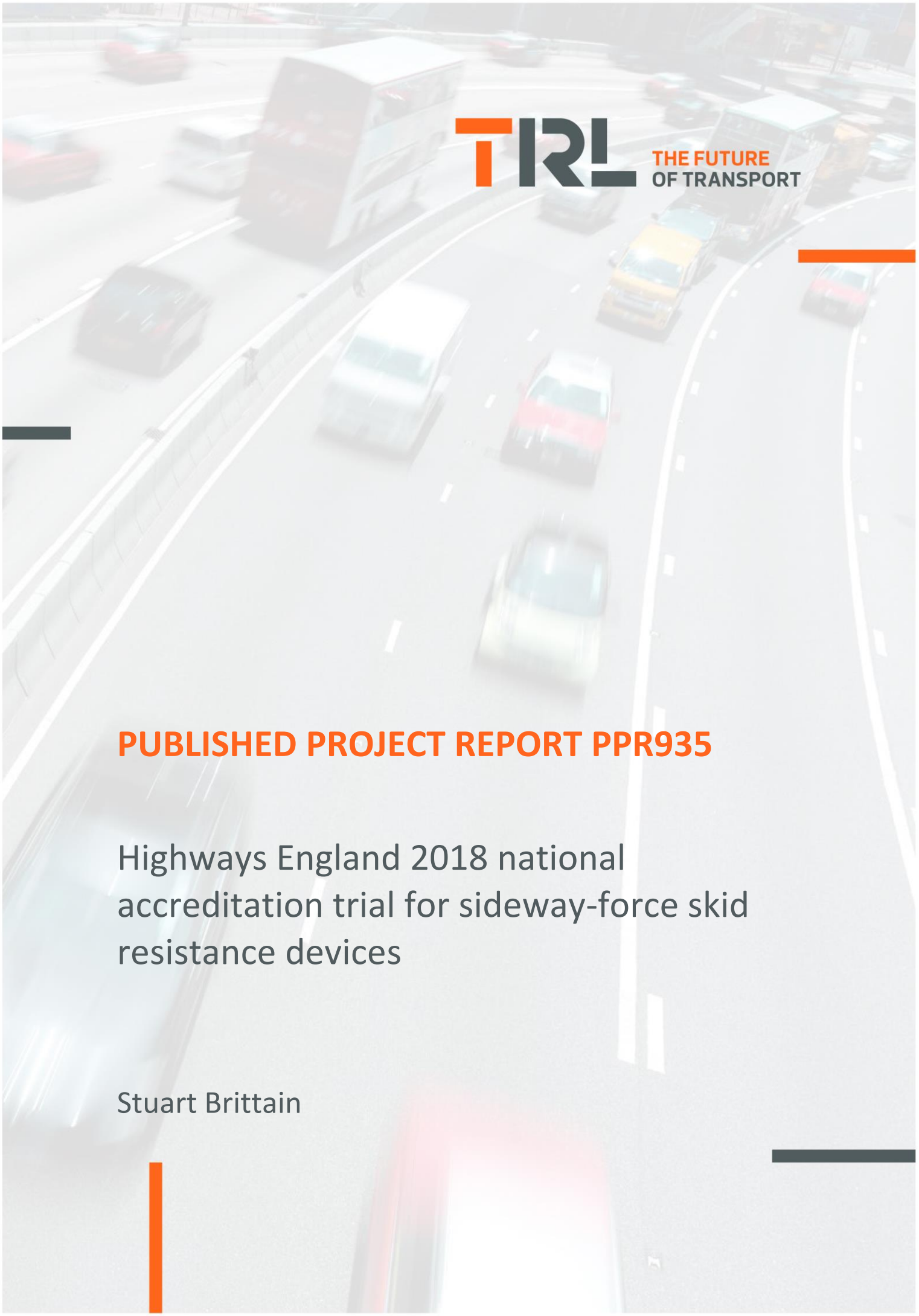

THE FUTURE OF TRANSPORT

PUBLISHED PROJECT REPORT PPR935

# Highways England 2018 national accreditation trial for sideway-force skid resistance devices

Stuart Brittain

## Report details

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## Disclaimer



## Contents amendment record

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# Executive Summary

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

The 2018 accreditation trial was held during the week beginning 9th April 2018. 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, 2016). Seventeen machines from the UK fleet attended, including two machines from the Republic of Ireland that sometimes carry out surveys in the UK.

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

- All seventeen machines met the criteria for the skid resistance measurements.
- All seventeen machines met the criteria for vehicle speed.
- All seventeen machines met the criteria for distance measurement.
- All seventeen machines were within the current tolerance for test wheel weight.
- All seventeen machines provided satisfactory water flow and direction.

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

- Fourteen machines were assessed for measurement of OSGRs. Twelve machines achieved a high performance and two machines a medium performance.
- Fourteen machines were assessed for measurement of Altitude. Eight machines achieved a high performance and six machines a medium performance.

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 2018 accreditation trial for sideway-force coefficient routine investigation machines was held on the HORIBA-MIRA proving ground (referred to as MIRA in the rest of this report) and the Longcross test track, on behalf of Highways England.

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

TRL has been responsible for planning and running the trials since 1995 and the 2018 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, 2016).

The trial comprised six general stages:

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

owners. Depending upon the issues that need to be addressed, these may include a repeat accreditation trial.

The 2018 main trials were held during the week beginning 9th April 2018 and seventeen 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 and are therefore included as part of the UK fleet.

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 2018.

# 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 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 the following 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

During the inspection day a new check on the test wheel angle was trialled, with the aim of including it as part of the checks/assessments in future accreditation trials.

## 2.3 Main running trial days – MIRA

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

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

All machines are operated with the dynamic vertical load measurement system turned on, which is 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 and network route

The 3 dimensional positional systems are assessed on the network route (near MIRA) and on the Longcross test track. This assessment determines whether 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 also used for the machines which are undergoing the 3 dimensional positional systems assessment.

## 3.1 Twin straights

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

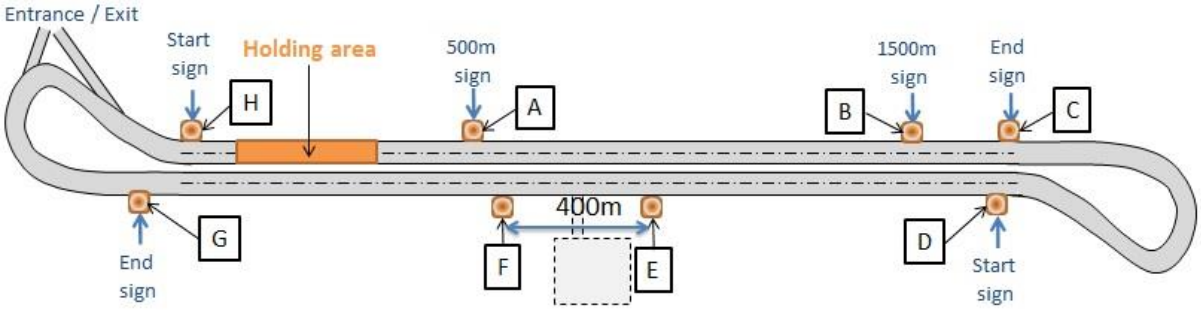


**Figure 3.1 Overview of Twin Straights and position of marker points**

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.

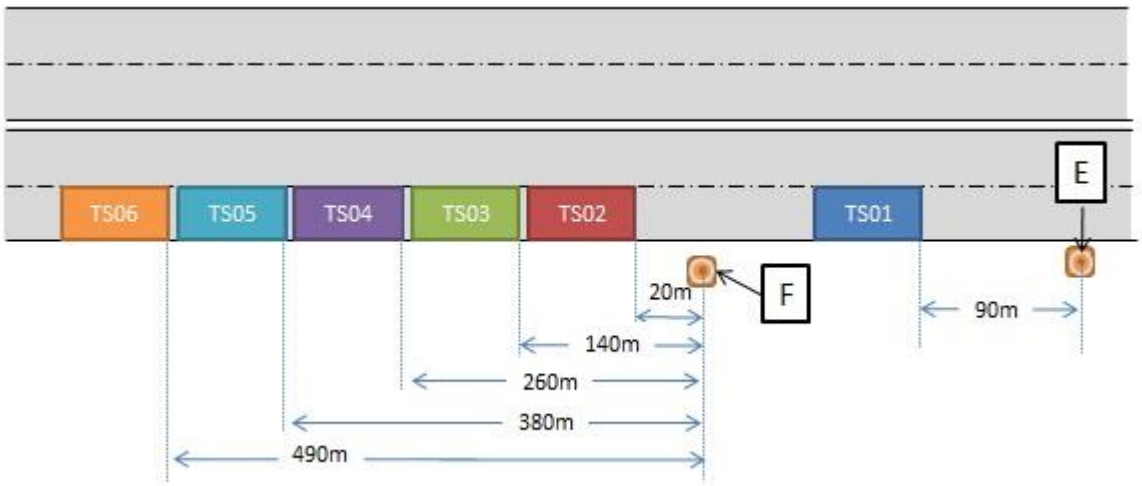


**Figure 3.2 Skid resistance test sections on Twin Straights**

**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

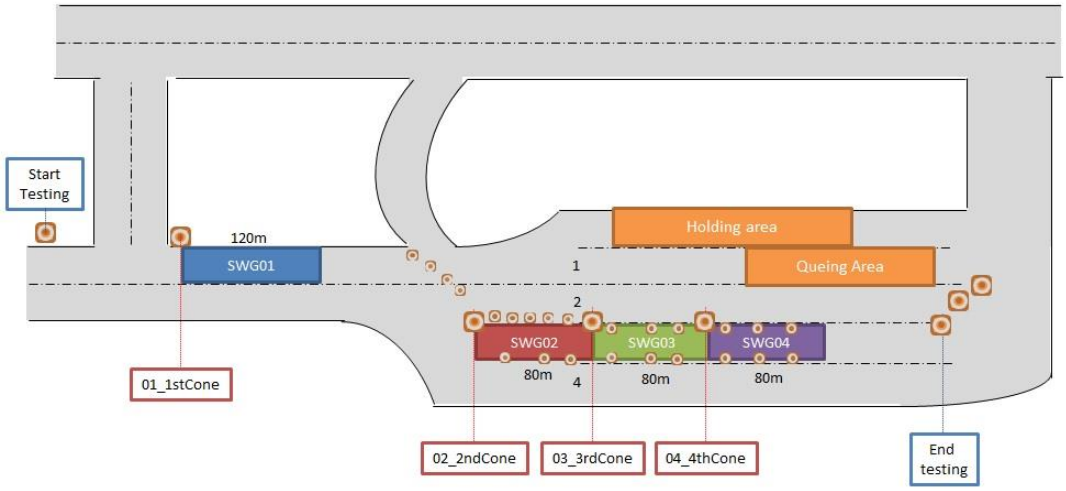


**Figure 3.3 Skid resistance test sections on the Straight Line Wet Grip area**

**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 |

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

## 3.3 Network route to Sheepy Magna

A network route 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.

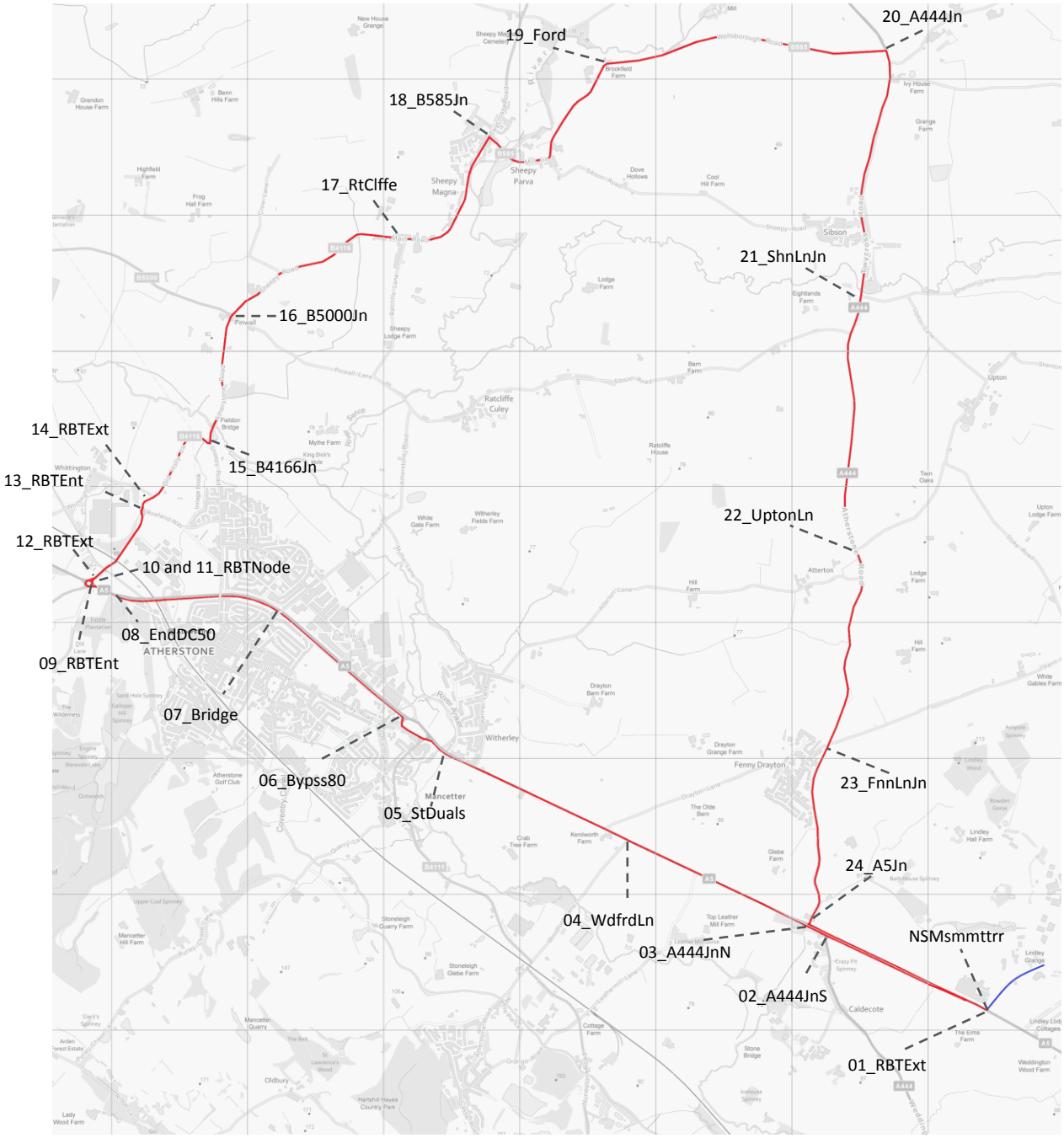


**Figure 3.4 Network route to Sheepy Magna**

## Table 3.3 Details of network route, including marker positions

| 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 Sheppy Magana |
| 12.90 | 1333 | **18_B585Jn** | At exit of T-Junction | Turn right on to B585 (Mill Lane) towards Market Bosworth. |
| 14.24 | 2108 | **19_Ford** | Centre of junction with sign post for ford. | Continue on B585 |
| 16.34 | 1847 | **20_A444Jn** | At junction with A444 | Turn right onto A444 towards Nuneaton. |
| 18.19 | 1910 | **21_ShnLnJn** | At Junction with Shenton Lane (signposted Upper Shenton) | Continue on A444 |
| 20.10 | 1476 | **22_UptonLn** | At junction with Upton Lane (on left, is sign posted for Upton) | Continue on A444 |
| 21.58 | 1385 | **23_FnnLnJn** | At junction with Fenn Lanes (on left, is sign posted for Bosworth Battlefield) | Continue on A444 |
| 22.96 | n/a | **24_A5Jn** | Centre of A444/A5 Junction | Turn left on to A5 towards Hinkley. Continue along the A5. On dual carriageway in Lane 1 This marks the end of the route. |

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

## 3.4 Longcross test track

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

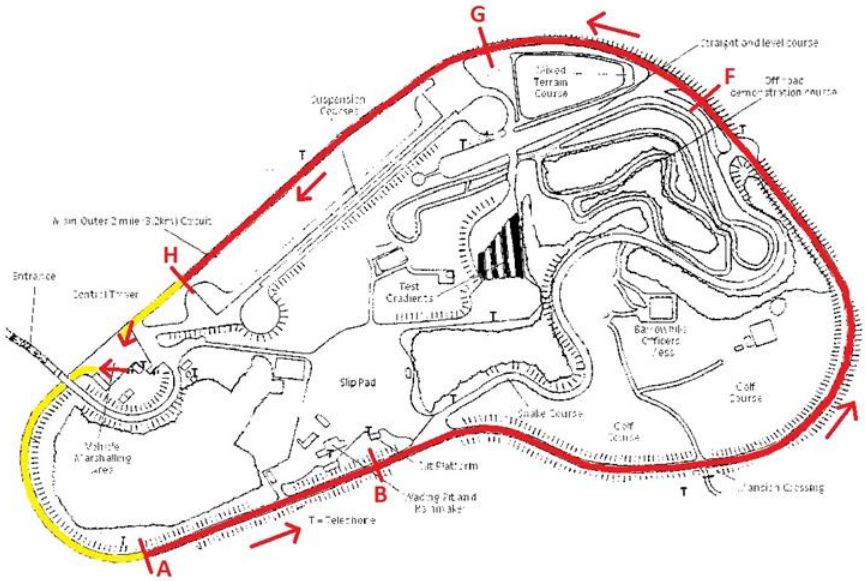


**Figure 3.5 Longcross test track site map**

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

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

# 4 Assessment criteria

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

## 4.1 Trial criteria from the Accreditation and QA document

### E.3 Equipment inspection

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

E3.2 Inspections will include:

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

### E.4 Running Trials

#### E4.1 Overview

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

#### E4.2 Skid resistance testing – Mandatory Requirement

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

E4.2.2 Some Equipment may have skid resistance measurement Systems fitted to both the nearside and offside of the Equipment. If fitted then these systems should be assessed independently and given independent Accreditation results. This requires that suitable reference data is collected for both wheel paths or that the Equipment

test on offset driving lines so that the test wheel traffics the same part of the test surface. The Auditor may specify that only one side of the Equipment will be assessed.

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

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

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

E4.2.5 The Auditor will calculate:

- The mean values for the Equipment for each 100m length test section or the length of the test section if shorter (averaging together the repeat measurements).
- The standard deviation of these mean values for the Fleet and for all of the Equipment at the trial, referred to as the Fleet between-Equipment standard deviation (BESD) and the Trial BESD. These values will be used to assess the consistency of the Equipment at the Trial.
- The standard deviation of the skid resistance values between runs for the Equipment for 100m lengths (or the length of the test section if shorter). This data is referred to as the between-run standard deviation (BRSD). These values will be used to assess the repeatability of each individual Equipment.

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

E4.2.7 The Trial BESD is acceptable if it is below the criterion given in Table 1. If the Trial BESD exceeds this criterion then the data will be further examined to identify outlying Equipment. This will include examining the fleet BESD and data from individual Equipment. Outlying Equipment will be rejected and the data reassessed until the performance is acceptable.

E4.2.8 In addition, any Equipment that deviates by more than 3 times the BESD criterion from the Fleet mean will be rejected. Any Equipment that is between two and three times the BESD criterion from the all-Equipment mean will be subject to further investigation.

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

**Table 1 – Acceptance Criteria for Skid resistance measurements**

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

## E4.3 Vehicle Speed – Mandatory Requirement

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

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

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

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

**Table 2 – Acceptance Criteria for Vehicle Speed Measurement**

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

## E4.1 Location Referencing – Distance Criteria

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

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

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

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

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

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

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

## E4.2 Test wheel weight

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

**Table 4 – Criteria for test wheel weight**

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

## E4.3 Water flow

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

**Table 5 – Criteria for water flow rate**

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

## E.5 Additional Tests

### E5.1 Overview

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

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

### E5.2 Location Referencing – OSGR data

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

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

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

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

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

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

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

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

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

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

### E5.3 Location Referencing – Altitude data

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

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

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

## E.6 Checking of file formats

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

# 5 Machine inspections

## 5.1 Water flow rate checks

After minor adjustments to some machines, it was deemed that all machines had satisfactory water flow 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 Acceptance Criteria for test wheel weight**

| Machine | Average static wheel weight | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | "Un-bounced" | | | | "Bounced" | | | |
| | Check 1 | Check 2 | Check 3 | Mean | Check 1 | Check 2 | Check 3 | Mean |
| 1 | 201.5 | 201.5 | 202.0 | 201.7 | 201.5 | 201.5 | 201.5 | 201.5 |
| 3 | 194.5 | 194.5 | 194.5 | 194.5 | 200.5 | 200.0 | 200.0 | 200.2 |
| 13 | 197.0 | 198.0 | 198.0 | 197.7 | 200.5 | 200.5 | 200.5 | 200.5 |
| 14 | 205.5 | 205.5 | 205.5 | 205.5 | 207.0 | 207.0 | 206.5 | 206.8 |
| 16 | 203.0 | 203.0 | 203.5 | 203.2 | 204.5 | 204.0 | 204.5 | 204.3 |
| 17 | 199.0 | 199.0 | 199.0 | 199.0 | 201.0 | 201.0 | 200.5 | 200.8 |
| 19 | 195.5 | 196.0 | 195.5 | 195.7 | 200.0 | 201.5 | 202.0 | 201.2 |
| 21 | 197.0 | 197.5 | 197.5 | 197.3 | 199.5 | 199.5 | 200.0 | 199.7 |
| 22 | 198.5 | 199.0 | 199.0 | 198.8 | 200.0 | 201.0 | 200.5 | 200.5 |
| 23 | 195.5 | 196.0 | 195.5 | 195.7 | 200.0 | 200.0 | 200.0 | 200.0 |
| 24 | 196.0 | 196.0 | 196.0 | 196.0 | 200.0 | 200.0 | 200.0 | 200.0 |
| 25 | 194.0 | 194.5 | 194.5 | 194.3 | 200.0 | 199.0 | 199.0 | 199.3 |
| 26 | 194.5 | 194.5 | 194.5 | 194.5 | 199.0 | 199.0 | 199.0 | 199.0 |
| 28 | 194.5 | 194.5 | 194.5 | 194.5 | 200.0 | 200.0 | 200.0 | 200.0 |
| 29 | 206.5 | 206.5 | 206.5 | 206.5 | 207.0 | 206.5 | 207.0 | 206.8 |
| 31 | 195.5 | 194.0 | 193.0 | 194.2 | 201.0 | 200.0 | 199.5 | 200.2 |
| 33 | 204.0 | 203.5 | 204.0 | 203.8 | 205.0 | 204.5 | 204.5 | 204.7 |

It can be seen in Table 5.1 that all of the "bounced" mean weights of the machines fell within the tolerances given in section 4.1. There is a noticeable difference in the bounced and un-bounced wheel weight values for some of the machines (e.g. Machine 3 and 31). 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 (DD) document that can be used voluntarily over a period so that experience can be gained before being accepted and introduced (if appropriate) as a full EN (European Norme). This is one of a series of documents for skid resistance measurement devices intended to encourage consistent standards in the use of similar machines in different European countries. It is envisaged that the requirements in this document will eventually supersede those in the current British Standard (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, six machines would have been outside the ±1 kg tolerance. This is a noticeable improvement over previous trials. 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.

The crews were also asked to conduct a horizontal calibration during the inspection day before conducting the network route tests. These were also completed successfully.

## 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 recorded the time in seconds to 2 decimal places.

There were some initial problems with setting up the timing gates and runs 2 and 3 for Machines 1-21 were measured using a pair of synchronised stopwatches.

The differences between the survey data and the independent measure are shown in Table 5.2. The differences between the independent measure and the target speed are shown in Table 5.3. Instances where the value exceeds the criteria levels in section 4.1 are highlighted in bold red text. It was not possible to record valid independent data on all runs, therefore some data are missing from the tables.

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

| ID | Speed recorded in data – independent measure of speed | | | | | | | | | | % within criteria |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Target speed 50km/h | | | | | Target speed 80km/h | | | | | |
| | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | |
| 1 | . | ***1.03*** | *-0.75* | -0.58 | -0.29 | -0.83 | 0.50 | -0.61 | -0.65 | -0.50 | 89% |
| 3 | . | *-0.16* | *-0.47* | 0.05 | 0.00 | 0.42 | 0.37 | 0.37 | 0.33 | 0.33 | 100% |
| 13 | . | ***7.21*** | *-0.60* | -0.42 | -0.40 | 0.09 | -0.04 | -0.04 | -0.09 | -0.13 | 89% |
| 14 | . | *0.80* | *-0.48* | -0.05 | -0.05 | 0.10 | 0.09 | 0.08 | -0.06 | -0.22 | 100% |
| 16 | . | *0.70* | *-0.42* | -0.19 | -0.21 | -0.27 | -0.36 | -0.36 | -0.40 | -0.40 | 100% |
| 17 | . | *0.40* | ***-1.19*** | -0.39 | -0.43 | -0.08 | -0.13 | -0.13 | -0.17 | -0.17 | 89% |
| 19 | . | *0.38* | *-0.39* | -0.06 | -0.09 | 0.12 | 0.13 | 0.05 | -0.14 | 0.00 | 100% |
| 21 | . | ***3.06*** | *-0.57* | 0.21 | 0.18 | -0.56 | -0.60 | -0.50 | -0.67 | -0.57 | 89% |
| 22 | -0.09 | -0.13 | -0.16 | -0.16 | -0.17 | -0.15 | -0.25 | -0.30 | -0.31 | -0.34 | 100% |
| 23 | 0.33 | 0.31 | 0.29 | 0.29 | -0.78 | 0.03 | 0.28 | 0.22 | 0.25 | 0.10 | 100% |
| 24 | -0.03 | -0.01 | 0.01 | -0.04 | -0.93 | -0.12 | -0.01 | -0.08 | -0.25 | -0.56 | 100% |
| 25 | 0.04 | 0.01 | 0.07 | 0.03 | 2.02 | 0.11 | 0.06 | -0.02 | -0.05 | 0.01 | 90% |
| 26 | 0.05 | 0.28 | 0.05 | 0.03 | 0.04 | -0.19 | -0.21 | -0.18 | -0.07 | -0.09 | 100% |
| 28 | -0.25 | -0.28 | -0.27 | -0.29 | -0.33 | 0.13 | 0.13 | 0.09 | 0.09 | 0.09 | 100% |
| 29 | -0.35 | -0.10 | -0.02 | -0.03 | -0.06 | -0.03 | 0.04 | -0.01 | 0.15 | -0.25 | 100% |
| 31 | 0.19 | 0.19 | 0.16 | 0.14 | 0.12 | 0.24 | 0.19 | 0.19 | 0.19 | 0.15 | 100% |
| 33 | 0.05 | 0.02 | 0.00 | -0.02 | -0.03 | 0.97 | 0.90 | 0.90 | 0.66 | 0.83 | 100% |

**Table 5.3 Difference between independent measure and target speed**

| ID | Independent measure of speed- target speed | | | | | | | | | | % within criteria |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Target speed 50km/h | | | | | Target speed 80km/h | | | | | |
| | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | Run 1 | Run 2 | Run 3 | Run 4 | Run 5 | |
| 1 | . | *-2.03* | *-0.40* | -0.52 | -0.79 | -1.05 | -1.53 | -0.66 | -0.57 | -0.79 | 100% |
| 3 | . | *0.16* | *0.03* | -0.31 | 0.00 | 0.58 | 0.63 | 0.63 | 0.67 | 0.67 | 100% |
| 13 | . | ***-8.21*** | *-0.40* | -0.58 | -0.60 | -0.09 | 0.04 | 0.04 | 0.09 | 0.13 | 89% |
| 14 | . | *-0.80* | *0.58* | 0.49 | 0.63 | 1.68 | 1.86 | **3.38** | -0.53 | 0.90 | 89% |
| 16 | . | *-0.70* | *0.42* | 0.19 | 0.21 | 0.27 | 0.36 | 0.36 | 0.40 | 0.40 | 100% |
| 17 | . | *0.60* | *2.19* | 1.39 | 1.43 | 1.08 | 1.13 | 1.13 | 1.17 | 1.17 | 100% |
| 19 | . | *-0.48* | *-0.34* | 0.03 | -0.99 | -0.53 | 1.40 | -0.49 | -0.13 | -0.70 | 100% |
| 21 | . | ***-3.11*** | *0.54* | -0.21 | -0.21 | 0.58 | -0.40 | 0.67 | 0.67 | -0.31 | 89% |
| 22 | 0.09 | -0.87 | 0.16 | -0.84 | 0.17 | 0.22 | -0.75 | -0.70 | 0.31 | -0.66 | 100% |
| 23 | -0.33 | -0.31 | -0.29 | -0.29 | 0.78 | -0.44 | -1.18 | -0.44 | -0.40 | -1.40 | 100% |
| 24 | -0.82 | -0.14 | -0.72 | 0.02 | -0.29 | 0.00 | -0.79 | -0.49 | 0.45 | 0.22 | 100% |
| 25 | 1.45 | 0.87 | 0.17 | -0.41 | -1.22 | 0.67 | -1.53 | 0.27 | -0.88 | -1.70 | 100% |
| 26 | -0.05 | -0.28 | -0.36 | -0.17 | -0.87 | -0.62 | -0.57 | -0.57 | -0.62 | -0.53 | 100% |
| 28 | -0.75 | -0.72 | -0.68 | -0.68 | -0.67 | -0.13 | -0.13 | -0.09 | -0.09 | -0.09 | 100% |
| 29 | -0.55 | -0.90 | -0.85 | -0.97 | -0.94 | -0.75 | -1.14 | -1.99 | -1.40 | -0.75 | 100% |
| 31 | -1.19 | -0.19 | -0.16 | -0.14 | -0.12 | 0.76 | 0.81 | 0.81 | 0.81 | 0.85 | 100% |
| 33 | -0.05 | -0.02 | 0.00 | 0.02 | 0.03 | -0.97 | -0.92 | -0.92 | -0.88 | -0.88 | 100% |

From these tables it can be seen that all machines achieved at least 80% of their data within the criteria. It is also likely that the large differences seen in some of the run 2 assessments were due to errors in the stopwatch tests. Therefore all machines are deemed acceptable with regards to measurement of survey speed.

## 5.6 Test wheel angle

As noted in Section 2.2 a new check was trialled at the accreditation trial with the aim of including it as part of the checks/assessments in future accreditation trials. The equipment used involved two frames and a horizontal bar, and is shown in use in Figure 5.1 and Figure 5.2.

**Figure 5.1 Test wheel angle equipment in use part 1**

**Figure 5.2 Test wheel angle equipment in use part 2**

The two frames were aligned to the test wheel and rear wheel as shown in the images, and the wheel angle was determined by measuring the lengths of the points where the beam crosses the plate on the rear wheel frame, and applying trigonometry.

Each machine was measured using this equipment three times. Although the equipment has been modified since the 2017 trial to better fit the range of machines it was found that the

range of values generated for each machine was too wide for this to be a robust test. As such the measurements made will not be reported here. It is therefore recommended that the test method should be examined and a modified or different test process should be tested at the next accreditation trial, with the aim to include it as a mandatory test in later trials once a robust technique has been developed.

# 6 Skid resistance measurements

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

## 6.1 Amendments to survey machines

At the end of the main running trials day 1, survey crews are given preliminary feedback using a red/amber/green scale on the performance of their machines based on the results from the first set of tests on the straight line wet grip area. They are then given an opportunity to investigate their machines before additional testing takes place. These categories are defined as:

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

During the network route tests minor issues were found with one machine (33). This machine was investigated and an issue with the horizontal load cell supply was found. This was rectified on the evening of the inspection day. This machine undertook the testing as normal on the main trial days, and repeated the network route on the evening of the 1st main trial day. Machine 28 also tested the network route on the evening of the 1st main trial day to provide reference data to show that the skid resistance levels on the 1st main trial day did not differ from the inspection day. For Machine 33 the data discussed below is from the tests after the issues were resolved.

At the end of day 1 all machines were identified as being in the green category, as such no repairs were undertaken after the day 1 testing.

## 6.2 Machine repeatability

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

- For the network route, Machines 14, 19, 21, and 33 were higher than the BRSD for the average for the route.
- The data from the tests on the Straight Line Wet Grip shows a slightly higher BRSD on SWG04. It has been found from previous trials that the BRSD is typically higher for SWG04. No machines were above the BRSD criteria for the average of the site.
- During the 50km/h testing on the Twin Straights two machines were above the criteria for the average of the site, these were Machines 24 and 33. During the 80km/h testing Machines 13 and 21 were above the criteria for the average.

No machine consistently exceeds the BRSD criterion during the trial and therefore all of the machines are performing acceptably with regards to between run variation.

## 6.3 Variation between machines

The average SR values produced by the machines for each of the test sites are shown in the tables below (Table 6.1 to Table 6.5). At the base of each table is the average calculated for the fleet indicated as “Fleet mean”, and the Between Equipment Standard Deviation for the fleet as “Fleet BESD”.

Two machines (Machine 13 and Machine 33) taking part in the trial were not accredited during the previous year. As such these two machines cannot be considered as part of the reference dataset. Therefore in addition to the mean and BESD for the fleet (all machines), the tables below also show the mean and BESD for the reference machines (the fleet excluding machines 13 and 33).

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 criteria, and in red if they are greater than 3 times the BESD criteria. The “Ref BESD” and “Fleet 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 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 | 71.5 | 94.5 | 86.2 | 88.8 | 91.3 | 64.9 | 82.3 | 87.4 | 73.8 | 63.7 | 80.2 | 55.9 | 50.5 | 66.2 | 75.5 |
| 3 | 67.2 | 91.2 | 84.4 | 87.5 | 87.7 | 65.0 | 80.9 | 85.0 | 76.9 | 64.3 | 79.3 | 58.0 | 54.6 | 68.6 | 75.0 |
| 13 | 64.5 | 87.4 | 80.9 | 83.3 | 83.6 | 64.0 | 80.7 | 86.9 | 74.2 | 58.9 | 78.3 | 54.0 | 45.5 | 66.4 | 72.0 |
| 14 | 66.5 | 94.9 | 83.9 | 86.3 | 88.7 | 63.0 | 79.5 | 85.5 | 74.2 | 60.6 | 77.2 | 55.1 | 47.9 | 63.9 | 73.4 |
| 16 | 66.8 | 91.9 | 85.6 | 89.1 | 88.8 | 66.5 | 82.6 | 90.2 | 74.9 | 63.4 | 80.6 | 54.1 | 46.6 | 65.5 | 74.8 |
| 17 | 71.0 | 91.8 | 86.4 | 88.5 | 89.2 | 66.7 | 84.0 | 88.3 | 76.0 | 62.2 | 77.4 | 55.0 | 49.1 | 70.8 | 75.5 |
| 19 | 67.7 | 91.9 | 86.1 | 88.6 | 89.7 | 66.8 | 83.1 | 89.9 | 75.7 | 64.4 | 79.1 | 55.9 | 52.7 | 69.6 | 75.8 |
| 21 | 66.5 | 89.2 | 83.3 | 86.4 | 88.2 | 64.4 | 79.4 | 83.4 | 74.8 | 60.1 | 79.7 | 53.6 | 48.5 | 66.6 | 73.1 |
| 22 | 69.8 | 92.6 | 84.5 | 87.9 | 88.7 | 68.8 | 80.4 | 87.2 | 75.7 | 63.4 | 80.8 | 55.7 | 51.2 | 70.4 | 75.5 |
| 23 | 64.5 | 87.7 | 81.5 | 85.3 | 84.1 | 63.6 | 81.4 | 85.1 | 76.3 | 59.8 | 77.3 | 54.9 | 49.1 | 66.4 | 72.6 |
| 24 | 65.4 | 91.6 | 82.4 | 85.3 | 87.3 | 64.1 | 80.6 | 85.7 | 70.6 | 60.6 | 76.5 | 52.8 | 47.9 | 66.4 | 72.7 |
| 25 | 65.2 | 90.6 | 80.1 | 86.4 | 84.9 | 64.2 | 78.4 | 85.8 | 72.0 | 61.5 | 76.3 | 53.2 | 49.6 | 66.1 | 72.5 |
| 26 | 68.2 | 93.8 | 86.1 | 88.3 | 88.7 | 67.6 | 83.0 | 89.7 | 76.1 | 62.0 | 80.5 | 55.4 | 52.2 | 69.0 | 75.8 |
| 28 | 66.0 | 87.8 | 79.7 | 83.4 | 84.2 | 64.9 | 79.4 | 84.9 | 74.3 | 60.4 | 75.1 | 53.3 | 48.4 | 66.5 | 72.0 |
| 29 | 70.9 | 92.6 | 87.9 | 88.7 | 89.4 | 65.3 | 84.4 | 87.1 | 77.6 | 65.7 | 81.0 | 57.4 | 53.6 | 70.2 | 76.5 |
| 31 | 70.3 | 93.4 | 84.3 | 87.0 | 88.5 | 64.9 | 81.3 | 87.1 | 75.3 | 60.3 | 78.6 | 56.2 | 48.3 | 69.2 | 74.6 |
| 33 | 66.3 | 89.7 | 82.9 | 91.6 | 91.7 | 72.0 | 86.9 | 89.7 | 83.2 | 65.3 | 84.7 | 59.4 | 54.2 | 77.1 | 78.2 |
| Ref mean | 67.8 | 91.7 | 84.2 | 87.2 | 88.0 | 65.4 | 81.4 | 86.8 | 74.9 | 62.2 | 78.6 | 55.1 | 50.0 | 67.7 | 74.4 |
| Ref BESD | 2.32 | 2.16 | 2.41 | 1.64 | 2.06 | 1.59 | 1.83 | 2.03 | 1.81 | 1.88 | 1.88 | 1.51 | 2.36 | 2.10 | 1.48 |
| Fleet mean | 67.5 | 91.3 | 83.9 | 87.2 | 87.9 | 65.7 | 81.7 | 87.0 | 75.4 | 62.1 | 79.0 | 55.3 | 50.0 | 68.2 | 74.4 |
| Fleet BESD | 2.34 | 2.31 | 2.40 | 2.13 | 2.40 | 2.23 | 2.18 | 2.02 | 2.64 | 2.10 | 2.30 | 1.77 | 2.69 | 3.05 | 1.78 |

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

### *6.3.2 Main running trial day 1 tests*

**Table 6.2 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 | 66.8 | 92.2 | 26.8 | 66.3 | 63.2 |
| 3 | 66.9 | 93.0 | 27.0 | 63.2 | 62.7 |
| 13 | 66.2 | 90.7 | 25.8 | 62.9 | 61.6 |
| 14 | 66.5 | 93.5 | 26.4 | 61.5 | 62.2 |
| 16 | 65.6 | 92.3 | 25.2 | 64.3 | 62.0 |
| 17 | 67.1 | 93.1 | 27.5 | 64.1 | 63.2 |
| 19 | 66.9 | 93.0 | 28.0 | 64.1 | 63.2 |
| 21 | 64.0 | 90.9 | 23.8 | 60.6 | 60.0 |
| 22 | 67.4 | 92.9 | 28.3 | 62.3 | 63.0 |
| 23 | 63.6 | 89.3 | 25.5 | 59.9 | 59.8 |
| 24 | 69.5 | 94.6 | 27.7 | 67.2 | 65.0 |
| 25 | 63.4 | 88.2 | 24.4 | 63.3 | 60.0 |
| 26 | 68.4 | 93.1 | 27.4 | 63.2 | 63.3 |
| 28 | 67.3 | 92.8 | 26.8 | 64.0 | 63.0 |
| 29 | 69.9 | 96.4 | 27.4 | 67.5 | 65.6 |
| 31 | 64.2 | 90.4 | 27.2 | 62.1 | 61.2 |
| 33 | 69.8 | 95.9 | 26.9 | 67.5 | 65.3 |
| Ref mean | 66.5 | 92.4 | 26.6 | 63.6 | 62.5 |
| Ref BESD | 2.02 | 2.02 | 1.31 | 2.22 | 1.69 |
| Fleet mean | 66.7 | 92.5 | 26.6 | 63.8 | 62.6 |
| Fleet BESD | 2.05 | 2.13 | 1.25 | 2.30 | 1.74 |

The first set of tests on the Straight Line Wet Grip area (Table 6.2) show that the fleet BESD is met for the average of the site (and for all sections in the site).

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

| ID | Average SR for 50km/h tests on Twin Straights | | | | | | |
|---|---|---|---|---|---|---|---|
| | TS01 | TS02 | TS03 | TS04 | TS05 | TS06 | Avg |
| 1 | 77.1 | 92.0 | 82.9 | 83.5 | 81.2 | 71.4 | 81.2 |
| 3 | 80.4 | 96.0 | 86.9 | 84.7 | 84.0 | 73.9 | 84.2 |
| 13 | 78.6 | 93.2 | 83.0 | 81.3 | 82.2 | 70.0 | 81.2 |
| 14 | 77.2 | 95.3 | 86.4 | 84.9 | 84.4 | 73.3 | 83.2 |
| 16 | 77.7 | 96.4 | 86.2 | 84.1 | 84.2 | 71.5 | 83.0 |
| 17 | 77.8 | 94.5 | 87.2 | 85.0 | 83.7 | 74.4 | 83.5 |
| 19 | 75.7 | 92.7 | 85.1 | 83.4 | 83.2 | 72.0 | 81.6 |
| 21 | 76.5 | 91.0 | 83.8 | 80.3 | 80.4 | 69.4 | 80.1 |
| 22 | 74.4 | 90.7 | 85.3 | 84.5 | 82.4 | 71.9 | 81.1 |
| 23 | 68.9 | 84.9 | 78.2 | 77.2 | 76.5 | 66.3 | 74.9 |
| 24 | 78.9 | 92.0 | 82.6 | 82.3 | 82.0 | 70.6 | 81.2 |
| 25 | 66.6 | 85.3 | 80.6 | 79.3 | 77.2 | 67.8 | 75.6 |
| 26 | 72.2 | 90.9 | 83.4 | 82.4 | 81.4 | 70.6 | 79.7 |
| 28 | 70.6 | 88.5 | 82.9 | 81.7 | 80.5 | 69.9 | 78.5 |
| 29 | 75.1 | 93.5 | 85.0 | 84.4 | 83.0 | 73.1 | 82.0 |
| 31 | 68.9 | 86.3 | 79.7 | 78.9 | 77.6 | 68.1 | 76.1 |
| 33 | 73.8 | 87.9 | 82.4 | 79.8 | 78.2 | 68.6 | 78.3 |
| Ref mean | 74.5 | 91.3 | 83.7 | 82.4 | 81.5 | 71.0 | 80.4 |
| Fleet BESD | 4.15 | 3.73 | 2.69 | 2.47 | 2.59 | 2.34 | 2.93 |
| Fleet mean | 74.7 | 91.2 | 83.6 | 82.2 | 81.3 | 70.8 | 80.3 |
| Fleet BESD | 4.01 | 3.62 | 2.54 | 2.41 | 2.56 | 2.27 | 2.79 |

On examination of the data collected from the 50km/h Twin Straights tests (Table 6.3) we can see that the Fleet BESD for the average of the sections exceeds the criterion (see Section 4.1). However, historically it has been found that the data from the Twin Straights are more variable than those for the Straight Line Wet Grip site. This is due to fact that the site has not had much traffic since it was laid. The data for this site has improved, however, as it stands, it is currently used only to provide supporting information for the skid resistance measurement part of the accreditation process.

**Table 6.4 Average SR from the 80km/h tests on the Twin Straights**

| ID | Average SR for 80km/h tests on Twin Straights | | | | | | |
|---|---|---|---|---|---|---|---|
| | TS01 | TS02 | TS03 | TS04 | TS05 | TS06 | Avg |
| 1 | 65.9 | 80.0 | 70.7 | 72.5 | 70.6 | 62.7 | 70.2 |
| 3 | 66.3 | 83.1 | 79.2 | 78.5 | 78.5 | 66.3 | 74.7 |
| 13 | 68.7 | 85.7 | 78.2 | 79.0 | 76.5 | 64.9 | 75.1 |
| 14 | 65.3 | 86.9 | 81.6 | 82.1 | 81.4 | 68.0 | 76.7 |
| 16 | 63.1 | 82.3 | 76.4 | 76.1 | 76.2 | 61.8 | 71.9 |
| 17 | 66.6 | 85.9 | 81.4 | 81.8 | 80.5 | 67.7 | 76.5 |
| 19 | 66.2 | 84.3 | 79.4 | 79.4 | 79.4 | 66.7 | 75.2 |
| 21 | 60.4 | 78.4 | 73.4 | 73.2 | 75.6 | 66.9 | 70.4 |
| 22 | 67.4 | 87.9 | 82.7 | 82.0 | 80.8 | 68.7 | 77.5 |
| 23 | 63.9 | 83.2 | 76.2 | 76.5 | 74.3 | 63.3 | 72.4 |
| 24 | 67.4 | 86.9 | 80.7 | 79.8 | 79.3 | 66.7 | 76.2 |
| 25 | 62.9 | 81.0 | 76.5 | 75.1 | 74.7 | 62.7 | 71.5 |
| 26 | 65.4 | 87.2 | 79.9 | 80.4 | 79.1 | 65.7 | 75.5 |
| 28 | 66.0 | 85.5 | 81.6 | 80.3 | 79.7 | 66.7 | 75.9 |
| 29 | 69.9 | 88.6 | 79.3 | 80.7 | 79.3 | 68.5 | 77.2 |
| 31 | 63.7 | 83.6 | 77.0 | 76.9 | 75.7 | 64.7 | 73.0 |
| 33 | 67.7 | 86.5 | 82.4 | 81.5 | 79.0 | 68.4 | 77.0 |
| Ref mean | 65.4 | 84.3 | 78.4 | 78.4 | 77.7 | 65.8 | 74.3 |
| Fleet BESD | 2.29 | 3.05 | 3.35 | 3.14 | 3.02 | 2.24 | 2.52 |
| Fleet mean | 65.7 | 84.5 | 78.6 | 78.6 | 77.7 | 65.9 | 74.5 |
| Fleet BESD | 2.35 | 2.91 | 3.28 | 3.04 | 2.86 | 2.20 | 2.45 |

The data from the 80km/h tests on the Twin Straights (Table 6.4) shows a better performance than the 50km/h tests with the Fleet BESD criteria being met for the average of the site (but not all of the sections).

Based on the very good performance on the SLWG site, and the good performance on the Twin Straights (particularly for the 80km/h tests), at the end of the first main running trial day all machines were identified as being in the green category (see section 6.1).

### *6.3.3 Main running trial day 2 tests*

The testing on day 2 is a repeat of the SLWG testing from the morning of day 1. This testing serves two purposes, the first is to confirm that the fleet is stable and the second is to allow any machines which underwent repairs or modifications after the first set of testing to repeat the assessment. As no machines underwent any repairs or modifications after the first day of testing, this testing is used to confirm the conclusions from the first day.

**Table 6.5 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 |
| 3 | 64.6 | 90.4 | 24.6 | 63.4 | 61.0 |
| 13 | 63.4 | 91.6 | 24.0 | 58.4 | 59.6 |
| 14 | 64.5 | 89.9 | 25.0 | 58.8 | 59.8 |
| 16 | 66.9 | 95.2 | 25.8 | 63.0 | 62.9 |
| 17 | 64.7 | 92.7 | 23.0 | 61.7 | 60.7 |
| 18 | 68.0 | 94.5 | 26.7 | 61.5 | 63.0 |
| 19 | 66.9 | 92.8 | 26.2 | 61.0 | 62.0 |
| 21 | 66.0 | 92.6 | 25.5 | 59.2 | 61.1 |
| 22 | 66.4 | 93.3 | 27.2 | 59.6 | 61.9 |
| 23 | 63.7 | 89.3 | 24.7 | 59.4 | 59.5 |
| 24 | 66.0 | 90.9 | 24.7 | 60.0 | 60.7 |
| 25 | 64.9 | 91.6 | 26.2 | 61.2 | 61.2 |
| 26 | 66.3 | 90.9 | 26.3 | 58.9 | 60.9 |
| 28 | 66.4 | 94.6 | 27.0 | 62.5 | 62.8 |
| 29 | 69.0 | 95.8 | 26.3 | 63.8 | 64.0 |
| 31 | 63.5 | 90.0 | 24.8 | 57.7 | 59.2 |
| 33 | 70.8 | 95.6 | 26.8 | 66.4 | 65.2 |
| Ref mean | 65.8 | 92.4 | 25.5 | 60.8 | 61.4 |
| Ref BESD | 1.64 | 1.98 | 1.18 | 1.89 | 1.39 |
| Fleet mean | 66.0 | 92.5 | 25.6 | 61.0 | 61.5 |
| Fleet BESD | 2.00 | 2.11 | 1.16 | 2.30 | 1.66 |

The second set of tests on the Straight Line Wet Grip area (Table 6.5) show that the fleet BESD is met for the average of the site (and for all sections in the site).

## 6.4 Summary of skid resistance testing

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

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

# 7 Location referencing

## 7.1 Distance measurement

For this assessment there are separate criteria for the push button entry of markers and for the entry of markers via automatic detection of retro-reflective posts or via OSGR fitted markers (given in section 4.1). The criteria for the push button entry are more lenient to allow for the additional uncertainty added by the reaction times of the operator. However it has been noted that the additional buffer added to the push button criteria make it easier to pass the push button criteria than the automatic marker detection criteria (i.e. it could be beneficial to switch off the automatic marker detection and manually enter the markers). Therefore to maintain the required level of performance for Highways England surveys, the following clause was added to the accreditation criteria:

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

Due to this split in requirements, all machines were assessed for distance measurement on the Twin Straights site. In addition, all of the machines providing BCD files (OSGR fitted data) were also assessed for OSGR fitted distance on the Longcross test site. The results from these two assessments and the summary conclusions are provided below.

### *7.1.1 Twin Straights*

To provide data for the assessment of distance measurement, the survey vehicles performed ten passes of the Twin Straights (5 passes at 50km/h and 5 passes at 80km/h), marking positions A-H as shown in Figure 3.1. This data was then assessed against the reference data collected from an optical survey of the site.

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

**Table 7.1 Distance measurement assessment on Twin straights**

| ID | Percentage of data within | | | | Assessment criteria used | Met criteria |
|---|---|---|---|---|---|---|
| | 1m | 2m | 5m | 10m | | |
| 1 | 25% | 88% | 98% | 98% | Automatic | Yes |
| 3 | 60% | 90% | 100% | 100% | Push | Yes |
| 13 | 70% | 100% | 100% | 100% | Automatic | Yes |
| 14 | 35% | 73% | 95% | 100% | Push | Yes |
| 16 | 15% | 50% | 100% | 100% | Push | Yes |
| 17 | 75% | 100% | 100% | 100% | Automatic | Yes |
| 19 | 65% | 100% | 100% | 100% | Automatic | Yes |
| 21 | 35% | 63% | 93% | 93% | Push | Yes |
| 22 | 33% | 48% | 88% | 100% | Push | Yes |
| 23 | 73% | 100% | 100% | 100% | Automatic | Yes |
| 24 | 53% | 93% | 100% | 100% | Automatic | Yes |
| 25 | 53% | 100% | 100% | 100% | Automatic | Yes |
| 26 | 58% | 100% | 100% | 100% | Automatic | Yes |
| 28 | 53% | 93% | 100% | 100% | Automatic | Yes |
| 29 | 35% | 78% | 100% | 100% | Push | Yes |
| 31 | 63% | 100% | 100% | 100% | Automatic | Yes |
| 33 | 48% | 78% | 100% | 100% | Automatic | Yes |

### *7.1.2 Longcross*

As previously noted (see section 7.1) survey contractors which supply OSGR fitted data must meet the criteria for the OSGR fitted distance measurement. This requirement was applicable to eleven machines.

To provide data for the assessment of OSGR fitted distance measurement, the survey vehicles performed six passes of the Longcross test track (3 passes at 50km/h and 3 passes at 80km/h), marking positions A, B, F, G and-H as shown in Figure 3.5. This data was then assessed against the reference data collected from an optical survey of the site.

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

| ID | Percentage of data within | | | | Assessment criteria used | Met criteria |
|---|---|---|---|---|---|---|
| | 1m | 2m | 5m | 10m | | |
| 1 | 0% | 33% | 100% | 100% | OSGR Fitted | Fail |
| 17 | 72% | 94% | 100% | 100% | OSGR Fitted | Pass |
| 19 | 83% | 100% | 100% | 100% | OSGR Fitted | Pass |
| 22 | 56% | 89% | 100% | 100% | OSGR Fitted | Pass |
| 23 | 89% | 100% | 100% | 100% | OSGR Fitted | Pass |
| 24 | 28% | 50% | 100% | 100% | OSGR Fitted | Fail |
| 25 | 61% | 89% | 100% | 100% | OSGR Fitted | Pass |
| 26 | 94% | 100% | 100% | 100% | OSGR Fitted | Pass |
| 28 | 100% | 100% | 100% | 100% | OSGR Fitted | Pass |
| 29 | 28% | 78% | 100% | 100% | OSGR Fitted | Fail |
| 31 | 83% | 100% | 100% | 100% | OSGR Fitted | Pass |

From Table 7.2 it can be seen that three machines (Machines 1, 24, and 29) do not meet the OSGR fitted criteria. However, it is likely that the OSGR fitted criteria is too demanding as it incorporates both the error on the distance measurement system and the error on the OSGR system. As this test is to identify the suitability of the distance measurement systems, it was decided that the machines would be assessed using the same criteria but using the original survey data (i.e. equivalent to the automatic markers assessment even if the survey crew used manual entry for the markers). All of these machines would have the following text added to their Accreditation Certificates:

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

The results from this assessment are given in Table 7.3.

**Table 7.3 Distance measurement assessment at Longcross (Original survey data)**

| ID | Percentage of data within | | | | Assessment criteria used | Met criteria |
|---|---|---|---|---|---|---|
| | 1m | 2m | 5m | 10m | | |
| 1 | 0% | 33% | 100% | 100% | Automatic | Fail |
| 17 | 33% | 89% | 100% | 100% | Automatic | Pass |
| 19 | 56% | 100% | 100% | 100% | Automatic | Pass |
| 22 | 50% | 72% | 100% | 100% | Automatic | Pass |
| 23 | 44% | 94% | 100% | 100% | Automatic | Pass |
| 24 | 22% | 33% | 100% | 100% | Automatic | Fail |
| 25 | 33% | 83% | 100% | 100% | Automatic | Pass |
| 26 | 100% | 100% | 100% | 100% | Automatic | Pass |
| 28 | 83% | 100% | 100% | 100% | Automatic | Pass |
| 29 | 44% | 89% | 100% | 100% | Automatic | Pass |
| 31 | 83% | 100% | 100% | 100% | Automatic | Pass |

From this assessment it can be seen that two machines (Machine 1 and Machine 24) fail to meet the criteria on the Longcross test site. However, both of these machines provided suitable data from the Horiba-MIRA test site (using the same criteria). Further review of this data suggested that these differences could be due to slight differences in the distance calibration factors for these machines and/or due to variations in the driving line. It was therefore decided (due to the good performance of these devices on the Horiba-MIRA site) that these machines would be awarded a pass with the following additional text in the Accreditation Certificate:

It met the automatic markers criteria for one test site and close for the other. The contractor should ensure the system is correctly calibrated and monitored during the ongoing QA. This machine is deemed satisfactory for distance measurement.

### *7.1.3 Summary of distance measurement assessment*

The awarded performance for distance measurement (and the criteria applied) is shown in Table 7.4. Machines which were deemed to be suitable but had additional comments added to the certificate are awarded a “Pass*”.

**Table 7.4 Distance measurement assessment Summary**

| ID | Assessment criteria used | Distance measurement |
|---|---|---|
| 1 | Automatic | Pass* |
| 3 | Push | Pass |
| 13 | Automatic | Pass |
| 14 | Push | Pass |
| 16 | Push | Pass |
| 17 | Automatic | Pass |
| 19 | Automatic | Pass |
| 21 | Push | Pass |
| 22 | Automatic | Pass |
| 23 | Automatic | Pass |
| 24 | Automatic | Pass* |
| 25 | Automatic | Pass |
| 26 | Automatic | Pass |
| 28 | Automatic | Pass |
| 29 | Automatic | Pass |
| 31 | Automatic | Pass |
| 33 | Automatic | Pass |

## 7.2 3 dimensional spatial coordinates data

The assessment of 3 dimensional spatial coordinates is mandatory for any device that is to be used on the central Highways England survey contract and optional for the other devices. Thirteen machines took part in these tests: Machines 1, 14, 16, 17, 19, 22-26, 29, 31 and 33. 3 dimensional spatial coordinates system for Machine 28 was not functional during the trial and undertook these tests in May/June. The results from these tests have been included in the below assessments and tables.

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 HARRIS2 survey vehicle.

The results from the OSGR and altitude assessments and the criteria applied are given in Appendix C and are summarised in Table 7.5 and Table 7.6. To promote consistency, it was decided that for this year's trial all machines would be assessed using the OSGR fitted criteria. Data from any machines which did not provide OSGR fitted data was fitted using Highways England's MSP software by TRL. It is recommended that the Accreditation and QA specification is updated to reflect this amended test procedure. The assessment criteria are given in section 4.1.

## Table 7.5 Summary of OSGR assessments

| ID | Performance on Network route | Performance at Longcross | Awarded Performance |
|---|---|---|---|
| 1 | High | High | High |
| 13 | High | Did not attend | Not assessed |
| 14 | High | High | High |
| 16 | High | High | High |
| 17 | High | High | High |
| 19 | High | High | High |
| 22 | High | High | High |
| 23 | High | High | High |
| 24 | High | High | High |
| 25 | High | High | High |
| 26 | High | High | High |
| 28 | High | High | High |
| 29 | High | Medium | Medium |
| 31 | High | High | High |
| 33 | High | Medium | Medium |

## Table 7.6 Summary of Altitude assessments

| ID | Performance on Network route | Performance at Longcross | Awarded Performance |
|---|---|---|---|
| 1 | Medium | Medium | Medium |
| 13 | High | Did not attend | Not assessed |
| 14 | Medium | Medium | Medium |
| 16 | Medium | High | Medium |
| 17 | High | High | High |
| 19 | Medium | High | Medium |
| 22 | High | High | High |
| 23 | High | High | High |
| 24 | High | High | High |
| 25 | High | High | High |
| 26 | High | High | High |
| 28 | High | High | High |
| 29 | High | Medium | Medium |
| 31 | High | High | High |
| 33 | Medium | Medium | Medium |

# 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 files:

- Machine 1
- Machine 13
- Machine 14
- Machine 16
- Machine 17
- Machine 19
- Machine 22
- Machine 23
- Machine 24
- Machine 25
- Machine 26
- Machine 28
- Machine 29
- Machine 31
- Machine 33

The following machines provided BCD files:

- Machine 1
- Machine 13
- Machine 17
- Machine 19
- Machine 22
- Machine 23
- Machine 24
- Machine 25
- Machine 26
- Machine 28
- Machine 29
- Machine 31

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

# 9 Conclusions

The 2018 sideway-force skid resistance accreditation trials were held during the week beginning the 9th April 2018. The trials were held on and around the MIRA proving ground and at the Longcross test track. Seventeen machines from the UK fleet attended.

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

**(i) Skid resistance measurement**

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

**(ii) Vehicle Speed attainment and recording**

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

**(iii) Distance measurement**

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

**(iv) Left test wheel weight**

All seventeen 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. Eleven of the seventeen machines meet this tighter tolerance.

**(v) Water flow**

All seventeen 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):

**(vi) Measurement of OSGRs**

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

**(vii) Measurement of Altitude**

Fourteen machines fitted with 3 dimensional spatial coordinate systems were assessed for the measurement of altitude. Eight machines achieved a high performance and six machines a medium performance.

**(viii) File formats**

All seventeen machines supplied suitable .s10 and .loc files. Fifteen machines provided suitable RCD files and twelve machines provided suitable BCD files.

A summary of the machines that attended the 2018 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.

Design Manual for Roads and Bridges. (2015, July). *Volume 7 Section 3 Part 1, HD28/15, Skidding Resistance*. London: The Stationery Office.

TRL. (2016). *Accreditation and Quality Assurance of Sideways Force Skid Resistance Survey Devices.* http://www.ukroadsliaisongroup.org/en/asset-condition/road-condition-information/data-collection/skid-resistance.cfm.

# Appendix A Machine identification and performance

**Table A.1 Machine identification and performance summary**

| ID | Current Owner | Registration number | Performance Summary | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Skid resistance measurement | Speed | Distance travelled[1] | OSGR | Altitude | S10 and loc file | RCD file | BCD file |
| 1 | PTS Ltd | W965 SVG | Pass | Pass | Pass | High | Medium | Satisfactory | Satisfactory | Satisfactory |
| 3 | DRDNI | IKZ 2203 | Pass | Pass | Pass | - | - | Satisfactory | - | - |
| 13 | WDM Ltd | S7 WDM | Pass | Pass | Pass | - | - | Satisfactory | Satisfactory | Satisfactory |
| 14 | PMS | 01 KK 1138 | Pass | Pass | Pass | High | Medium | Satisfactory | Satisfactory | - |
| 16 | Highway Surveyors Ltd | S66 HSL | Pass | Pass | Pass | High | Medium | Satisfactory | Satisfactory | - |
| 17 | WDM Ltd | S800 WDM | Pass | Pass | Pass | High | High | Satisfactory | Satisfactory | Satisfactory |
| 19 | WDM Ltd | S900 WDM | Pass | Pass | Pass | High | Medium | Satisfactory | Satisfactory | Satisfactory |
| 21 | Surrey CC | KX07YXH | Pass | Pass | Pass | - | - | Satisfactory | - | - |
| 22 | PTS Ltd | KX07YVH | Pass | Pass | Pass | High | High | Satisfactory | Satisfactory | Satisfactory |
| 23 | WDM Ltd | S11 WDM | Pass | Pass | Pass | High | High | Satisfactory | Satisfactory | Satisfactory |
| 24 | WDM Ltd | S12 WDM | Pass | Pass | Pass | High | High | Satisfactory | Satisfactory | Satisfactory |
| 25 | WDM Ltd | S13 WDM | Pass | Pass | Pass | High | High | Satisfactory | Satisfactory | Satisfactory |
| 26 | WDM Ltd | S14 WDM | Pass | Pass | Pass | High | High | Satisfactory | Satisfactory | Satisfactory |
| 28 | Operated by TRL on behalf of Highways England | WX60 AXN | Pass | Pass | Pass | High[2] | High[2] | Satisfactory | Satisfactory | Satisfactory |
| 29 | PTS Ltd | YD02 XSN | Pass | Pass | Pass | Medium | Medium | Satisfactory | Satisfactory | Satisfactory |
| 31 | WDM Ltd | S16 WDM | Pass | Pass | Pass | High | High | Satisfactory | Satisfactory | Satisfactory |
| 33 | PMS | 17 2G 1777 | Pass | Pass | Pass | Medium | Medium | 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.

[2] OSGR and Altitude for this machine were assessed via additional testing after the trial.

# Appendix B Between run standard deviation

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

**Table B.1 Machine repeatability for the Network route**

| ID | Between run SD | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | Avg |
| 1 | 2.66 | 2.83 | 2.29 | 2.22 | 1.84 | 1.38 | 1.85 | 3.57 | 3.11 | 0.78 | 1.22 | 0.98 | 1.60 | 2.16 | 2.18 |
| 3 | 2.12 | 0.99 | 0.29 | 0.34 | 0.91 | 1.26 | 1.01 | 0.36 | 1.24 | 1.61 | 0.07 | 1.61 | 4.15 | 2.14 | 1.64 |
| 13 | 1.94 | 2.45 | 2.14 | 2.21 | 2.44 | 2.39 | 2.90 | 2.18 | 4.47 | 3.82 | 2.99 | 1.52 | 0.75 | 2.20 | 2.61 |
| 14 | 2.98 | 2.59 | 3.67 | 2.98 | 3.77 | 3.25 | 4.27 | 4.13 | 4.02 | 0.31 | 4.18 | 1.91 | 1.38 | 1.95 | 3.17 |
| 16 | 1.17 | 2.11 | 1.32 | 1.29 | 0.37 | 1.01 | 0.48 | 1.23 | 1.60 | 3.63 | 2.13 | 1.16 | 1.71 | 1.64 | 1.68 |
| 17 | 4.04 | 1.81 | 1.72 | 1.01 | 1.03 | 0.86 | 2.89 | 2.61 | 1.83 | 2.28 | 1.48 | 1.43 | 1.83 | 4.25 | 2.31 |
| 19 | 2.37 | 3.02 | 3.62 | 4.18 | 2.51 | 3.57 | 2.83 | 1.52 | 4.73 | 2.13 | 3.67 | 2.78 | 0.54 | 2.87 | 3.06 |
| 21 | 2.76 | 1.70 | 3.79 | 4.02 | 2.20 | 2.92 | 3.96 | 2.89 | 3.89 | 2.47 | 3.26 | 1.93 | 1.30 | 3.25 | 3.00 |
| 22 | 2.11 | 3.28 | 2.69 | 1.08 | 0.96 | 0.93 | 1.54 | 1.37 | 2.49 | 2.59 | 1.47 | 1.87 | 2.39 | 1.77 | 2.02 |
| 23 | 1.40 | 0.84 | 1.18 | 2.14 | 0.48 | 1.18 | 1.56 | 1.90 | 3.20 | 1.53 | 2.80 | 2.64 | 0.99 | 1.45 | 1.83 |
| 24 | 2.34 | 1.78 | 2.19 | 1.77 | 1.97 | 1.78 | 2.65 | 1.91 | 2.01 | 1.64 | 2.71 | 0.88 | 1.00 | 0.54 | 1.90 |
| 25 | 1.71 | 2.56 | 1.13 | 3.68 | 1.59 | 0.76 | 0.95 | 2.27 | 1.50 | 1.61 | 1.37 | 1.91 | 1.24 | 2.52 | 1.92 |
| 26 | 0.92 | 1.83 | 1.49 | 0.81 | 0.56 | 1.33 | 2.11 | 2.33 | 0.57 | 1.91 | 0.94 | 0.87 | 1.78 | 0.76 | 1.43 |
| 28 | 1.37 | 1.23 | 1.33 | 0.37 | 1.26 | 2.87 | 2.52 | 1.67 | 1.41 | 2.24 | 0.52 | 2.04 | 3.30 | 1.06 | 1.85 |
| 29 | 1.28 | 1.71 | 0.60 | 0.61 | 0.36 | 1.71 | 1.89 | 1.35 | 1.74 | 2.82 | 2.97 | 1.30 | 2.55 | 2.53 | 1.85 |
| 31 | 2.52 | 0.82 | 1.79 | 0.42 | 3.03 | 0.90 | 0.74 | 1.61 | 1.45 | 0.53 | 2.38 | 1.45 | 1.23 | 1.38 | 1.63 |
| 33 | 1.95 | 0.84 | 0.31 | 5.30 | 3.42 | 1.72 | 3.27 | 2.44 | 3.06 | 1.41 | 1.39 | 0.24 | 3.85 | 5.88 | 3.01 |
| Avg | 2.23 | 2.05 | 2.14 | 2.51 | 1.99 | 1.96 | 2.45 | 2.26 | 2.77 | 2.17 | 2.37 | 1.68 | 2.12 | 2.59 | 2.25 |

**Table B.2 Machine repeatability for the 1st set of tests on the Straight Line Wet Grip**

| ID | Between run SD | | | | |
|---|---|---|---|---|---|
| | SWG01 | SWG02 | SWG03 | SWG04 | Avg |
| 1 | 1.36 | 1.13 | 1.94 | 3.64 | 2.21 |
| 3 | 1.03 | 2.21 | 0.67 | 2.74 | 1.83 |
| 13 | 1.37 | 1.30 | 0.64 | 3.79 | 2.10 |
| 14 | 1.51 | 0.99 | 0.34 | 2.43 | 1.52 |
| 16 | 0.76 | 1.87 | 0.65 | 3.69 | 2.08 |
| 17 | 0.53 | 0.47 | 0.98 | 3.34 | 1.73 |
| 19 | 1.46 | 1.25 | 0.65 | 2.01 | 1.43 |
| 21 | 0.42 | 1.62 | 0.60 | 2.63 | 1.55 |
| 22 | 1.16 | 0.85 | 1.35 | 1.83 | 1.34 |
| 23 | 0.89 | 0.93 | 0.42 | 2.52 | 1.41 |
| 24 | 1.61 | 1.53 | 0.40 | 2.85 | 1.81 |
| 25 | 0.56 | 0.84 | 0.68 | 2.13 | 1.20 |
| 26 | 1.40 | 0.81 | 0.85 | 1.29 | 1.13 |
| 28 | 1.05 | 0.72 | 0.43 | 4.02 | 2.08 |
| 29 | 1.19 | 1.01 | 1.26 | 2.48 | 1.58 |
| 31 | 0.99 | 1.03 | 1.21 | 2.82 | 1.67 |
| 33 | 1.43 | 1.79 | 1.02 | 3.21 | 2.01 |
| Avg | 1.16 | 1.28 | 0.92 | 2.89 | 1.72 |

**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 | 1.95 | 1.79 | 0.56 | 4.24 | 2.49 |
| 3 | 1.03 | 2.03 | 1.04 | 1.54 | 1.45 |
| 13 | 1.07 | 1.93 | 0.41 | 4.03 | 2.26 |
| 14 | 0.37 | 1.32 | 0.65 | 2.62 | 1.47 |
| 16 | 0.38 | 1.61 | 0.69 | 4.01 | 2.14 |
| 17 | 1.24 | 1.61 | 0.27 | 1.82 | 1.36 |
| 19 | 1.07 | 1.40 | 1.16 | 2.74 | 1.70 |
| 21 | 0.64 | 1.17 | 0.24 | 1.12 | 0.87 |
| 22 | 0.87 | 1.52 | 1.39 | 0.94 | 1.20 |
| 23 | 1.15 | 1.50 | 0.63 | 2.62 | 1.62 |
| 24 | 1.55 | 1.58 | 1.99 | 2.88 | 2.05 |
| 25 | 1.02 | 0.97 | 1.90 | 5.25 | 2.81 |
| 26 | 1.23 | 1.12 | 0.24 | 0.88 | 0.96 |
| 28 | 1.03 | 2.00 | 0.96 | 2.24 | 1.63 |
| 29 | 0.88 | 1.75 | 0.58 | 1.96 | 1.39 |
| 31 | 0.69 | 0.90 | 0.93 | 1.85 | 1.16 |
| 33 | 0.96 | 2.59 | 0.17 | 4.54 | 2.60 |
| Avg | 1.08 | 1.63 | 0.97 | 2.96 | 1.81 |

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

| ID | Between run SD | | | | | | |
|---|---|---|---|---|---|---|---|
| | TS01 | TS02 | TS03 | TS04 | TS05 | TS06 | Avg |
| 1 | 2.67 | 2.73 | 3.14 | 2.92 | 2.19 | 1.70 | 2.63 |
| 3 | 3.84 | 3.44 | 2.67 | 1.22 | 1.33 | 1.74 | 2.72 |
| 13 | 0.61 | 2.28 | 0.48 | 0.93 | 1.97 | 1.34 | 1.36 |
| 14 | 3.67 | 3.20 | 2.74 | 2.37 | 3.09 | 1.74 | 2.89 |
| 16 | 1.70 | 2.99 | 1.80 | 1.26 | 1.50 | 2.01 | 1.97 |
| 17 | 4.01 | 2.49 | 0.68 | 1.42 | 0.69 | 2.64 | 2.50 |
| 19 | 1.93 | 2.16 | 1.85 | 0.46 | 1.43 | 0.92 | 1.61 |
| 21 | 3.26 | 1.45 | 1.21 | 1.00 | 0.93 | 0.82 | 1.82 |
| 22 | 1.23 | 0.33 | 1.50 | 1.38 | 0.44 | 0.86 | 1.10 |
| 23 | 1.73 | 0.65 | 0.55 | 0.81 | 0.74 | 0.44 | 0.99 |
| 24 | 4.91 | 3.09 | 4.32 | 2.88 | 5.21 | 2.36 | 3.88 |
| 25 | 0.96 | 1.24 | 1.88 | 1.91 | 1.83 | 1.97 | 1.64 |
| 26 | 1.64 | 1.62 | 0.53 | 1.05 | 0.70 | 0.64 | 1.18 |
| 28 | 2.78 | 1.19 | 1.19 | 0.70 | 0.27 | 0.29 | 1.51 |
| 29 | 0.94 | 1.74 | 0.80 | 0.20 | 0.21 | 0.84 | 0.98 |
| 31 | 0.67 | 0.67 | 0.80 | 0.56 | 0.08 | 0.86 | 0.68 |
| 33 | 5.37 | 3.21 | 2.72 | 1.99 | 2.15 | 1.51 | 3.29 |
| Avg | 2.86 | 2.25 | 2.01 | 1.57 | 1.91 | 1.49 | 2.12 |

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

| ID | Between run SD | | | | | | |
|---|---|---|---|---|---|---|---|
| | TS01 | TS02 | TS03 | TS04 | TS05 | TS06 | Avg |
| 1 | 3.76 | 1.68 | 3.01 | 1.99 | 1.31 | 3.14 | 2.77 |
| 3 | 1.78 | 1.12 | 0.63 | 0.96 | 1.04 | 1.30 | 1.23 |
| 13 | 4.83 | 4.59 | 0.98 | 1.84 | 1.09 | 0.57 | 3.10 |
| 14 | 0.78 | 1.70 | 1.03 | 1.62 | 2.01 | 0.52 | 1.30 |
| 16 | 3.87 | 1.64 | 1.32 | 1.61 | 1.00 | 0.59 | 2.15 |
| 17 | 1.44 | 0.69 | 1.21 | 1.38 | 2.08 | 1.17 | 1.33 |
| 19 | 0.98 | 0.34 | 1.22 | 0.47 | 0.64 | 0.60 | 0.79 |
| 21 | 1.25 | 8.21 | 8.33 | 6.38 | 3.47 | 7.76 | 6.51 |
| 22 | 0.58 | 1.29 | 0.34 | 0.48 | 0.56 | 0.44 | 0.69 |
| 23 | 1.53 | 1.96 | 0.84 | 0.81 | 0.49 | 0.68 | 1.23 |
| 24 | 0.63 | 0.71 | 1.17 | 0.17 | 0.74 | 0.66 | 0.73 |
| 25 | 1.16 | 0.81 | 1.09 | 0.24 | 1.09 | 0.43 | 0.87 |
| 26 | 1.01 | 1.53 | 0.61 | 1.67 | 0.59 | 0.46 | 1.11 |
| 28 | 0.75 | 1.88 | 1.44 | 0.80 | 0.70 | 0.48 | 1.13 |
| 29 | 1.06 | 2.36 | 2.94 | 2.13 | 2.99 | 1.84 | 2.21 |
| 31 | 1.91 | 1.17 | 0.82 | 0.49 | 0.55 | 0.39 | 1.12 |
| 33 | 1.43 | 2.27 | 3.05 | 2.60 | 2.63 | 3.04 | 2.52 |
| Avg | 2.08 | 2.69 | 2.54 | 2.06 | 1.63 | 2.29 | 2.28 |

# Appendix C Assessment of 3 dimensional spatial coordinates data

## C.1 OSGR data

Performance assessed using the OSGR fitted criteria.

**Table C.1 Assessment of OSGR measurements against the reference: Network route**

| ID | 10m data points Network route: % within | | | | | | | Performance level |
|---|---|---|---|---|---|---|---|---|
| | 3m | 6m | 12m | 17m | 20m | 25m | 30m | |
| 1 | 83% | 97% | 98% | 99% | 99% | 100% | 100% | High |
| 13 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 14 | 74% | 94% | 99% | 100% | 100% | 100% | 100% | High |
| 16 | 97% | 99% | 100% | 100% | 100% | 100% | 100% | High |
| 17 | 99% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 19 | 99% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 22 | 97% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 23 | 99% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 24 | 99% | 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 | 98% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 29 | 87% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 31 | 99% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 33 | 10% | 40% | 98% | 100% | 100% | 100% | 100% | High |

**Table C.2 Assessment of OSGR measurements against the reference: Longcross Test track**

| ID | 10m data points on test track: % within | | | | | | | Performance level |
|---|---|---|---|---|---|---|---|---|
| | 2m | 4m | 5m | 7m | 8m | 20m | 25m | |
| 1 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 14 | 95% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 16 | 95% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 17 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 19 | 100% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 22 | 96% | 99% | 100% | 100% | 100% | 100% | 100% | High |
| 23 | 96% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 24 | 98% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 25 | 95% | 99% | 99% | 100% | 100% | 100% | 100% | High |
| 26 | 97% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 28 | 99% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 29 | 89% | 100% | 100% | 100% | 100% | 100% | 100% | Medium |
| 31 | 99% | 100% | 100% | 100% | 100% | 100% | 100% | High |
| 33 | 81% | 99% | 100% | 100% | 100% | 100% | 100% | Medium |

## C.2 Altitude data

**Table C.3 Assessment of altitude measurements against the reference: Network route**

| ID | 10m data points on Network route Section start and end points on test track: % within | | | | | Performance level |
|---|---|---|---|---|---|---|
| | 2m | 4m | 5m | 6m | 20m | |
| 1 | 80% | 100% | 100% | 100% | 100% | Medium |
| 13 | 100% | 100% | 100% | 100% | 100% | High |
| 14 | 13% | 99% | 100% | 100% | 100% | Medium |
| 16 | 48% | 100% | 100% | 100% | 100% | Medium |
| 17 | 90% | 100% | 100% | 100% | 100% | High |
| 19 | 6% | 90% | 100% | 100% | 100% | Medium |
| 22 | 100% | 100% | 100% | 100% | 100% | High |
| 23 | 94% | 100% | 100% | 100% | 100% | High |
| 24 | 100% | 100% | 100% | 100% | 100% | High |
| 25 | 96% | 100% | 100% | 100% | 100% | High |
| 26 | 99% | 100% | 100% | 100% | 100% | High |
| 28 | 94% | 100% | 100% | 100% | 100% | High |
| 29 | 100% | 100% | 100% | 100% | 100% | High |
| 31 | 100% | 100% | 100% | 100% | 100% | High |
| 33 | 69% | 100% | 100% | 100% | 100% | Medium |

**Table C.4 Assessment of altitude measurements against the reference: Test track**

| ID | 10m data points on test track: % within | | | | | Performance level |
|---|---|---|---|---|---|---|
| | 2m | 4m | 5m | 6m | 20m | |
| 1 | 87% | 100% | 100% | 100% | 100% | Medium |
| 14 | 51% | 98% | 100% | 100% | 100% | Medium |
| 16 | 100% | 100% | 100% | 100% | 100% | High |
| 17 | 90% | 100% | 100% | 100% | 100% | High |
| 19 | 99% | 100% | 100% | 100% | 100% | High |
| 22 | 100% | 100% | 100% | 100% | 100% | High |
| 23 | 99% | 100% | 100% | 100% | 100% | High |
| 24 | 99% | 100% | 100% | 100% | 100% | High |
| 25 | 96% | 100% | 100% | 100% | 100% | High |
| 26 | 100% | 100% | 100% | 100% | 100% | High |
| 28 | 100% | 100% | 100% | 100% | 100% | High |
| 29 | 58% | 100% | 100% | 100% | 100% | Medium |
| 31 | 99% | 100% | 100% | 100% | 100% | High |
| 33 | 83% | 100% | 100% | 100% | 100% | Medium |

# Highways England 2018 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 2018 trial run by TRL and held on the Horiba-MIRA proving ground between 10th and 12th April 2018 and on the Longcross test track on 13th April 2018.

**Other titles from this subject area**

| | |
|---|---|
| **PPR 936** | Highways England 2017 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020 |
| **PPR 937** | Highways Agency 2016 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020 |
| **PPR 938** | Highways Agency 2015 national accreditation trial for sideway-force skid resistance devices. S Brittain. 2020 |
| **CPR 1448** | SCRIM accreditation transitional trial. P Roe, S Brittain, P D Sanders. 2011 |

**TRL**
Crowthorne House, Nine Mile Ride,
Wokingham, Berkshire, RG40 3GA,
United Kingdom
T: +44 (0) 1344 773131
F: +44 (0) 1344 770356
E: enquiries@trl.co.uk
W: www.trl.co.uk

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