IKZ 2203	Pass	Pass	*High*	-	-	-	-
13	WDM Ltd	S7 WDM	Pass	Pass	*High*	-	-	-	-
14	PMS Eire	01 KK 1138	Pass	Pass	*High*	*High*	*Low*	Pass	-
16	Highway Surveyors Ltd	S66 HSL	Pass	Pass	High	Low	Medium	-	-
17	WDM Ltd	S800 WDM	Pass	Pass	High	High	Medium	Pass	Pass
18	PMS Eire	04G13042	Pass	Pass	Medium	Medium	Medium	Pass	-
19	WDM Ltd	S900 WDM	Pass	Pass	High	High	High	Pass	Pass
21	Surrey CC	KX07YXH	Pass	Pass	*High*	-	-	-	-
22	PTS Ltd	KX07YVH	Pass	Pass	*Medium*	*High*	*Medium*	Pass	Pass
23	WDM Ltd	S11 WDM	Pass	Pass	High	High	Medium	Pass	Pass
24	WDM Ltd	S12 WDM	Pass	Pass	High	High	High	Pass	Pass
25	WDM Ltd	S13 WDM	Pass	Pass	High	High	Medium	Pass	Pass
26	WDM Ltd	S14 WDM	Pass	Pass	High	High	Medium	Pass	Pass
28	Operated by TRL on behalf of Highways England	WX60 AXN	Pass	Pass	High	Low	Medium	-	-
29	PTS Ltd	YD02 XSN	Pass	Pass	Medium	Medium	Fail	Pass	Pass
31	WDM Ltd	S16 WDM	Pass	Pass	High	High	High	Pass	Pass
32	WDM Ltd	Trade plates	Pass	Pass	High	High	High	Pass	Pass

[1] Performance assessed using the push button criteria are shown with a lighter colour shade and grey italic text.

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 1st set of tests on Straight Line Wet Grip

Machine	Between run SD on Straight Line Wet Grip			
	SWG01	SWG02	SWG03	SWG04
1	1.36	2.80	2.87	3.58
3	2.70	1.62	3.03	3.32
13	2.64	1.76	0.94	2.11
14	1.23	2.14	1.03	2.08
16	2.06	2.30	1.64	2.76
17	1.59	1.70	2.44	2.06
18	1.84	2.45	2.63	2.28
19	1.72	2.18	1.02	2.51
21	1.50	2.21	2.00	3.13
22	1.09	1.74	2.61	2.74
23	1.57	2.66	3.19	2.95
24	1.62	2.28	2.94	5.13
25	3.52	0.91	2.01	2.64
26	0.58	1.92	1.77	1.30
28	1.22	1.38	2.60	2.80
29	1.37	1.65	3.60	2.38
31	6.29	2.52	2.36	2.12
32	4.00	1.60	2.50	3.17

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

Machine	Between run SD on Straight Line Wet Grip			
	SWG01	SWG02	SWG03	SWG04
1	0.82	2.32	0.63	1.67
3	2.47	1.69	0.97	2.28
13	1.51	1.56	0.27	2.01
14	2.11	3.59	1.03	1.14
16	1.17	1.11	1.18	2.54
17	0.91	1.03	0.54	0.95
18	2.25	1.45	0.85	2.31
19	0.67	0.96	1.20	1.67
21	1.25	1.51	0.76	1.58
22	2.04	0.56	0.92	2.04
23	1.81	1.04	0.26	1.14
24	2.29	1.24	2.40	2.85
25	1.62	2.38	1.62	2.85
26	1.08	1.37	0.76	3.10
28	0.23	1.06	0.90	1.78
29	2.51	2.44	2.18	3.29
31	1.93	2.16	2.16	2.52
32	1.69	2.31	0.86	0.96

Table B.3 Machine repeatability for the network route

Machine	RMS average of 100m Between run SD for network route								
	NSM01	NSM02	NSM03	NSM04	NSM05	NSM06	NSM07	NSM08	NSM09
1	4.97	2.36	2.19	1.76	2.31	2.67	15.87	2.46	1.67
3	3.98	2.09	1.27	1.44	2.25	1.52	2.49	2.17	1.53
13	2.29	2.32	1.90	1.02	1.44	2.01	1.82	1.30	1.93
14	2.83	1.37	0.57	1.76	2.80	1.63	2.60	2.40	2.76
16	3.76	2.03	3.00	3.18	1.43	2.93	2.68	2.94	2.66
17	4.75	3.68	1.56	3.01	1.98	1.21	1.90	1.61	1.77
18	3.82	3.02	1.93	2.93	2.18	2.28	2.39	2.52	1.86
19	3.81	1.82	2.25	1.87	2.32	1.92	2.24	2.14	2.78
21	3.58	1.80	1.17	1.68	2.21	2.32	2.64	1.58	1.58
22	3.41	2.11	2.38	2.56	1.20	2.13	4.49	3.00	2.48
23	3.63	3.57	2.20	2.45	2.57	2.89	3.37	3.32	3.82
24	2.84	1.95	1.95	1.39	2.24	2.66	3.32	4.19	3.34
25	3.75	2.52	2.24	3.26	3.67	2.63	3.85	3.93	2.78
26	3.19	2.53	1.71	1.58	2.69	2.78	2.29	3.00	2.51
28	3.37	2.21	1.25	1.14	2.16	2.12	2.57	2.88	2.56
29	5.70	3.30	3.27	1.97	3.33	2.55	2.33	2.15	2.91
31	2.64	1.84	1.64	1.68	1.35	1.58	2.27	2.15	2.04
32	2.91	1.44	0.96	1.80	1.43	1.63	2.23	2.40	2.50

Table B.4 Machine repeatability for the 50km/h tests on the Twin Straights

Machine	Between run SD for 50km/h tests on Twin Straights					
	TS01	TS02	TS03	TS04	TS05	TS06
1	5.46	10.69	4.44	1.55	1.06	1.89
3	4.92	2.88	1.62	0.59	0.34	0.72
13	4.85	7.62	4.32	1.00	0.45	0.25
14	6.79	12.56	7.67	5.38	3.43	3.29
16	3.66	6.16	2.85	1.16	2.66	1.32
17	4.16	4.29	2.84	3.10	3.35	1.37
18	1.88	1.35	1.43	0.69	3.69	0.47
19	1.01	2.97	3.38	5.90	5.29	4.10
21	6.86	7.24	3.16	1.15	0.67	0.73
22	1.02	2.35	3.71	4.03	6.24	2.13
23	2.14	1.42	0.54	1.49	0.74	0.87
24	1.12	3.82	3.45	8.22	5.90	5.28
25	0.47	1.87	3.05	2.56	0.31	4.04
26	3.17	2.79	1.97	2.76	2.29	0.88
28	1.08	0.32	1.59	1.12	1.75	0.21
29	2.22	1.23	1.14	1.75	1.55	0.76
31	0.82	4.06	2.47	5.74	5.41	3.07
32	0.39	1.15	1.38	0.82	0.25	0.16

Table B.5 Machine repeatability for the 80km/h tests on the Twin Straights

Machine	Between run SD for 80km/h tests on Twin Straights					
	TS01	TS02	TS03	TS04	TS05	TS06
1	3.05	0.97	0.69	1.36	0.32	0.81
3	0.81	1.71	0.57	0.92	0.33	0.14
13	1.92	3.26	2.96	1.24	1.72	0.62
14	6.52	5.96	6.22	9.89	7.36	5.05
16	2.06	0.10	0.12	1.80	0.32	0.20
17	3.16	2.11	2.66	2.46	4.07	2.93
18	2.42	1.69	2.64	0.15	1.19	1.20
19	1.10	0.64	0.36	0.50	0.17	0.14
21	3.29	2.99	1.91	1.15	0.83	0.55
22	3.09	1.86	1.09	0.85	1.20	0.49
23	1.59	2.01	1.04	0.02	0.66	0.57
24	3.00	0.82	1.47	1.57	2.96	0.58
25	2.81	1.44	1.41	4.66	8.14	1.02
26	3.67	2.52	0.74	0.15	0.20	0.36
28	3.00	5.42	4.97	7.92	4.83	2.69
29	4.07	0.67	2.51	1.17	0.63	1.19
31	0.23	0.55	1.10	2.54	5.96	1.15
32	2.80	1.27	1.58	1.03	0.79	0.43

Appendix C Assessment of 3 dimensional spatial coordinates data

C.1 OSGR data from test track – Section start points

Table C.1 Assessment of OSGR measurements against the reference for section start points 50km/h (Test track)

Machine	Marker entry method	Section start and end points on test track						Performance level
		% within 2m	% within 4m	% within 5m	% within 10m	% within 15m	% within 20m	
14	Push	81	100	100	100	100	100	*High*
16	Auto	90	100	100	100	100	100	High
17	Auto	100	100	100	100	100	100	High
18	Auto	90	100	100	100	100	100	High
19	Auto	100	100	100	100	100	100	High
22	Push	86	100	100	100	100	100	*High*
23	Auto	100	100	100	100	100	100	High
24	Auto	100	100	100	100	100	100	High
25	Auto	100	100	100	100	100	100	High
26	Auto	100	100	100	100	100	100	High
28	Auto	19	86	100	100	100	100	Low
29	Auto	24	81	86	100	100	100	Low
31	Auto	100	100	100	100	100	100	High
32	Auto	100	100	100	100	100	100	High

Table C.2 Assessment of OSGR measurements against the reference for section start points 80km/h (Test track)

Machine	Marker entry method	Section start and end points on test track						Performance level
		% within 2m	% within 4m	% within 5m	% within 10m	% within 15m	% within 20m	
14	Push	81	100	100	100	100	100	*High*
16	Auto	19	76	76	90	95	100	Low
17	Auto	90	100	100	100	100	100	High
18	Auto	86	100	100	100	100	100	Medium
19	Auto	95	100	100	100	100	100	High
22	Push	95	100	100	100	100	100	*High*
23	Auto	100	100	100	100	100	100	High
24	Auto	100	100	100	100	100	100	High
25	Auto	100	100	100	100	100	100	High
26	Auto	100	100	100	100	100	100	High
28	Auto	8	42	83	100	100	100	Low
29	Auto	81	95	100	100	100	100	Medium
31	Auto	100	100	100	100	100	100	High
32	Auto	76	86	95	100	100	100	Low

C.2 OSGR data from test track – 10m data points

Table C.3 Assessment of OSGR measurements against the reference for 10m points 50km/h (Test track)

Machine	Marker entry method	10m data points on test track						Performance level
		% within 2m	% within 4m	% within 5m	% within 10m	% within 15m	% within 20m	
14	Push	78	99	100	100	100	100	*High*
16	Auto	71	97	100	100	100	100	Low
17	Auto	95	100	100	100	100	100	High
18	Auto	59	97	99	100	100	100	Low
19	Auto	97	100	100	100	100	100	High
22	Push	74	99	100	100	100	100	*High*
23	Auto	100	100	100	100	100	100	High
24	Auto	99	100	100	100	100	100	High
25	Auto	98	100	100	100	100	100	High
26	Auto	97	100	100	100	100	100	High
28	Auto	60	98	100	100	100	100	Low
29	Auto	44	88	94	100	100	100	Low
31	Auto	91	100	100	100	100	100	High
32	Auto	92	100	100	100	100	100	High

Table C.4 Assessment of OSGR measurements against the reference for 10m points 80km/h (Test track)

Machine	Marker entry method	10m data points on test track						Performance level
		% within 2m	% within 4m	% within 5m	% within 10m	% within 15m	% within 20m	
14	Push	77	97	100	100	100	100	*High*
16	Auto	70	86	95	100	100	100	Low
17	Auto	90	100	100	100	100	100	High
18	Auto	67	100	100	100	100	100	Low
19	Auto	93	100	100	100	100	100	High
22	Push	81	98	99	100	100	100	*High*
23	Auto	98	100	100	100	100	100	High
24	Auto	95	100	100	100	100	100	High
25	Auto	100	100	100	100	100	100	High
26	Auto	95	100	100	100	100	100	High
28	Auto	48	96	98	100	100	100	Low
29	Auto	79	98	100	100	100	100	Low
31	Auto	91	100	100	100	100	100	High
32	Auto	88	100	100	100	100	100	Medium

C.3 Altitude data from test track– Section start points

Table C.5 Assessment of Altitude measurements against the reference for section start points 50km/h (Test track)

Machine	Marker entry method	Section start and end points on test track					Performance level
		% within 2m	% within 4m	% within 5m	% within 6m	% within 20m	
14	Push	10	33	38	86	100	*Low*
16	Auto	76	95	100	100	100	Medium
17	Auto	86	100	100	100	100	Medium
18	Auto	71	100	100	100	100	Medium
19	Auto	90	100	100	100	100	High
22	Push	43	90	95	100	100	*Medium*
23	Auto	86	100	100	100	100	Medium
24	Auto	100	100	100	100	100	High
25	Auto	38	100	100	100	100	Medium
26	Auto	100	100	100	100	100	High
28	Auto	86	100	100	100	100	Medium
29	Auto	0	0	0	0	0	Fail
31	Auto	95	100	100	100	100	High
32	Auto	100	100	100	100	100	High

Table C.6 Assessment of Altitude measurements against the reference for section start points 80km/h (Test track)

Machine	Marker entry method	Section start and end points on test track					Performance level
		% within 2m	% within 4m	% within 5m	% within 6m	% within 20m	
14	Push	14	62	67	71	100	*Low*
16	Auto	57	81	86	90	100	Medium
17	Auto	71	100	100	100	100	Medium
18	Auto	48	90	95	100	100	Medium
19	Auto	95	100	100	100	100	High
22	Push	33	100	100	100	100	*Medium*
23	Auto	81	100	100	100	100	Medium
24	Auto	100	100	100	100	100	High
25	Auto	62	100	100	100	100	Medium
26	Auto	81	90	90	100	100	Medium
28	Auto	92	100	100	100	100	High
29	Auto	0	0	0	0	0	Fail
31	Auto	95	100	100	100	100	High
32	Auto	43	86	90	95	100	Medium

C.4 Altitude data from test track– 10m data points

Table C.7 Assessment of Altitude measurements against the reference for 10m points 50km/h (Test track)

Machine	Marker entry method	10m data points on test track					Performance level
		% within 2m	% within 4m	% within 5m	% within 6m	% within 20m	
14	Push	7	34	42	90	100	*Low*
16	Auto	87	99	100	100	100	Medium
17	Auto	87	100	100	100	100	Medium
18	Auto	48	100	100	100	100	Medium
19	Auto	94	100	100	100	100	High
22	Push	29	94	97	100	100	*Medium*
23	Auto	88	100	100	100	100	Medium
24	Auto	100	100	100	100	100	High
25	Auto	38	100	100	100	100	Medium
26	Auto	99	100	100	100	100	High
28	Auto	85	100	100	100	100	Medium
29	Auto	0	0	0	0	0	Fail
31	Auto	97	100	100	100	100	High
32	Auto	100	100	100	100	100	High

Table C.8 Assessment of Altitude measurements against the reference for 10m points 80km/h (Test track)

Machine	Marker entry method	10m data points on test track					Performance level
		% within 2m	% within 4m	% within 5m	% within 6m	% within 20m	
14	Push	22	66	67	73	100	*Low*
16	Auto	54	85	94	99	100	Medium
17	Auto	80	100	100	100	100	Medium
18	Auto	28	84	90	94	100	Medium
19	Auto	94	100	100	100	100	High
22	Push	15	100	100	100	100	*Medium*
23	Auto	87	100	100	100	100	Medium
24	Auto	100	100	100	100	100	High
25	Auto	65	100	100	100	100	Medium
26	Auto	73	94	96	99	100	Medium
28	Auto	93	100	100	100	100	High
29	Auto	0	0	0	0	0	Fail
31	Auto	97	100	100	100	100	High
32	Auto	82	100	100	100	100	Medium

Highways England 2015 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, reliable and consistent survey data. To this aim, Highways England commission annual accreditation trials for Sideways Force Skid Resistance devices supported by ongoing QA for the devices. In order to undertake accredited surveys, the survey devices are required to meet the mandatory criteria of the trial.

This report covers the 2015 trial run by TRL and held on the Horiba-MIRA proving ground between 28th and 30th April 2015 and on the Longcross test track on 27th April 2015.

Other titles from this subject area

CPR 1874	Highways Agency 2014 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2014
CPR 1650	Highways Agency 2013 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2013
CPR 1451	Highways Agency 2012 national SCRIM accreditation trial. S Brittain and P Werro. 2012
CPR 1448	SCRIM accreditation transitional trial. P Roe, S Brittain, P D Sanders. 2011

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