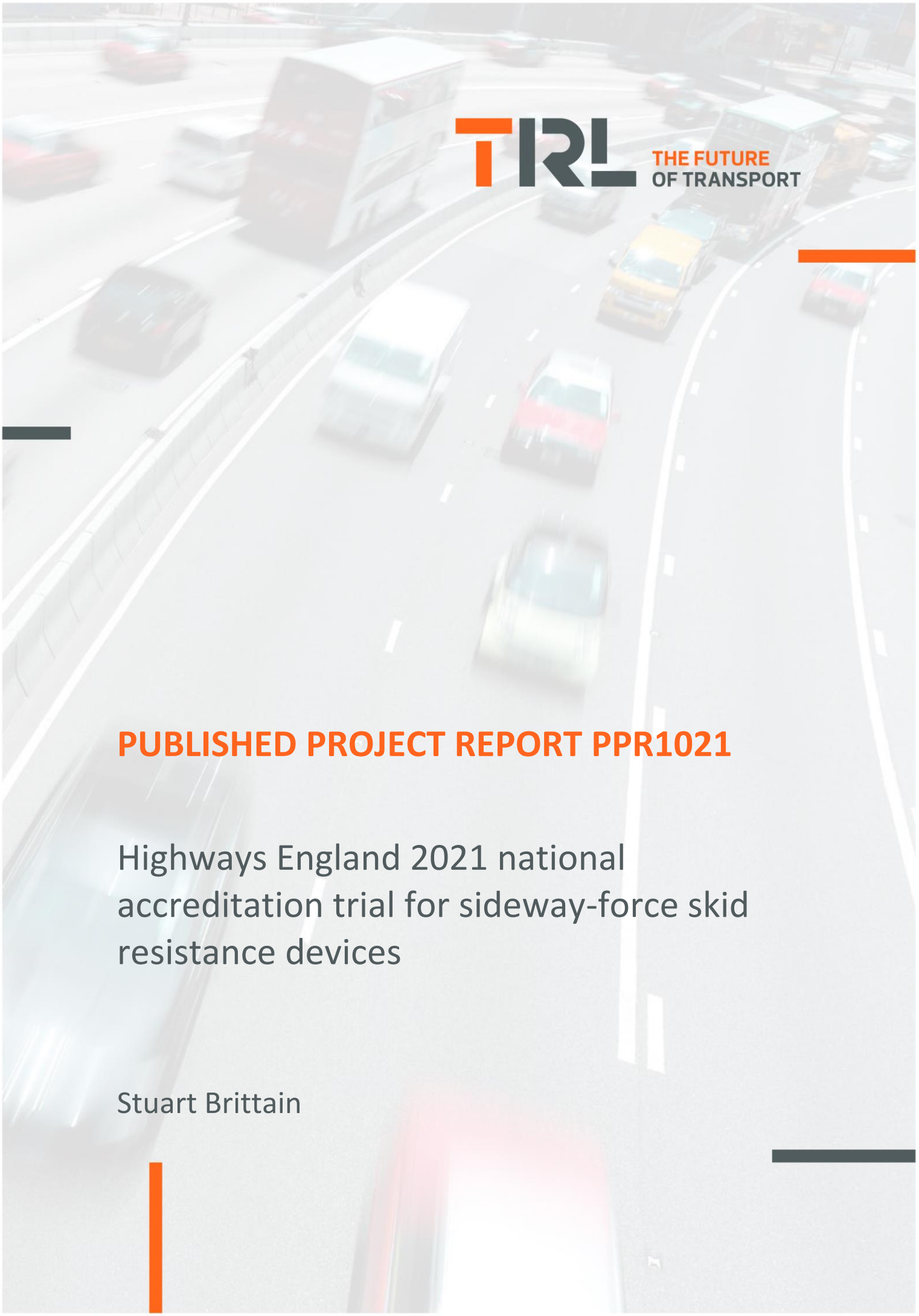

THE FUTURE OF TRANSPORT

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Highways England 2021 national accreditation trial for sideway-force skid resistance devices

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Disclaimer

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Contents

Executive Summary

The national accreditation for sideway-force skid resistance devices is organised annually by TRL, on behalf of Highways England. The purpose of this accreditation 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 skidding resistance standard (DMRB CS 228). 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 2021 accreditation trial was held during the week beginning 19th April 2021. Due to the ongoing health situation of COVID-19, the trial structure was different to previous years. However, the trial process included all of the required assessments. Sixteen machines attended, including one machine that operates in the USA.

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

- All sixteen machines were found to be satisfactory with regards to the machine being in good general mechanical order and test wheel weight.
- All sixteen machines met the criteria for the skid resistance measurements.
- All sixteen machines met the criteria for vehicle speed.
- All sixteen machines met the criterion for distance measurement.
- All sixteen machines provided satisfactory water flow rate and direction.

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

- Fourteen machines were assessed for the measurement of OSGRs. Two machines achieved a high performance, four a medium, seven a low and one was identified as not suitable.
- Fourteen machines were assessed for the measurement of altitude. Five machines achieved a high performance, eight a medium performance and one was identified as not suitable.

During the assessment of the OSGR performance it was seen that the fleet performed poorly against the criteria as they currently stand. It was identified that this was due to the criteria for the percentage of data within 2m of the reference. Most devices showed a good performance for the percentage of data within 3m.

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

1 Introduction

The 2021 accreditation 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 skidding resistance standard (DMRB CS 228).

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 accreditations since 1995. Due to COVID-19, the 2020 Accreditation was amended to involve a series of Accreditation check processes (Brittain, 2022). Although by the time of the 2021 Accreditation, COVID-19 was still a present issue, it was possible to undertake a full Accreditation of the devices using a modified trial process. This modified trial process was discussed, developed and agreed with the survey contractors via video conference prior to the trial.

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. Operators were required to undertake weighing of their own test wheel assembly and vertical calibrations before the trial.
2. **Distance, speed and OSGR assessments (Longcross)**: Laps (3 at 50km/h and 3 at 80km/h for each machine) were undertaken of the Longcross test track. Timing gates were setup over one section on the site. Data from this testing was used to assess the distance and speed measurements of the machines and also the OSGR systems (where fitted).
3. **Waterflow and Test track skid resistance measurements (MIRA)**: Machines were inspected to check the performance of the water flow control. Laps (5 at 50km/h for each machine) were undertaken of the Straight Line Wet Grip (SWG) facility at MIRA to assess the skid resistance performance.
4. **Machine alterations**: Operators were provided feedback on the performance on the first set of testing on the SWG. This information was used by the operators to make alterations to the machines if required before the remaining testing in the trial.
5. **Network route testing**: Laps (3 for each machine) were undertaken of the network route near MIRA. This data was used to support the skid resistance assessment on the SWG and the distance and OSGR assessment at Longcross.
6. **Repeat test track skid resistance measurements**: The SWG testing was repeated to assess fleet variability and the performance of devices following any required alterations arising from Stage 4.

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:

https://ukrlg.ciht.org.uk/ukrlg-home/guidance/road-condition-information/data-collection/skid-resistance/

The 2021 trial was held during the week beginning 19th April 2021. Fifteen machines based in the UK and one machine 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 April 2021.

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.

2 Pre-trial preparation

2.1 Test wheel weighing and vertical calibrations

As part of the inspection day in previous trials, TRL would carry out weighing of the test wheel assemblies and observe the operators conducting a vertical calibration and check of their systems. To reduce the number of close contact tasks required to be undertaken at the trial sites (to lower COVID-19 risks), survey contractors were asked to carry out these measurements and provide the data to TRL before arriving on site.

2.2 Test tyres

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. In previous trials a set of tyres was selected for the testing and swapped between machines to remove this source of variation. Due to health implications as a result of COVID-19 it was decided that the practice of swapping tyres at the trial should be removed.

To account for the possible effect of tyre variation on the data, operators were asked to use a selection of their own tyres supplemented by one tyre provided to them by the accreditation team for the testing. The tyres provided to the operators were scrubbed in prior to the trial and the data produced was checked for consistency to confirm their suitability for the trial.

2.3 Site Preparation

Prior to the trial, a drive through of the network route is undertaken to identify if there could be any issues with using the route during the trial e.g. road works, or any aspects that may need to be considered when assessing the data collected e.g. road deterioration or recent maintenance.

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 provide some leeway so that cones are not hit on a regular basis. Therefore, although this approach may reduce the driving line variability, some may still remain.

3 Test sections

The trial uses one area of the MIRA proving ground (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 assessment of distance, speed and OSGR/Altitude systems.

3.1 Straight Line Wet Grip area

The Straight Line Wet Grip area on the MIRA proving ground is utilised to provide lengths with a range of skid resistance levels including some particularly low values not present on the network route. The position of the sections is given in Figure 3.1and details of the sections are given in Table 3.1

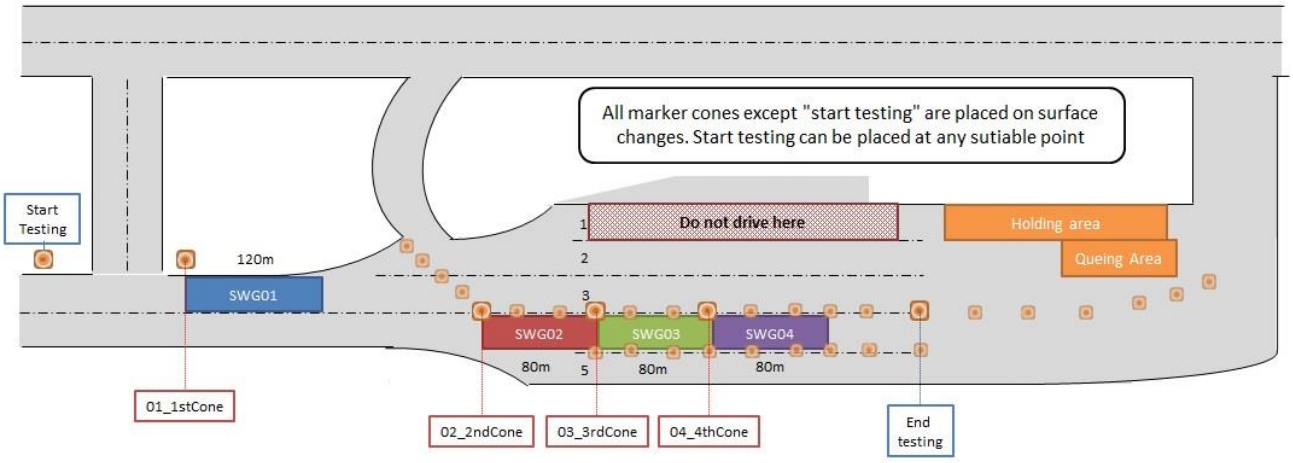

Figure 3.1: Skid resistance test sections on the Straight Line Wet Grip area

Table 3.1: 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.

3.2 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 3.2 (Contains Ordinance Survey data © Crown copyright and database right 2021). Details of the route are given in Table 3.2.

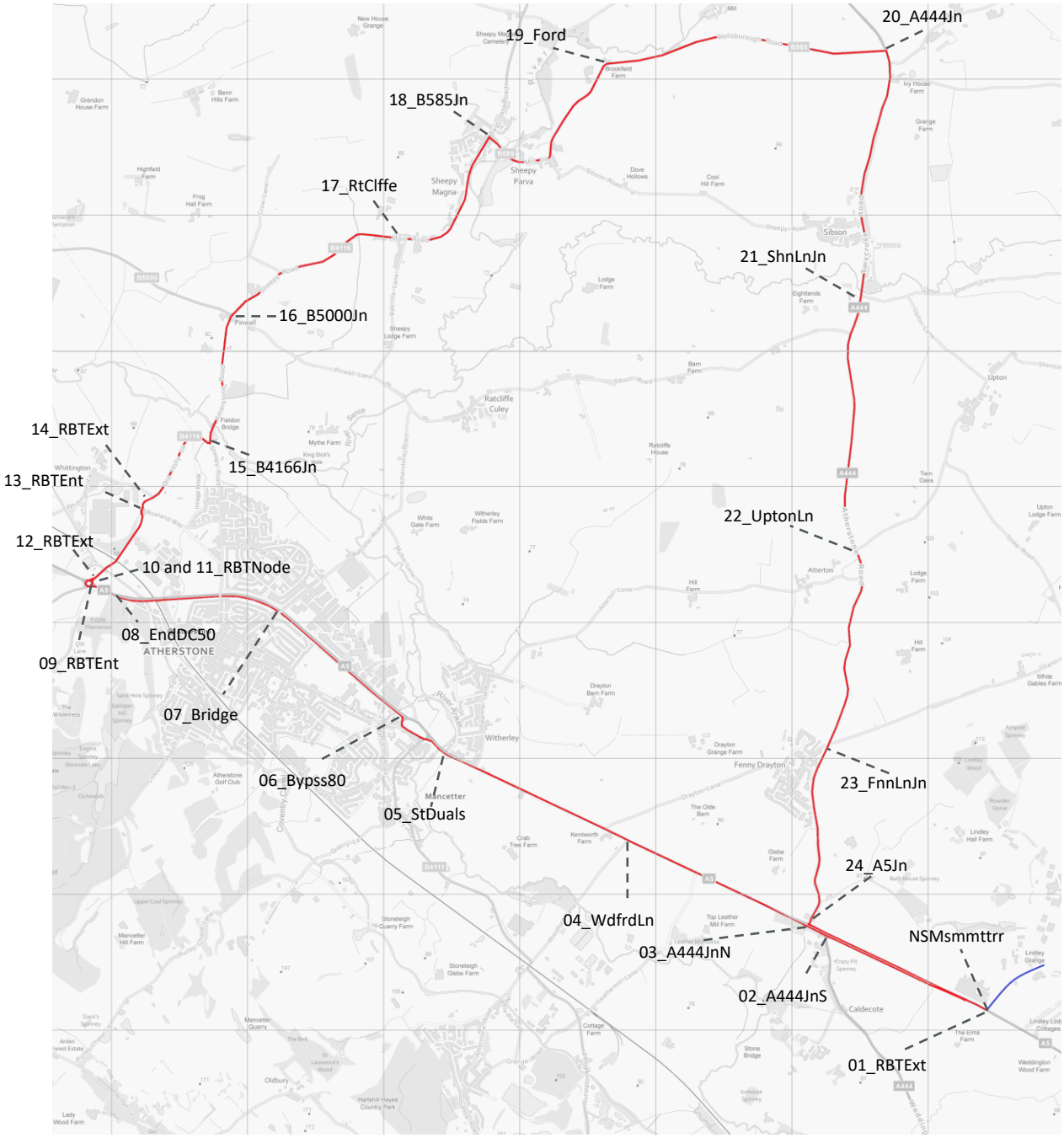

Figure 3.2: Network route to Sheepy Magna

Table 3.2: 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.

3.3 Longcross test track

This site includes more corners and tree coverage than 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 3.3 and detailed in Table 3.3.

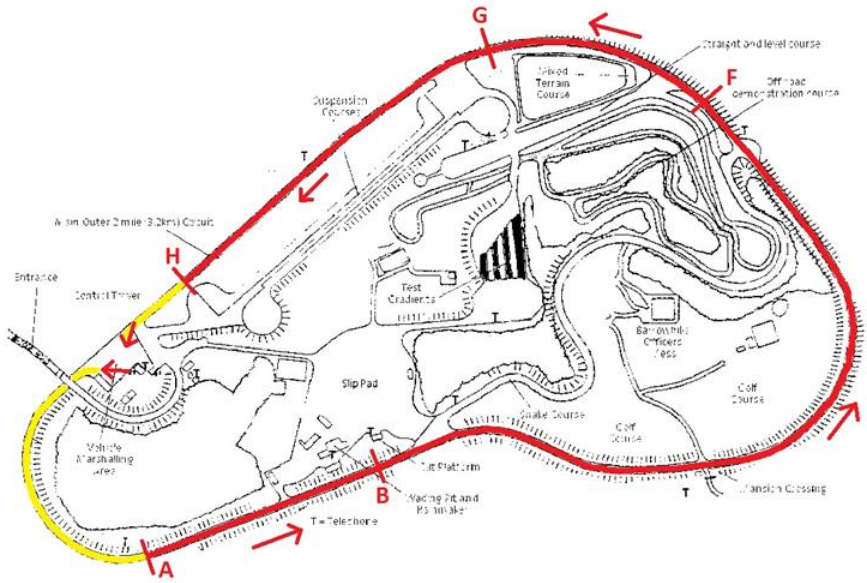

Figure 3.3: Longcross test track site map

Table 3.3: 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 Machine inspections

4.1 Left test wheel weight checks

As discussed in section 2.1 the survey contractors were asked to weigh the test wheel assemblies on the their machines and provide the data before the trial. The measurements supplied are given in Table 4.1.

Table 4.1: 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	202.0	202.5	203.0	202.5	204.0	204.0	204.0	204.0
3	197.0	197.0	197.0	197.0	199.5	199.5	199.5	199.5
13	200.0	200.0	200.5	200.2	202.5	202.5	202.5	202.5
16	202.6	202.2	203.4	202.7	204.1	204.5	204.6	204.4
17	189.0	189.0	189.0	189.0	201.0	201.0	201.0	201.0
19	199.5	199.5	199.5	199.5	201.0	201.0	201.0	201.0
21	198.0	198.0	198.0	198.0	199.0	199.0	199.0	199.0
22	200.8	200.9	200.8	200.8	201.8	201.3	201.5	201.5
23	200.0	200.0	200.0	200.0	202.0	202.0	202.0	202.0
24	197.0	197.0	197.0	197.0	200.5	200.5	200.5	200.5
25	195.5	195.5	195.5	195.5	199.5	199.5	199.5	199.5
26	197.0	197.5	197.5	197.3	200.5	200.5	200.5	200.5
28	196.5	196.5	197.0	196.7	198.0	198.5	200.0	198.8
29	206.2	205.7	205.4	205.8	206.3	206.2	206.3	206.3
31	200.0	200.0	200.0	200.0	202.0	202.0	202.0	202.0
34	199.5	199.0	199.5	199.3	202.5	202.0	202.5	202.3

It can be seen in Table 4.1 that all of the "bounced" mean weights of the machines fell within the tolerances given in appendix D.1. There is a noticeable difference in the bounced and un-bounced wheel weight values for one of the machines (Machine 17). The owner of this machine should be aware that this may be an indication of some deterioration in the shaft assembly and may cause issues at a future date.

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. The requirements in this document may be incorporated into future revisions of the British Standard.

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 the 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 British Standard or the CEN document are due for review.

4.2 Water flow rate checks

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

4.3 Vertical and horizontal load calibration

Operators were asked to arrive on site with the machines having had a recent vertical calibration. The crews were also asked to conduct a horizontal calibration at the start of each day of testing that involved collection of skid resistance measurements.

4.4 Distance calibration

Initially a 400m site on the A3095 was identified for use for distance calibration of devices. However, due to roadworks this site was not available preceding the trial and as such a length on the Longcross test track was provided to perform a distance calibration. This length was 290.1m long and communicated to all participants before the trial. During testing it was identified that some machines required a 400m length for the calibration, as such they could not carry out a calibration during the trial. These machines had all undertaken a distance calibration shortly before attending the trial. Before the next trial, a suitable 400m length at the Longcross test track should be identified to allow calibration on this site for all machines.

4.5 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 at Longcross.

The time taken for the machines to travel between markers A and B (see Figure 3.3), 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 speed reported in the survey data and the independent measurement are shown in Table 4.2. The differences between the independent measure and the target speed are shown in

Table 4.3. Instances where the value exceeds the criteria levels in Appendix D.1 are highlighted in in bold red text. It was not possible to record valid independent data on all runs, therefore some data are missing from the tables. It is believed that this was due to the

gates becoming misaligned during testing and unintentional triggers. The positioning and setup of the gates should be reviewed for future trials.

Table 4.2: 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 1	Run 2	Run 3	
1	0.24	0.23	0.33	0.49	0.59	0.65	100%
3	0.08	0.08	0.09	0.26	0.18	0.36	100%
13	.	0.32	.	0.57	0.65	0.58	100%
16	0.04	0.07	0.12	0.71	0.10	-0.17	100%
17	0.07	.	.	0.46	0.26	0.48	100%
19	0.19	-0.01	.	0.10	.	.	100%
21	0.68	.	0.77	**1.01**	0.89	0.75	80%
22	-0.45	-0.45	-0.42	-0.42	-0.32	-0.36	100%
23	0.22	.	0.27	0.62	0.44	0.31	100%
24	0.02	-0.01	0.19	0.40	0.42	0.51	100%
25	0.30	0.17	0.32	.	.	0.37	100%
26	.	0.24	0.19	.	0.60	.	100%
28	.	.	-0.54	-0.79	.	.	100%
29	0.36	0.28	0.26	0.67	.	**1.59**	80%
31	0.19	0.20	0.27	0.62	.	0.49	100%
34	-0.05	-0.01	-0.01	0.36	0.30	0.46	100%

Table 4.3: 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 1	Run 2	Run 3	
1	0.39	0.41	1.29	**4.27**	1.48	0.88	83%
3	0.27	0.27	-0.09	1.54	0.82	1.12	100%
13	.	-2.24	.	-1.46	-0.83	-0.83	100%
16	-0.04	-0.07	-0.85	0.22	0.52	0.09	100%
17	-2.93	.	.	1.06	-0.09	-1.72	100%
19	-1.98	0.32	.	1.18	.	.	100%
21	-0.07	.	-0.09	1.77	0.76	2.47	100%
22	0.55	0.55	0.53	0.94	0.46	0.46	100%
23	**3.13**	.	0.83	**3.04**	**3.99**	**5.14**	**20%**
24	1.67	2.18	2.05	2.81	2.58	2.87	100%
25	0.74	0.83	0.34	.	.	0.94	100%
26	.	-0.38	0.22	.	0.40	.	100%
28	.	.	2.23	2.98	.	1.54	100%
29	0.43	0.50	0.03	0.76	.	0.03	100%
31	0.88	0.83	0.83	0.76	.	0.58	100%
34	0.05	0.01	0.01	-0.40	-0.34	-0.46	100%

From these tables it can be seen that all sixteen machines achieved at least 80% of their data within the criteria for the difference between the data recorded in the survey and the independent measure. Fifteen of the sixteen machines also achieved at least 80% within the criteria for the difference in the independent measure of survey speed and the target speed.

One machine (Machine 23) was consistency lower than the target survey speed for the 80km/h measurements. As the recorded survey speed was accurate, it was decided that this machine should be recorded as meeting the speed criteria along with notifying the owner of the machine so that they can review the speed control mechanisms on the device.

Therefore, all machines are deemed acceptable with regards to measurement of survey speed.

5 Skid resistance measurements

Skid resistance measurements were taken on two sites (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 Appendix D.1).

5.1 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 area shows a higher BRSD on SWG04. It has been found from previous trials that the BRSD is typically higher for SWG04.
- The second set of tests shows a higher BRSD on sections SWG03 and SWG04.
- For the network route there were a small number sections where increased BRSD was seen for a few machines.
- Machine 31 has a slightly higher BRSD than the rest of the fleet on the Network route, but has comparable or lower values during the Straight Line Wet Grip testing.

Therefore, all machines were deemed to be performing acceptably with regards to between run variation.

5.2 Variation between machines

The average SR values produced by the machines for each of the test sites are shown in the tables below (Table 5.1 to Table 5.5). 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”.

One machine (Machine 34) taking part in the trial was not accredited during the previous year. As such this machine 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 appendix D.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.

5.2.1 First set of Straight Line Wet Grip tests (20th April)

One Machine (Machine 01) suffered a breakdown on travelling to the site and as such was unable to take part in the testing on this day. The results from the 1st set of tests on the Straight Line Wet Grip are shown in Table 5.1.

Table 5.1: 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	-	-	-	-	-
3	62.0	83.6	26.6	48.2	56.1
13	66.2	87.5	26.1	49.0	58.5
16	77.6	105.2	32.5	64.7	71.1
17	65.3	87.7	28.4	58.6	60.7
19	69.2	90.9	28.0	53.4	61.6
21	70.7	91.6	26.7	51.8	61.7
22	64.4	87.4	26.9	50.9	58.4
23	63.8	85.0	23.9	46.7	56.1
24	67.4	92.7	27.7	51.4	60.9
25	69.0	93.8	28.3	53.6	62.3
26	68.7	90.9	25.0	48.7	59.8
28	69.3	87.7	26.3	48.8	59.6
39	65.4	87.3	22.9	45.2	56.7
31	65.5	88.3	25.0	46.5	57.6
34	66.4	87.6	29.2	51.8	59.9
Ref mean	67.5	90.0	26.7	51.2	60.1
Ref BESD	3.82	5.24	2.33	5.20	3.79
Trial mean	67.4	89.8	26.9	51.3	60.1
Trial BESD	3.69	5.08	2.33	5.01	3.65

It can be seen from Table 5.1 that the BESD criteria is not met for the average of the site for the trial dataset. In addition, it can be seen that Machine 16 is producing values significantly higher than the rest of the fleet. If Machine 16 is removed from the analysis then the BESD criteria is met for the trial dataset. The updated reference and trial statistics following removal of this machine are shown in Table 5.2.

Table 5.2: Updated reference and trial statistics following removal of Machine 16 - 1st set of tests on the Straight Line Wet Grip

	Average SR on Straight Line Wet Grip				
	SWG01	SWG02	SWG03	SWG04	Avg
Ref mean	66.7	88.8	26.3	50.2	59.2
Ref BESD	2.57	2.99	1.71	3.61	2.17
Trial mean	66.7	88.7	26.5	50.3	59.3
Trial BESD	2.47	2.89	1.82	3.50	2.09

Due to this performance, the owners of Machine 16 were notified and asked to investigate their machine before undertaking the network route testing. The owners of Machine 16 reviewed their machine and identified that the calibration was out for this testing and rectified this for the remaining testing.

5.2.2 Network route tests (21st April)

As noted in section 3.2, fourteen 100m lengths of varying skid resistance levels have been selected on the network route for the analysis. These lengths are selected for homogeneity of skid resistance within the length and low indications of variation due to test line. As such the lengths used (and the typical skid resistance values) may vary between trials. During 2020 significant lengths of the route were maintained. As such a number of the sections have been amended for this trial.

The results from the testing on the route are shown in Table 5.3.

Table 5.3: 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	59.6	56.2	68.1	80.1	69.7	55.1	51.6	62.0	50.5	48.1	54.7	62.1	57.7	67.4	60.2
3	61.1	58.3	70.4	86.3	69.1	60.1	57.2	65.3	54.1	55.1	55.1	62.5	58.3	68.0	62.9
13	63.7	60.5	72.5	86.4	72.7	60.5	59.4	65.7	55.9	53.5	58.7	66.8	62.0	74.5	65.2
16	58.7	54.0	67.6	81.7	67.2	55.8	46.9	63.0	48.2	46.9	52.6	61.4	54.2	67.8	59.0
17	63.6	59.0	73.1	86.0	70.9	61.0	58.1	65.3	55.1	53.9	58.2	65.1	59.6	72.0	64.4
19	65.8	63.7	74.4	90.9	75.7	63.6	60.4	67.7	57.3	55.4	60.3	69.2	61.6	74.7	67.2
21	67.9	64.0	76.2	90.9	76.1	64.1	59.9	68.3	58.6	55.1	59.9	67.5	61.2	76.2	67.6
22	59.7	56.8	65.7	80.3	68.0	59.3	55.9	60.9	52.1	49.6	52.9	60.6	56.4	66.7	60.3
23	63.8	61.0	71.8	84.5	71.5	59.5	58.8	64.7	53.7	53.3	56.9	64.5	60.5	70.5	63.9
24	63.5	62.6	74.0	91.2	74.6	62.0	62.9	65.3	56.6	54.4	58.3	67.8	61.6	73.7	66.3
25	63.7	59.3	72.2	90.0	72.9	62.0	59.0	65.8	56.5	55.8	58.2	67.6	60.3	72.6	65.4
26	61.8	58.7	70.3	85.0	70.4	56.9	54.7	62.4	51.8	50.8	56.1	63.2	57.2	68.2	62.0
28	61.4	54.2	69.7	84.8	69.5	58.3	55.8	64.2	51.7	53.2	54.5	66.0	57.4	69.2	62.1
29	60.1	56.4	64.7	80.4	65.8	54.2	51.6	59.6	49.4	46.4	51.6	60.4	56.5	65.7	58.8
31	66.4	63.2	71.1	86.5	74.7	63.4	59.0	67.1	53.7	54.1	57.9	66.1	59.7	72.2	65.4
34	60.4	57.3	69.0	81.4	68.2	57.1	58.4	61.2	52.7	49.7	53.7	61.3	57.1	68.4	61.1
Ref mean	62.7	59.2	70.8	85.7	71.2	59.7	56.8	64.5	53.7	52.4	56.4	64.7	58.9	70.6	63.4
Ref BESD	2.70	3.29	3.22	3.88	3.15	3.14	4.15	2.49	3.03	3.18	2.72	2.87	2.33	3.30	2.89
Trial mean	62.6	59.1	70.7	85.4	71.1	59.6	56.9	64.3	53.6	52.2	56.2	64.5	58.8	70.5	63.2
Trial BESD	2.67	3.21	3.15	3.90	3.14	3.10	4.03	2.54	2.94	3.15	2.71	2.90	2.30	3.24	2.85

It can be seen from Table 5.3 that the trial BESD is not within the criterion for the average of the site. This would ordinarily require machines to be excluded in order to move the Trial BESD to be within the criterion. 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 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 machines is suitable.

5.2.3 Second set of Straight Line Wet Grip tests (22nd April)

The results from the 2nd set of tests on the Straight Line Wet Grip are shown in Table 5.4.

Table 5.4: 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	64.7	86.7	19.0	46.2	55.6
3	64.7	85.2	25.0	45.1	56.4
13	64.7	85.4	22.7	46.2	56.2
16	62.3	86.7	15.5	43.9	53.6
17	65.9	87.4	29.4	57.5	60.9
19	69.9	93.2	27.0	57.8	63.1
21	73.0	94.6	25.5	47.0	61.9
22	66.0	87.2	24.6	45.0	57.1
23	66.6	87.0	22.6	43.9	56.7
24	66.0	88.7	23.7	46.2	57.6
25	69.2	92.3	26.8	50.0	61.0
26	65.7	86.2	22.2	42.7	55.9
28	67.1	85.0	23.4	45.6	57.0
39	61.8	81.1	20.9	45.3	53.6
31	67.6	90.3	24.5	45.1	58.4
34	66.8	87.9	27.9	45.3	58.4
Ref mean	66.4	87.8	23.5	47.2	57.7
Ref BESD	2.85	3.52	3.37	4.57	2.87
Trial mean	66.4	87.8	23.8	47.1	57.7
Trial BESD	2.76	3.40	3.43	4.44	2.78

On examination of the data from the 2nd set of Straight Line Wet Grip testing (Table 5.4) it can be seen that the Trial BESD is not within the criteria. This poor performance is being driven by the particularly high values for Machines 17 and 19 on section SWG04. The data from these machines were re-reviewed and it was identified that there was significant variation on this section (while the other sections were more consistent between runs). This can be seen in Figure 5.1 which shows the data from Machine 19.

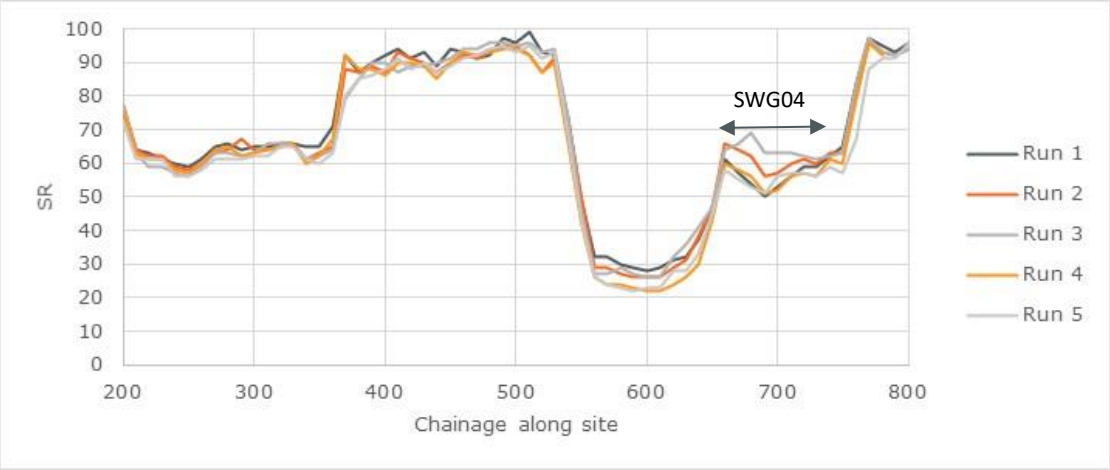

Figure 5.1: Data for Machine 19 from the 2nd set of tests on the Straight Line Wet Grip

This variation, combined with the higher levels of between run variation seen on section SWG04 on both days (as discussed in section 5.1) suggests variations in driving line are affecting the data on this section. The data for the fleet following removal of the two anomalous runs for Machines 17 and 19 (runs 2 and 4 and Runs 2 and 3 respectively) is shown in Table 5.5.

Table 5.5: Average SR from the 2nd set of tests on the Straight Line Wet Grip – with anomalous runs removed for Machines 17 and 19

ID	Average SR on Straight Line Wet Grip				
	SWG01	SWG02	SWG03	SWG04	Avg
1	64.7	86.7	19.0	46.2	55.6
3	64.7	85.2	25.0	45.1	56.4
13	64.7	85.4	22.7	46.2	56.2
16	62.3	86.7	15.5	43.9	53.6
17	*65.4*	*87.1*	*27.7*	*55.4*	*59.9*
19	*70.0*	*93.2*	*26.1*	*55.3*	*62.4*
21	73.0	94.6	25.5	47.0	61.9
22	66.0	87.2	24.6	45.0	57.1
23	66.6	87.0	22.6	43.9	56.7
24	66.0	88.7	23.7	46.2	57.6
25	69.2	92.3	26.8	50.0	61.0
26	65.7	86.2	22.2	42.7	55.9
28	67.1	85.0	23.4	45.6	57.0
39	61.8	81.1	20.9	45.3	53.6
31	67.6	90.3	24.5	45.1	58.4
34	66.8	87.9	27.9	45.3	58.4
Ref mean	66.3	87.8	23.3	46.9	57.5
Ref BESD	2.86	3.52	3.12	3.81	2.70
Trial mean	66.4	87.8	23.6	46.8	57.6
Trial BESD	2.77	3.40	3.23	3.70	2.62

On examination of Table 5.5 it can be seen that trial BESD is within the threshold for the average of the site and all machines are within 2 times the BESD criteria of the reference mean on the average of the site. Therefore, based on this data and the data collected on the network route all machines are deemed acceptable with regards to skid resistance measurements.

5.3 Summary of skid resistance testing

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

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

6 Location referencing

6.1 Distance measurement

The assessment of distance measurement recorded by the machines was undertaken using data from the Longcross test track. 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 3.3

There are three mechanisms for recording location referencing points in the survey data:

1. Push button entry – survey contractor pushes a button to enter the location of the point manually
2. Automatic marker detection – using a system to automatically detect the markers, typically retroreflective marker detection
3. OSGR fitting – identifying locations of the markers using the collected OSGR data and known coordinate positions of the markers

In order to assess the distance measurement system in isolation, the OSGR fitting method is not used in the assessment (as this would introduce an additional variation into the assessment). Therefore, machines are assessed on the push button or automatic marker entry depending on whether the machine has automatic marker detection fitted. To account for potential operator error-in the push button entry method these two approaches have slightly different criteria (see Appendix D).

In order to maintain the levels of accuracy required by Highways England for their surveys, the machines that have OSGR systems fitted and may survey their network will be assessed using the Automatic markers criteria (regardless of if automatic marker detection is fitted or not).

The results from the testing on the Longcross test track are shown in Table 6.1 along with the criteria applied and the performance awarded.

Table 6.1: Distance measurement assessment

ID	Percentage of data within				Assessment criteria used	Met criterion
	1m	2m	5m	10m		
1	75%	100%	100%	100%	Automatic	Pass
3	25%	100%	100%	100%	Push	Pass
13	83%	100%	100%	100%	Automatic	Pass
16	92%	100%	100%	100%	Automatic	Pass
17	100%	100%	100%	100%	Automatic	Pass
19	92%	100%	100%	100%	Automatic	Pass
21	100%	100%	100%	100%	Automatic	Pass
22	58%	83%	100%	100%	Push	Pass
23	92%	100%	100%	100%	Automatic	Pass
24	100%	100%	100%	100%	Automatic	Pass
25	100%	100%	100%	100%	Automatic	Pass
26	100%	100%	100%	100%	Automatic	Pass
28	100%	100%	100%	100%	Automatic	Pass
29	75%	100%	100%	100%	Automatic	Pass
31	100%	100%	100%	100%	Automatic	Pass
34	50%	100%	100%	100%	Automatic	Pass

From Table 6.1 it can be seen that all machines meet the assessment criteria applied. In addition, it can be seen that all machines meet the automatic markers criteria (80% within 2m) regardless of method.

6.2 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; fourteen of the sixteen machines took part in these tests. One machine (Machine 28) has a GPS system fitted but could not collect any OSGR data during the trial due to issues with the logging equipment experienced on the day. This machine will have its OSGR system assessed separately from this work.

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 detailed results from the OSGR and altitude assessments and the criteria applied are given in Appendix C. These are summarised in Table 6.2 and Table 6.3. All machines were 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. The assessment criteria are given in Appendix D. The final performance level awarded is the same as the lowest level achieved by the device from all the tests completed during the trial.

Table 6.2: Summary of OSGR assessments

ID	Performance on Network route (OSGR fitted)	Performance at Longcross		Awarded Performance
		OSGR fitted	Marker entry	
1	High	Medium	Low	Low
3	High	Low	High	Low
13	High	High	Low	Low
16	High	Low	Not Suitable	Not Suitable
17	High	High	Medium	Medium
19	High	High	Low	Low
21	-	.	-	-
22	High	High	Medium	Medium
23	High	High	Low	Low
24	High	High	Medium	Medium
25	High	High	High	High
26	High	High	Medium	Medium
28	-	-	-	-
29	High	Low	Low	Low
31	High	High	High	High
34	High	Low	Low	Low

Table 6.3: Summary of Altitude assessments

ID	Performance on Network route (OSGR fitted)	Performance at Longcross (Marker entry)	Awarded Performance
1	Medium	Medium	Medium
3	Medium	High	Medium
13	High	High	High
16	Not Suitable	Not Suitable	Not Suitable
17	Medium	High	Medium
19	High	High	High
21	-	-	-
22	Medium	High	Medium
23	High	High	High
24	High	Medium	Medium
25	High	High	High
26	High	Medium	Medium
28	-	-	-
29	Medium	Medium	Medium
31	High	High	High
34	Medium	Medium	Medium

It can be seen that the OSGR performance (Table 6.2) for the fleet as a whole is mixed. The performance on the network route consistently provides high levels of performance - as would be expected (because the collected data is fitted to a provided route file using the MSP software). However, the performances at Longcross (for both the 'raw' OSGR data and the subsequent fitted data) range from low to high performances. On closer examination of the data (see Table C.3) it can be seen that the devices were often missing the threshold on the percentage of measurements within 2m of the reference but meeting it for 4m and above. For the Automatic markers criteria 90% of the data should be within 2m to achieve a high performance and 80% for a medium performance.

It is noted that this level of the fleet performance is lower than expected and that achieved at previous accreditation trials. There are a lot less devices being awarded the full 'high' performance category this year. With the majority of the fleet performing a little lower than expected it was deemed that it was unlikely that this was due to issues with all the individual measurement systems. The most likely cause was due to a lower number of GPS satellites being overhead in the sky above Longcross at the time of testing.

However, some machines are very close, for example machine 24 achieved 89% at 2m and 100% at 4m and 20m, meaning the device missed a high performance by only 1% (at the 2m level). Machines 17 and 24 performed to a similar standard but were 2% short. Therefore, these devices could also be considered to have a 'high' level of performance in relative terms. Using this understanding of the results some of the other devices, that classified as performing 'low' on the test track (as a result of the 2m results only), could also be considered to be performing slightly higher and perhaps deemed 'medium'.

For the measurement of altitude most devices achieved either a medium or a high level of performance. However, Machine 16 was deemed 'unsuitable' and this was because all of the data was offset by approximately 50m above the reference.

7 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 3
- Machine 13
- Machine 16
- Machine 17
- Machine 19
- Machine 22
- Machine 23
- Machine 24
- Machine 25
- Machine 26
- Machine 28
- Machine 29
- Machine 31
- Machine 34

The following machines provided BCD files:

- Machine 1
- Machine 3 (operated by different contractor for trial)
- Machine 13
- Machine 16
- Machine 17
- Machine 19
- Machine 22
- Machine 23
- Machine 24
- Machine 25
- Machine 26
- Machine 28
- Machine 29
- Machine 31
- Machine 34

Examination of the supplied RCD and BCD found that the data formatting was in general suitable. Machine 3 was operated by a different contractor for the trial, and the normal operator would not produce BCD files. As such the certificate for this machine is recorded as "not assessed" against the BCD file format.

8 Feedback following trials

TRL operates a process of continuous improvement for the trials seeking feedback and observations from the attendees and from staff conducting the work. As previously noted (see section 1) the trial procedure for the 2021 accreditation differed from previous years due to changes implemented to account for COVID risks while still suitably assessing the survey vehicles. This modified trial process was discussed, developed and agreed with the survey contractors via video conference prior to the trial.

After completion of the trial TRL received a complaint from one of the survey contractors with regards to the undertaking of the trial. The main points raised were:

- The start of the trial at Longcross on Monday was poorly organised and started late.
- There were no toilets available to the crews on the Straight-Line Wet Grip (SLWG) on Tuesday until 13:30 and when they did arrive, no hand sanitiser was available in them. In addition, the agreed 'clock system' was not implemented (method of marking when the toilet was last used to allow gaps between use).
- There appeared to be different levels of health and safety engagement between the different survey contractors. For example, the survey contractor raising the issue use reversing assistants as standard where other companies may not. It was also observed that another contractor's operator was walking behind one of their reversing vehicles whilst they were on the phone.

Although changes to the processes needed to be made at short notice, the situation described above is extremely disappointing and not acceptable. TRL take such issues very seriously and a detailed investigation was undertaken to identify how this can be avoided in future. A summary of the findings are given below.

8.1 Longcross

Although testing at Longcross for OSGR co-ordinates has been standard for a number of years, the trials of 2021 were the first in which all vehicles were required to test this site. In addition, this year the testing included assessment of the speed measurement (which previously was undertaken at MIRA).

On the day there was a breakdown in communication regarding getting to Longcross and TRL staff arrived at the track later than anticipated. Some of the TRL accreditation staff on site were also insufficiently briefed and this compounded the situation. Therefore, testing started later than expected. In addition, some survey crews arrived earlier than requested causing an apparent increase in waiting times. However, despite these issues the testing finished at 13:00 as estimated in the instructions.

We have updated our study plans for this work to ensure staff are on site earlier and we recommend that the Auditor for the next trial reviews and updates the timetables for testing in the instructions. In addition, the Auditor should ensure that all staff on site are fully briefed and not just the key staff.

8.2 Toilets on the Straight Line Wet Grip

The original order for the toilets was placed with the supplier on 16th February 2021. This was for 8 toilets due to arrive at MIRA on Monday (the day before testing). As agreed in the meeting with the survey contractors on the 8th April, the number of toilets was increased to 12. The toilet supplier was unable to supply 12 toilets on Monday; however they could supply the extra for Tuesday and it was agreed that all 12 would be delivered to MIRA at 08.00am on Tuesday 20th April.

When the toilets did not arrive, the suppliers were contacted and stated that the delivery had been slightly delayed but would arrive shortly. Unfortunately, this was not the case and they arrived later meaning that toilets were not available on the Straight Line Wet Grip (SLWG) part of the track until after 13.00.

Furthermore, the toilets were supplied without hand sanitiser as per the agreed order. Given the rush and problems encountered with delivery the 'clock system' was overlooked and not implemented as agreed.

Although from time to time things will not go to plan (i.e. in this case toilets do not arrive) it is recommended that Auditor ensures that there are adequate contingency plans to account for these situations. These contingencies should be known to all Trial Marshals and communicated to the survey contractors as appropriate.

8.3 General Health and Safety

It has been observed that there is a variable approach toward general health and safety across the survey industry. Health and safety is taken very seriously in preparation for and at the trials. It is therefore recommended that the Auditor ensures that Health and Safety section of the site briefings highlights the required level of conduct for the day and all participants will be required to agree to this. This conduct should be agreed with staff qualified in HSE assessment and with the survey contractors before the trial. Any staff breaking these rules may be escorted from the site and unable to take part in the remainder of the trial.

9 Conclusions

The 2021 sideway-force skid resistance accreditation trials were held during the week commencing 19th April 2021. The trials were held on and around the MIRA proving ground and at the Longcross test track. The format of the trials was adapted this year due to COIVID-19 restrictions. Sixteen machines attended.

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

(i) General condition

No machines were identified as having any issues with their general condition during the trial.

(ii) Skid resistance measurement

All sixteen machines met the criteria for the measurement of skid resistance at the trial.

(iii) Vehicle Speed attainment and recording

All sixteen machines met the criteria for vehicle speed attainment and recording.

(iv) Distance measurement

All sixteen machines met the criteria with regards to the measurement of distance.

(v) Left test wheel weight

All sixteen machines met the current ±8 kg tolerance for test wheel weight.

(vi) Water flow

All sixteen 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

Fourteen machines fitted with 3 dimensional spatial coordinate systems were assessed for the measurement of OSGRs. Two machines achieved a high performance, four a medium, seven a low and one was identified as not suitable.

During the assessment of the OSGR performance it was seen that the fleet performed less well against the 2m criteria. However, it was deemed that this may be due to conditions experienced on the day rather than systematic errors across the fleet. Most devices showed a good or very good performance for the percentage of data within 3m and above.

(viii) Measurement of Altitude

Fourteen machines fitted with 3 dimensional spatial coordinate systems were assessed for the measurement of altitude. Five machines achieved a high

performance, eight four a medium performance and one was identified as not suitable.

(ix) File formats

All sixteen machines supplied suitable .s10 and .loc files. Fifteen machines provided suitable RCD files and fourteen machines provided suitable BCD files. One of the machines that provided BCD files was operated by a different company for the trial and as such has been recorded as “not assessed” for the BCD file on their certificate.

A summary of the machines that attended the 2021 accreditation trial and the criteria that they met can be found in Appendix A.

After completion of the trial TRL received a complaint form one of the survey contractors with regards to the undertaking of the trial. This complaint was reviewed, and the following recommendations are made to the Auditor of the next trial:

- Review and update timetables for testing in the instructions. Ensure fully briefed Trial Marshals are on site before the expected times for participants and the site is ready for testing.
- Develop and maintain contingency plans for occasions where things do not go to plan. Ensure that the contingencies are known to all Trial Marshals and are communicated to survey contractors as appropriate.
- Ensure that Health and Safety section of the site briefings highlights the required level of conduct for the day and all participants will be required to agree to this. This conduct should be agreed with staff qualified in HSE assessment and with the survey contractors before the trial. Any staff breaking these rules may be escorted from the site and unable to take part in the remainder of the trial.

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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	Low	Medium	Satisfactory	Satisfactory	Satisfactory
3	DRDNI	IKZ 2203	Pass	Pass	Pass	Pass	Low	Medium	Satisfactory	Satisfactory	-
13	WDM Ltd	S700 WDM	Pass	Pass	Pass	Pass	Low	High	Satisfactory	Satisfactory	Satisfactory
16	Saber	S66 HSL	Pass	Pass	Pass	Pass	Not Suitable	Not Suitable	Satisfactory	Satisfactory	Satisfactory
17	WDM Ltd	S800 WDM	Pass	Pass	Pass	Pass	Medium	Medium	Satisfactory	Satisfactory	Satisfactory
19	WDM Ltd	S900 WDM	Pass	Pass	Pass	Pass	Low	High	Satisfactory	Satisfactory	Satisfactory
21	Surrey CC	KX07YXH	Pass	Pass	Pass	Pass	-	-	Satisfactory	-	-
22	PTS Ltd	KX07YVH	Pass	Pass	Pass	Pass	Medium	Medium	Satisfactory	Satisfactory	Satisfactory
23	WDM Ltd	S11 WDM	Pass	Pass	Pass	Pass	Low	High	Satisfactory	Satisfactory	Satisfactory
24	WDM Ltd	S12 WDM	Pass	Pass	Pass	Pass	Medium	Medium	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	Medium	Medium	Satisfactory	Satisfactory	Satisfactory
28	Operated by TRL on behalf of Highways England	WX60 AXN	Pass	Pass	Pass	Pass	TBC	TBC	Satisfactory	Satisfactory	Satisfactory
29	PTS Ltd	YD02 XSN	Pass	Pass	Pass	Pass	Low	Medium	Satisfactory	Satisfactory	Satisfactory
31	WDM Ltd	S16 WDM	Pass	Pass	Pass	Pass	High	High	Satisfactory	Satisfactory	Satisfactory
34	WDM Ltd	WDM SM1	Pass	Pass	Pass	Pass	Low	Medium	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 appendix D.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. Note: averages are calculated by taking the square root of the average variance (i.e. standard deviation squared).

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

ID	Between run SD				
	SWG01	SWG02	SWG03	SWG04	Avg
1	.	.	.	.	.
3	0.64	0.65	1.52	2.01	1.27
13	2.18	1.47	1.16	3.07	2.11
16	1.83	2.56	1.69	2.86	2.23
17	1.55	1.10	2.96	0.95	1.79
19	2.71	1.10	1.90	5.55	3.20
21	2.09	1.60	1.41	4.07	2.47
22	1.54	2.10	2.24	4.09	2.54
23	1.12	2.22	2.20	2.49	1.97
24	0.50	1.63	1.74	3.30	1.91
25	2.48	1.37	1.82	1.94	2.03
26	1.59	0.96	1.30	2.28	1.61
28	2.19	1.76	2.48	4.16	2.72
29	2.50	0.56	2.08	3.07	2.29
31	1.85	2.22	1.73	1.88	1.92
34	2.68	0.94	2.08	4.54	2.85
Avg	1.95	1.59	1.94	3.30	2.25

Table B.2: Machine repeatability for the Network route

ID	Between run SD														
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	Avg
1	1.99	0.32	1.28	1.53	1.43	1.44	1.81	0.85	1.05	0.50	0.28	0.77	1.01	0.33	1.32
3	1.68	1.59	2.14	0.79	1.89	1.93	1.22	0.22	0.79	1.70	0.78	1.98	0.91	0.93	1.51
13	1.14	2.57	2.67	1.89	1.22	3.15	4.01	2.53	1.69	2.55	2.11	2.67	3.04	2.57	2.49
16	1.68	1.25	0.31	2.97	3.16	2.43	0.79	2.21	4.34	0.66	2.41	2.83	0.54	1.77	2.32
17	2.43	0.46	1.94	0.71	1.09	0.59	2.16	1.49	0.77	0.68	0.37	0.74	0.80	0.54	1.41
19	0.42	4.07	3.96	3.40	1.56	0.23	1.93	1.73	0.91	0.86	0.59	1.66	0.62	0.35	2.34
21	1.98	2.25	3.30	1.46	1.22	1.13	1.94	1.52	2.89	1.96	1.80	1.42	1.61	1.01	2.07
22	0.13	1.63	0.87	1.35	0.97	2.16	0.67	1.84	2.32	1.37	1.26	0.96	1.53	1.24	1.48
23	0.97	1.01	2.05	1.39	1.65	0.92	1.18	0.79	2.43	0.94	0.54	1.02	2.60	0.65	1.43
24	1.08	3.08	2.87	2.86	1.97	3.02	1.46	0.89	0.86	2.26	1.24	1.83	1.92	1.20	2.21
25	1.06	1.77	5.15	0.76	1.84	1.54	0.38	1.45	1.42	0.99	1.00	2.57	1.51	0.77	2.06
26	2.17	2.27	3.74	1.51	3.10	2.62	2.38	2.54	4.70	1.98	2.12	2.45	0.82	2.80	2.84
28	0.42	0.99	0.99	0.60	0.61	1.71	0.13	0.68	5.44	1.24	0.80	2.11	0.67	1.58	1.94
39	1.92	2.59	1.62	2.09	1.83	3.31	4.40	2.60	2.28	1.73	2.22	3.76	2.18	1.15	2.57
31	4.60	4.56	2.58	2.86	3.39	3.17	2.57	5.13	3.88	2.98	2.25	4.54	3.99	4.47	3.68
34	0.92	1.66	2.83	1.07	2.26	1.00	2.48	0.88	0.86	0.31	0.48	1.05	2.02	2.21	1.63
Avg	2.18	3.45	2.69	1.91	1.99	2.12	2.17	2.05	2.74	1.61	1.47	2.28	1.87	1.81	2.35

Table B.3: Machine repeatability for the 2nd set of tests on the Straight Line Wet Grip

ID	Between run SD				
	SWG01	SWG02	SWG03	SWG04	Avg
1	1.52	0.70	1.71	3.01	1.87
3	1.19	1.27	1.80	1.70	1.47
13	2.40	1.39	2.23	2.32	2.16
16	1.71	1.52	0.76	2.89	1.86
17	0.88	1.57	4.08	3.61	2.68
19	1.78	1.11	2.79	3.78	2.48
21	1.51	1.61	2.88	2.19	2.04
22	2.88	1.81	3.36	3.18	2.87
23	0.95	1.43	2.27	1.81	1.60
24	1.02	0.92	1.79	1.41	1.29
25	1.20	1.50	2.73	2.54	1.99
26	0.81	1.78	1.94	1.26	1.44
28	3.99	1.57	2.77	2.05	2.96
29	1.03	2.05	3.50	4.09	2.74
31	2.26	2.82	2.59	2.58	2.53
34	1.70	1.11	4.72	4.47	3.22
Avg	1.87	1.58	2.79	2.84	2.27

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	96%	100%	100%	100%	100%	100%	100%	High
3	100%	100%	100%	100%	100%	100%	100%	High
13	99%	100%	100%	100%	100%	100%	100%	High
16	86%	100%	100%	100%	100%	100%	100%	High
17	99%	100%	100%	100%	100%	100%	100%	High
19	100%	100%	100%	100%	100%	100%	100%	High
21	-	-	-	-	-	-	-	-
22	97%	100%	100%	100%	100%	100%	100%	High
23	99%	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	-	-	-	-	-	-	-	-
29	95%	100%	100%	100%	100%	100%	100%	High
31	98%	100%	100%	100%	100%	100%	100%	High
34	98%	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	3m	4m	5m	7m	8m	20m	25m	
1	89%	100%	100%	100%	100%	100%	100%	100%	Medium
3	65%	93%	100%	100%	100%	100%	100%	100%	Low
13	91%	100%	100%	100%	100%	100%	100%	100%	High
16	59%	75%	86%	97%	99%	100%	100%	100%	Low
17	94%	99%	100%	100%	100%	100%	100%	100%	High
19	93%	99%	99%	99%	100%	100%	100%	100%	High
21	-	-	-	-	-	-	-	-	.
22	95%	100%	100%	100%	100%	100%	100%	100%	High
23	96%	99%	100%	100%	100%	100%	100%	100%	High
24	91%	99%	100%	100%	100%	100%	100%	100%	High
25	94%	99%	100%	100%	100%	100%	100%	100%	High
26	96%	100%	100%	100%	100%	100%	100%	100%	High
28	-	-	-	-	-	-	-	-	-
29	65%	80%	100%	100%	100%	100%	100%	100%	Low
31	96%	99%	100%	100%	100%	100%	100%	100%	High
34	63%	84%	95%	99%	100%	100%	100%	100%	Low

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	3m	4m	5m	7m	8m	20m	25m		
1	50%	95%	100%	100%	100%	100%	100%	100%	Automatic	Low
3	29%	78%	95%	97%	100%	100%	100%	100%	Push	High
13	69%	93%	99%	100%	100%	100%	100%	100%	Automatic	Low
16	26%	33%	55%	75%	99%	100%	100%	100%	Automatic	Not Suitable
17	88%	99%	100%	100%	100%	100%	100%	100%	Automatic	Medium
19	75%	97%	99%	99%	100%	100%	100%	100%	Automatic	Low
21	-	-	-	-	-	-	-	-	-	-
22	24%	55%	67%	83%	93%	95%	100%	100%	Push	Medium
23	62%	94%	99%	100%	100%	100%	100%	100%	Automatic	Low
24	89%	99%	100%	100%	100%	100%	100%	100%	Automatic	Medium
25	90%	98%	99%	100%	100%	100%	100%	100%	Automatic	High
26	88%	99%	100%	100%	100%	100%	100%	100%	Automatic	Medium
28	-	-	-	-	-	-	-	-	-	-
29	42%	65%	98%	100%	100%	100%	100%	100%	Automatic	Low
31	90%	99%	100%	100%	100%	100%	100%	100%	Automatic	High
34	6%	36%	84%	97%	99%	100%	100%	100%	Automatic	Low

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	81%	98%	100%	100%	100%	Medium
3	78%	100%	100%	100%	100%	Medium
13	97%	100%	100%	100%	100%	High
16	0%	0%	0%	0%	0%	Not Suitable
17	85%	100%	100%	100%	100%	Medium
19	98%	100%	100%	100%	100%	High
21	-	-	-	-	-	-
22	40%	99%	100%	100%	100%	Medium
23	98%	100%	100%	100%	100%	High
24	95%	100%	100%	100%	100%	High
25	94%	100%	100%	100%	100%	High
26	96%	100%	100%	100%	100%	High
28	-	-	-	-	-	-
29	85%	100%	100%	100%	100%	Medium
31	96%	100%	100%	100%	100%	High
34	83%	100%	100%	100%	100%	Medium

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

ID	10m data points on test track: % within						Performance level
	2m		4m	5m	6m	20m	
1	53%	94%	100%	100%	100%	100%	Medium
3	98%	100%	100%	100%	100%	100%	High
13	100%	100%	100%	100%	100%	100%	High
16	0%	0%	0%	0%	0%	0%	Not Suitable
17	96%	100%	100%	100%	100%	100%	High
19	100%	100%	100%	100%	100%	100%	High
21	-	-	-	-	-	-	-
22	100%	100%	100%	100%	100%	100%	High
23	95%	98%	100%	100%	100%	100%	High
24	85%	92%	99%	100%	100%	100%	Medium
25	95%	100%	100%	100%	100%	100%	High
26	87%	100%	100%	100%	100%	100%	Medium
28	-	-	-	-	-	-	-
29	57%	99%	100%	100%	100%	100%	Medium
31	100%	100%	100%	100%	100%	100%	High
34	74%	89%	91%	99%	100%	100%	Medium

Appendix D Assessment criteria

The accreditation trial criteria are specified in "Accreditation and Quality Assurance of Sideways Force Skid Resistance Survey Devices" (TRL, 2020). This document is a live document (i.e. is subject to change) and the February 2020 version of the document was used for the 2020 Accreditation process. The relevant section of the document is reproduced verbatim below (section D.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.

D.1 Trial criteria from the Accreditation and QA document

E.3 Equipment inspection

E3.1 Equipment shall be inspected to ensure that they are in a suitable condition to conduct the tests. Contractors should be provided with an inspection check sheet to complete and provide to the Auditor in advance of the Trial.

E3.2 Inspections shall include:

- Water flow System (including verification of flow rate, nozzle alignment and general condition).
- Verification of the test wheel weight.
- Verifying that the Equipment is in good general mechanical order.

E3.3 During the trial the Auditor should confirm that the Contractors have undertaken the following calibrations:

- Vertical load System
- Horizontal load System

E.4 Running Trials

E4.1 Overview

E4.1.1 As detailed in Appendix B, trials shall 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 shall 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 is collected at the target test speed.

E4.2.4 The Contractor shall 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 shall 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 shall 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 shall 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 shall 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 shall be regarded as unacceptable.

E4.2.7 The Trial BESD shall be acceptable if it is below the criterion given in Table 1. If the Trial BESD exceeds this criterion then the data shall be further examined to identify outlying Equipment. This should include examining the fleet BESD and data from individual Equipment. Outlying Equipment shall 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 shall be rejected. Any Equipment that is between two and three times the BESD criterion from the all-Equipment mean shall 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 shall 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

E4.2.10 The Auditor should also review the vertical load Parameter in the data collected at the trial with the aim to identify anomalies and to develop tests for this Parameter to be included in future specifications. If the Auditor identifies anomalies in this data, this may lead to additional testing of Equipment, Accreditation for Equipment being withheld and/or issuing of Improvement Notices (see Section H).

E4.2.11 In addition to the above assessments the Auditor should review the profiles of the Survey Data over the site for each Equipment and investigate any anomalies. Based on the results of the investigation the Auditor may withhold Accreditation for Equipment and/or issue an Improvement Notice as detailed in Section H.

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 independent measure compared with the required target survey speed.

E4.3.2 The test shall 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

E4.4 Location Referencing – Distance Criteria

E4.4.1 The Accreditation of distance measurement shall be carried out using at least 6 measurements of distance made using the Equipment.

E4.4.2 There are three mechanisms for recording location referencing points in the survey data:

- Push button entry relies on the survey operator pushing a button to enter the location of the point manually.
- Automatic marker 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.

E4.4.3 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 the push button and automatic markers 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)
Distance measured	≥80% within 5m	≥80% within 2m

E4.4.4 If the Survey Contractor will be supplying data to a Customer with OSGR fitted location reference points then the original survey data for these Equipment (i.e. not OSGR fitted) shall be assessed on the automatic markers criteria (regardless of the marker entry method used during the survey).

E4.5 Test wheel weight

E4.5.1 The Accreditation of test wheel weight shall 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 shall 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).

E4.5.2 For this assessment the test wheel shall be raised/lowered and the "un-bounced" measurement taken. The System shall then be bounced and the "bounced" measurement taken. This process shall be repeated until at least 3 sets of measurements have been taken. The Auditor should review the differences between the bounced and un-bounced values and the ranges for the three sets of measurements. The "bounced" measurements made shall 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

E4.6 Water flow

E4.6.1 The water delivery system shall 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 is required to 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 shall be determined (through consultation between the Auditor and the Developer). Each Equipment shall 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 both 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 may be 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 E4.4.2 there are three mechanisms for recording the location of location referencing points. The differences in these approaches result in different criteria for OSGR assessment. However, it is noted that automatic marker detection is normally not possible on a network route test and as such no automatic marker criteria are given for the network route.

E5.2.2 OSGR Systems shall be assessed using both the OSGR fitted criteria and the marker entry criteria (Push or Automatic) matching the method used during the survey. The criteria applied shall be noted on the Accreditation certificate. If the Survey Contractor does not supply OSGR fitted data, then the data will be fitted by the Auditor and noted as such on the Accreditation Certificate.

E5.2.3 OSGR data collected from the closed test sections shall 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
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

E5.2.4 OSGR data collected from a live traffic route shall 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
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

E5.2.5 The OSGR performance recorded on the Accreditation Certificate shall correspond to the lowest performance of all of the test sites used and the criteria applied, unless it is identified that some data should be disregarded. If any data is disregarded then this should be recorded on the Accreditation Certificate along with the reasons.

E5.3 Location Referencing – Altitude data

E5.3.1 Altitude data collected shall 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 shall be asked to deliver accreditation data files in the required format.

Highways England 2021 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 2021 trial run by TRL and held in the week beginning the 19th April.

Other titles from this subject area

PPR975	Highways England 2020 national accreditation verification for sideway-force skid resistance devices. S Brittain. 2022
PPR1020	Highways Agency 2019 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2022
PPR935	Highways Agency 2018 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020
PPR936	Highways England 2017 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020

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