

THE FUTURE OF TRANSPORT

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National Highways 2025 UK Dynamic Plate Test Device Accreditation Trial

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Executive Summary

The 2025 UK Dynamic Plate Test (DPT) device accreditation trial was held on the Twin Straights on the Horiba-MIRA proving ground in the week beginning the 29th September 2025. This was the twenty-seventh mandatory DPT accreditation trial to be held in the UK with the objective being to assess the performance of all DPT machines likely to be operating on the National Highways Strategic Road Network (SRN). DPT machines include Falling Weight Deflectometers (FWDs), Heavy Weight Deflectometers (HWDs) and Super Heavy Weight Deflectometers (SHWDs).

The performance of individual machines was assessed by examining and reviewing the results from the machines operating on specified test sections. Only machines that can demonstrate satisfactory performance in the accreditation trial may subsequently be approved for use on the SRN.

A total of twenty-four machines took part in the trial, consisting of:

- Fourteen trailer-mounted Dynatest FWDs;
- Seven trailer-mounted Dynatest HWDs;
- One trailer-mounted Sweco FWD;
- One trailer-mounted Sweco HWD; and
- One trailer-mounted Rincent HWD.

The 2025 trial followed a format similar to the approaches that have been used successfully in previous trials carried out since 1999. Three days are set aside for the trial and for the 2025 trial all three days were used. The first day included machine inspections and initial testing of the machines. The second day was used to reassess machines (following some alterations). The third day was used to reassess machines and to complete the testing.

The assessments undertaken comprised the following:

- Repeatability of deflection measurement (a mandatory test).
- Reproducibility of deflection measurement (a mandatory test).
- Accuracy of measurement of elapsed distance against an independent reference (a mandatory test).
- Accuracy of measurement of pavement temperature (at 100mm and surface temperature) and air temperature against an independent reference (a non-mandatory test); and
- Accuracy of 3-dimensional positional data where fitted (a non-mandatory test).

At the completion of the trial, it was identified that:

- All twenty-four machines met the repeatability of deflection criteria.
- Twenty-three machines met the reproducibility of deflection criteria.
- All twenty-four machines met the measurement of elapsed distance criteria.

- 3-dimensional positional data was supplied by sixteen of the test machines. This data was provided in latitude/longitude/height format during the trial and participants were asked to provide the data converted into Ordnance Survey Grid Reference (OSGR) format after the trial. Using the OSGR converted data, ten machines achieved a high performance level and six a medium performance level.
- All twenty-two operators of the machines provided 100mm pavement temperature measurements using hand-held probes. Nine achieved a high performance rating, elven achieved a medium, three a low and one a not suitable rating.
- Eleven machines provided surface temperature measurements using infra-red thermometers (IRTs) fixed to their machines that were suitable for assessment. Three machines achieved a high performance, four a medium performance, one a low performance and two were identified as not suitable.
- Eleven machines provided air temperature measurements from apparatus fixed to their machines that were suitable for assessment. This data was assessed using the surface temperature criteria. Five machines achieved a high performance, three a medium performance, one a low performance and two were identified as not suitable.

The results for all of the machines are summarised in a single table in Appendix G.

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1 Introduction

Current advice on the use of Dynamic Plate Test devices, (where they are referred to as Falling Weight Deflectometers [FWDs]), provided in CS 229 of the Design Manual for Roads and Bridges (DMRB CS 229, 2025), requires that all of these machines shall be operated in accordance with the Accreditation and Quality Assurance of Dynamic Plate Test Survey Devices document (TRL, 2020). This Accreditation and QA specification document outlines the Accreditation trial procedure that needs to be undertaken. This process forms part of a system to ensure that consistent, high-quality data is obtained from condition surveys. In addition, Defence Estates' Design and Maintenance Guide 27, "A Guide to Airfield Pavement Design and Evaluation" requires that FWDs be approved at an annual accreditation trial before they may be permitted to survey on MoD airfields.

The objectives of the 2025 Dynamic Plate Test (DPT) Accreditation trial were:

- To ensure that all measuring systems are in good mechanical order.
- To ensure consistent performance of individual machines and the reproducibility of all machines, including any supporting measurements (i.e. temperature and location).
- To monitor and seek improvements in performance over the longer term.

The twenty-seventh mandatory UK DPT accreditation trial was held in the week beginning the 29th September 2025, organised on behalf of National Highways. The trial followed a similar format to the approaches that were used in previous trials carried out since 1999. The 2025 trial included the following mandatory checks:

- Reproducibility;
- Repeatability; and
- Distance measurement;

and the following non-mandatory checks:

- Temperature measurement at 100mm, air and surface; and
- OSGR data (obtained from 3-dimensional positional systems).

The deflection tests and associated acceptance criteria are broadly based on those published by the CROW Standards organisation in the Netherlands. In August 2011, CROW issued an updated version of their recommendations (CROW, 2011) which has been used to guide the design of the tests incorporated in this trial.

From 1999 to April 2010, the trials were conducted on the Small Roads System at TRL in Berkshire. The trials were then moved to the Horiba-MIRA Proving grounds in Warwickshire in November 2010 and October 2011. Due to programming issues, the trial returned to the Small Roads System at TRL in November 2012. The 2013 trial, and all subsequent trials, have been held on the proving grounds at Horiba-MIRA.

This report describes the conduct and findings of the September 2025 accreditation trial and presents the details of the machines that took part.

2 Trial details

2.1 Participants

Twenty-four machines (all trailer-mounted) took part in the 2025 National Highways DPT accreditation trial, comprising fifteen Falling Weight Deflectometers (FWD) and nine Heavy Weight Deflectometers (HWD). The machines in attendance were owned by thirteen separate organisations as shown in Table 2.1 (note "FFWD" is a newer FWD type, the Fast FWD and uses an electric motor instead of hydraulics to increase the speed of testing).

Table 2.1: DPT machines attending the trial

Company	Machines brought to trial
AECOM	2 × Dynatest 8002 FWD, 2 × Dynatest 8082 HWD
Alptest	1 x Dynatest 8002 FWD
Atlas Geophysical Limited	1 x Sweco Primax 2100 HWD
Construction Testing Solutions Ltd	1 x Dynatest 8002 FWD
Dynatest	1 x Dynatest 8002 FWD, 1 x Dynatest 8082 HWD
Milestone	1 x Sweco PRI1500 FWD
PMS Ltd.	2 x Dynatest 8002 FWD, 1 x Dynatest 8082 HWD
Pulse Surveying Ltd.	2 x Dynatest 8002 FWD
SOCOTEC	1 x RINCENT HeavyDyn HWD
Stanger	1 x Dynatest 8002 FWD
TRL Ltd.	1 x Dynatest 8002 FWD
Wills Bros Group	1 x Dynatest 8002 FWD
XAIS-PTS	1 × Dynatest 8002 FWD, 3 x Dynatest 8082 HWD 1 x Dynatest 8012 FFWD

More details of the attending machines are provided in Appendix A and example photographs are given in Appendix B.

Throughout this report, the individual machines are referred to by the running numbers assigned to them for the trial. For ease of comparison, machines usually retain the same running number year-on-year.

2.2 Preparation of vehicles

All operators were provided with detailed instructions for the trial and asked to prepare their machines for testing under standard conditions prior to their arrival at the trial, as follows:

- Positions of deflection sensors: 0, 300, 600, 900, 1200, 1500 and 2100 mm. Note: this is the recommended setup described in CS 229 and is different from the positions used for trials before 2013.
- Standard loading plate, diameter 300mm.
- Data storage in standard metric output (".F20" or ".F25" format).

For the repeatability testing the following were also specified:

- Load 50kN (fixed height, seek may not be used).
- Configured for 12 drops at each test station.

For the reproducibility testing the following were also specified:

- Load 50kN (fixed height or seek).
- Configured for 5 drops at each test station.

Operators were also advised to have the peak smoothing function, if available, activated and asked to record and provide time histories.

2.3 Inspection of vehicles

Operators were asked to provide details of the latest manufacturer's calibration and their own dynamic calibrations and stack/tower consistency checks prior to the start of the trial. The machines were subsequently checked by a TRL inspector before testing began to ensure that the geophones were in the correct positions. The configurations are summarised in Appendix A.

2.4 Location of trial

Four test sections were used for the trial, each with different construction and associated deflection levels and all located on the Twin Straights on the Horiba-MIRA proving ground. Each section contained three test stations (12 stations in total), located between the wheelpaths, which were clearly marked out using road paint (see Figure 2.1 below) and swept clear of debris prior to the trial. An additional station (number 13) is located on a concrete section and is used (along with stations 2, 5 and 8) in the repeatability testing. Two additional test lengths were set up; one to allow operators to undertake distance calibrations and one for the odometer test. Construction details for the four deflection test sections can be found in Appendix C. Crews were instructed that the loading plate should be placed completely within the marked box for testing.



Figure 2.1: Test station marked by a painted box

2.5 Temperature monitoring

Pavement temperatures were measured by TRL throughout the trial using five sets of temperature sensors with measurements recorded using data loggers.

Three of the five sets contained thermocouples to measure the 40mm and 100mm pavement temperatures (or the water bucket at station 13) and also the air and pavement surface temperatures. The loggers, connected to the sensors, were set to record the temperature measurement once every minute. These sets were located near station 2, station 10 and station 13.

The remaining two sets, which use platinum resistance probes, were set up on different stations at different parts of the trial. The loggers connected to the sensors were set to record the temperature every second.

The results from these sensors, and the positions of the platinum resistance probes, are further discussed in sections 5.1 and 6.1.

2.6 Planned test programme

Details about the trial, including the test programme and instructions, were provided to all participants in advance of the trial. An outline of the planned trial programme provided to participants, including details on the contingency planning, is reproduced below. The testing conducted, including any changes to the process, are discussed in the rest of the report.

2.6.1 Day 1 – inspection, repeatability and reproducibility testing

All machines are due to arrive on site for 8:30. After arrival on site, participants will be briefed on the test plan and site rules. This will be followed by machine inspections and the repeatability testing. TRL staff members will be available during testing to assist crews with positioning at test stations.

Four stations (2, 5, 8 and 13) have been selected for the repeatability testing. For this testing, two laps of twelve replicate drops at each station are required, with peak values of load and deflection recorded as well as time histories. For the repeatability testing the load “Seek” setting is switched off.

The data from the repeatability laps will be processed by TRL during the test day and feedback provided to operators so that they can investigate their machine, if required, before they take part in the reproducibility laps.

Once the repeatability laps are completed (and processed), the machines will undertake the reproducibility testing.

For the reproducibility testing five replicate drops are made at each of the twelve test stations, with peak values of load and deflection recorded as well as time histories. Each complete set of 12 test stations is referred to as a lap.

Operators will be asked to undertake three reproducibility laps. If time permits, crews will be asked to make temperature measurements using pre-drilled holes (the same ones used for the temperature loggers to measure the 100mm depth). In addition, on returning to the start of the test site, the operators will be asked to measure a predefined length to provide an assessment of the odometers fitted to the equipment. If there is insufficient time available then these measurements (temperature and distance) will be carried out on a later day in the trial.

Data collected will be processed on site. Where appropriate, i.e. if there is an issue with the machine, feedback from this processing will be provided to the operators as soon as possible.

At the completion of the testing on this day, operators will be informed of the selected test plan for day 2.

2.6.2 Day 2 –Investigation of machines and continued testing

The test plan for day 2 will be dependent on the outcomes of the testing on day 1. The two main options for this day are:

- If machines are identified as requiring alterations following testing on day 1 then the morning of day 2 will be set aside to allow these to be undertaken. The remaining machines will return to site for 10:00 to conduct at least 3 reproducibility laps.
- If no machines are identified as requiring alterations then all machines will return to site for 8:30 to complete and outstanding testing.

If significant number of machines require alteration or significant alterations are needed, then consideration will be given to using all of day 2 for alterations and continuing the testing on day 3.

2.6.3 Day 3 – Completion of testing

Day 3 will be used to complete any testing that could not be completed on days 1 and 2 e.g. due to bad weather, a stop testing call from HORIBA-MIRA or other unforeseen events.

3 Machine set-up and configuration

The machine checks on the first day of the trial ran efficiently, due largely to the vehicle inspection check sheets being sent to participants and completed prior to the trial. Most of the machines arrived correctly set up and configured with only minor changes required following inspection by TRL staff.

Appendix A itemises the configuration of the various machines, while Table 3.1 summarises the findings with regards to availability of key information requested in the trial documentation.

Table 3.1: Summary of key information for DPTs provided on arrival

Checklist item	Number compliant (out of 24)
Completed Check list returned to TRL before trial	24
Date of last tower calibration	23
Date of last dynamic calibration	22[1]
Date of last manufacturer's calibration	24

Since the 2007 accreditation trial, it has been agreed with the DPT operators that routine dynamic and tower calibration records be made available for viewing at the accreditation trial. The dates supplied by the contractors for their latest calibrations (regardless of whether evidence of the calibration was supplied) are shown in Appendix A.

[1] One of the two machines that did not provide the date of the last dynamic calibration is a new machine to this process and as such has not started the QA procedure yet.

4 Repeatability testing

Since the repeatability test assesses the ability of the machine to produce repeatable results, this testing can be carried out at different times for each machine (i.e. the results are not temperature dependent and therefore they do not need to test the site in convoy). This testing is conducted using stations 2, 5, 8 and 13 and the results were assessed using the test criteria in Appendix D, D.1.

The first step of the repeatability testing is to produce a valid test dataset. This requires the data to have the load applied within a specified range, and the standard deviation of the load applied also needs to be within a specified range. The requirements for a valid test are also given in Appendix D, D.1.

Some machines had issues providing valid results during the repeatability testing on Day 1. In addition, during the reproducibility testing (discussed in sections 5 and 6) some machines were identified as requiring investigation and subsequently underwent alterations. Therefore, additional repeatability testing for these machines was carried out on Day 2 and Day 3.

Table 4.1 shows a summary of the final results for the repeatability assessment for all machines for geophones D1 to D7. For this testing there are 56 data points per machine (7 geophones x 4 stations x 2 laps). The full details of each repeatability test (identifying the failures and details on load applied) can be found in Appendix E.

Table 4.1: Repeatability assessment

DPT ID	Failures for D1	Failures for D2	Failures for D3	Failures for D4	Failures for D5	Failures for D6	Failures for D7	Percentage met criteria	Status
2	0	0	0	0	0	0	0	100.0%	Pass
5	0	0	0	0	0	0	0	100.0%	Pass
6	0	0	0	0	0	1	0	98.2%	Pass
10	0	0	0	0	0	0	0	100.0%	Pass
11	0	0	0	0	0	0	0	100.0%	Pass
13	0	0	0	0	1	0	1	96.4%	Pass
15	0	0	0	0	0	0	0	100.0%	Pass
16	0	0	0	0	0	0	0	100.0%	Pass
28	0	0	0	0	0	0	0	100.0%	Pass
30	0	0	0	0	0	0	0	100.0%	Pass
32	0	0	0	0	0	0	0	100.0%	Pass
33	0	0	0	0	0	0	0	100.0%	Pass
34	0	0	0	0	0	0	0	100.0%	Pass
37	0	0	0	0	0	0	0	100.0%	Pass
39	1	0	0	0	0	0	0	98.2%	Pass
45	0	0	0	0	0	0	0	100.0%	Pass
47	0	0	0	0	0	0	1	98.2%	Pass
48	0	0	0	0	0	0	0	100.0%	Pass
50	0	0	0	0	0	0	0	100.0%	Pass
52	0	0	0	0	0	0	0	100.0%	Pass
53	0	0	0	0	0	0	0	100.0%	Pass
54	1	0	0	0	0	0	0	98.2%	Pass
56	0	0	0	0	0	0	0	100.0%	Pass
57	0	0	0	0	0	0	0	100.0%	Pass

From Table 4.1, it can be seen that all Machines met the repeatability criteria.

5 Reproducibility testing - Day 1

5.1 Temperature variation – Day 1

The maximum permitted change in the 100mm depth pavement temperature during a test lap is 3°C. The aim of this limit is to minimise changes in deflections due to temperature changes within the pavement construction in each test lap.

During the test days of the trial, pavement temperatures were recorded at 40 and 100mm depths near stations 2 and 10 by TRL. In addition, air and surface temperatures were also collected near these stations. The temperature at depth data collected for Day 1 are shown in Figure 5.1. The air and surface temperatures collected for Day 1 are shown in Figure 5.2.

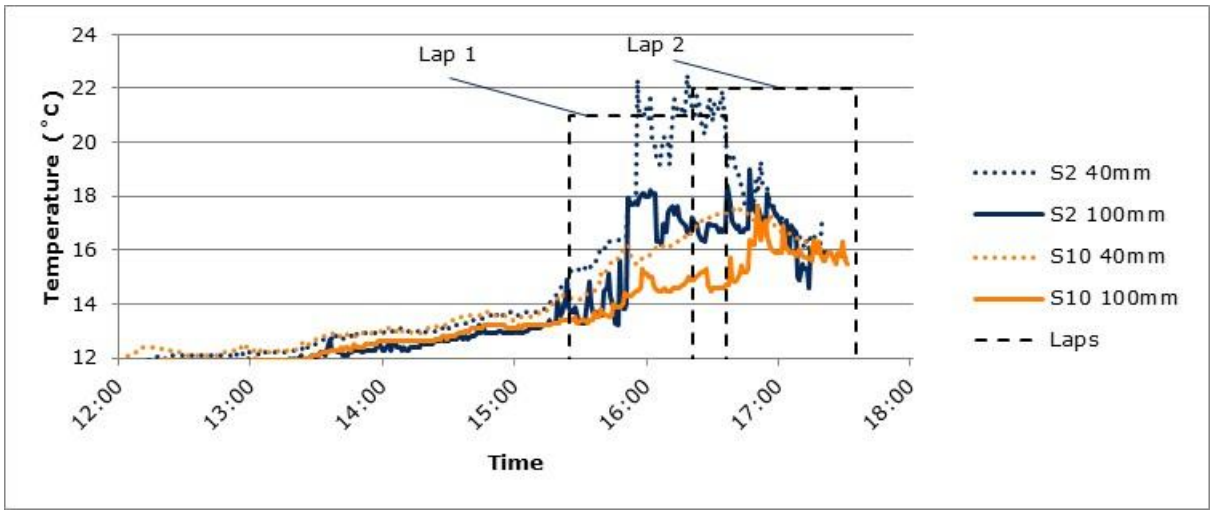

Figure 5.1: Pavement temperatures during Day 1

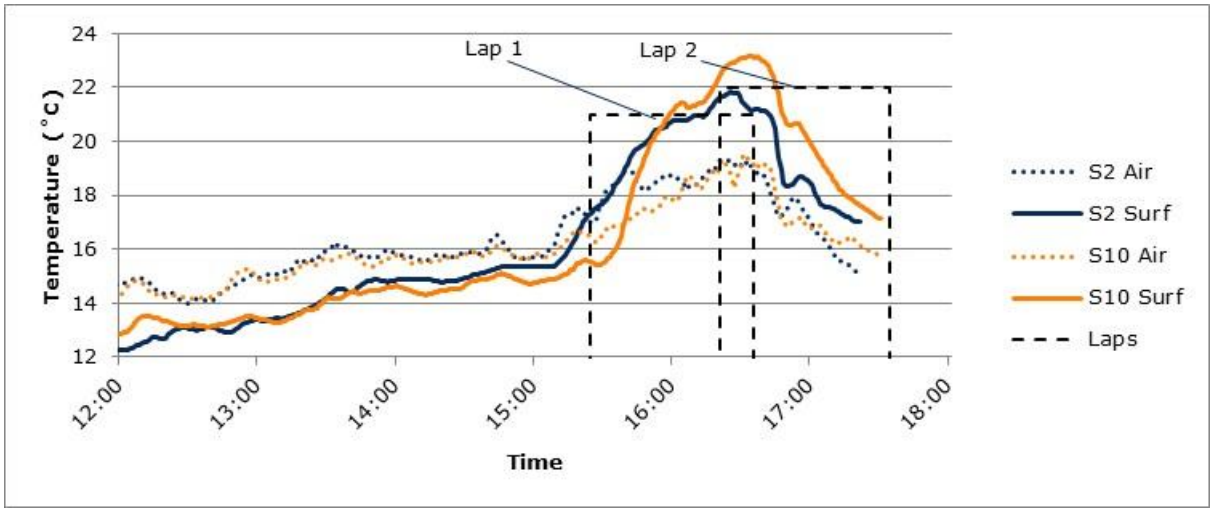

Figure 5.2: Air and surface temperatures during Day 1

Summaries of the pavement temperature measurements for each test lap on Day 1 are given in Table 5.1 and Table 5.2 for stations 2 and 10 respectively.

Table 5.1: Pavement temperatures (˚C) for each lap during Day 1, near station 2

Lap	Start time	Start temp 40mm	Start temp 100mm	End time	End temp 40mm	End temp 100mm	Duration (hh:mm)	Temp diff during lap 40mm	Temp diff during lap 100mm
01	15:25	15.0	13.9	16:36	20.4	16.8	01:11	5.4	2.9
02	16:21	21.3	17.2	17:35	17.0	15.9	01:14	-4.3	-1.3

Table 5.2: Pavement temperatures (˚C) for each lap during Day 1, near station 10

Lap	Start time	Start temp 40mm	Start temp 100mm	End time	End temp 40mm	End temp 100mm	Duration (hh:mm)	Temp diff during lap 40mm	Temp diff during lap 100mm
01	15:25	14.3	13.4	16:36	17.4	14.6	01:11	3.1	1.2
02	16:21	16.6	14.9	17:35	15.7	15.5	01:14	-0.9	0.6

It can be seen that the 100mm depth temperatures where within the 3°C limit on all laps on Day 1.

5.2 Reproducibility testing – Day 1

In order to evaluate the performance of each machine with regards to reproducibility, two laps are required (see Appendix D for further details). Due to the chances of isolated anomalous geophone readings, the accreditation rules permit the measurement from a single geophone from one test station to be removed from each reproducibility lap.

During Day 1, two reproducibility laps were undertaken. It was decided that if all machines met the deflection criteria at this stage of the testing then Day 2 would be used to collect the remaining temperature and distance measurements, as required. However, a number of machines did not meet all the criteria on Day 1. Therefore, the operators were given the opportunity to investigate their machines and all machines were retested on Day 2 followed by some additional testing on Day 3. The results of the Day 2 testing are discussed in section 6 and Day 3 in section 7.

During this testing, Machines 50 and 54 were unable to take part in testing on lap 1 and therefore only one lap is shown for these machines in the graphs below.

The Field Calibration Factor (FCF) and Standard Deviation of the Deviation Ratio (SDDR) values derived from each machine's lap are given in Appendix F, F.1 (including the laps done on Days 2 and 3). To clearly distinguish between the test days, the first lap on Day 2 was labelled as 21 and the first lap on Day 3 was labelled as 31. Further details on the FCF and SDDR, and how they are calculated, are given in Appendix D.

5.2.1 Plots of FCF and SDDR (prior to geophone removal)

Plots of the FCF and SDDR values (before removal of a single data point) for laps 1 and 2 on day 1 are shown in Figure 5.3 and Figure 5.4 (FCF and SDDR, respectively). In these figures, the circle and square show the mean FCF and SDDR, respectively, for the machine on the lap.

The error bars show the range of the FCF and SDDR values for each geophone. Machines would be deemed suitable if the mean FCFs are within the mean limit (i.e. between 0.95 and 1.05), the individual FCFs within the individual limit (i.e. between 0.90 and 1.10), and the SDDR mean and individual values are below their corresponding limits (0.05 and 0.07 respectively).

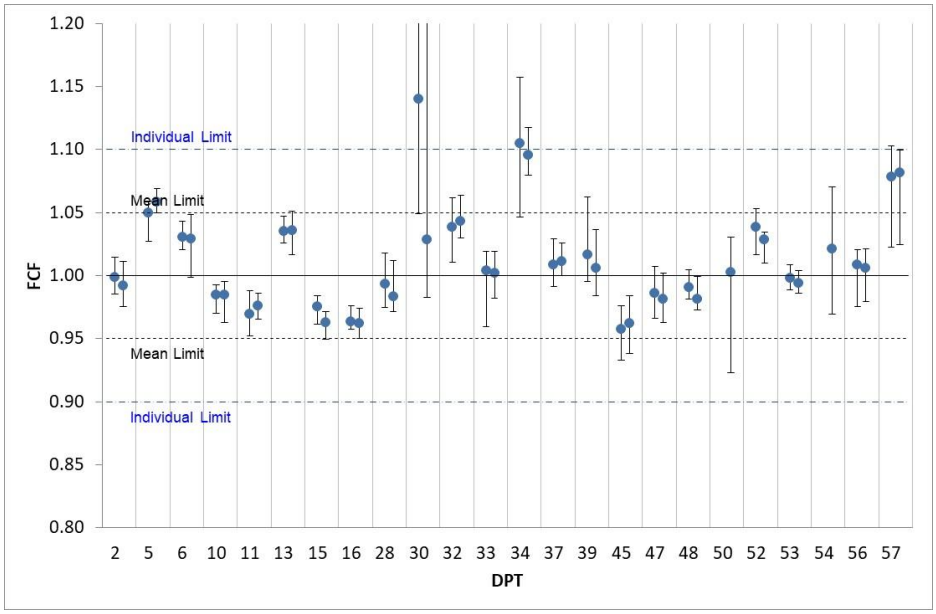

Figure 5.3: FCFs, day 1 last two laps– full dataset

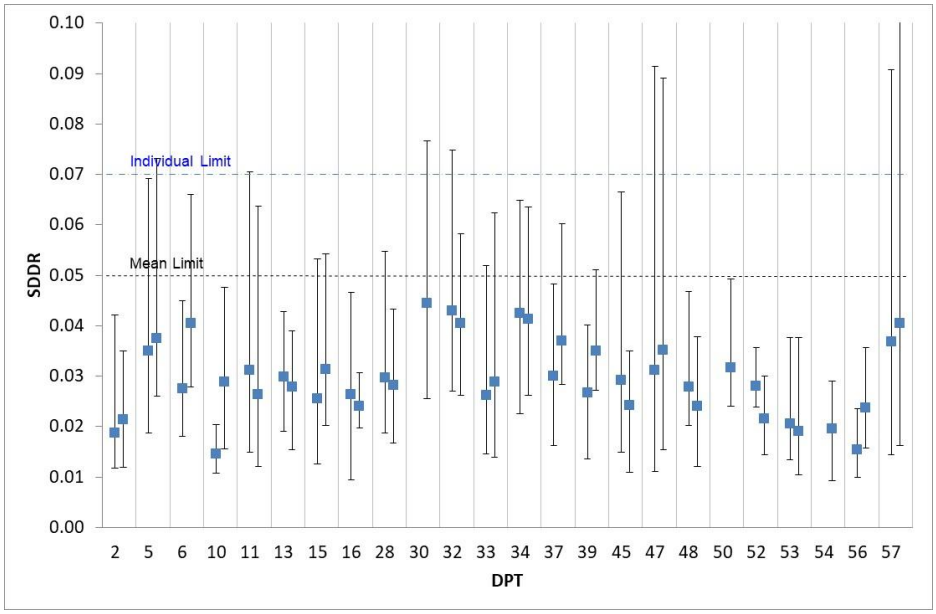

Figure 5.4: SDDRs, day 1 last two laps – full dataset

From Figure 5.3 and Figure 5.4, it can be seen that (prior to removal of single geophone points):

- Machine 5 is producing Mean FCF values too high and the individual SDDR limit is exceeded.
- Machine 11 is exceeding the individual SDDR limit.

- Machine 30 is producing FCF values too high for both the mean and the individual geophones. In addition, the SDDR is also too high for both the mean and individual geophones.
- Machine 32 exceeds the limit for individual SDDR.
- Machine 34 is producing FCF values too high for both the mean and the individual geophones.
- Machine 47 exceeds the limit for individual SDDR.
- Machine 57 is producing FCF values too high for both the mean and the individual geophones. In addition, the SDDR is also too high for individual geophones.

5.2.2 Plots of FCF and SDDR (after geophone removal)

As previously noted, due to chances of isolated anomalous geophone readings, the process permits the measurement from a single geophone from one test station to be removed from each reproducibility lap. The data from the last two laps from Day 1 after removal of a single data point (where required) are shown in Figure 5.5 and Figure 5.6.

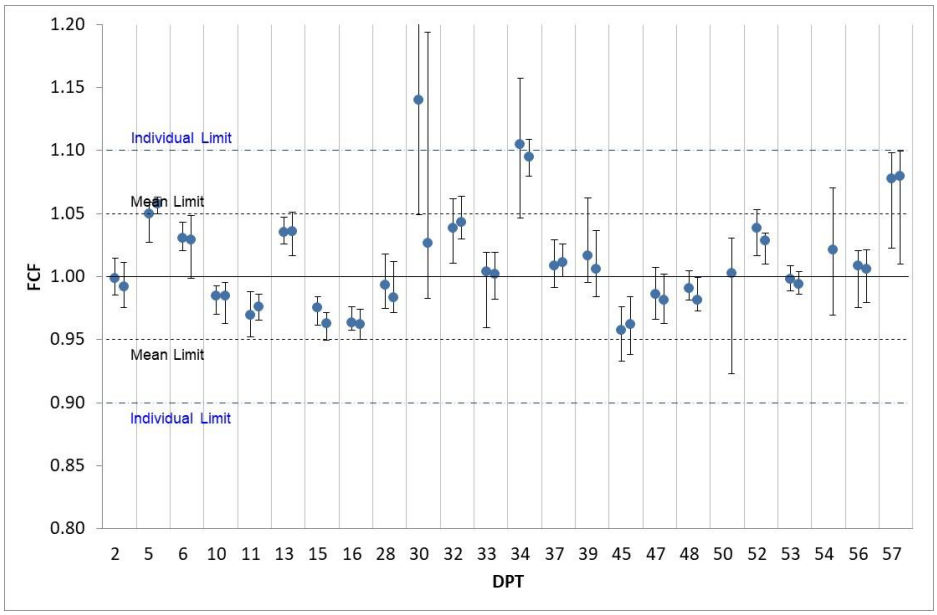

Figure 5.5: FCFs, day 1 last two laps – single data point removed where required

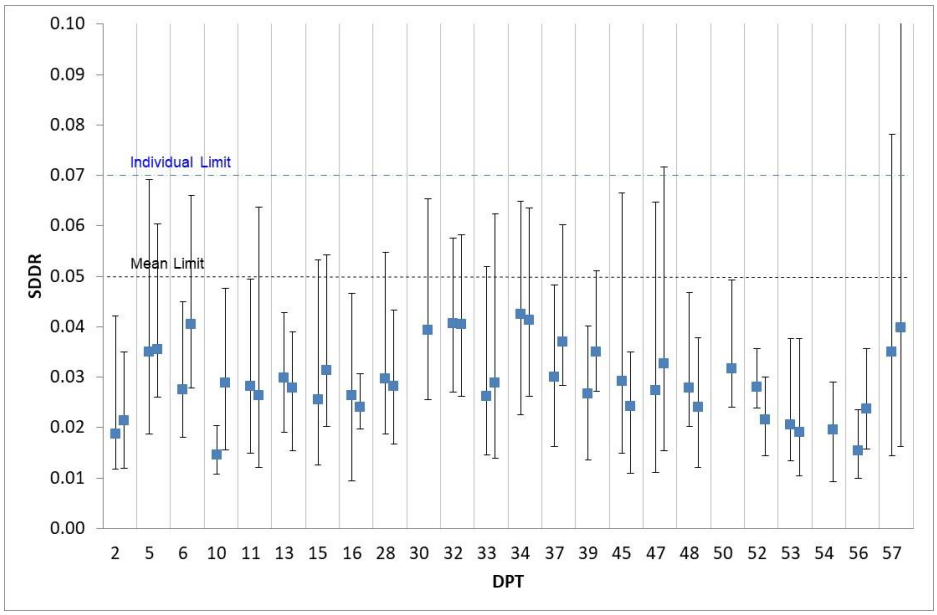

Figure 5.6: SDDRs, day 1 last two laps – single data point removed where required

From this data, it can be seen that some machines are still not meeting the FCF, SDDR or both. This information was fed back to operators and is discussed below.

5.2.3 Feedback provided following testing on Day 1

Following the processing of data from Day 1, the following feedback was provided to the operators:

- **Machine 5**. This machine was too high for the mean FCF on lap 2 and was on the threshold for lap 1.
- **Machine 30**. This machine was too high for the mean FCF on lap 1 and was too high for individual geophones for FCF on both laps. In addition, the SDDR exceeded the limit for both the mean and individual geophones on lap 1.
- **Machine 34**. This machine was too high for the mean and individual geophones for FCF on both laps.
- **Machine 47**. This machine exceeded the threshold for SDDR on individual geophones for lap 2.
- **Machine 57**. This machine was too high for the mean for FCF on both laps. In addition, it exceeded the threshold for SDDR on individual geophones on both laps.

Prior to testing on Day 2 the relative gain of the loadcells were lowered on machines 5, 30, 34 and 57. No changes were made for Machine 47.

6 Reproducibility testing – Day 2

6.1 Temperature variation – Day 2

The temperatures recorded by the TRL data loggers for the 40 and 100mm depths near stations 2 and 10 for Day 2 are shown in Figure 6.1. The corresponding air and surface temperatures for these stations are shown in Figure 6.2. Note, to clearly differentiate from the testing on day 1, the first lap on Day 2 was called lap 21.

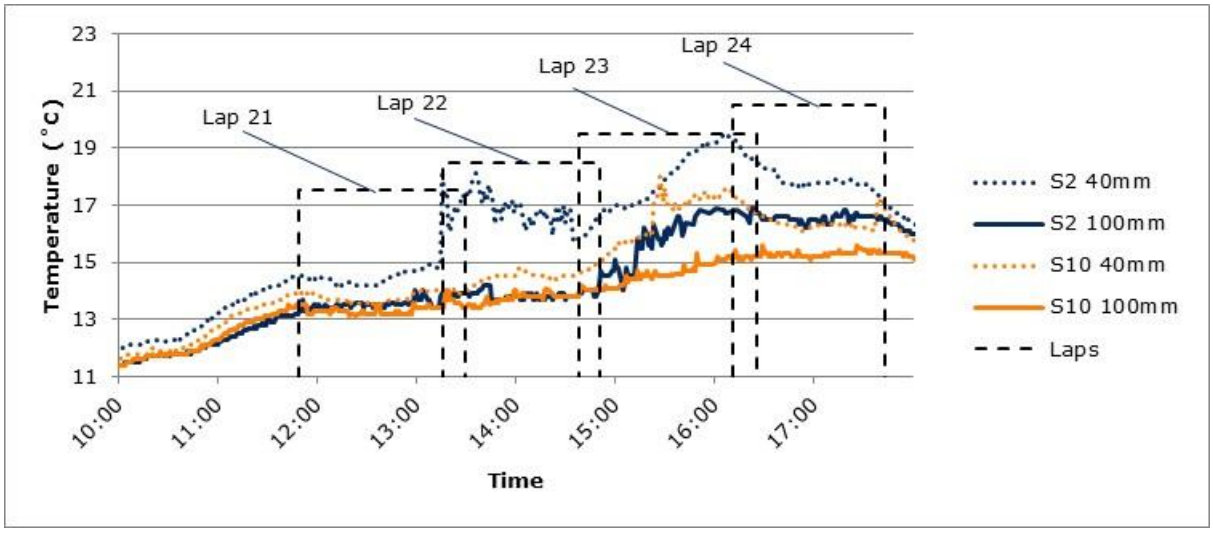

Figure 6.1: Pavement temperatures during Day 2

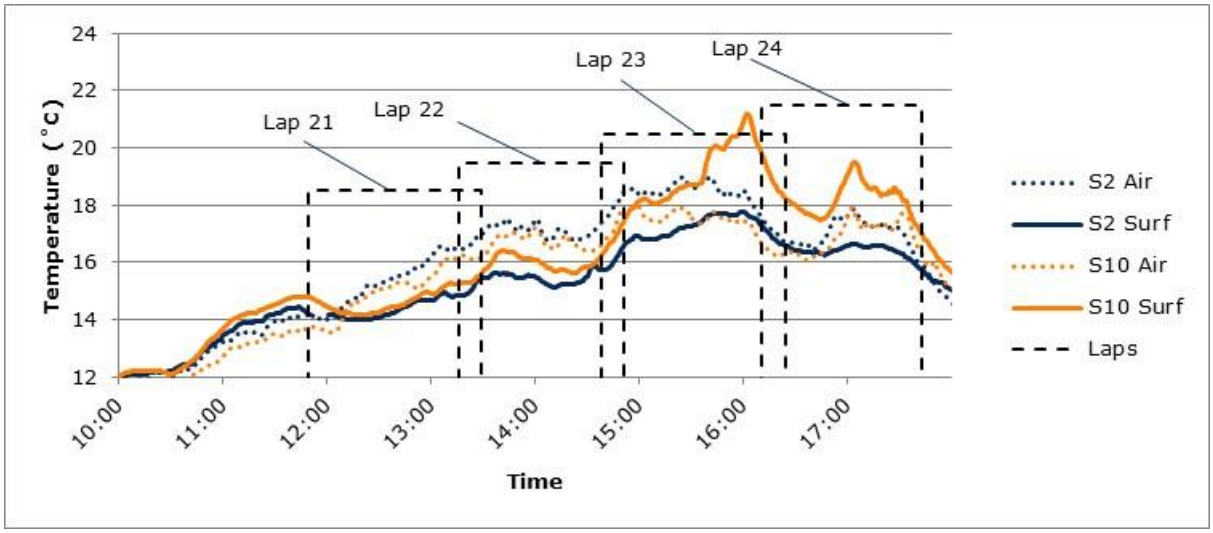

Figure 6.2: Air and surface temperatures during Day 2

Summaries of the pavement temperature measurements for each test lap on Day 2 are given in Table 6.1 and Table 6.2 for stations 2 and 10, respectively.

Table 6.1: Pavement temperatures (˚C) for each lap during Day 2, near station 2

Lap	Start time	Start temp 40mm	Start temp 100mm	End time	End temp 40mm	End temp 100mm	Duration (hh:mm)	Temp diff during lap 40mm	Temp diff during lap 100mm
21	11:49	14.5	13.2	13:29	17.4	13.9	01:40	2.9	0.7
22	13:16	18.2	13.9	14:51	16.5	14.2	01:35	-1.7	0.3
23	14:38	15.8	13.8	16:25	18.6	16.9	01:47	2.8	3.1
24	16:11	19.3	16.7	17:43	17.1	16.5	01:32	-2.2	-0.2

Table 6.2: Pavement temperatures (˚C) for each lap during Day 2, near station 10

Lap	Start time	Start temp 40mm	Start temp 100mm	End time	End temp 40mm	End temp 100mm	Duration (hh:mm)	Temp diff during lap 40mm	Temp diff during lap 100mm
21	11:49	13.9	13.5	13:29	14.0	13.4	01:40	0.1	-0.1
22	13:16	14.0	13.4	14:51	15.0	14.0	01:35	1.0	0.6
23	14:38	14.6	13.8	16:25	16.7	15.2	01:47	2.1	1.4
24	16:11	17.3	15.2	17:43	16.8	15.3	01:32	-0.5	0.1

It can be seen that the differences in 100mm depth temperatures were within the limit (3°C) for all but one instance (station 2 lap 23) on Day 2. As such, additional caution may need to be applied when considering data from lap 23.

6.2 Reproducibility testing – Day 2

To evaluate the performance of each machine with regards to reproducibility, two laps are chosen from the test set. To distinguish these chosen laps, they are denoted as lap i and lap ii. For the majority of the machines, the laps chosen for i and ii were laps 23 and 24 (the last two laps of day 2). The exception to this was Machine 13, which performed suitably throughout the trial but had some issues on lap 24. Laps 22 and 23 were selected for this machine.

The FCF and SDDR values derived from each machine's lap are given in Appendix F, F.1 (including the laps from Day 1 and Day 3).

Prior to testing on this day, the machines identified with issues on day 1 were given the opportunity to investigate their devices. During the initial testing on this day, issues were found with the following machines:

- **Machine 30**. On lap 21, this machine was found to be too high on FCF for individual geophones (D7) and was investigated. Following investigation, geophone D7 was swapped for a spare. It missed out on lap 22 and then took part in the remaining laps.
- **Machine 32**. This machine did not take part in lap 21. On lap 23, the mean FCF was too high. The machine was altered after lap 24 and it collected data on its own to see if the alteration appeared to fix the issue. The alteration made was to adjust the relative gain on the loadcell.

- **Machine 34.** This machine was too high for both the mean FCF and the individual geophone for SDDR (D7) on lap 21. On lap 22, this machine was too high for the mean FCF. It was altered before lap 23. The alteration made was to adjust the relative gain on the loadcell and to replace geophones D6 and D7.
- **Machine 47.** On lap 23, this machine exceeded the limit for the individual SDDR (D7). This machine was altered before lap 24. The alteration made was to replace geophone D7.
- **Machine 57.** On laps 21 and 22, this machine was too high for the individual and mean FCF. It also exceeded the limit for individual SDDR (D7) on lap 21 and both individual (D6 and D7) and mean SDDR on lap 22. It was altered before lap 23. The alteration made was to adjust the relative gain on the loadcell and to replace geophone D7.

6.2.1 Plots of FCF and SDDR (prior to geophone removal)

The results from laps i and ii (prior to the removal of individual geophone readings) are shown graphically in Figure 6.3 for FCF and Figure 6.4 for SDDR. The vertical bars in these figures indicate the range of values from individual sensors and the filled circles/squares indicate the mean value for all seven sensors.

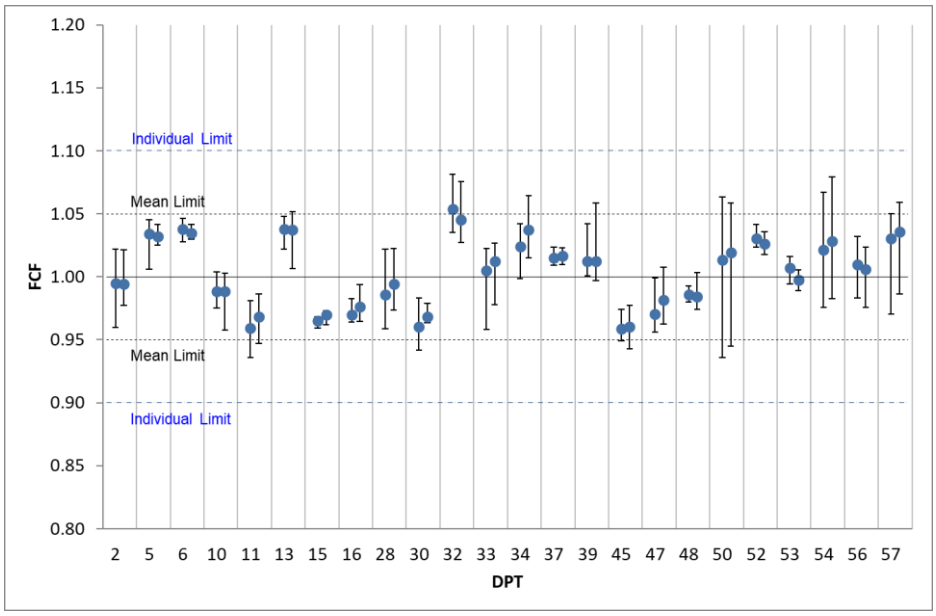

Figure 6.3: FCF for each DPT (Day 2 for laps i and ii – full dataset)

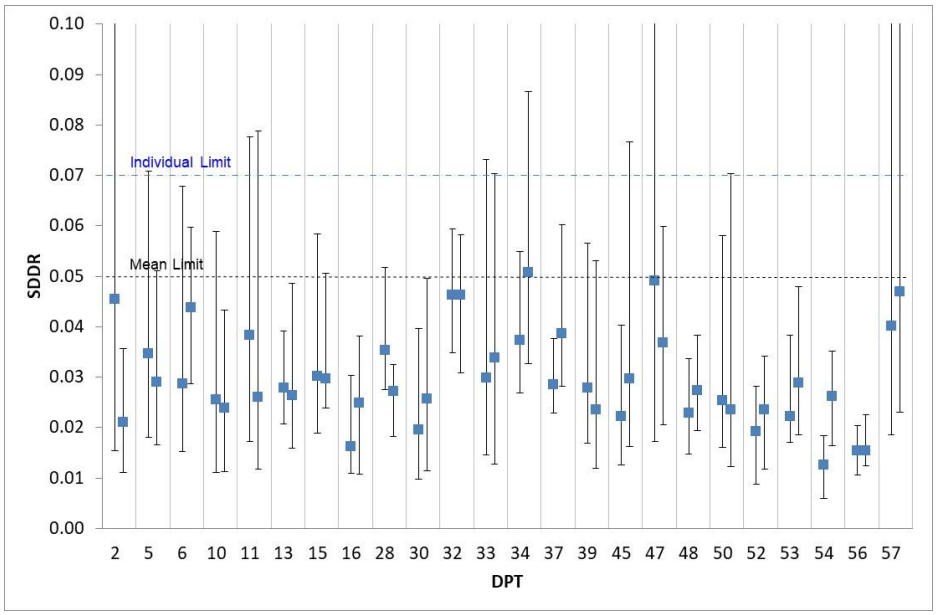

Figure 6.4: SDDR for each DPT (Day 3 for laps i and ii – full dataset)

From these two figures, the following observations (before geophone removal) can be made:

- **Machine 2**. Exceeds the individual SDDR limit on lap i.
- **Machine 5**. Exceeds the individual SDDR limit on lap i.
- **Machine 11**. Exceeds the individual SDDR limit on both laps.
- **Machine 32**. Produces a mean FCF too high on lap i.
- **Machine 33**. Exceeds the individual SDDR limit on both laps.
- **Machine 34**. Exceeds the individual and mean SDDR limit on lap ii.
- **Machine 45**. Exceeds the individual SDDR limit on lap ii.
- **Machine 47**. Exceeds the individual SDDR limit on lap i.
- **Machine 50**. Exceeds the individual SDDR limit on lap ii.
- **Machine 57**. Exceeds the individual SDDR limit on lap i. Exceeds the mean and individual SDDR limit on lap ii.

6.2.2 Plot of FCF and SDDR (after geophone removal)

The results from laps i and ii (after geophone removal for identified machines) are shown graphically in Figure 6.5 for FCF and Figure 6.6 for SDDR.

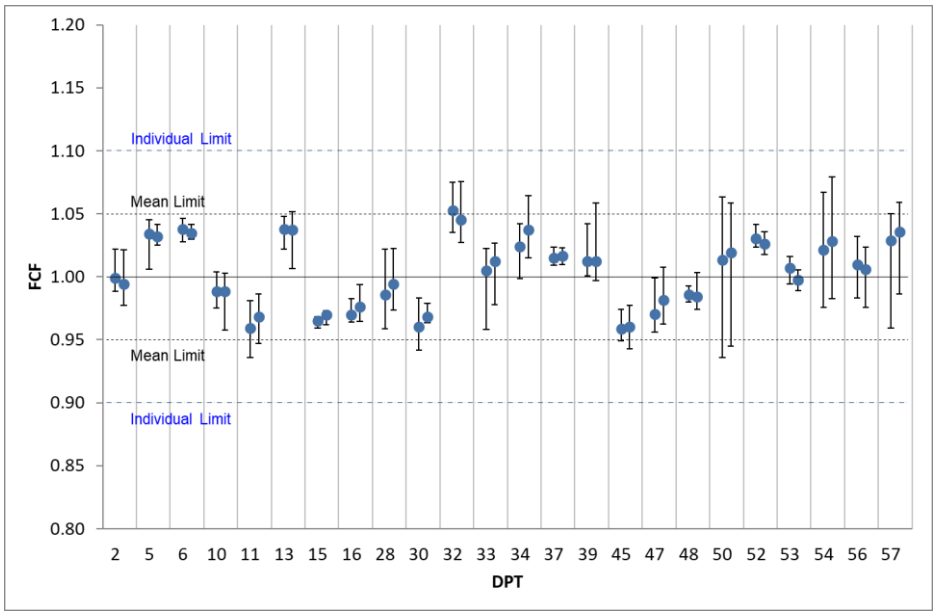

Figure 6.5: FCF for each DPT (laps i and ii – single data point removed where required)

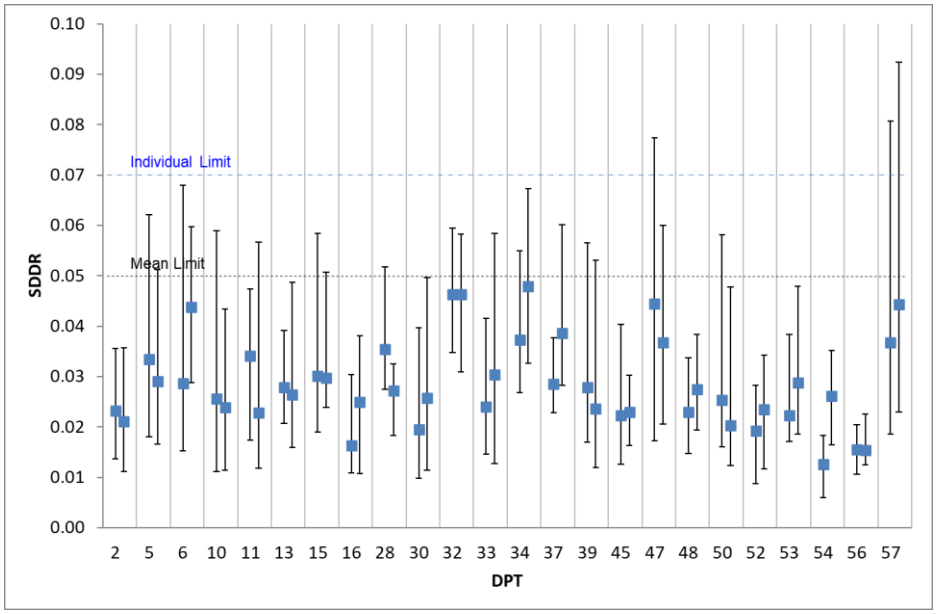

Figure 6.6: SDDR for each DPT (laps i and ii – single data point removed where required)

Following the removal of a single geophone reading from one station on each lap (where required) it can be seen that:

- **Machine 32**. Produced mean FCF too high on lap i.
- **Machine 47**. Exceeded the individual SDDR limit on lap i.
- **Machine 57**. Exceeded the individual SDDR limit on both laps.

Due to these remaining issues, it was decided that further testing would be carried out on Day 3 using a sub-set of machines. In addition, day 3 would be used to carry out additional

repeatability laps (for machines which undertook alterations during this day) and to complete the distance assessment for devices which needed to recalibrate (discussed in section 8.1).

7 Testing on Day 3

The accreditation trial is planned as a three-day trial, with the third day used to complete any testing that could not be completed on days 1 and 2 e.g. due to bad weather, a "stop testing" call from HORIBA-MIRA, or other unforeseen events.

For the 2025 trial, Day 3 was used to carry out additional testing.

7.1 Temperature variation – Day 3

The temperatures recorded by the TRL data loggers for the 40 and 100mm depths near stations 2 and 10 for Day 3 are shown in Figure 7.1. The corresponding air and surface temperature data for these stations on Day 3 are shown in Figure 7.2. Note, to differentiate from the testing on the previous days, the first lap on Day 3 was called lap 31.

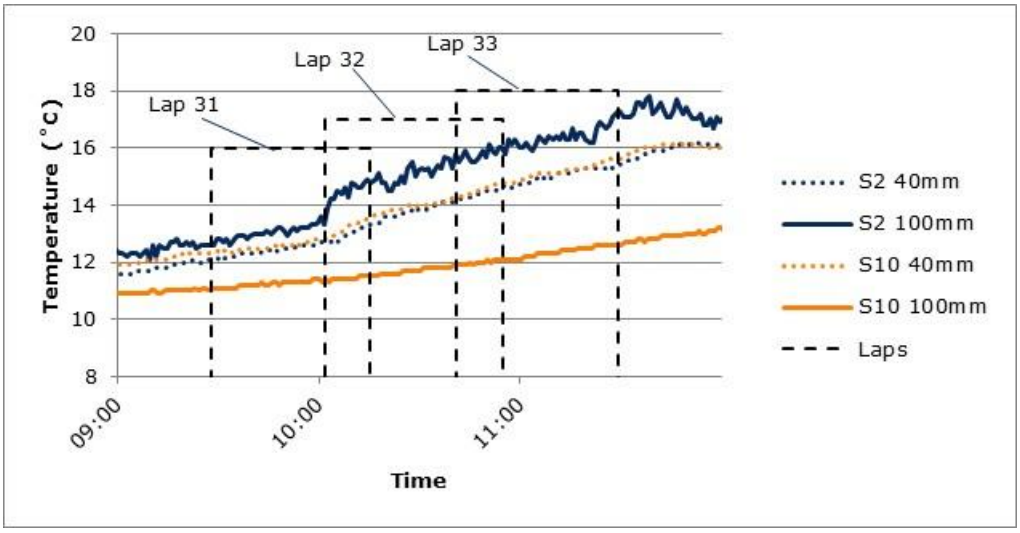

Figure 7.1: Pavement temperatures during Day 3

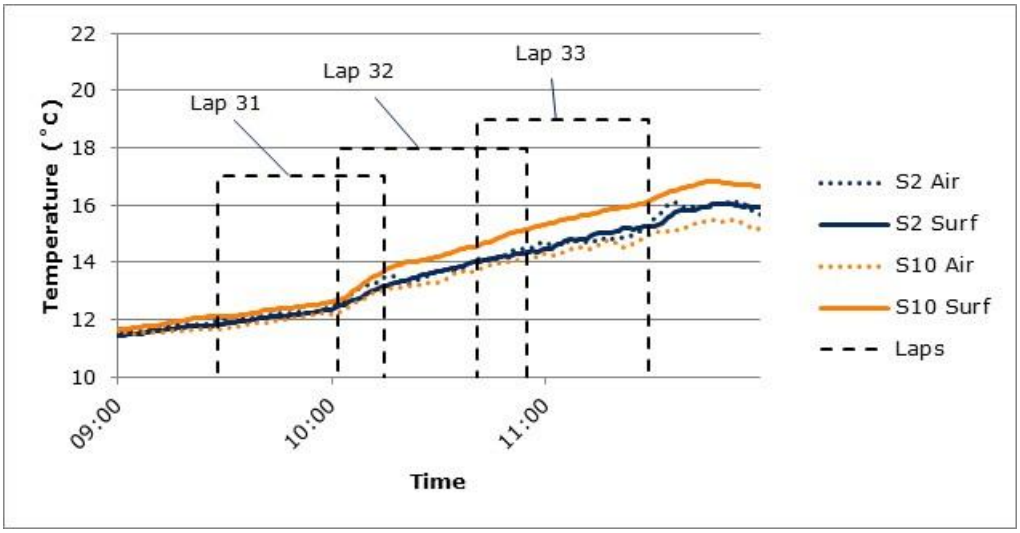

Figure 7.2: Air and surface temperatures during Day 3

The pavement temperature measurements for each test lap on Day 3 are summarised in Table 7.1 and Table 7.2 for stations 2 and 10 respectively.

Table 7.1: Pavement temperatures (˚C) for each lap during Day 3, near station 2

Lap	Start time	Start temp 40mm	Start temp 100mm	End time	End temp 40mm	End temp 100mm	Duration (hh:mm)	Temp diff during lap 40mm	Temp diff during lap 100mm
31	09:28	12.1	12.6	10:15	13.3	14.9	00:47	1.2	2.3
32	10:02	12.7	13.3	10:55	14.6	16.0	00:53	1.9	2.7
33	10:41	14.1	15.8	11:29	15.4	17.2	00:48	1.3	1.4

Table 7.2: Pavement temperatures (˚C) for each lap during Day 3, near station 10

Lap	Start time	Start temp 40mm	Start temp 100mm	End time	End temp 40mm	End temp 100mm	Duration (hh:mm)	Temp diff during lap 40mm	Temp diff during lap 100mm
31	09:28	12.3	11.0	10:15	13.5	11.5	00:47	1.2	0.5
32	10:02	12.8	11.3	10:55	14.7	12.1	00:53	1.9	0.8
33	10:41	14.3	11.9	11:29	15.6	12.6	00:48	1.3	0.7

It can be seen that the differences in 100mm depth temperatures were within the limit (3°C) for all laps on Day 3.

7.2 Reproducibility testing – Day 3

To assess the updated performance of machines 32, 47 and 57, three reproducibility laps (31, 32 and 33) were undertaken using a reduced fleet. To provide reference data (and, in some cases, to collect additional repeatability or distance measurements) machines 6, 30, 34, 45, 50, and 53 also took part in testing.

To investigate the updated performance of the machines identified as outliers in day 2, the data from the last two reproducibility laps on day 3 were analysed. This data was compared to the averages from day 2 using the data from the additional devices to calculate conversion factors. The process undertaken for this was to:

1. Calculate the average of laps 23 and 24 for each station and geophone for all devices – referred to as Day 2 average fleet mean
2. Calculate the average of laps 23 and 24 for each station and geophone for the reference machine subset – referred to as Day 2 average reference devices
3. Divide the Day 2 average reference device values by the average of the reference machine subset for lap 32 to produce conversion factors for each station and geophone on lap 32 back to day 2.
4. Apply these conversion factors for each assessed machine in lap 32, and calculate the FCF and SDDR values for these machines using the Day 2 average fleet mean.

5. Repeat steps 3 and 4 for laps 33, and 34.

7.2.1 Plots of FCF and SDDR (prior to geophone removal)

The results from laps 32 and 33 (reprocessed to compare to the day 2 average, prior to the removal of individual geophone readings) are shown graphically in Figure 7.3 and Figure 7.4.

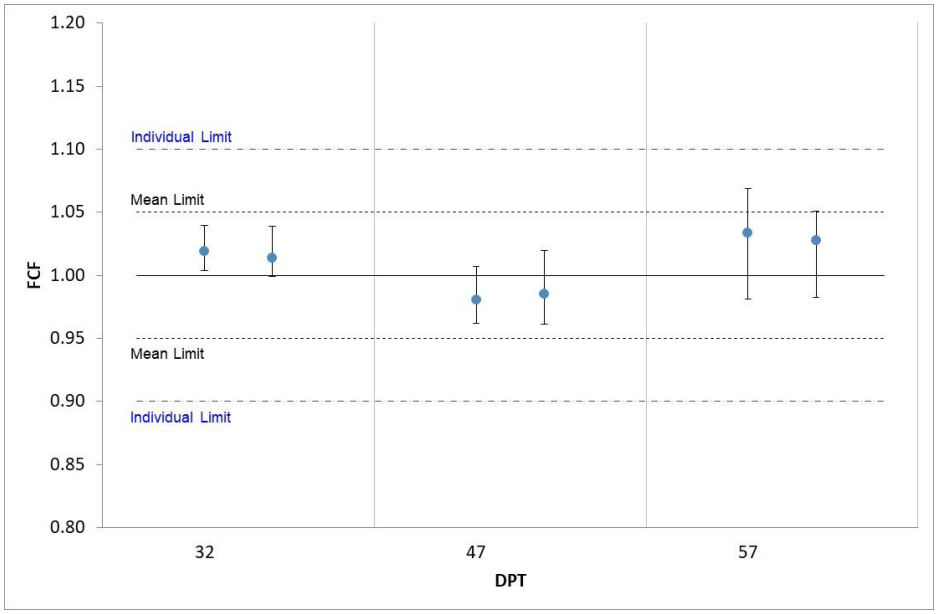

Figure 7.3: FCF for each DPT (Day 3 for laps 32 and 33 – full data set)

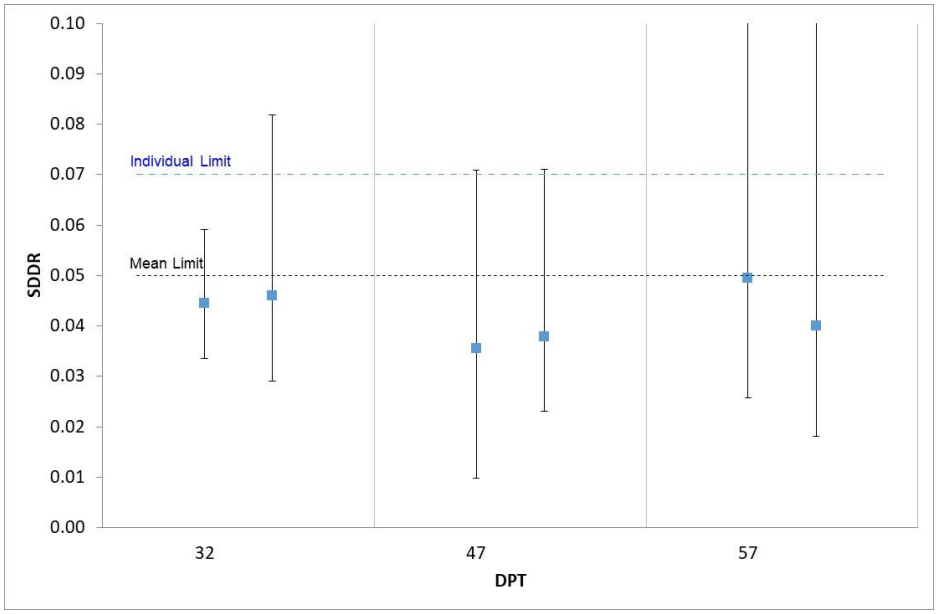

Figure 7.4: SDDR for each DPT (Day 3 for laps 32 and 33 – full data set)

It can be seen from Figure 7.3 that all three machines meet the FCF criteria. From Figure 7.4 it can be seen that all three machines exceed the individual SDDR criterion on one or both laps when using the full set of data.

7.2.2 Plot of SDDR (after geophone removal)

The SDDR results from laps 32 and 33 (reprocessed to compare to the day 2 average, after geophone removal, where required) are shown graphically in Figure 7.5.

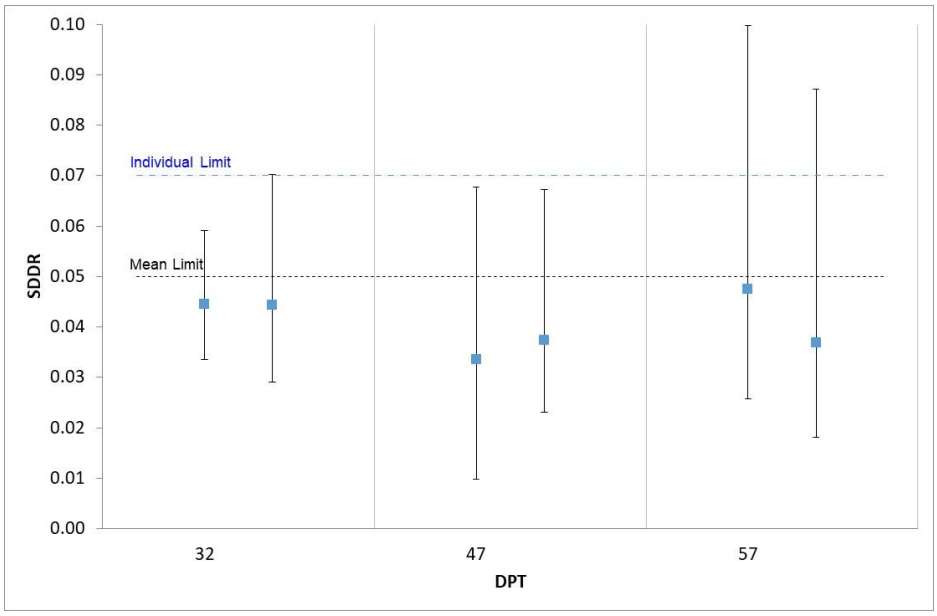

Figure 7.5: SDDR for each DPT (Day 3 for laps 32 and 33 – single data point removed where required)

Following the removal of a single geophone reading from one station on each lap, it can be seen that machines 32 and 47 are now within the individual SDDR criterion. However, Machine 57 does not meet the individual SDDR criterion on either lap.

8 Distance and OSGR

8.1 Distance measurement tests

In order to assess the measurement of distance, the operators were asked to measure the distance between two marker cones. The distance between them, 531.28m, was not provided to the operators.

The criteria applied to this data in previous years are described in Appendix D, D.1. However, it has been identified that the criteria were too easy to meet and did not assess the performance that these devices can achieve. Therefore, following discussions with the FWD User Group, an amended set of criteria were agreed (as shown below) and have been used since the 2024 trial. The criteria will be updated in a future version of the Accreditation and QA specification. The test is carried out at least four times, and a pass is awarded if 80% of the measurements are within ±2m or 0.1% of the measurement length (whichever is greater). Therefore, for this trial the criteria was within ±2m.

During the initial testing, five machines (6, 30, 45, 50 and 53) were found to be outside of the tolerance (measuring up to 2.4m longer and 3.3m shorter than the length). These machines were subsequently recalibrated and additional measurements were taken on days 2 and 3 to provide a full set of post-calibration measurements.

The differences between the final operator measurements and the reference length are given in Table 8.1 (negative denotes the operator recorded a shorter length). In this table, the data is shown in grey if the difference measured was within or equal to 1m of the reference value and highlighted in bold and red font if the difference measured was greater than the tolerance (i.e. 2m).

Table 8.1: Difference (m) between operators' measured values and reference

DPT ID	Difference Lap a	Difference Lap b	Difference Lap c	Difference Lap d	Performance
2	-0.3	-0.3	-0.3	-0.3	Pass
5	0.1	-0.1	0.0	-0.1	Pass
6	-0.1	-0.1	-0.2	-0.1	Pass
10	-1.3	-0.3	-0.3	-0.3	Pass
11	1.7	1.7	1.7	1.7	Pass
13	-0.3	-0.3	-0.3	-0.3	Pass
15	-0.3	-0.3	0.7	-0.3	Pass
16	-1.3	-1.3	-1.3	-1.3	Pass
28	1.7	1.7	1.7	1.7	Pass
30	-0.1	-0.3	-0.1	-0.2	Pass
32	-0.3	-0.3	-0.3	-0.3	Pass
33	-0.3	-0.3	-0.3	-0.3	Pass
34	-1.3	-1.3	-1.3	-1.3	Pass
37	-0.3	-0.3	0.7	-0.3	Pass
39	-0.4	0.5	0.0	-0.1	Pass
45	-1.3	-1.3	-1.3	-1.3	Pass
47	0.2	0.2	0.2	-0.3	Pass
48	0.7	-0.3	0.5	0.1	Pass
50	0.1	0.1	0.1	0.5	Pass
52	-0.3	-0.3	-0.3	-0.3	Pass
53	-0.3	-0.3	-0.3	-0.3	Pass
54	-1.3	-1.3	-1.3	-0.3	Pass
56	0.7	-0.3	0.7	-0.3	Pass
57	-0.3	-0.3	-0.3	-0.3	Pass

It can be seen from this table that all machines met the trial criteria. In addition, 75% of the measurements were within 1m of the reference distance.

8.2 OSGR measurements (from 3-dimensional positional data)

3-dimensional positional data were supplied for assessment by 16 of the 24 machines at the trial. These machines all provided the data in lat/long/height format. However, the accreditation specification states that the data should be in OSGR format (eastings and northings). Therefore, the operators were asked to convert this data to OSGR format and to provide both datasets for review. The horizontal offset from the reference point estimated from the lat/long data was compared against the horizontal offset from the reference point for the supplied OSGR data. This was done to check for anomalies in the conversion. This found a few instances of the operators using a simplified conversion for the process. The affected operators were asked to resubmit their data using the official conversion and to ensure that 3-dimensional positional data is processed using the official conversion in future.

The performance of each machine was then assessed using the provided OSGR data. The percentage of the data within 2m, 5m and 10m for each of the machines that supplied

positional data is given in Table 8.2. This data is highlighted in bold and red text if the percentage is below 75% for any of the criteria.

Table 8.2: Assessment of positional data

DPT ID	Percentage within 2m of reference	Percentage within 5m of reference	Percentage within 10m of reference	Performance band
6	89.8%	100.0%	100.0%	High
11	**50.0%**	100.0%	100.0%	Medium
13	95.8%	100.0%	100.0%	High
16	86.1%	98.6%	98.6%	High
28	100.0%	100.0%	100.0%	High
30	85.4%	100.0%	100.0%	High
32	100.0%	100.0%	100.0%	High
33	100.0%	100.0%	100.0%	High
34	100.0%	100.0%	100.0%	High
39	76.4%	98.6%	100.0%	High
47	**73.1%**	85.2%	88.0%	Medium
48	87.5%	100.0%	100.0%	High
50	**29.2%**	91.7%	100.0%	Medium
52	**40.3%**	100.0%	100.0%	Medium
54	**33.8%**	100.0%	100.0%	Medium
56	**63.9%**	100.0%	100.0%	Medium

It can be seen from Table 8.2 that ten machines achieved the high performance rating, and six machines achieved medium.

9 Operator temperature measurements

9.1 Temperature at depth (100mm)

The DPT operators were asked to use their own equipment to record temperatures from two pre-drilled holes and the temperature of water in a bucket during Days 1 and 2 so that the accuracy of their temperature collection could be assessed. These holes are drilled to 100mm depth and located near stations 2 and 10. These holes have glycerol added to the bottom to get good thermal contact and the levels are periodically checked during the trial. The water bucket was located near to station 13.

During the testing on day 1, it was identified that many operators were unclear on which holes they should be taking measurements from. Additional clarification was provided so that all operators collected data from the correct holes on day 2. As such the day 1 data from the pre-drilled has been disregarded.

The operators' data is compared to the data collected by temperature data loggers located in the same holes and water bucket. However, during the review of data, it was identified that the logger measurements were not always suitable for use in the assessment and therefore it was decided that the fleet average would be used as the reference for the assessment.

The temperatures recorded by the operators using temperature probes are plotted against the reference in Figure 9.1 to Figure 9.4.

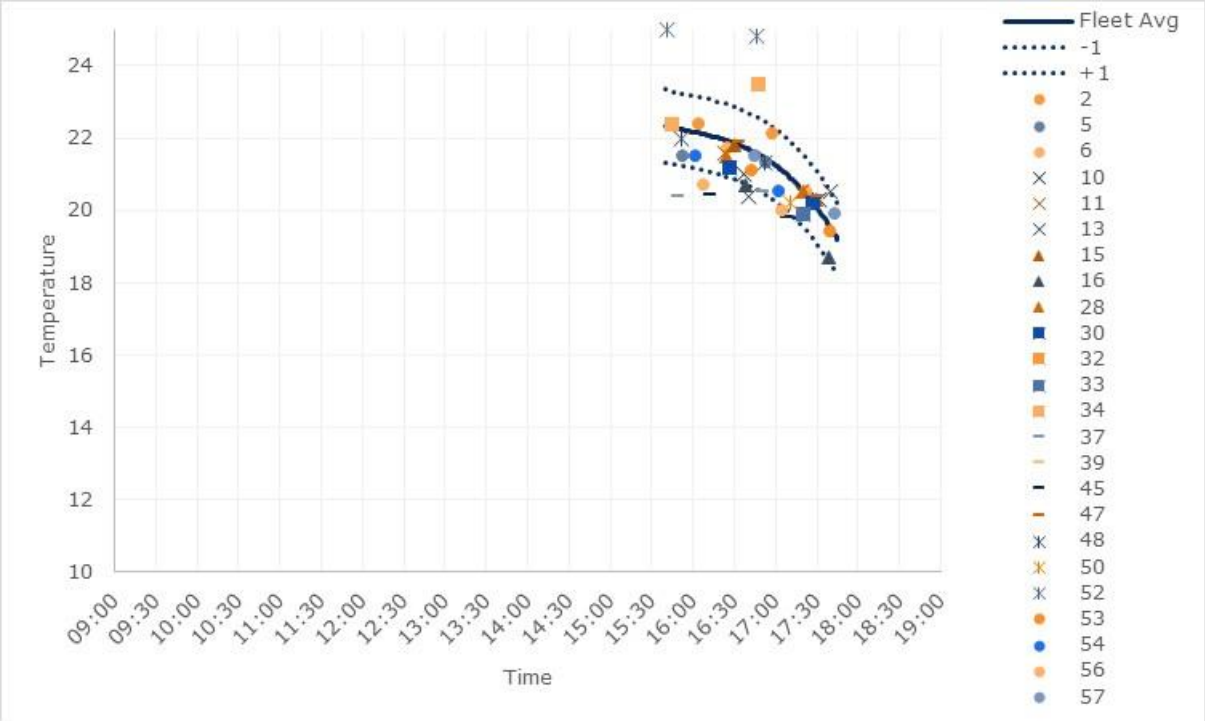

Figure 9.1: Operators' and reference temperatures (Day 1 water bucket)

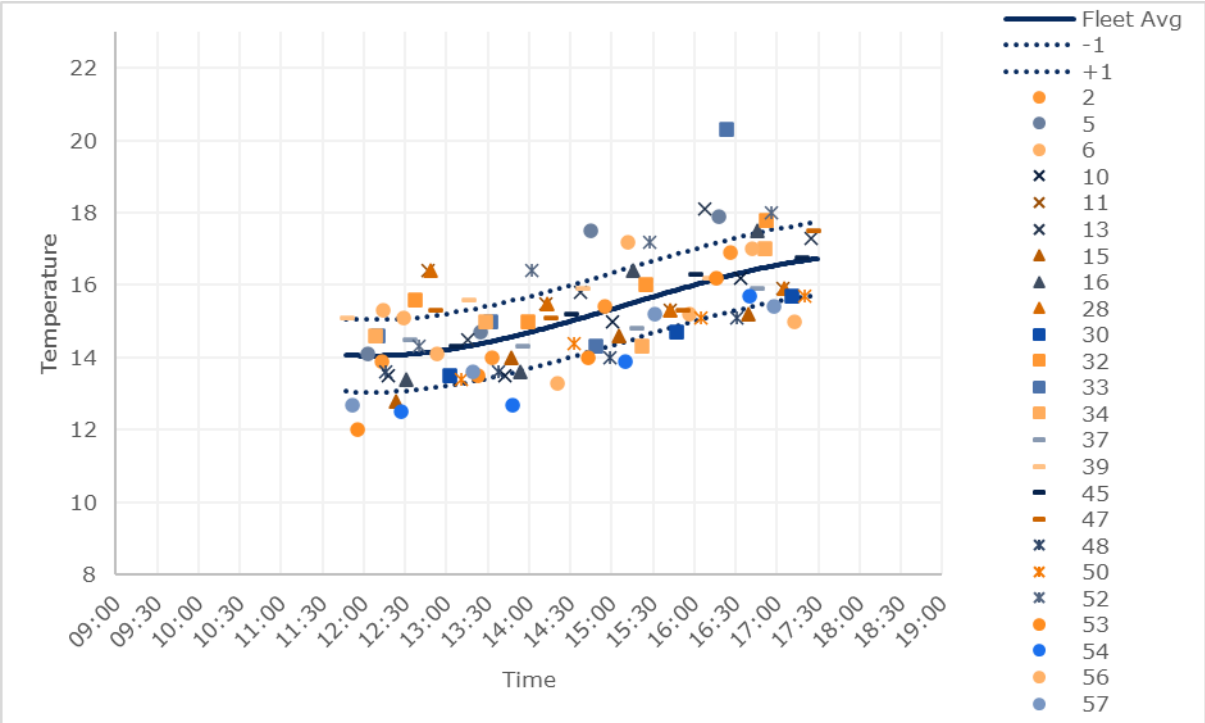

Figure 9.2: Operators' and reference temperatures (Day 2 near station 2, 100mm depth)

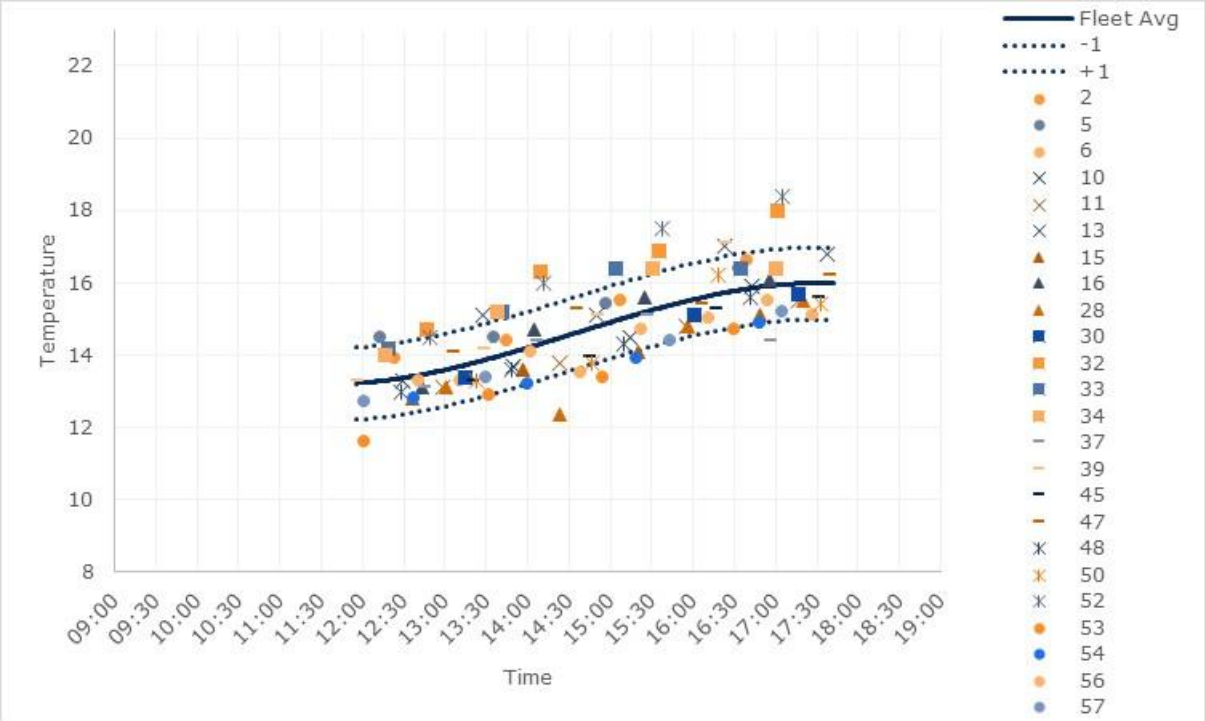

Figure 9.3: Operators' and reference temperatures (Day 2 near station 10, 100mm depth)

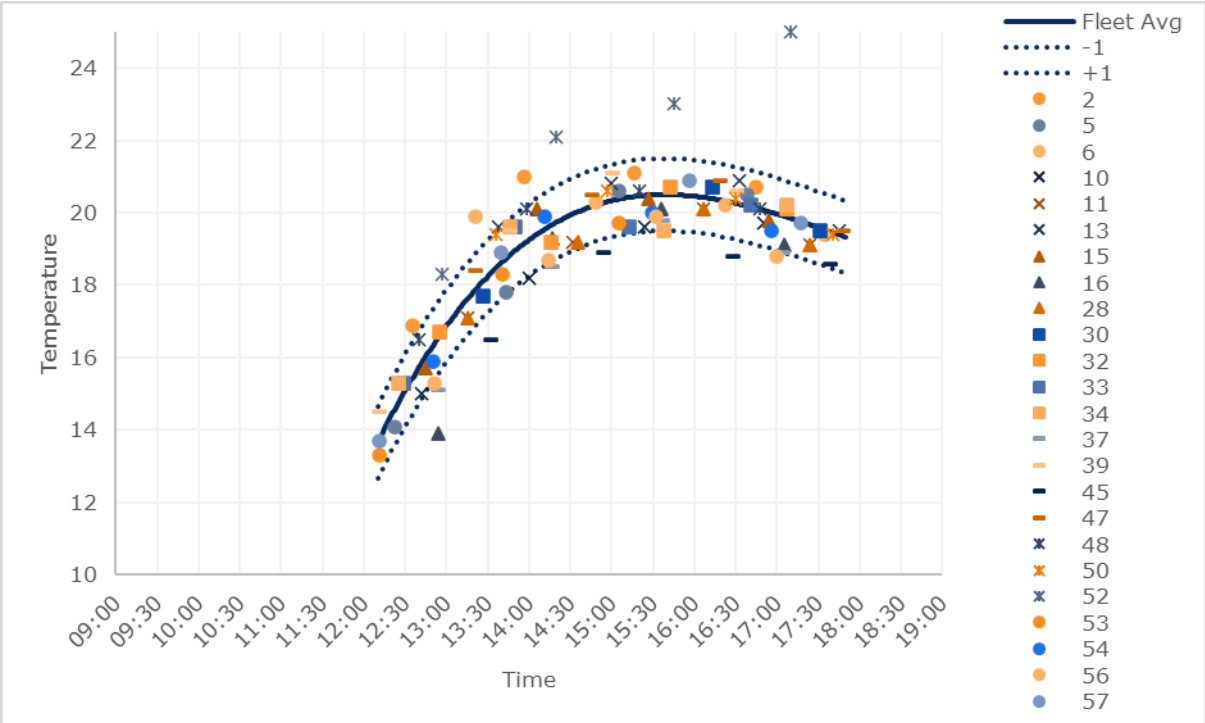

Figure 9.4: Operators' and reference temperatures (Day 2 water bucket)

It can be seen from these plots that most of the operators' measurements are close to the reference datasets although there are some noticeable outliers.

The test criteria for temperature measurement at depth are given in Appendix D, D.1. The differences are presented in Table 9.1, Table 9.2 and Table 9.3. In the tables, values are highlighted in bold and red font if the value was more than 1˚C away from the reference. The overall performance and ratings assigned are presented in Table 9.4.

Table 9.1: Assessment of operators' temperature measurement at depth - station 2

DPT ID	Lap 1 diff	Lap 2 diff	Lap 21 diff	Lap 22 diff	Lap 23 diff	Lap 24 diff
2	.	.	-0.1	-0.4	0.1	0.6
5	.	.	0.1	0.3	**2.3**	**1.7**
6	.	.	-0.1	**-1.6**	-0.8	**-1.6**
10	.	.	-0.6	**-1.0**	-0.3	-0.1
11	.	.	**2.3**	0.7	-0.5	-0.7
13	.	.	0.2	0.7	**2.0**	0.6
15	.	.	**-1.3**	-0.6	-0.8	**-1.2**
16	.	.	-0.7	**-1.0**	0.9	**1.1**
28	.	.	**2.2**	0.7	-0.5	-0.7
30	.	.	-0.7	.	**-1.2**	-0.9
32	.	.	**1.5**	0.3	0.4	**1.3**
33	.	.	0.6	0.6	-0.9	**4.1**
34	.	.	0.6	0.6	**-1.3**	0.5
37	.	.	0.4	-0.3	-0.7	-0.5
39	.	.	**1.0**	**1.3**	0.8	0.1
45	.	.	0.0	0.2	0.3	0.1
47	.	.	**1.1**	0.2	-0.6	0.8
48	.	.	-0.5	-0.9	**-1.3**	**-1.2**
50	.	.	-0.9	-0.6	-1.0	-1.0
52	.	.	0.2	**1.7**	**1.5**	**1.5**
53	.	.	**-2.1**	-0.9	**-1.1**	0.0
54	.	.	**-1.6**	**-1.9**	**-1.6**	-0.7
56	.	.	**1.0**	**1.2**	**1.7**	0.6
57	.	.	**-1.4**	-0.7	-0.5	**-1.1**

Table 9.2: Assessment of operators' temperature measurement at depth - station 10

DPT ID	Lap 1 diff	Lap 2 diff	Lap 21 diff	Lap 22 diff	Lap 23 diff	Lap 24 diff
2	.	.	0.6	0.4	0.5	0.8
5	.	.	**1.2**	0.6	0.5	0.6
6	.	.	-0.4	**-1.2**	-0.6	-0.9
10	.	.	-0.1	-0.4	-0.6	0.0
11	.	.	-0.5	-0.7	-0.7	-0.5
13	.	.	**1.3**	0.3	**1.3**	0.8
15	.	.	-0.6	-0.6	**-1.0**	-0.8
16	.	.	-0.4	0.4	0.4	0.2
28	.	.	-0.5	**-2.1**	-0.7	-0.5
30	.	.	-0.3	.	-0.4	-0.3
32	.	.	**1.2**	**2.0**	**1.6**	**2.1**

DPT ID	Lap 1 diff	Lap 2 diff	Lap 21 diff	Lap 22 diff	Lap 23 diff	Lap 24 diff
33	.	.	0.9	**1.2**	**1.4**	0.6
34	.	.	0.7	**1.2**	**1.1**	0.5
37	.	.	-0.4	0.1	-0.1	**-1.5**
39	.	.	0.1	0.3	0.3	**1.4**
45	.	.	-0.5	-0.8	-0.4	-0.4
47	.	.	0.4	0.7	-0.2	0.2
48	.	.	-0.4	-0.5	-0.7	-0.2
50	.	.	-0.5	-0.9	0.5	-0.6
52	.	.	1.0	**1.7**	**2.2**	**2.5**
53	.	.	**-1.6**	**-1.0**	**-1.5**	**-1.1**
54	.	.	-0.6	**-1.0**	**-1.2**	-1.0
56	.	.	-0.1	-0.1	-0.5	-0.4
57	.	.	-0.5	-0.5	-1.0	-0.7

Table 9.3: Assessment of operators' temperature measurement at depth - water bucket

DPT ID	Lap 1 diff	Lap 2 diff	Lap 21 diff	Lap 22 diff	Lap 23 diff	Lap 24 diff
2	0.3	0.8	**1.5**	**1.9**	0.7	0.6
5	-0.7	-0.1	-0.4	-0.9	0.2	0.3
6	-0.2	0.0	**2.0**	0.1	-0.1	-0.1
10	-0.8	0.3	-0.9	**-1.1**	-0.9	-0.4
11	-0.3	-0.1	-0.5	-0.8	-0.3	-0.6
13	**-1.3**	1.0	**1.0**	0.5	0.7	0.1
15	-0.1	0.2	-0.3	0.7	-0.1	-0.2
16	**-1.0**	-0.9	**-2.7**	-0.4	-0.4	-0.8
28	-0.4	0.0	-0.5	-0.8	-0.3	-0.6
30	-0.7	0.0	-0.4	.	0.3	-0.1
32	**3.9**	-0.6	0.1	-0.5	0.2	0.2
33	**3.8**	-0.6	0.3	0.6	-0.8	0.0
34	0.1	**2.0**	0.5	0.8	-1.0	0.3
37	**-1.9**	-1.0	**-1.5**	**-1.2**	-0.7	**-1.0**
39	.	.	0.8	0.7	0.8	0.3
45	**-1.6**	**-1.2**	**-1.8**	**-1.4**	**-1.5**	-0.9
47	0.1	0.4	0.5	0.3	0.6	0.1
48	-0.2	-0.2	0.8	0.9	0.1	0.0
50	.	-0.7	0.9	0.3	0.1	0.0
52	**2.7**	**3.2**	**1.6**	**2.4**	**2.5**	**5.2**
53	-0.5	-0.1	-0.4	-0.4	-0.7	.
54	-0.7	-0.7	-0.4	0.4	-0.5	-0.5
56	**-1.4**	**-1.1**	**-1.1**	-0.9	-0.6	**-1.2**
57	-0.1	0.6	0.0	0.3	0.4	-0.1

Table 9.4: Overall assessment of operators' temperature measurement at depth

DPT ID	Percentage within 1˚C for S2	Percentage within 1˚C for S10	Percentage within 1˚C for W/B	Overall Percentage within 1˚C	Rating
2	100%	100%	67%	86%	High
5	50%	75%	100%	79%	Medium
6	50%	75%	83%	71%	Medium
10	75%	100%	83%	86%	High
11	75%	100%	100%	93%	High
13	75%	50%	67%	64%	Medium
15	50%	75%	100%	79%	Medium
16	50%	100%	67%	71%	Medium
28	75%	75%	100%	86%	High
30	67%	100%	100%	91%	High
32	50%	0%	83%	50%	Low
33	75%	50%	83%	71%	Medium
34	75%	50%	83%	71%	Medium
37	100%	75%	33%	64%	Medium
39	50%	75%	100%	75%	Medium
45	100%	100%	17%	64%	Medium
47	75%	100%	100%	93%	High
48	50%	100%	100%	86%	High
50	100%	100%	100%	100%	High
52	25%	25%	0%	14%	Not Suitable
53	50%	0%	100%	54%	Low
54	25%	50%	100%	64%	Medium
56	25%	100%	33%	50%	Low
57	50%	100%	100%	86%	High

It can be seen from Table 9.4 that nine machines achieved the high performance rating, eleven machines achieved a medium, three a low and one a not suitable rating.

9.2 Contactless surface and air temperature measurements

A methodology for estimating the temperature at 100mm is given in the Design Manual for Roads and Bridges (DMRB CS 229, 2025). This method uses the surface temperature at the time of the survey (collected using on-board IRT sensors on the DPT) and the average air temperature for the previous day (acquired from a weather station). A number of contractors have fitted sensors for the automatic measurement of air and surface temperatures to their survey machines. Although air temperature measurements from the survey device are not used in this calculation, the air temperature measurements provided have also been assessed using the same criteria as the surface temperature measurements.

The data from the surface measurements are discussed in 9.2.1 and air measurements in 9.2.2.

9.2.1 Surface temperature measurements

Of the twenty-four machines which took part in the trial, twenty machines included data for surface temperature in their survey files. However, a number of these datasets did not vary over the course of the trial or were otherwise unsuitable. These devices have been identified as "not suitable" on the accreditation certificates along with supporting text. Some devices produced realistic values, but were not identified as fitted on the pre-trial checklist. These were discussed with the corresponding operators and it has been identified that these devices were not calibrated. Therefore, these devices have been identified as "not assessed" on the accreditation certificates, along with supporting text. After excluding these devices, eleven machines were identified as being valid for assessment of their performance. These were machines 6, 30, 37, 39, 45, 47, 48, 50, 53, 54 and 56. The surface temperature data from stations 2 and 10 for these devices are shown, along with the reference dataset, in Figure 9.5 and Figure 9.6 respectively for Day 1, and in Figure 9.7 and Figure 9.8 for Day 2. For this assessment, it was identified that the logger measurements (using a thermocouple attached to the road surface) were not suitable. Instead, a cubic line of best fit calculated from the fleet average was used. Machines 37, 45 and 50 were excluded from the calculation of the fleet average due to being noticeable outliers during some, or all, of the testing. Also, due to the limited number of tests (and devices), the data from day 1 was excluded from the final assessment.

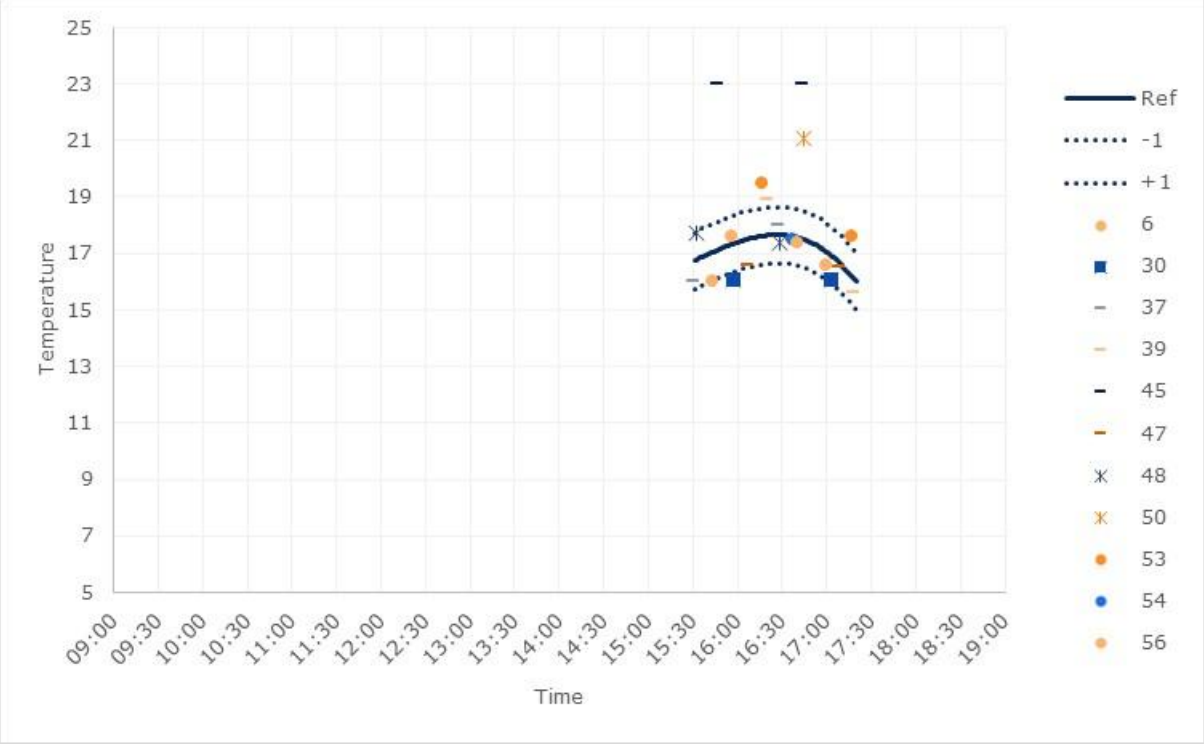

Figure 9.5: Operators' and reference surface temperatures (Day 1 near station 2)

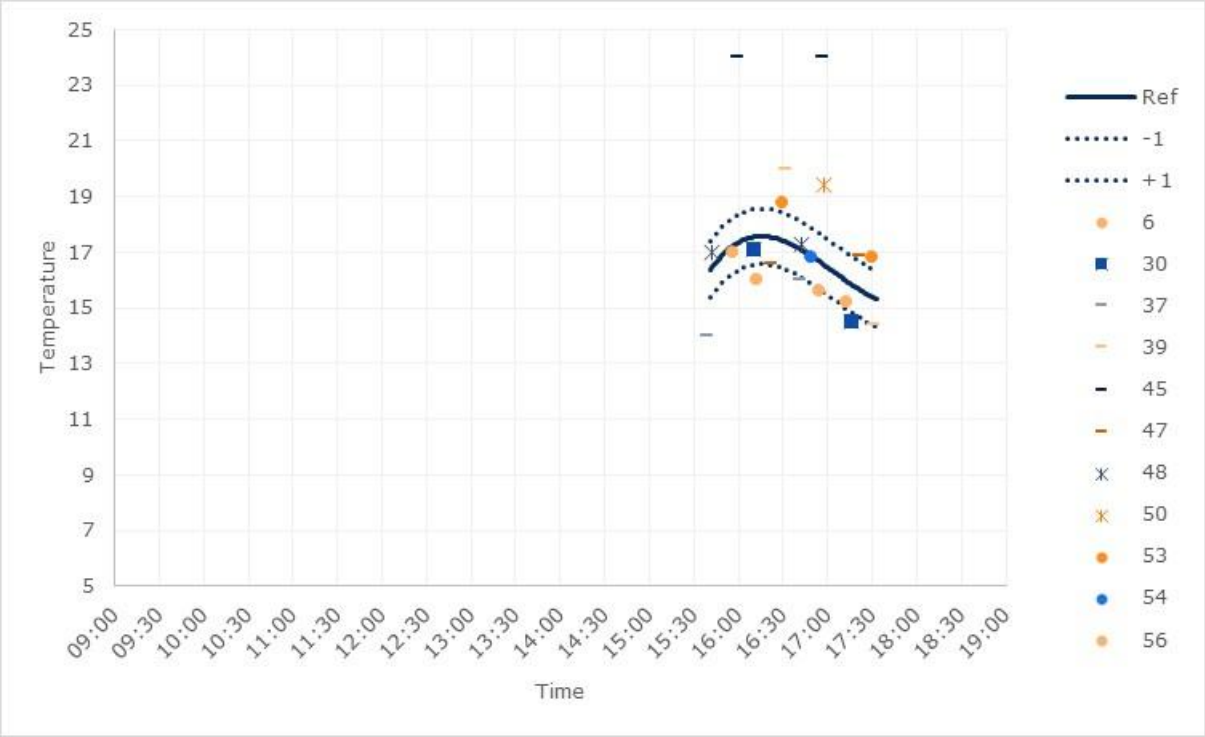

Figure 9.6: Operators' and reference surface temperatures (Day 1 near station 10)

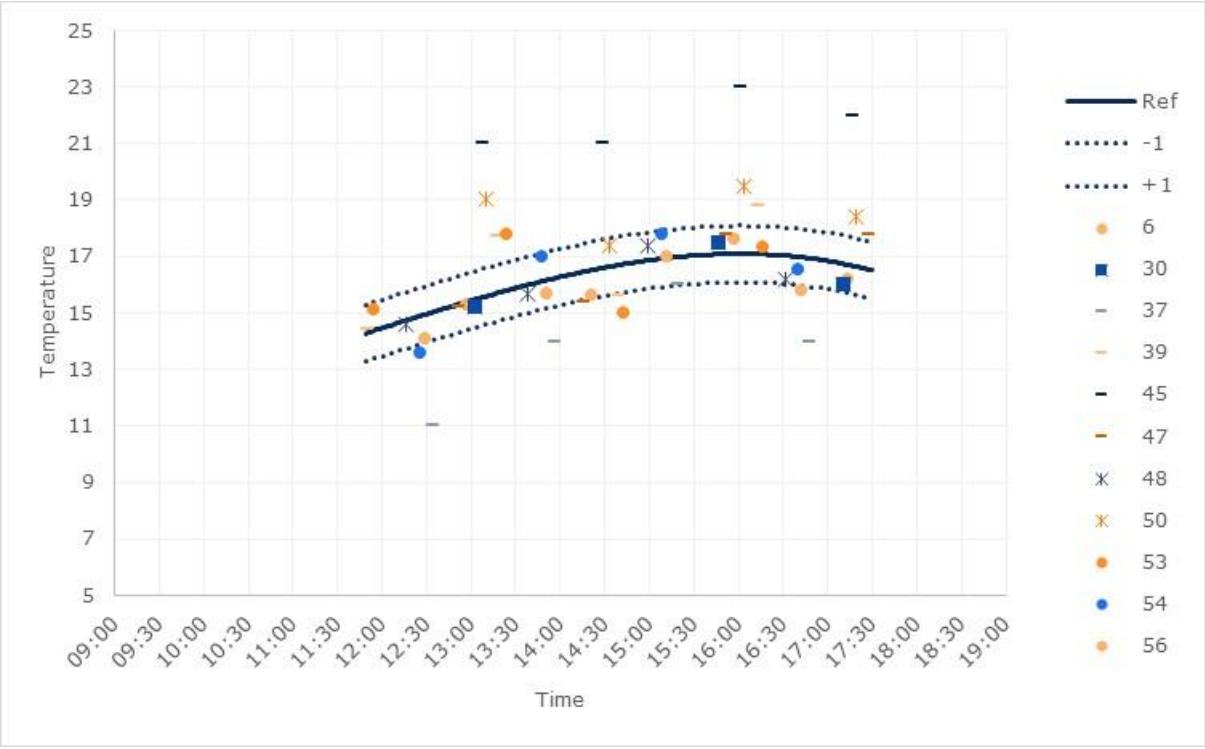

Figure 9.7: Operators' and reference surface temperatures (Day 2 near station 2)

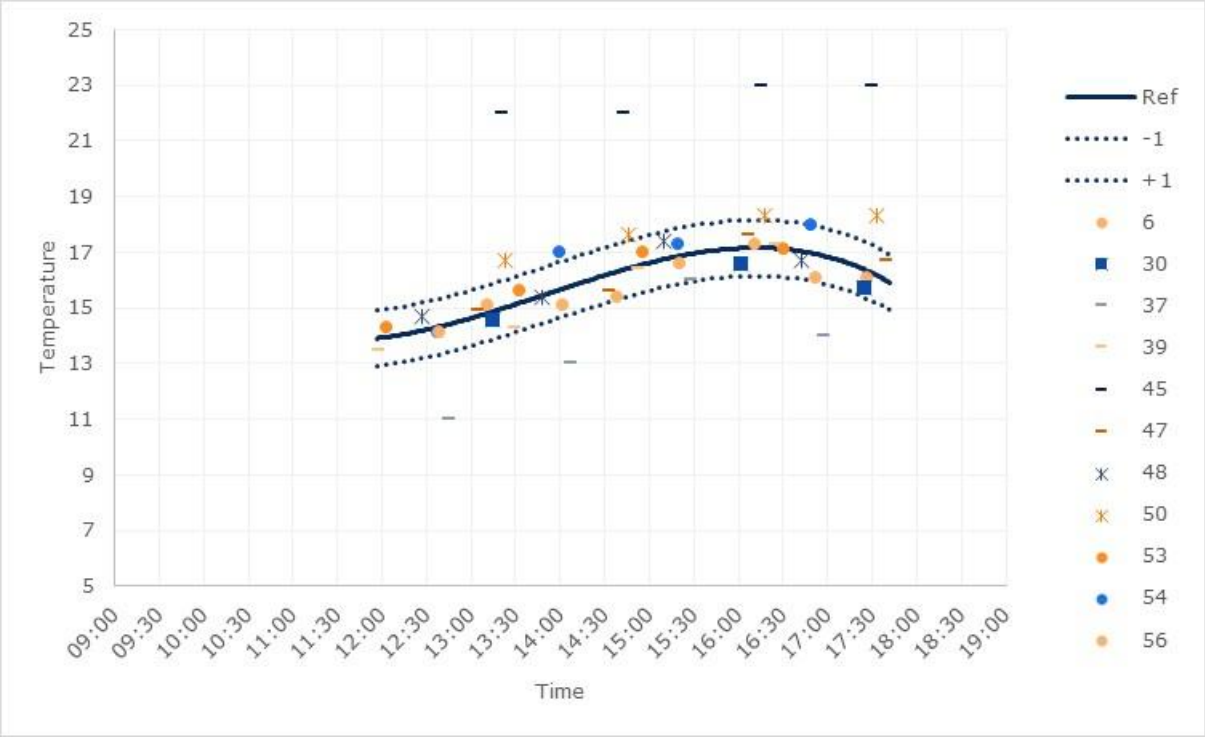

Figure 9.8: Operators' and reference surface temperatures (Day 2 near station 10)

The test criteria for surface temperature measurement are given in Appendix D, D.2. The differences are presented in Table 9.5 and Table 9.6. In the tables, values are highlighted in bold and red font if the value was more than 1˚C away from the reference. The data from day 1 was excluded from the assessment (due to fewer machines taking part, affecting the reference calculation) and is shown in grey text. The overall performance and ratings assigned are presented in Table 9.7.

Table 9.5: Assessment of operators' surface temperature measurement - station 2

DPT ID	Lap 1 diff	Lap 2 diff	Lap 21 diff	Lap 22 diff	Lap 23 diff	Lap 24 diff
6	0.3	-0.5	-0.1	-0.9	0.5	-0.5
30	-1.2	-0.8	-0.3	.	0.4	-0.7
37	.	0.3	**-4.0**	**-2.2**	-1.0	**-2.9**
39	1.3	-0.5	0.1	**2.0**	**-1.1**	**1.7**
45	5.9	5.5	**5.4**	**4.4**	**5.9**	**5.3**
47	-0.9	-0.2	-0.1	**-1.1**	0.7	**1.3**
48	0.9	-0.3	-0.1	-0.3	0.5	-0.8
50	.	3.6	**3.4**	0.8	**2.4**	**1.8**
53	1.9	1.4	0.7	**2.0**	**-1.7**	0.2
54	.	-0.1	**-1.3**	0.9	0.9	-0.5
56	-1.0	-0.2	-0.8	-0.5	0.1	**-1.2**

Table 9.6: Assessment of operators' surface temperature measurement - station 10

DPT ID	Lap 1 diff	Lap 2 diff	Lap 21 diff	Lap 22 diff	Lap 23 diff	Lap 24 diff
6	-1.6	-0.8	0.3	-0.9	0.1	-0.2
30	-0.4	-1.3	-0.2	.	-0.5	-0.7
37	.	-1.1	**-3.4**	**-2.8**	-0.9	**-2.9**
39	2.6	-1.0	-0.4	-0.8	-0.1	0.2
45	6.7	7.4	**7.0**	**5.6**	**5.8**	**6.7**
47	-0.9	1.2	0.2	-0.6	0.4	0.7
48	0.5	0.2	0.5	0.0	0.7	-0.3
50	.	2.9	**1.7**	**1.2**	**1.1**	**2.1**
53	1.4	1.4	0.3	0.4	0.4	0.0
54	.	-0.1	-0.2	**1.3**	0.4	**1.0**
56	-0.2	-1.1	-0.2	-0.6	-0.3	-0.8

Table 9.7: Overall assessment of operators' surface temperature measurement

DPT ID	Percentage within 1˚C for S2	Percentage within 1˚C for S10	Overall Percentage within 1˚C	Rating
6	100%	100%	100%	High
30	100%	100%	100%	High
37	25%	25%	25%	Low
39	25%	100%	63%	Medium
45	0%	0%	0%	Not Suitable
47	50%	100%	75%	Medium
48	100%	100%	100%	High
50	25%	0%	13%	Not Suitable
53	50%	100%	75%	Medium
54	75%	50%	63%	Medium
56	75%	100%	88%	High

It can be seen from Table 9.7 that three machines achieved a high performance, four a medium, one a low and two were rated as not suitable.

9.2.2 Air temperature measurements

Of the twenty-four machines which took part in the trial, nineteen machines included data for air temperature in their survey files. However, a number of these datasets did not vary over the course of the trial or were otherwise unsuitable. These devices have been identified as "not suitable" on the accreditation certificates along with supporting text. Some devices produced realistic values, but were not identified as fitted on the pre-trial checklist. These were discussed with the corresponding operators and it has been identified that these devices were not calibrated. Therefore, these devices have been identified as "not assessed" on the accreditation certificates, along with supporting text. After excluding these devices, eleven machines were identified as suitable for being valid for assessment of their performance. These were machines 6, 30, 37, 39, 45, 47, 48, 50, 53, 54 and 56. The air temperature data from stations 2 and 10 for these devices are shown along with the

reference dataset in Figure 9.9 and Figure 9.10 respectively for Day 1, and in Figure 9.11 and Figure 9.12 for Day 2. For this assessment it was identified that the logger measurements were not suitable. Instead, a cubic line of best fit calculated from the fleet average, after removal of machines 45, 48, 50 and 54 which were identified as outliers, were used.

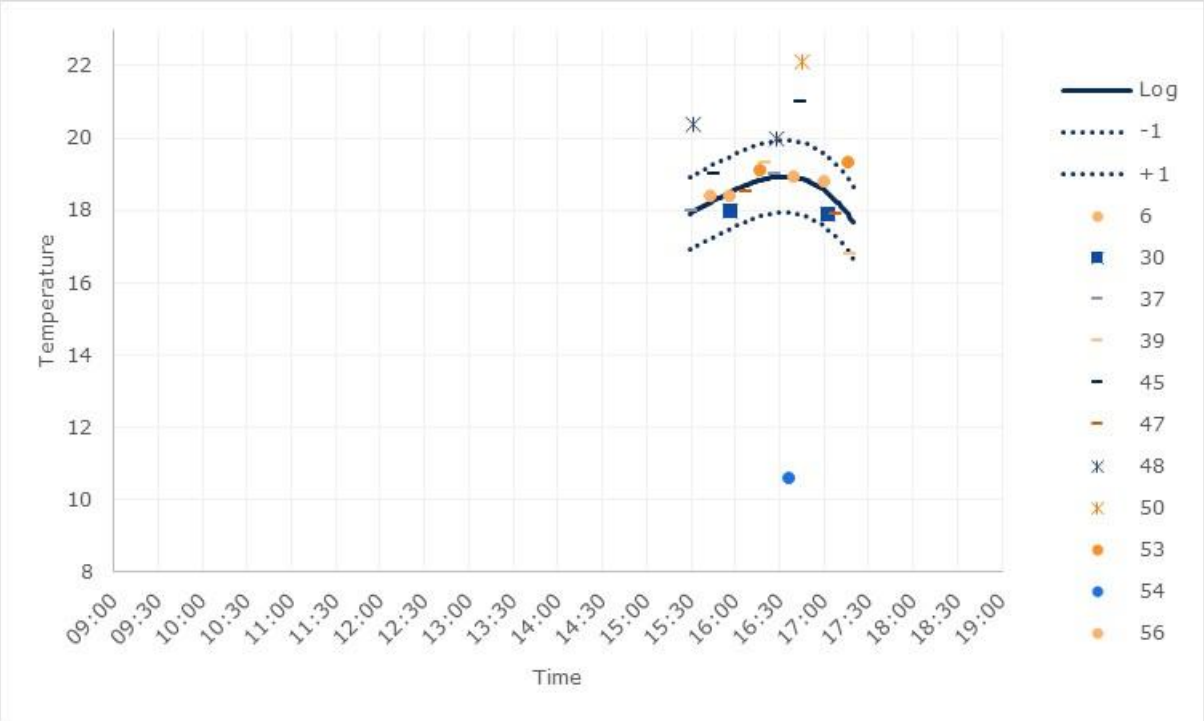

Figure 9.9: Operators' and reference Air temperatures (Day 1 near station 2)

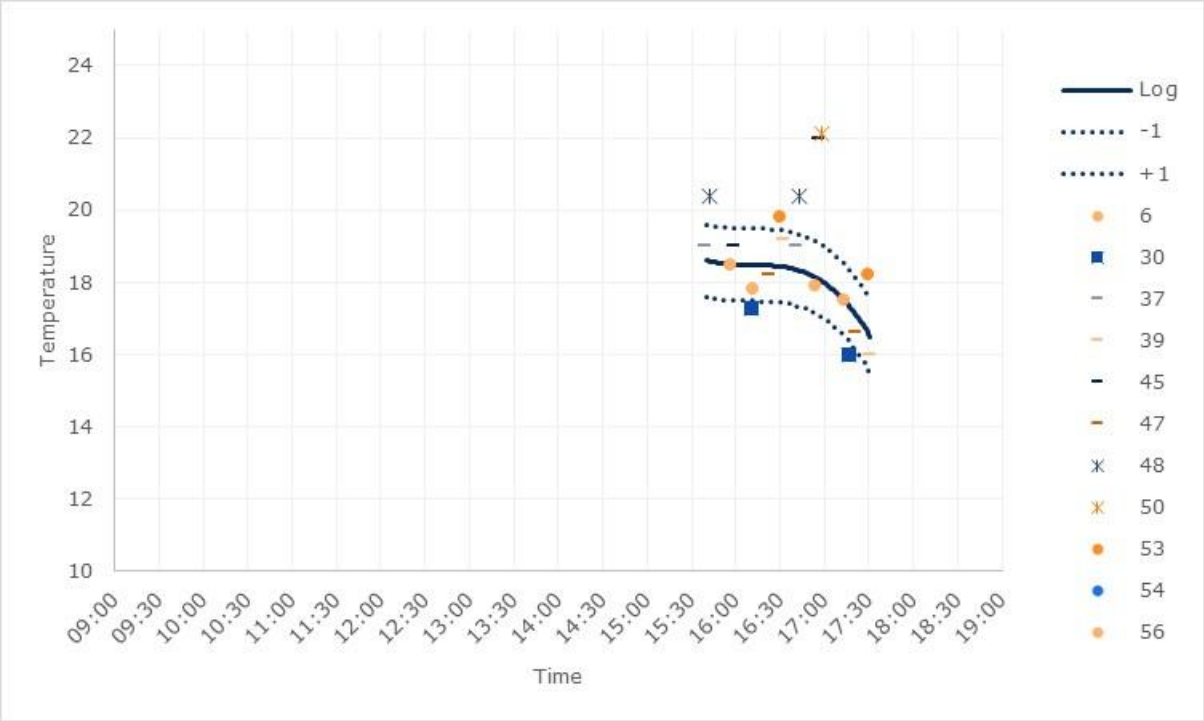

Figure 9.10: Operators' and reference Air temperatures (Day 1 near station 10)

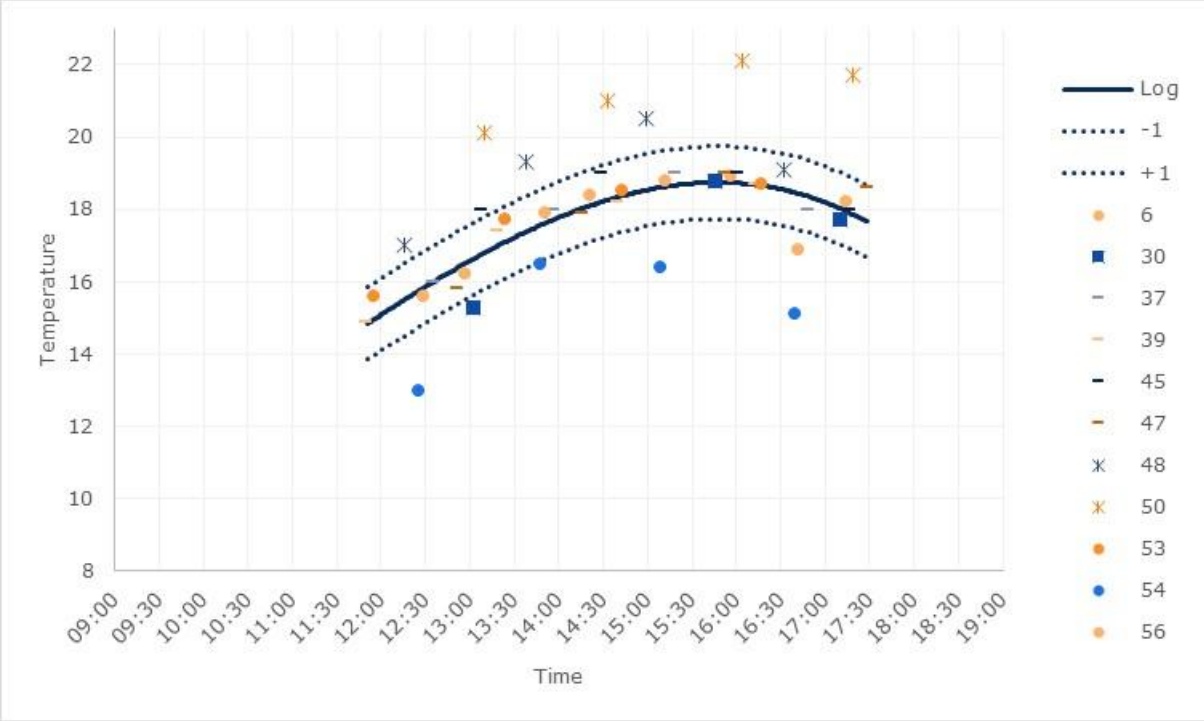

Figure 9.11: Operators' and reference Air temperatures (Day 2 near station 2)

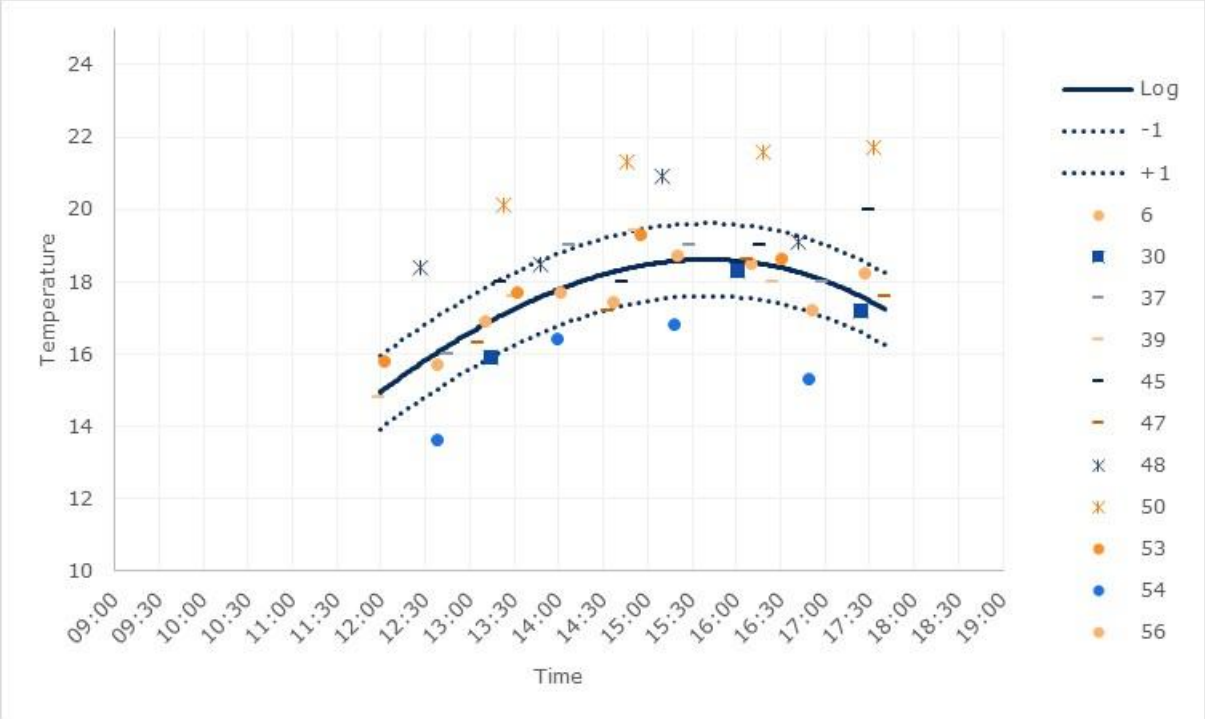

Figure 9.12: Operators' and reference Air temperatures (Day 2 near station 10)

Air temperature measurements from DPTs at the time of testing are not used for the contactless 100mm temperature calculation method and as such there are no formal criteria set for this measurement. However, it seemed prudent to assess the data supplied by the machines, therefore the criteria for the surface measurements were applied. The differences are presented in Table 9.8 and Table 9.9. In these tables, values are highlighted in bold and red font if the value was more than 1˚C away from the reference. The overall performance and ratings assigned are presented in Table 9.10.

Table 9.8: Assessment of operators' air temperature measurement - station 2

DPT ID	Lap 1 diff	Lap 2 diff	Lap 21 diff	Lap 22 diff	Lap 23 diff	Lap 24 diff
6	-0.1	0.2	-0.3	0.3	0.2	0.2
30	-0.5	-0.6	**-1.3**	.	0.1	-0.3
37	0.1	0.1	0.0	0.3	0.3	-0.4
39	0.4	-1.0	.	0.4	-0.1	0.0
45	0.7	**2.1**	**1.2**	0.8	0.3	0.1
47	-0.2	-0.4	-0.6	-0.1	0.3	0.9
48	**2.4**	**1.1**	**1.5**	**1.9**	**2.0**	0.6
50	.	**3.2**	**3.3**	**2.7**	**3.4**	**3.8**
53	0.3	**1.5**	0.7	0.6	0.1	0.0
54	.	**-8.3**	**-2.8**	**-1.1**	**-2.2**	**-3.4**
56	0.2	0.0	-0.2	0.3	0.2	**-1.5**

Table 9.9: Assessment of operators' air temperature measurement - station 10

DPT ID	Lap 1 diff	Lap 2 diff	Lap 21 diff	Lap 22 diff	Lap 23 diff	Lap 24 diff
6	-0.7	0.0	0.1	-0.9	0.0	0.7
30	**-1.2**	**-1.4**	-1.0	.	-0.3	-0.4
37	.	0.6	-0.2	**1.1**	0.4	-0.1
39	0.8	-0.5	.	0.4	1.0	-0.4
45	0.5	**3.9**	0.9	-0.3	0.5	**2.5**
47	-0.3	-0.5	-0.4	**-1.0**	0.0	0.3
48	**1.8**	**2.1**	**2.7**	0.9	**2.4**	0.8
50	.	**4.1**	**3.0**	**2.9**	**3.1**	**4.3**
53	**1.4**	**1.6**	0.7	0.4	0.9	0.2
54	.	**-10.2**	**-2.4**	**-1.4**	**-1.8**	**-2.9**
56	0.0	-0.2	-0.4	-0.1	0.1	-0.9

Table 9.10: Overall assessment of operators' air temperature measurement

DPT ID	Percentage within 1˚C for S2	Percentage within 1˚C for S10	Overall Percentage within 1˚C	Rating
6	100%	100%	100%	High
30	80%	60%	70%	Medium
37	100%	80%	91%	High
39	100%	100%	100%	High
45	67%	67%	67%	Medium
47	100%	83%	92%	High
48	17%	33%	25%	Low
50	0%	0%	0%	Not suitable
53	83%	67%	75%	Medium
54	0%	0%	0%	Not suitable
56	83%	100%	92%	High

Table 9.10 shows that, for the air temperature measurements, five achieved a high performance, three a medium, one a low and two were identified as not suitable.

10 Summary of trial findings

The 2025 UK DPT accreditation trial was held at Horiba-MIRA in the week beginning the 29th September 2025. Twenty-four machines took part in the trial.

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

(i) Repeatability of Deflections

- All twenty-four machines met the trial requirements for the repeatability assessment.

(ii) Reproducibility of Deflections

- All twenty-four machines met the trial requirements for the mean Field Calibration Factor (FCF).
- All twenty-four machines met the trial requirements for the individual geophone Field Calibration Factors (FCF).
- All twenty-four machines met the trial requirements for the mean Standard Deviation of the Deviation Ratio (SDDR).
- Twenty-three machines met the trial requirements for the individual Standard Deviation of the Deviation Ratio (SDDR).

(iii) Distance measurement

- All twenty-four machines met the trial requirements for distance assessment.

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

(iv) OSGR Co-ordinates

- Sixteen machines provided 3-dimensional positional data for assessment. This data is reported in lat/long format in the survey files, and the contractors were asked to convert this data into OSGR format. The performance of the machines was assessed on this converted data. ten machines were identified as having achieved a high performance level and six a medium performance level.

(v) Temperature measurement at depth (100mm)

- All twenty-two operators of the machines provided 100mm pavement temperature measurements using hand-held probes. Nine achieved a high performance rating, elven achieved a medium, three a low and one a not suitable rating.

(vi) Surface temperature measurement

- Eleven machines provided surface temperature measurements using IRTs fixed to their machines that were suitable for assessment. Three machines achieved a high performance, four a medium performance, one a low performance and two were identified as not suitable.

(vii) Air temperature measurement

- Eleven machines provided air temperature measurements from apparatus fixed to their machines that were suitable for assessment. This data was assessed using the surface temperature criteria. Five machines achieved a high performance, three a medium performance, one a low performance and two were identified as not suitable.

In summary, twenty-three of the twenty-four machines that participated in the 2025 accreditation trial fully met the mandatory requirements of the trial.

The outcome of the trial for each machine, against both the mandatory and non-mandatory criteria, is summarised in Appendix G.

References

CROW. (2011). *Falling Weight Deflectometer Calibration Guide Report D11-07. Protocol 10. FWD correlation trial.* Ede, The Netherlands: Crow.

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Appendix A Machine details table

DPT ID	Owner	Make, model and serial number	Trailer or vehicle mounted?	No of weights / buffers per side	Plate type	Date of last tower calibration	Date of last dynamic calibration	Date of last manufacturer calibration
2	AECOM Ltd.	Dynatest FWD 8002 SN 102	Trailer	4/3	2-way Segmented	17/02/2025	09/09/2025	04/09/2025
5	AECOM Ltd.	Dynatest HWD 8082 SN 050	Trailer	0/5	2-way Segmented	14/02/2025	29/09/2025	22/08/2025
6	PMS	Dynatest HWD 8082 SN 018	Trailer	0/5	Solid	27/06/2025	28/08/2025	16/09/2025
10	AECOM Ltd.	Dynatest FWD 8002 SN 192	Trailer	4/3	2-way Segmented	17/02/2025	29/09/2025	08/08/2025
11	Pulse Surveying Ltd.	Dynatest FWD 8002 SN 187	Trailer	4/2	Solid	12/05/2025	15/09/2025	22/07/2025
13	AECOM Ltd.	Dynatest HWD 8082 SN 029	Trailer	0/5	Solid	13/02/2025	29/09/2025	30/07/2025
15	Construction Testing Solutions	Dynatest FWD 8002 SN 203	Trailer	5/2	2-way Segmented	-	-	19/05/2025
16	XAIS-PTS	Dynatest FWD 8002 SN 214	Trailer	4/2	2-way Segmented	13/08/2025	13/08/2025	13/08/2025
28	Pulse Surveying Ltd.	Dynatest FWD 8002 SN 271	Trailer	4/2	Solid	13/05/2025	15/09/2025	17/07/2025
30	PMS	Dynatest FWD 8002 SN 173	Trailer	4/2	Solid	03/06/2025	03/09/2025	21/03/2025
32	XAIS-PTS	Dynatest HWD 8082 SN 069	Trailer	0/0	Solid	27/06/2025	27/06/2025	27/06/2025

DPT ID	Owner	Make, model and serial number	Trailer or vehicle mounted?	No of weights / buffers per side	Plate type	Date of last tower calibration	Date of last dynamic calibration	Date of last manufacturer calibration
33	XAIS-PTS	Dynatest HWD 8082 SN 070	Trailer	0/0	Solid	11/06/2025	11/06/2025	11/06/2025
34	XAIS-PTS	Dynatest HWD 8082 SN 108	Trailer	0/0	4-way Segmented	03/07/2025	03/07/2025	03/07/2025
37	Stanger Testing Services Ltd.	Dynatest FWD 8002 SN 352	Trailer	6/3	4-way Segmented	16/05/2025	16/05/2025	16/05/2025
39	TRL	Dynatest FWD 8002 SN 388	Trailer	4/2	2-way Segmented	16/09/2025	17/09/2025	May 2025
45	Atlas Geophysical	Sweco PRI2100 0903-088	Trailer	3/4	Single	23/08/2025	05/09/2025	23/08/2025
47	PMS	Dynatest FWD 8002 SN 452	Trailer	4/2	4-way Segmented	02/12/2024	16/06/2025	17/09/2025
48	Alptest Ltd	Dynatest FWD 8002 SN 424	Trailer	4/2	4-way Segmented	28/07/2025	28/07/2025	22/09/2025
50	SOCOTEC	RINCENT HeavyDyn HVY-101A	Trailer	10/4	Solid	29/09/2025	09/09/2025	17/01/2025
52	XAIS-PTS	Dynatest FFWD 8012 SN 057	Trailer	4/2	4-way Segmented	18/07/2025	18/07/2025	18/07/2025
53	Dynatest	Dynatest FWD 8002 SN 098	Trailer	4/2	4-way Segmented	24/09/2025	18/06/2025	08/01/2025
54	Milestone Pavement Technologies	Sweco PRI1500 0822/664	Trailer	3/7	4-way Segmented	01/04/2025	27/08/2025	01/04/2025
56	Wills Bros Ltd.	Dynatest FWD 8002 SN 033	Trailer	4/2	2-way Segmented	23/06/2025	05/08/2025	23/06/2025
57	Dynatest	Dynatest HWD 8082 SN 010	Trailer	1/4	2-way Segmented	24/09/2025	New to process	25/09/2025

Appendix B Photographs of machine types (taken at previous trials)



Figure B.1: Dynatest 8002 FWD



Figure B.2: Dynatest 8082 HWD



Figure B.3: SWECO Primax 2100 HWD



Figure B.4: SWECO Primax 1500 HWD

Appendix C Construction details for the National Highways reference site at Horiba-MIRA proving ground

Table C.1: Design thicknesses and material types for the National Highways reference site

Section	Test points	Surface course	Binder course	Base	Total asphalt thickness (mm)	Sub-base
1	1-3	30mm TSC	235mm EME2	-	270	200mm C8/10 HBM
2	4-6	35mm TSC	170mm DBM	-	200	250mm 6F1 granular capping material
3	7-9	30mm TSC	170mm EME2	-	200	200mm Type 1 granular material
4	10-12	35mm TSC	35mm Axo	230mm JRC	70	150-175mm Hoggin

Notes: TSC = Cl 942 Thin Surface Course EME2 = Enrobé à Module Élevé, DBM = Dense Bitumen Macadam, Axo = Axoshield, HBM = Hydraulically Bound Material, JRC = Jointed reinforced concrete, 6F1 = Selected granular capping.

Table C.2: Thicknesses and materials for the National Highways reference site from cores

Section	Test points	Surface course	Binder/ Binder + base courses (mm)	Total asphalt thickness (mm)	Base/Sub-base (mm)
1	1-3	42mm TSC	228	270	217 (HBM sub-base)
2	4-6	37mm TSC	158	192	-
3	7-9	35mm TSC	191	226	-
4	10-12	30mm TSC	36 Axo	66	194 (JRC base)

Notes: TSC = Cl 942 Thin Surface Course , HBM = Hydraulically Bound Material, JRC = Jointed reinforced concrete, Axo= Axoshield

Table C.3: Thicknesses and materials for the National Highways reference site from GPR

Section	Test points	Material	Minimum (mm)	Average (mm)	Maximum (mm)
1	1-3	Asphalt layer	192	242	272
1	1-3	HBM layer	166	188	215
1	1-3	Total bound	388	431	468
2	4-6	Total bound (Asphalt)	167	192	240
3	7-9	Total bound (Asphalt)	167	199	240
4	10-12	Asphalt surfacing only[2]	47	65	76

Notes: HBM = Hydraulically Bound Material

[2] These results are for the bitumen-bound surfacing. No lower GPR trace due to steel reinforcement.

Appendix D Assessment criteria

The accreditation trial criteria are specified in "Accreditation and Quality Assurance of Dynamic Plate Test Survey Devices" (TRL, 2020). The accreditation specification document is a live document (i.e. is subject to change) and the September 2020 version of the document was used for the trial. The relevant sections of the document are reproduced verbatim below in blue text (section D.1 and D.2 of this report). Note that the numbering of the headings in the text within these sections have been kept as the numbering as given in the accreditation specification. In addition, the reproduced text refers to appendices that are not included in this report.

The reproduced text has some defined terms. This includes "Equipment" which 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 load measurement system, 3-dimensional positional system, 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 the Equipment belongs and to whom Accreditation Certificates are awarded.

D.1 Mandatory Trial criteria from the Accreditation and QA document

E4.2 Repeatability testing – Mandatory Requirement

E4.2.1 Repeatability testing shall be conducted on a series of test stations identified by the Auditor. The requirements for these test stations are given in Appendix C.

E4.2.2 Repeatability testing shall use a test procedure typical of general usage on the network. The test procedure shall include a minimum of two seating drops and ten measurement drops at each test station. The specific details of the test procedure for Repeatability testing (including nominal peak load and number of drops) shall be communicated by the Auditor prior to the trial.

E4.2.3 It is noted that some Equipment have drop height variation functionality which varies the drop height based on the load measured on the previous drops (sometimes referred to as "seek" mode). This functionality shall not be used for the repeatability testing.

E4.2.4 The following shall be achieved with regards to the load applied on each station:

- The mean load applied shall be within 10% of the target load.
- The standard deviation of the load recorded shall be less than, or equal to two percent of the mean of the recorded values.

E4.2.5 In the event that these load requirements are not achieved the data will be disregarded and additional tests shall be undertaken. If the Equipment does not meet the load requirements given above in subsequent tests then it is deemed to be unable to undertake the assessment and to have failed the Repeatability criteria.

E4.2.6 The valid Repeatability data shall be collected and the Equipment shall pass the Repeatability test if it meets the criteria given in Table 1. A worked example of the analysis process is given in App D.1.

Table 1 – Deflection Repeatability Criteria

Parameter	Acceptability Limit
Standard deviation of load corrected deflections	95% of the data less than or equal to 2µm or the sum of 1µm and 0.75% of the mean of the recorded normalised values (whichever is greater)

E4.3 Reproducibility testing – Mandatory Requirement

E4.3.1 Reproducibility testing shall be based on at least two test sets conducted on a series of test stations identified by the Auditor. The requirements for these test sets and test stations are given in Appendix C.

E4.3.2 For the Reproducibility test the 100mm pavement temperature should not change by more than ±3°C between tests conducted by the different Equipment on the same test station in each test set. If the temperature varies by more than this then this is likely to introduce additional variation to the Survey Data of the Equipment. Additional test sets may then need to be undertaken in order to obtain the required amount of Survey Data within the required temperature range.

E4.3.3 Reproducibility testing shall use a test procedure typical of general usage on the network. The test procedure shall include a minimum of one seating drop and four measurement drops at each test station. The specific details of the test procedure (including nominal peak load and number of drops) shall be communicated by the Auditor prior to the trial.

E4.3.4 The Field Calibration Factor (FCF) and the Standard Deviation of the Deviation Ratio (SDDR) are used as the basis for the assessment of Reproducibility.

E4.3.5 For each deflection sensor the reference deflection divided by the Equipment's mean deflection, averaged over all test stations, is defined as the FCF for that sensor. The overall FCF for each Equipment is calculated by averaging the FCF values for the individual sensors. The FCF therefore indicates, on average, how well the deflections recorded by each Equipment relate to the reference deflection basins.

E4.3.6 The difference between the deflection measured by each sensor at each test point and that of the reference deflection basin, expressed as a fraction of the reference deflection is defined as the Deviation Ratio. For each Equipment, the SDDR is calculated over all test stations and gives an indication of the consistency with which the Equipment tends to over-read or under-read over the set of test stations.

E4.3.7 The FCF and SDDR statistics shall be calculated by the Auditor for each test set. The Equipment shall pass the Reproducibility test if the criteria in Table 2 are met for each test set. A worked example of the analysis process is given in App D.2.

Table 2 - Deflection Reproducibility Criteria

Parameter	Maximum	Minimum
FCF: Mean for all sensors	1.05	0.95
FCF: Individual sensor value	1.10	0.90
SDDR: Mean for all sensors	0.05	N/A
SDDR: Individual sensor value	0.07	N/A

E4.3.8 Occasionally, Equipment will produce isolated anomalous sensor readings which may result in FCF or SDDR values falling outside the acceptable limits. To compensate for this, the accreditation procedure allows for the measurement from a single sensor from one test station to be removed from the analysis of each lap of the test site if required.

E4.4 Location Referencing Testing (Distance) – Mandatory Requirement

E4.4.1 Accreditation of an Equipment's ability to measure distance is carried out by comparing its measurements of a test length with the Reference Data. The test is carried out at least four times. All of the test measurements shall be within the criteria given in Table 3.

Table 3 - Acceptance Criteria for Location Reference Measurement

Parameter	Acceptability Limit
Elapsed chainage versus Reference Data	± 2m or 1% (whichever is greater)

D.2 Additional test criteria from the Accreditation and QA document

E5.2 Location reference – OSGR coordinates

E5.2.1 For Equipment undertaking this test, the difference in position (as the horizontal error) between the reported OSGR coordinates from each test station and the reference OSGR coordinates will be calculated. A minimum of 18 stations will be used to undertake this test (either 18 different test stations or a lower number of test stations using multiple laps). The criteria for the assessment of OSGR coordinates are given in Table 4.

Table 4 - Acceptance Criteria for OSGR data

Performance	Criteria
High	≥75% of the data is within 2m of the Reference Data
Medium	≥75% of the data is within 5m of the Reference Data
Low	≥75% of the data is within 10m of the Reference Data
Not suitable	Otherwise

E5.3 Temperature measurement – direct measurement method

E5.3.1 If undertaking this test, the Contractor will be required to collect at least eight measurements at 100mm depth during the course of the test laps. These probes are required to provide results with a resolution equal to or better than 0.1˚C. Therefore if the probe does not then it will be identified as "Not suitable" regardless of the performance seen for the measurements (with a note identifying the reason for the performance given). The criteria for the direct measurement method are given in Table 5.

Table 5 - Acceptance Criteria for direct measurement method

Performance	Criteria
High	≥80% of the data is within 1.0°C of the Reference Data
Medium	≥60% of the data is within 1.0°C of the Reference Data
Low	≥25% of the data is within 1.0°C of the Reference Data
Not suitable	Otherwise

E5.3.2 The Re-accreditation trial may also incorporate a check on the calibration of the temperature Systems via measurement of a static sample of known temperature (e.g. ice).

E5.4 Temperature measurement – Contactless measurement

E5.4.1 If undertaking this test the Contractor shall be required to collect at least eight measurements of the pavement surface at defined points (specified by the Auditor) during the course of the test laps. These sensors are required to provide results with a resolution equal to or better than 0.1˚C. Therefore if the sensor does not then it will be identified as "Not suitable" regardless of the performance seen for the measurements (with a note identifying the reason for the performance given). The criteria for the assessment of temperature measurement of the pavement surface are given in Table 6.

Table 6 - Acceptance Criteria for temperature measurement of pavement surface

Performance	Criteria
High	≥80% of the data is within 1.0°C of the Reference Data
Medium	≥60% of the data is within 1.0°C of the Reference Data
Low	≥25% of the data is within 1.0°C of the Reference Data
Not suitable	Otherwise

E5.4.2 In addition to providing the surface temperatures, the Contractor shall provide the predicted temperature at 100mm depth using this data. The Auditor may allow Contractors to provide these predicted temperatures after the trial to allow for processing time. To aid this calculation the Auditor should provide, or identify a suitable location for air temperature data for the previous day for the site. The Auditor shall confirm on the Accreditation Certificate whether the calculations have been accurately calculated.

Appendix E Repeatability trial data

Data is highlighted in bold red text if it does not meet the criteria (for a valid test or for the assessment). Laps not used in the assessment are shown in italics and grey text (apart from the data points which exceed the criteria).

E.1 Machine 2

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	694.7	0.1%	73	61	55	49	41	34	23	0.2	0.2	0.2	0.4	0.3	0.1	0.3
1	5	680.1	0.2%	512	396	260	157	88	56	34	1.7	0.6	0.9	0.3	0.5	0.4	0.3
1	8	694.0	0.2%	229	203	163	124	90	63	34	0.2	0.3	0.3	0.4	0.1	1.4	0.6
1	13	698.0	0.2%	125	116	98	80	64	48	30	0.3	0.8	0.7	0.1	0.3	0.4	0.6
2	2	690.4	0.2%	74	63	56	48	40	32	24	0.4	0.5	0.6	0.1	0.3	0.7	0.4
2	5	676.3	0.3%	536	413	263	161	91	53	35	1.3	1.1	0.9	0.9	0.6	1.6	0.4
2	8	693.9	0.2%	230	204	166	125	89	63	32	0.5	0.3	1.6	0.2	0.7	0.7	0.5
2	13	699.6	0.1%	124	113	96	79	62	48	29	0.6	0.1	0.3	0.1	0.1	0.2	0.1

E.2 Machine 5

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	*2*	*722.0*	*0.2%*	*67*	*56*	*50*	*43*	*38*	*31*	*21*	*0.6*	*0.3*	*0.4*	*0.4*	*0.5*	*0.8*	*0.6*
1	*5*	*710.0*	*0.2%*	*511*	*386*	*244*	*150*	*93*	*59*	*39*	*1.3*	*0.9*	*0.7*	*1.1*	*1.1*	*0.5*	*1.4*
1	*8*	*695.4*	*0.1%*	*216*	*191*	*154*	*116*	*86*	*61*	*33*	*0.8*	*0.1*	*0.1*	*0.2*	*0.2*	*0.1*	*0.4*
1	*13*	*689.7*	*0.2%*	*118*	*105*	*89*	*73*	*58*	*44*	*27*	*0.4*	*0.1*	*0.1*	*0.1*	*0.2*	*0.3*	*0.2*
2	*2*	*712.4*	*0.2%*	*64*	*57*	*50*	*44*	*38*	*32*	*21*	*0.2*	*0.1*	*0.1*	*0.2*	*0.2*	*0.2*	*0.2*
2	*5*	*700.4*	*0.1%*	*510*	*398*	*252*	*151*	*93*	*58*	*37*	*0.9*	*0.4*	*0.4*	*1.2*	*0.2*	*0.4*	*0.3*
2	*8*	*688.8*	*0.1%*	*219*	*195*	*156*	*118*	*86*	*62*	*32*	*0.3*	*0.3*	*0.2*	*0.2*	*0.3*	*0.2*	*0.3*
2	*13*	*685.3*	*0.2%*	*117*	*106*	*91*	*75*	*60*	*47*	*27*	*0.3*	*0.1*	*0.1*	*0.1*	*0.2*	*0.3*	*0.4*
3	2	700.7	0.6%	67	57	52	45	40	32	22	0.7	0.3	0.3	0.2	0.4	0.1	0.3
3	5	686.8	0.1%	501	391	251	154	96	64	40	0.9	0.7	0.4	0.3	1.0	0.5	0.8
3	8	677.8	0.2%	223	195	157	119	88	62	33	0.6	0.5	0.6	0.3	0.4	0.5	0.3
3	13	672.7	0.3%	122	109	92	74	59	45	35	0.6	0.4	0.2	0.2	0.2	0.4	0.3
4	2	690.0	0.2%	68	58	51	45	39	32	22	0.9	0.1	0.1	0.1	0.1	0.2	0.1
4	5	676.8	0.1%	504	404	253	155	96	63	41	0.9	0.5	0.2	0.3	0.7	0.4	0.2
4	8	670.4	0.1%	223	199	159	120	89	62	33	0.9	0.3	0.1	0.3	0.3	0.1	0.2
4	13	668.2	0.2%	123	109	92	74	58	44	32	0.4	0.2	0.1	0.3	0.1	0.4	0.2

E.3 Machine 6

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	708.3	0.9%	64	55	49	43	37	31	21	0.2	0.4	0.3	1.0	0.7	0.4	0.2
1	5	688.7	0.4%	454	361	236	146	89	60	33	1.2	1.1	1.0	0.8	0.5	0.4	0.8
1	8	673.8	0.6%	215	189	153	116	85	60	31	0.3	0.4	0.4	0.8	0.4	0.5	0.3
1	13	669.9	0.5%	121	108	92	76	61	48	30	0.3	0.3	0.3	0.6	0.4	0.3	0.9
2	2	697.7	0.4%	68	56	50	43	37	31	20	0.4	0.5	0.4	0.3	1.1	1.0	0.3
2	5	670.7	0.8%	493	390	249	150	92	59	38	0.7	0.5	0.5	0.4	0.3	**4.2**	0.5
2	8	654.7	0.4%	223	198	158	119	87	62	31	0.3	1.0	0.4	0.5	0.5	0.5	1.4
2	13	644.3	0.7%	121	110	93	77	61	46	27	0.4	0.3	0.3	0.8	0.2	0.4	0.5

E.4 Machine 10

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	692.9	0.8%	76	61	54	49	41	35	24	1.0	0.3	0.3	1.1	0.2	0.9	0.7
1	5	681.0	1.0%	523	399	257	158	96	60	38	4.2	3.1	2.0	1.3	1.3	0.9	0.9
1	8	704.6	0.9%	230	200	161	125	91	65	34	1.0	0.8	0.6	0.7	0.6	0.9	0.6
1	13	704.5	0.1%	123	108	92	76	60	47	28	0.6	0.4	0.1	0.1	0.4	0.1	0.3
2	2	693.6	0.1%	72	61	55	50	43	33	23	0.8	0.5	0.5	0.7	0.5	0.5	0.0
2	5	675.5	0.7%	542	403	256	156	92	61	36	1.5	0.8	0.8	0.9	0.4	1.1	0.7
2	8	683.8	0.2%	233	202	163	126	91	65	34	0.4	0.3	0.4	0.4	0.2	0.3	0.5
2	13	689.3	0.3%	118	107	93	78	62	48	28	0.4	0.5	0.4	0.2	0.2	0.1	0.1

E.5 Machine 11

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	677.5	0.1%	74	61	56	49	42	36	25	0.3	0.5	0.5	0.2	0.2	0.2	0.3
1	5	667.2	0.2%	520	400	260	156	94	57	34	0.8	0.6	0.4	0.3	0.5	0.3	0.3
1	8	679.4	0.1%	233	203	165	126	93	66	34	0.2	0.2	0.1	0.2	0.2	0.1	0.1
1	13	685.1	0.1%	126	114	95	80	64	51	31	0.2	0.3	0.5	0.2	0.2	0.4	0.6
2	2	680.8	0.3%	72	62	56	49	44	35	24	0.3	0.2	0.2	0.2	0.4	0.2	0.6
2	5	668.0	0.1%	558	412	264	160	94	60	36	1.4	0.5	0.4	0.7	0.4	0.5	0.9
2	8	681.6	0.2%	236	208	167	127	94	66	34	0.3	0.2	0.2	0.2	0.2	0.2	0.3
2	13	686.0	0.2%	128	115	96	81	67	53	31	0.4	0.3	0.2	0.4	0.2	0.2	0.3

E.6 Machine 13

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	*2*	*738.1*	*0.6%*	*67*	*56*	*50*	*43*	*38*	*32*	*21*	***2.1***	*0.1*	*0.1*	*1.2*	*0.1*	*0.6*	*1.3*
1	*5*	*718.1*	*0.8%*	*507*	*376*	*243*	*152*	*94*	*60*	*36*	*1.5*	*0.5*	*0.4*	*0.6*	*1.0*	*0.6*	*0.7*
1	*8*	*702.0*	*0.7%*	*223*	*192*	*155*	*119*	*88*	*62*	*32*	***3.2***	*0.6*	*1.3*	*0.4*	*0.4*	*1.7*	***2.2***
1	*13*	*692.8*	*0.4%*	*124*	*108*	*91*	*76*	*60*	*46*	*29*	*1.0*	*0.4*	*0.2*	*1.1*	*0.2*	*1.6*	*1.0*
2	*2*	*729.5*	*0.5%*	*69*	*56*	*51*	*45*	*39*	*31*	*23*	*0.5*	*0.3*	*0.5*	*0.4*	*0.7*	*1.7*	*1.0*
2	*5*	*708.5*	*0.9%*	*514*	*387*	*249*	*153*	*92*	*61*	*34*	*1.7*	*0.9*	*0.5*	*0.5*	*0.6*	***2.7***	*1.1*
2	*8*	*695.3*	*0.7%*	*226*	*195*	*157*	*120*	*89*	*63*	*33*	*0.4*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*	*0.7*
2	*13*	*674.3*	*0.4%*	*121*	*107*	*92*	*75*	*61*	*46*	*27*	*0.4*	*0.3*	*0.2*	*0.4*	*0.3*	*0.2*	*0.5*
3	2	725.6	0.6%	68	56	51	46	39	32	22	0.4	0.4	0.5	0.7	**2.3**	1.5	**3.7**
3	5	706.7	0.5%	525	395	251	153	92	58	37	1.3	0.6	0.4	0.3	0.3	0.5	0.7
3	8	694.6	0.7%	229	196	158	121	89	63	32	0.9	0.3	0.2	1.0	0.6	0.4	0.6
3	13	667.0	0.3%	123	106	91	74	60	45	26	0.3	0.3	0.3	0.4	0.3	0.6	0.7
4	2	711.6	0.5%	72	57	51	45	38	33	22	0.6	0.6	0.5	0.4	1.2	2.0	0.9
4	5	700.1	0.7%	524	391	252	153	91	57	36	2.5	1.2	1.0	0.7	0.6	0.7	1.1
4	8	684.4	0.4%	232	200	161	123	90	63	33	0.4	0.4	0.5	0.5	0.8	0.8	0.5
4	13	669.3	0.3%	125	107	93	78	63	49	31	1.0	1.1	1.0	1.1	1.1	1.2	1.3

E.7 Machine 15

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	703.7	0.2%	71	62	55	49	42	35	25	0.3	0.1	0.2	0.3	0.2	0.2	0.3
1	5	687.1	0.1%	488	378	251	153	92	58	33	0.3	0.2	0.3	0.5	0.2	0.3	0.2
1	8	699.7	0.2%	233	203	164	125	92	65	34	0.3	0.3	0.1	0.4	0.3	0.2	0.2
1	13	703.1	0.2%	128	115	99	82	67	53	33	0.2	0.2	0.2	0.2	0.2	0.1	0.2
2	2	695.5	0.2%	72	63	57	50	43	36	25	0.4	0.5	0.4	0.5	0.4	0.3	0.4
2	5	684.2	0.2%	549	416	265	158	91	58	34	0.8	0.5	0.2	0.2	0.7	0.2	0.4
2	8	695.1	0.1%	237	208	167	126	93	66	34	0.3	0.3	0.4	0.2	0.3	0.2	0.3
2	13	701.3	0.2%	130	115	99	82	66	52	30	0.2	0.1	0.2	0.3	0.2	0.5	0.6

E.8 Machine 16

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	*2*	*696.1*	*0.3%*	*73*	*61*	*56*	*47*	*41*	*34*	*25*	*0.6*	*0.4*	*0.5*	*0.9*	*0.4*	*0.4*	*0.4*
1	*5*	*678.7*	*0.2%*	*529*	*391*	*266*	*161*	*96*	*61*	*37*	*0.7*	***7.6***	***3.7***	*1.2*	*0.8*	*0.5*	*0.4*
1	*8*	*691.6*	*0.2%*	*233*	*205*	*166*	*126*	*92*	*65*	*35*	*0.6*	*0.3*	*0.4*	*0.6*	*0.5*	*0.5*	*0.2*
1	*13*	*699.5*	*0.2%*	*126*	*113*	*96*	*80*	*64*	*50*	*32*	*0.2*	*0.3*	*0.3*	*0.2*	*0.2*	*0.2*	*0.5*
2	*2*	*678.6*	*0.2%*	*68*	*64*	*57*	*49*	*43*	*36*	*25*	***2.8***	*0.7*	*0.4*	*0.4*	*0.2*	*0.2*	*0.7*
2	*5*	*664.3*	*0.2%*	*544*	*419*	*263*	*161*	*93*	*58*	*38*	*1.2*	*0.8*	*0.6*	*0.4*	*0.4*	*0.3*	*0.2*
2	*8*	*678.4*	*0.1%*	*238*	*209*	*168*	*129*	*94*	*65*	*34*	*0.6*	*1.0*	*0.4*	*1.6*	***2.1***	*0.5*	*0.3*
2	*13*	*684.5*	*0.2%*	*129*	*119*	*99*	*78*	*67*	*52*	*31*	*0.5*	*0.5*	*0.2*	*0.6*	*0.2*	*0.1*	*0.1*
3	2	676.2	0.2%	75	64	57	50	43	36	25	0.3	0.7	0.4	0.2	0.2	0.1	0.4
3	5	662.4	0.1%	573	420	265	158	94	59	36	0.9	0.7	0.6	0.5	0.3	0.7	0.2
3	8	676.4	0.2%	241	212	170	129	94	66	34	0.4	0.4	0.3	0.2	0.3	0.2	0.1
3	13	683.0	0.2%	129	116	97	80	65	52	33	0.1	0.2	0.5	0.5	0.2	0.2	0.3
4	2	674.9	0.1%	71	68	60	51	47	35	22	1.5	1.4	1.1	0.2	0.6	0.2	0.9
4	5	662.0	0.1%	556	430	263	163	98	59	37	1.0	2.7	2.2	0.8	0.6	0.3	0.3
4	8	675.2	0.2%	243	210	170	128	94	66	34	0.5	0.7	0.6	0.3	0.3	0.2	0.3
4	13	681.3	0.2%	128	117	100	83	68	52	33	0.8	0.2	0.2	0.2	0.1	0.2	0.1

E.9 Machine 28

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	696.5	0.2%	73	62	55	48	41	36	24	0.1	0.2	0.1	0.2	0.1	0.2	0.2
1	5	686.8	0.1%	513	397	258	155	95	58	35	0.9	1.1	1.0	0.5	0.6	0.1	0.2
1	8	699.8	0.2%	230	203	161	125	92	63	34	0.3	0.3	1.0	0.2	0.3	0.9	0.3
1	13	703.3	0.1%	125	115	97	82	66	51	32	0.1	0.3	0.1	0.3	0.4	0.2	0.2
2	2	699.5	0.2%	72	76	59	52	41	34	26	0.9	1.7	0.3	0.7	0.2	0.5	1.0
2	5	686.6	0.2%	537	408	261	157	94	56	36	0.9	0.5	0.4	0.2	0.3	0.2	0.2
2	8	699.2	0.1%	237	202	164	125	89	63	33	0.4	0.8	0.2	0.5	0.6	0.6	1.4
2	13	702.0	0.1%	129	117	98	82	66	53	30	0.5	0.6	0.1	0.2	0.1	0.2	0.4

E.10 Machine 30

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	706.6	0.2%	76	58	54	47	42	34	20	0.6	0.4	0.7	0.1	0.2	0.2	0.1
1	5	699.3	0.1%	485	388	251	155	96	60	29	0.6	0.5	0.5	0.3	0.4	0.9	0.8
1	8	709.5	0.3%	228	197	161	121	93	64	28	0.5	0.4	0.9	0.3	0.7	0.3	0.4
1	13	715.7	0.2%	124	109	93	76	62	47	23	0.5	0.1	0.3	0.1	0.3	0.2	0.3
2	2	697.1	0.2%	74	63	58	44	39	32	23	0.4	0.5	1.2	1.4	0.4	0.7	0.6
2	5	685.2	0.2%	537	410	265	158	96	58	30	0.7	0.8	1.4	0.3	0.4	0.4	0.3
2	8	701.7	0.2%	235	202	164	123	93	67	29	0.4	0.3	0.6	0.5	0.5	0.9	1.0
2	13	706.6	0.2%	129	112	96	79	64	50	25	0.2	0.3	0.4	0.3	0.2	0.4	0.7
3	2	679.3	0.3%	72	61	56	48	42	34	22	0.3	0.5	0.6	0.4	0.7	0.8	0.6
3	5	657.4	1.0%	545	426	271	167	100	59	31	1.7	1.4	0.7	1.0	0.8	0.7	0.6
3	8	668.5	0.3%	240	207	169	129	96	67	29	0.4	1.4	0.3	0.4	0.5	0.5	0.5
3	13	683.9	0.2%	137	121	102	84	67	53	32	0.7	0.3	0.2	0.2	0.2	0.2	0.3
4	2	677.5	1.0%	72	62	55	50	43	33	23	0.2	0.3	0.3	0.4	0.4	1.3	1.4
4	5	661.5	0.2%	544	414	266	161	98	61	32	1.2	0.6	0.7	0.2	1.0	1.1	1.2
4	8	676.9	0.8%	241	206	167	126	97	68	30	0.4	0.5	0.4	0.2	0.6	0.9	1.3
4	13	688.2	0.3%	138	125	102	84	68	52	31	0.6	1.2	0.4	0.6	0.5	0.5	0.4
5	2	669.2	0.2%	76	64	58	50	44	37	25	0.2	0.4	0.9	0.1	0.4	0.7	0.8
5	5	652.5	0.2%	567	407	259	157	94	62	34	1.0	1.1	0.9	0.9	0.5	1.9	0.3
5	8	665.0	0.2%	248	217	174	131	96	67	33	0.5	0.5	0.5	0.4	0.5	1.6	1.4
5	13	675.2	0.2%	133	118	100	82	66	54	33	0.2	0.3	0.2	0.2	0.7	0.6	0.7
6	2	664.8	0.2%	75	65	57	50	44	37	25	0.2	0.5	0.5	0.2	0.1	0.4	0.4
6	5	651.3	0.2%	593	435	269	162	97	61	35	1.6	1.2	1.5	0.6	0.6	1.1	0.8
6	8	657.5	0.2%	253	217	174	133	96	69	32	0.5	0.5	0.6	0.7	0.7	0.8	0.7
6	13	664.8	0.3%	128	116	99	82	66	53	32	0.6	0.6	0.4	0.2	0.5	1.3	0.9

E.11 Machine 32

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	*2*	*729.5*	*0.6%*	*64*	*54*	*50*	*44*	*37*	*31*	*21*	*0.3*	*0.2*	*0.1*	*0.2*	*0.2*	*0.2*	*0.2*
1	*5*	*713.4*	*0.4%*	*465*	*379*	*250*	*157*	*98*	*62*	*34*	*2.5*	*1.2*	*0.5*	*0.4*	*0.2*	*0.4*	*0.6*
1	*8*	*703.8*	*0.5%*	*211*	*190*	*156*	*121*	*88*	*64*	*33*	*0.8*	*0.4*	*0.5*	*0.5*	*0.4*	*0.3*	*0.3*
1	*13*	*692.0*	*0.4%*	*117*	*106*	*93*	*76*	*61*	*46*	*27*	*0.6*	*0.6*	*0.5*	*0.5*	*0.3*	*0.2*	*0.3*
2	*2*	*728.4*	*0.6%*	*59*	*56*	*51*	*45*	*38*	*32*	*22*	*1.8*	*0.3*	*0.2*	*0.2*	*0.3*	*0.2*	*0.2*
2	*5*	*703.9*	*0.8%*	*483*	*392*	*260*	*160*	*97*	*63*	*39*	*1.2*	*0.7*	*0.5*	*0.4*	*0.4*	*0.3*	*1.0*
2	*8*	*692.5*	*0.2%*	*218*	*194*	*158*	*121*	*89*	*63*	*32*	*0.8*	*0.5*	*0.4*	*0.3*	*0.2*	*0.2*	*0.3*
2	*13*	*672.8*	*0.5%*	*118*	*108*	*93*	*76*	*61*	*47*	*27*	*0.7*	*0.2*	*0.2*	*0.1*	*0.3*	*0.2*	*0.1*
3	2	710.4	0.3%	67	57	52	45	38	32	22	0.6	0.2	0.2	0.2	0.2	0.3	0.6
3	5	681.4	0.7%	534	412	265	162	101	61	39	1.2	1.0	0.6	0.4	0.8	0.6	0.3
3	8	686.9	0.3%	232	205	166	128	93	65	33	0.5	0.5	0.5	0.5	1.6	0.5	0.2
3	13	660.1	0.4%	119	109	95	78	63	48	31	0.6	0.2	0.5	0.5	0.3	0.3	0.2
4	2	702.4	0.3%	67	56	52	46	39	33	22	0.3	0.4	0.3	0.2	0.3	0.6	0.2
4	5	668.6	0.5%	552	415	266	161	101	62	39	3.2	1.9	1.3	0.6	1.0	0.4	0.3
4	8	675.6	0.3%	232	204	166	126	92	66	34	0.5	0.3	0.6	0.2	1.3	0.4	0.1
4	13	660.4	0.1%	124	111	96	79	62	48	31	0.7	0.2	0.2	0.3	0.1	0.4	0.2

E.12 Machine 33

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	717.7	0.4%	68	58	52	45	39	33	23	0.6	0.2	0.3	0.6	0.4	0.4	0.6
1	5	703.2	0.3%	472	367	246	153	90	61	35	0.4	0.2	0.3	0.2	0.8	1.3	2.0
1	8	694.7	0.3%	222	194	158	120	87	66	32	0.6	0.4	0.7	1.0	1.2	0.4	1.7
1	13	682.6	0.3%	117	107	92	77	62	50	32	0.5	0.3	0.3	0.3	0.8	0.8	0.7
2	2	707.6	0.3%	72	59	53	47	40	34	24	0.5	0.3	0.2	0.3	0.2	0.3	0.4
2	5	686.2	0.3%	527	400	257	156	93	62	37	0.8	1.6	0.8	0.7	0.6	0.7	0.5
2	8	677.6	0.3%	230	201	163	124	91	66	34	0.9	0.2	0.5	0.4	0.5	0.1	0.3
2	13	771.5	0.6%	118	108	93	77	62	49	30	1.5	0.1	0.2	0.2	0.3	0.1	0.3

E.13 Machine 34

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	731.3	0.2%	57	52	48	41	35	29	20	0.9	0.5	1.2	0.9	1.0	0.5	0.7
1	5	694.6	0.2%	462	359	235	147	90	59	38	2.2	0.7	0.3	0.3	0.3	1.0	0.5
1	8	694.1	0.1%	205	183	148	113	83	59	32	0.3	0.4	0.4	1.6	1.3	1.0	0.4
1	13	673.8	0.3%	110	100	84	71	58	47	28	1.5	0.3	0.4	0.4	0.7	1.6	0.2
2	2	726.1	0.3%	58	53	47	41	36	30	20	0.6	0.4	0.2	0.1	0.9	0.6	0.3
2	5	685.8	0.3%	482	377	244	151	93	56	36	0.9	0.5	0.7	0.6	1.8	**2.1**	1.1
2	8	688.2	0.2%	209	187	150	114	84	59	32	0.4	0.4	0.2	0.1	0.2	0.3	0.3
2	13	674.3	0.3%	114	102	85	72	58	43	27	0.8	0.6	0.4	0.4	0.7	0.7	0.5
3	2	720.6	0.4%	66	55	51	45	37	30	21	1.4	0.4	0.4	0.6	0.2	0.4	0.2
3	5	700.0	0.2%	494	388	249	154	95	62	37	0.6	0.5	0.4	0.3	**2.1**	0.3	0.7
3	8	693.0	0.4%	220	195	156	119	87	61	31	1.0	0.3	0.5	0.7	1.1	1.8	0.8
3	13	682.9	0.3%	120	112	94	77	61	49	42	0.3	0.5	0.2	0.3	0.4	0.7	0.5
4	2	719.9	0.3%	65	55	50	43	37	30	22	0.9	0.6	0.3	0.8	0.6	1.4	0.4
4	5	688.9	0.5%	530	395	254	155	97	60	40	1.3	1.2	0.3	0.4	0.6	0.6	**2.3**
4	8	685.6	0.2%	220	196	157	120	88	63	34	1.7	0.9	0.3	1.2	0.5	1.3	0.8
4	13	675.7	0.2%	120	110	92	75	58	44	33	0.4	0.2	0.2	0.2	0.2	1.1	0.7
5	2	695.9	0.2%	67	58	52	46	39	33	22	0.7	0.3	0.3	0.3	0.5	0.8	0.2
5	5	670.2	0.3%	561	417	263	159	96	63	41	0.9	0.7	0.7	0.6	0.4	1.0	1.0
5	8	672.4	0.3%	233	206	165	125	92	66	33	0.7	0.5	0.4	1.6	0.4	0.1	0.3
5	13	659.0	0.4%	116	107	92	76	60	49	30	0.5	0.3	0.2	0.2	0.4	0.4	0.7
6	2	700.9	0.1%	68	58	52	45	39	32	22	1.2	0.3	0.5	0.5	0.2	0.4	0.4
6	5	666.8	0.2%	569	421	265	160	96	66	41	2.0	0.7	0.8	1.0	0.3	0.7	0.9
6	8	669.8	0.4%	234	206	166	126	92	65	33	0.8	0.4	0.1	0.3	0.4	0.5	0.3
6	13	656.5	0.4%	123	111	95	79	62	48	31	0.6	0.4	0.3	0.2	0.2	0.5	0.6

E.14 Machine 37

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	686.4	0.2%	68	55	55	46	39	33	22	0.4	1.3	0.8	0.1	0.3	0.1	0.0
1	5	667.2	0.2%	529	400	260	159	93	61	38	1.5	1.5	0.5	0.5	0.5	0.5	0.1
1	8	693.9	0.3%	224	196	160	122	89	64	33	0.4	0.2	0.2	0.5	0.3	0.3	0.5
1	13	706.4	0.4%	132	118	101	84	67	53	32	0.5	0.3	0.3	0.3	0.2	0.2	0.5
2	2	676.1	0.3%	67	59	53	47	40	33	23	0.5	0.4	0.2	0.3	0.5	0.4	0.5
2	5	655.5	0.2%	524	409	262	162	93	57	36	1.4	0.4	1.4	0.6	0.4	0.1	1.0
2	8	684.7	0.2%	227	200	162	124	90	64	33	0.4	0.5	0.5	0.9	0.6	0.2	0.5
2	13	698.7	0.3%	120	107	92	77	61	47	27	0.4	0.4	0.3	0.8	0.4	0.3	0.5

E.15 Machine 39

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	*2*	*703.4*	*0.1%*	*72*	*61*	*55*	*48*	*42*	*34*	*24*	***3.6***	*0.5*	*0.3*	*0.1*	*1.1*	*0.5*	*1.5*
1	*5*	*690.5*	*0.3%*	*488*	*387*	*255*	*152*	*92*	*55*	*32*	*1.2*	*0.7*	*0.5*	***2.7***	*0.2*	*0.6*	*0.8*
1	*8*	*707.0*	*0.1%*	*227*	*201*	*162*	*121*	*90*	*65*	*32*	*1.4*	*0.9*	*0.4*	*1.3*	*0.5*	*1.4*	*0.3*
1	*13*	*706.0*	*0.1%*	*124*	*110*	*93*	*75*	*63*	*51*	*29*	*0.8*	*0.7*	*0.3*	*1.3*	*0.3*	*1.1*	*0.5*
2	*2*	*692.8*	*0.1%*	*73*	*64*	*56*	*46*	*41*	*37*	*24*	*1.9*	***2.7***	*0.4*	*0.3*	*0.7*	*0.7*	***2.3***
2	*5*	*679.6*	*0.1%*	*531*	*388*	*272*	*165*	*86*	*56*	*30*	*3.4*	***19.8***	***4.4***	***7.4***	***2.6***	*1.7*	*1.2*
2	*8*	*681.1*	*0.1%*	*231*	*204*	*161*	*122*	*89*	*66*	*32*	*0.4*	*0.6*	*1.3*	*2.0*	*1.0*	*0.7*	*0.7*
2	*13*	*703.1*	*0.3%*	*126*	*117*	*98*	*80*	*66*	*52*	*30*	*0.5*	*0.9*	*0.1*	*0.4*	*0.5*	*0.3*	*1.1*
3	2	676.4	0.1%	70	60	55	47	41	34	24	0.3	0.1	0.2	0.1	0.2	0.2	0.3
3	5	664.0	0.1%	506	385	251	148	90	54	29	0.9	0.4	0.2	0.3	0.2	0.3	0.5
3	8	676.0	0.1%	227	199	161	121	89	63	32	0.3	0.2	0.3	0.2	0.2	0.3	0.3
3	13	685.5	0.1%	128	114	98	79	65	51	37	0.3	0.1	0.3	0.1	0.2	0.3	0.5
4	2	677.2	0.1%	69	61	54	47	41	34	23	0.3	0.4	0.4	0.3	0.1	0.1	0.2
4	5	664.4	0.1%	511	390	251	150	91	54	32	0.7	0.3	0.3	0.3	0.2	0.3	0.1
4	8	674.5	0.1%	228	200	162	121	90	64	32	0.3	0.4	0.2	0.3	0.2	0.3	0.5
4	13	684.4	0.1%	127	111	95	77	62	50	35	**2.1**	1.0	1.0	0.9	0.8	0.7	0.4

E.16 Machine 45

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	700.1	0.3%	71	61	55	49	42	35	24	0.4	0.4	0.3	0.4	0.3	0.1	0.1
1	5	700.2	0.2%	498	397	263	164	100	63	38	1.4	1.2	0.9	0.7	0.4	0.6	0.3
1	8	699.1	0.2%	232	205	166	128	95	68	35	0.7	0.5	0.2	0.5	0.7	0.2	0.4
1	13	714.6	0.3%	121	107	91	76	62	48	30	0.4	0.3	0.3	0.5	0.4	0.2	0.4
2	2	691.1	0.2%	74	62	55	49	43	36	25	0.1	0.4	0.1	0.1	0.5	0.1	0.3
2	5	698.1	0.1%	515	403	263	164	99	63	38	1.2	0.7	0.4	0.4	0.5	0.4	0.0
2	8	699.0	0.1%	234	207	167	130	95	68	35	0.5	0.6	0.5	0.3	0.4	0.1	0.0
2	13	710.7	0.1%	121	108	92	77	62	50	30	0.1	0.3	0.4	0.1	0.5	0.0	0.0

E.17 Machine 47

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	707.3	0.1%	71	61	57	49	43	38	25	0.1	0.9	0.6	0.9	0.5	1.5	0.4
1	5	694.6	0.1%	506	408	265	160	94	57	32	1.5	1.2	0.5	0.5	0.1	0.5	0.0
1	8	707.1	0.1%	232	202	167	126	92	66	34	0.4	0.6	0.4	0.3	0.4	0.5	0.5
1	13	710.7	0.2%	133	116	101	83	65	53	31	0.3	1.1	0.5	0.3	0.5	0.6	0.1
2	2	691.8	0.2%	74	64	58	49	42	35	25	0.9	1.2	0.6	**2.0**	1.3	0.7	0.4
2	5	687.6	0.2%	541	420	270	153	90	62	35	1.4	1.8	0.8	0.9	0.5	1.8	**3.6**
2	8	700.5	0.2%	234	205	169	127	92	65	33	0.3	1.1	0.1	0.2	0.3	1.0	0.4
2	13	704.8	0.1%	130	117	103	82	68	53	31	0.2	0.4	0.8	0.3	0.2	0.2	0.2
3	2	695.1	0.2%	74	64	58	51	43	37	25	**3.4**	0.4	0.5	0.5	0.4	0.4	0.5
3	5	684.7	0.1%	551	429	272	155	91	56	32	1.6	0.5	0.4	0.3	0.3	0.5	0.6
3	8	701.9	0.1%	241	212	171	129	93	66	33	0.7	0.3	0.2	0.2	0.1	0.2	0.2
3	13	704.3	0.1%	128	114	101	82	65	54	29	0.2	0.2	0.4	0.1	0.1	1.0	**2.3**
4	2	689.5	0.1%	74	67	59	53	45	36	27	1.0	1.1	0.3	1.5	1.4	1.0	**2.4**
4	5	685.8	0.1%	545	436	275	160	92	55	33	0.9	0.4	0.3	0.2	0.1	0.4	0.3
4	8	700.6	0.1%	242	213	172	129	93	65	33	0.2	0.2	0.2	0.1	0.1	0.2	0.5
4	13	702.1	0.1%	127	120	96	77	65	58	31	0.7	0.1	0.4	0.2	0.1	0.4	0.6
5	2	692.2	0.2%	76	65	58	51	44	37	25	1.6	0.1	0.3	0.2	0.1	0.2	0.1
5	5	685.2	0.1%	566	424	274	155	89	54	31	0.9	1.1	1.1	0.5	0.2	0.6	0.2
5	8	698.6	0.1%	244	215	172	130	93	65	33	0.6	0.3	0.3	0.2	0.1	0.2	0.2
5	13	694.0	0.1%	130	116	102	81	66	54	32	1.8	0.1	0.5	0.4	0.2	0.5	0.9

E.18 Machine 48

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	698.9	0.2%	72	62	55	49	42	35	24	0.6	0.2	0.1	0.2	0.3	0.2	0.1
1	5	675.8	0.3%	447	362	243	149	88	54	34	0.7	0.5	0.4	0.4	0.4	0.2	0.3
1	8	703.4	0.2%	230	201	163	124	90	64	33	0.3	0.3	0.2	0.2	0.2	0.2	0.2
1	13	703.2	0.2%	126	112	95	79	63	49	29	0.7	0.1	0.2	0.3	0.1	0.4	0.1
2	2	757.5	0.2%	71	62	55	49	42	35	24	0.4	0.1	0.1	0.1	0.2	0.1	0.4
2	5	754.2	0.2%	519	401	257	155	92	54	33	0.6	0.6	0.3	0.4	0.2	0.3	0.4
2	8	758.5	0.1%	234	205	166	126	91	65	34	0.3	0.2	0.2	0.2	0.2	0.2	0.1
2	13	761.9	0.1%	127	113	97	81	65	51	30	0.5	0.1	0.1	0.1	0.1	0.1	0.2

E.19 Machine 50

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	677.9	0.9%	79	57	53	45	39	32	0	0.6	0.5	0.5	0.4	0.6	0.5	0.0
1	5	636.8	**2.2%**	630	412	278	162	99	64	0	**12.5**	**11.7**	**8.1**	**5.0**	**2.7**	**2.7**	0.0
1	8	660.4	0.9%	261	194	163	118	88	61	0	1.1	1.2	1.1	0.8	0.6	0.4	0.0
1	13	**632.6**	0.6%	143	111	100	81	66	51	0	0.7	0.7	0.1	0.3	0.4	0.5	0.0
2	2	713.4	0.8%	78	59	54	46	40	33	33	0.8	1.1	0.5	0.5	0.7	0.6	**2.1**
2	5	695.0	**2.6%**	636	406	273	157	95	60	43	**15.3**	**14.5**	**10.3**	**6.1**	**3.7**	**2.1**	**2.1**
2	8	725.8	1.6%	259	193	161	118	87	60	42	**3.7**	**4.0**	**4.2**	**2.9**	**2.5**	1.7	0.5
2	13	677.7	0.2%	141	109	99	78	64	50	33	0.2	**3.2**	0.5	1.4	1.3	0.9	**8.1**
3	2	710.3	0.6%	75	57	53	44	39	32	22	0.3	0.2	0.6	0.2	0.1	0.5	0.7
3	5	697.9	1.5%	533	379	258	151	92	58	29	4.9	**4.2**	**3.0**	1.8	1.6	1.0	0.8
3	8	712.1	1.8%	238	191	160	117	85	60	30	**3.1**	**2.5**	2.0	1.3	0.7	1.0	0.3
3	13	709.7	0.9%	133	108	95	75	60	45	35	1.5	1.4	1.2	0.9	0.9	0.7	0.8
4	2	710.2	0.5%	75	57	53	45	39	32	22	0.4	0.3	0.3	0.2	0.3	0.2	0.2
4	5	684.3	1.4%	548	392	266	156	95	60	29	**6.6**	**7.5**	**5.2**	**3.2**	1.8	1.6	0.6
4	8	722.7	1.6%	240	190	160	117	86	60	29	2.4	2.2	1.6	1.2	0.7	0.7	0.5
4	13	705.0	0.7%	136	111	98	78	63	48	39	0.9	1.1	1.1	0.6	0.5	0.8	0.6
5	2	718.5	0.5%	75	57	53	45	39	32	21	0.2	0.5	0.5	0.5	0.4	0.3	0.7
5	5	690.5	0.6%	570	407	272	159	97	61	31	2.2	2.5	1.6	0.6	0.7	0.6	0.5
5	8	727.6	1.2%	240	191	161	117	86	60	30	0.7	1.0	1.8	1.0	0.5	0.7	0.3
5	13	692.3	0.4%	134	110	98	77	62	49	38	0.3	0.3	0.4	0.3	0.5	0.9	0.6
6	2	718.8	1.2%	73	56	53	44	38	32	22	0.7	0.5	0.3	0.3	0.8	0.4	0.5
6	5	692.1	0.6%	569	405	274	159	97	61	31	2.2	2.3	1.6	1.0	1.0	0.6	0.5
6	8	723.8	1.2%	244	195	165	120	88	62	29	2.8	2.4	2.2	1.7	1.2	0.6	0.5
6	13	708.1	0.7%	136	111	98	77	62	47	35	1.3	0.9	0.7	0.6	0.6	0.4	0.7

E.20 Machine 52

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	749.0	0.1%	70	58	52	46	40	33	23	0.3	0.1	0.2	0.2	0.3	0.3	0.8
1	5	739.8	0.1%	476	370	240	146	86	54	34	0.5	0.5	0.4	0.3	0.3	0.2	0.2
1	8	745.5	0.2%	222	195	156	119	87	61	31	0.2	0.2	0.2	0.2	0.2	0.3	0.6
1	13	750.7	0.1%	117	104	90	75	61	47	28	0.2	0.2	0.2	0.2	0.2	0.2	0.3
2	2	749.0	0.1%	70	58	52	46	40	33	23	0.3	0.1	0.2	0.2	0.3	0.3	0.8
2	5	739.8	0.1%	476	370	240	146	86	54	34	0.5	0.5	0.4	0.3	0.3	0.2	0.2
2	8	745.5	0.2%	222	195	156	119	87	61	31	0.2	0.2	0.2	0.2	0.2	0.3	0.6
2	13	750.7	0.1%	117	104	90	75	61	47	28	0.2	0.2	0.2	0.2	0.2	0.2	0.3

E.21 Machine 53

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	*2*	***902.1***	*0.3%*	*69*	*59*	*52*	*46*	*40*	*33*	*23*	*0.6*	*0.3*	*0.2*	*0.1*	*0.4*	*0.5*	*0.1*
1	*5*	***883.2***	*0.3%*	*499*	*397*	*253*	*155*	*94*	*62*	*39*	*2.3*	*1.9*	*1.7*	*1.0*	*0.7*	*1.3*	*0.6*
1	*8*	***904.6***	*0.2%*	*225*	*198*	*158*	*121*	*89*	*64*	*34*	*0.9*	*1.0*	*0.9*	*0.7*	*0.8*	*0.5*	*0.4*
1	*13*	***906.5***	*0.3%*	*123*	*109*	*93*	*77*	*61*	*48*	*29*	*1.0*	*0.4*	*0.6*	*0.2*	*0.1*	*0.2*	*0.1*
2	2	723.7	0.5%	71	61	55	48	41	35	24	0.8	0.5	0.7	0.4	0.4	0.3	0.3
2	5	713.0	0.4%	545	430	261	157	93	59	36	1.6	1.6	1.2	0.9	0.7	0.8	0.6
2	8	725.5	0.7%	234	201	165	125	90	65	34	1.1	1.0	1.3	1.2	0.9	0.9	0.5
2	13	724.2	0.4%	129	112	94	78	62	49	28	0.7	0.1	0.4	0.2	0.2	0.1	0.2
3	2	719.4	0.5%	73	61	54	48	39	35	25	0.4	0.3	0.2	0.5	0.8	0.3	0.9
3	5	709.6	0.4%	544	417	260	155	92	59	37	2.1	2.4	1.6	1.2	0.8	0.7	0.8
3	8	723.9	0.3%	233	206	164	124	91	65	33	0.8	1.2	1.0	1.0	0.8	0.8	0.5
3	13	728.5	0.3%	129	115	97	80	63	51	30	1.1	1.0	0.6	0.5	0.5	0.6	0.5

E.22 Machine 54

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	713.7	1.8%	63	58	52	46	39	34	23	0.8	0.2	0.2	0.3	0.2	0.2	0.1
1	5	689.9	1.7%	480	379	249	154	94	60	37	**7.9**	0.7	0.4	0.4	0.2	0.2	0.9
1	8	688.6	1.8%	218	194	158	121	90	65	33	0.5	0.5	0.4	0.4	0.2	0.7	0.2
1	13	706.7	0.4%	126	113	96	80	64	52	32	1.0	0.6	0.7	0.5	0.4	0.5	0.8
2	2	713.2	1.5%	67	58	53	46	39	35	24	0.2	0.2	0.3	0.2	0.2	0.3	0.3
2	5	693.3	1.7%	495	389	254	154	92	61	37	1.2	0.8	0.3	0.3	1.2	1.5	0.2
2	8	684.9	1.5%	218	195	157	122	90	65	34	0.6	0.4	0.5	0.2	0.4	0.1	0.3
2	13	709.8	1.0%	120	108	93	77	62	50	31	1.0	0.3	0.9	0.2	0.3	0.2	0.8

E.23 Machine 56

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	700.1	0.3%	70	60	53	47	41	34	24	0.6	0.2	0.3	0.5	0.2	0.4	0.2
1	5	672.7	0.3%	486	405	259	159	96	60	35	1.9	1.2	1.0	0.6	0.4	0.4	0.4
1	8	710.2	0.3%	222	197	159	121	90	64	34	0.4	0.3	0.2	0.2	0.2	0.2	0.2
1	13	708.4	0.3%	125	113	96	79	64	49	32	0.6	0.2	0.1	0.1	0.2	0.6	0.2
2	2	706.1	0.3%	71	61	54	48	42	35	24	0.2	0.1	0.2	0.1	0.1	0.1	0.1
2	5	678.7	0.3%	511	406	257	156	93	59	36	1.0	0.7	0.4	0.2	0.2	0.1	0.2
2	8	701.1	0.3%	225	200	160	122	90	65	34	0.6	0.2	0.1	0.1	0.1	0.2	0.1
2	13	703.0	0.3%	122	111	96	79	65	52	33	0.2	0.1	0.4	0.2	0.3	0.4	0.6

E.24 Machine 57

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
1	2	**894.3**	0.3%	62	52	47	41	34	30	19	0.3	0.1	0.2	0.1	0.7	1.3	0.6
1	5	**865.0**	0.3%	462	364	236	146	93	64	43	0.7	0.4	0.3	0.2	0.3	0.2	0.6
1	8	**873.9**	0.2%	202	177	144	110	80	58	33	0.2	0.2	0.3	0.3	0.4	0.2	0.3
1	13	**857.6**	0.2%	114	101	88	72	57	44	28	0.2	0.3	0.1	0.1	0.1	0.3	0.4
2	2	**779.8**	0.1%	62	54	49	42	35	31	20	0.1	0.1	0.3	0.1	0.2	0.1	0.1
2	5	747.4	0.5%	479	380	242	150	92	64	43	0.3	0.3	0.2	0.3	0.2	0.3	0.8
2	8	771.1	0.1%	206	180	147	112	82	60	32	0.3	0.2	0.2	0.3	0.3	0.4	0.1
2	13	767.3	0.2%	109	98	84	70	56	44	25	0.2	0.1	0.1	0.4	0.1	0.3	0.2
3	2	725.3	0.2%	63	54	49	44	36	30	21	0.2	0.3	0.3	0.6	0.2	0.3	0.2
3	5	702.3	0.3%	495	388	244	149	93	62	42	0.5	0.5	0.4	0.2	0.2	0.3	0.3
3	8	721.3	0.2%	208	183	148	113	81	59	32	0.2	0.1	0.3	0.2	0.5	0.2	0.5
3	13	722.1	0.2%	111	99	85	71	56	43	28	0.2	0.2	0.2	0.2	0.3	0.1	0.9
4	2	731.0	0.2%	65	54	48	43	37	31	20	0.2	0.2	0.2	0.1	0.1	0.4	0.4
4	5	717.8	0.2%	484	379	246	149	91	60	41	0.7	0.3	0.3	0.3	0.6	0.2	1.0
4	8	716.1	0.3%	213	188	151	116	82	60	32	0.3	0.2	0.4	0.1	0.5	0.2	0.3
4	13	725.5	0.1%	113	102	87	72	58	45	29	0.5	0.1	0.1	0.3	0.2	0.1	0.1
5	2	731.8	0.2%	64	54	49	42	36	30	20	0.2	0.1	0.5	0.1	0.1	0.3	0.3
5	5	705.3	0.3%	459	366	241	150	90	62	42	0.5	0.4	0.3	0.2	0.2	0.1	0.1
5	8	702.5	0.2%	210	185	150	115	84	60	32	0.2	0.2	0.3	0.2	0.3	0.1	0.4
5	13	715.0	0.2%	120	107	92	76	60	46	41	0.2	0.2	0.1	0.2	0.5	0.2	0.2
6	2	724.4	0.2%	65	55	48	43	37	31	21	0.5	0.2	0.3	0.1	0.1	0.1	0.3
6	5	707.0	0.3%	476	377	244	153	93	65	45	0.7	0.3	0.3	0.3	0.1	0.3	1.4
6	8	708.1	0.3%	211	187	151	114	84	59	33	0.7	0.9	0.9	1.0	0.5	0.2	0.3
6	13	705.7	0.5%	114	101	87	70	54	40	31	0.3	0.1	0.2	0.6	0.5	0.1	0.2

Lap	Station	Mean Load	SD of Load (%)	Mean D1	Mean D2	Mean D3	Mean D4	Mean D5	Mean D6	Mean D7	SD D1	SD D2	SD D3	SD D4	SD D5	SD D6	SD D7
7	2	674.8	0.3%	67	57	51	46	39	33	23	0.3	0.2	0.1	0.1	0.4	0.3	0.1
7	5	665.2	0.2%	524	410	260	157	99	66	43	0.6	0.4	0.3	0.5	1.0	0.2	0.4
7	8	714.0	0.3%	225	199	161	122	88	64	37	0.1	0.1	0.4	0.2	0.2	0.2	0.8
7	13	720.9	0.3%	122	110	94	78	62	48	34	0.1	0.1	0.3	0.3	0.4	1.8	0.8
8	2	735.6	0.2%	68	58	52	45	39	33	22	0.2	0.2	0.2	0.3	0.1	0.2	0.3
8	5	711.7	0.4%	532	411	261	160	96	65	44	0.3	0.6	0.2	0.3	0.3	0.4	0.4
8	8	711.3	0.4%	227	197	160	122	88	64	35	0.2	0.4	0.4	0.3	0.6	0.3	0.8
8	13	723.7	0.3%	120	109	94	78	62	48	34	0.3	0.2	0.3	0.3	0.5	0.5	0.1

Appendix F Reproducibility trial data

Note: In the tables below, bold red text indicates that the value is outside of acceptable limits. Data from laps disregarded in the accreditation analysis are shown in grey italics (except where the value is outside of acceptable limits). To clearly distinguish between the test days, the first lap on Day 2 was labelled as 21 and the first lap on Day 3 was labelled as 31.

F.1 All reproducibility trial data

Table F.1: Machine 02 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.995*	*0.986*	*0.990*	*0.989*	*1.008*	*1.009*	*1.015*	*0.999*	*0.012*	*0.012*	*0.012*	*0.012*	*0.015*	*0.026*	*0.042*	*0.019*
2	*N*	*0.995*	*0.976*	*0.985*	*0.978*	*0.996*	*1.004*	*1.011*	*0.992*	*0.035*	*0.015*	*0.013*	*0.014*	*0.012*	*0.028*	*0.033*	*0.021*
21	*N*	*0.999*	*0.992*	*0.997*	*0.986*	*1.006*	*1.015*	*1.023*	*1.003*	*0.026*	*0.013*	*0.011*	*0.014*	*0.010*	*0.013*	*0.027*	*0.016*
22	*N*	*0.988*	*0.983*	*0.990*	*0.980*	*1.002*	*1.011*	*1.024*	*0.997*	*0.020*	*0.010*	*0.014*	*0.019*	*0.014*	*0.027*	*0.026*	*0.018*
23	Y	0.989	0.960	0.995	0.988	1.000	1.011	1.022	0.995	0.027	**0.169**	0.015	0.017	0.023	0.032	0.036	0.045
24	Y	0.982	0.985	0.990	0.978	1.001	1.005	1.021	0.995	0.019	0.011	0.014	0.024	0.015	0.029	0.036	0.021

Table F.2: Machine 05 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.056*	*1.051*	*1.056*	*1.059*	*1.057*	*1.043*	*1.027*	*1.050*	*0.031*	*0.019*	*0.019*	*0.024*	*0.034*	*0.049*	*0.069*	*0.035*
2	*N*	*1.069*	*1.050*	*1.056*	*1.062*	*1.061*	*1.061*	*1.052*	***1.059***	*0.031*	*0.027*	*0.026*	*0.029*	*0.033*	*0.043*	***0.073***	*0.037*
21	*N*	*1.047*	*1.037*	*1.047*	*1.046*	*1.042*	*1.042*	*1.033*	*1.042*	*0.025*	*0.017*	*0.019*	*0.022*	*0.027*	*0.043*	*0.056*	*0.030*
22	*N*	*1.046*	*1.031*	*1.040*	*1.044*	*1.029*	*1.031*	*1.034*	*1.036*	*0.026*	*0.017*	*0.017*	*0.019*	*0.030*	*0.037*	*0.069*	*0.031*
23	Y	1.045	1.033	1.042	1.043	1.035	1.033	1.006	1.034	0.039	0.018	0.020	0.023	0.027	0.044	**0.071**	0.035
24	Y	1.041	1.025	1.033	1.034	1.029	1.037	1.026	1.032	0.035	0.017	0.017	0.019	0.026	0.040	0.051	0.029

Table F.3: Machine 06 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.029*	*1.025*	*1.029*	*1.032*	*1.043*	*1.037*	*1.021*	*1.031*	*0.033*	*0.018*	*0.022*	*0.022*	*0.020*	*0.032*	*0.045*	*0.027*
2	*N*	*1.048*	*1.030*	*1.029*	*1.030*	*1.038*	*1.031*	*0.999*	*1.029*	*0.055*	*0.028*	*0.030*	*0.029*	*0.038*	*0.038*	*0.066*	*0.041*
21	*N*	*1.071*	*1.032*	*1.040*	*1.031*	*1.046*	*1.038*	*1.019*	*1.040*	*0.054*	*0.023*	*0.026*	*0.019*	*0.029*	*0.029*	*0.040*	*0.031*
22	*N*	*1.043*	*1.026*	*1.032*	*1.038*	*1.041*	*1.037*	*1.032*	*1.036*	*0.039*	*0.023*	*0.027*	*0.031*	*0.038*	*0.044*	*0.069*	*0.039*
23	Y	1.039	1.028	1.035	1.039	1.046	1.043	1.033	1.038	0.027	0.015	0.017	0.017	0.024	0.032	0.068	0.029
24	Y	1.035	1.030	1.033	1.034	1.036	1.042	1.031	1.035	0.053	0.029	0.034	0.035	0.041	0.057	0.060	0.044

Table F.4: Machine 10 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.983*	*0.993*	*0.990*	*0.982*	*0.989*	*0.987*	*0.970*	*0.985*	*0.016*	*0.011*	*0.012*	*0.013*	*0.015*	*0.016*	*0.020*	*0.015*
2	*N*	*0.963*	*0.992*	*0.995*	*0.988*	*0.985*	*0.990*	*0.979*	*0.985*	*0.048*	*0.016*	*0.016*	*0.023*	*0.025*	*0.036*	*0.039*	*0.029*
21	*N*	*0.981*	*0.997*	*0.999*	*0.986*	*0.990*	*0.987*	*0.970*	*0.987*	*0.047*	*0.006*	*0.009*	*0.011*	*0.012*	*0.016*	*0.031*	*0.019*
22	*N*	*0.953*	*0.986*	*0.990*	*0.979*	*0.983*	*0.982*	*0.970*	*0.978*	*0.041*	*0.010*	*0.012*	*0.013*	*0.019*	*0.017*	*0.019*	*0.019*
23	Y	0.978	0.999	1.004	0.990	0.988	0.985	0.975	0.989	0.059	0.011	0.012	0.022	0.014	0.016	0.045	0.026
24	Y	0.985	1.003	1.000	0.987	0.997	0.989	0.958	0.989	0.029	0.011	0.013	0.015	0.022	0.033	0.043	0.024

Table F.5: Machine 11 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.988*	*0.977*	*0.971*	*0.976*	*0.959*	*0.953*	*0.963*	*0.969*	*0.029*	*0.015*	*0.022*	*0.015*	*0.032*	*0.035*	***0.071***	*0.031*
2	*N*	*0.986*	*0.972*	*0.982*	*0.976*	*0.966*	*0.966*	*0.984*	*0.976*	*0.019*	*0.015*	*0.020*	*0.012*	*0.025*	*0.030*	*0.064*	*0.026*
21	*N*	*1.007*	*0.976*	*0.983*	*0.977*	*0.961*	*0.973*	*0.966*	*0.978*	*0.030*	*0.014*	*0.011*	*0.014*	*0.015*	*0.020*	*0.035*	*0.020*
22	*N*	*0.976*	*0.965*	*0.974*	*0.970*	*0.964*	*0.959*	*0.960*	*0.967*	*0.015*	*0.015*	*0.015*	*0.019*	*0.024*	*0.042*	*0.069*	*0.029*
23	Y	0.981	0.958	0.967	0.965	0.955	0.955	0.936	0.959	0.038	0.039	0.017	0.024	0.030	0.043	**0.078**	0.038
24	Y	0.987	0.970	0.976	0.974	0.947	0.956	0.969	0.968	0.013	0.013	0.012	0.016	0.029	0.021	**0.079**	0.026

Table F.6: Machine 13 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.026*	*1.047*	*1.044*	*1.039*	*1.031*	*1.026*	*1.034*	*1.035*	*0.031*	*0.019*	*0.021*	*0.029*	*0.028*	*0.039*	*0.043*	*0.030*
2	*N*	*1.029*	*1.051*	*1.045*	*1.038*	*1.039*	*1.031*	*1.016*	*1.036*	*0.033*	*0.019*	*0.015*	*0.024*	*0.027*	*0.038*	*0.039*	*0.028*
21	*N*	*1.018*	*1.053*	*1.052*	*1.041*	*1.037*	*1.038*	*1.041*	*1.040*	*0.017*	*0.019*	*0.020*	*0.029*	*0.025*	*0.028*	*0.062*	*0.028*
22	*N*	*1.022*	*1.048*	*1.045*	*1.042*	*1.028*	*1.040*	*1.040*	*1.038*	*0.031*	*0.021*	*0.021*	*0.026*	*0.027*	*0.031*	*0.039*	*0.028*
23	Y	1.006	1.050	1.047	1.045	1.033	1.052	1.028	1.037	0.026	0.016	0.016	0.020	0.023	0.035	0.049	0.026
24	Y	1.024	1.058	1.055	1.048	1.048	1.045	1.054	1.048	0.013	0.015	0.016	0.022	0.021	0.028	**0.081**	0.028

Table F.7: Machine 15 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.961*	*0.975*	*0.971*	*0.983*	*0.976*	*0.977*	*0.984*	*0.975*	*0.018*	*0.013*	*0.019*	*0.020*	*0.023*	*0.032*	*0.053*	*0.025*
2	*N*	*0.950*	*0.966*	*0.964*	*0.972*	*0.964*	*0.965*	*0.962*	*0.963*	*0.026*	*0.020*	*0.025*	*0.028*	*0.032*	*0.034*	*0.054*	*0.031*
21	*N*	*0.968*	*0.973*	*0.972*	*0.971*	*0.966*	*0.972*	*0.965*	*0.970*	*0.022*	*0.014*	*0.014*	*0.014*	*0.020*	*0.026*	*0.030*	*0.020*
22	*N*	*0.957*	*0.968*	*0.966*	*0.973*	*0.967*	*0.970*	*0.983*	*0.969*	*0.022*	*0.015*	*0.015*	*0.015*	*0.025*	*0.031*	*0.051*	*0.025*
23	Y	0.966	0.965	0.965	0.966	0.959	0.966	0.969	0.965	0.027	0.021	0.019	0.019	0.030	0.037	0.058	0.030
24	Y	0.973	0.973	0.968	0.972	0.962	0.973	0.970	0.970	0.030	0.025	0.024	0.024	0.024	0.030	0.051	0.030

Table F.8: Machine 16 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.958*	*0.960*	*0.964*	*0.962*	*0.964*	*0.976*	*0.961*	*0.964*	*0.030*	*0.018*	*0.009*	*0.029*	*0.032*	*0.020*	*0.047*	*0.026*
2	*N*	*0.974*	*0.958*	*0.962*	*0.956*	*0.962*	*0.974*	*0.950*	*0.962*	*0.023*	*0.022*	*0.020*	*0.026*	*0.022*	*0.025*	*0.031*	*0.024*
21	*N*	*0.969*	*0.953*	*0.963*	*0.951*	*0.963*	*0.970*	*0.956*	*0.961*	*0.018*	*0.039*	*0.015*	*0.067*	*0.012*	*0.038*	*0.036*	*0.032*
22	*N*	*0.974*	*0.960*	*0.966*	*0.966*	*0.967*	*0.974*	*0.976*	*0.969*	*0.036*	*0.011*	*0.007*	*0.017*	*0.016*	*0.017*	*0.025*	*0.018*
23	Y	0.973	0.969	0.969	0.969	0.964	0.983	0.965	0.970	0.020	0.011	0.011	0.013	0.014	0.015	0.030	0.016
24	Y	0.986	0.973	0.969	0.968	0.965	0.978	0.994	0.976	0.024	0.020	0.011	0.023	0.025	0.033	0.038	0.025

Table F.9: Machine 28 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.975*	*0.983*	*0.987*	*0.988*	*0.998*	*1.018*	*1.005*	*0.993*	*0.036*	*0.019*	*0.023*	*0.019*	*0.022*	*0.034*	*0.055*	*0.030*
2	*N*	*0.976*	*0.976*	*0.984*	*0.971*	*0.986*	*1.012*	*0.981*	*0.984*	*0.043*	*0.020*	*0.023*	*0.042*	*0.017*	*0.020*	*0.033*	*0.028*
21	*N*	*0.968*	*0.976*	*0.986*	*0.971*	*0.993*	*1.016*	*0.986*	*0.985*	*0.044*	*0.016*	*0.021*	*0.029*	*0.013*	*0.015*	*0.050*	*0.027*
22	*N*	*0.968*	*0.969*	*0.983*	*0.969*	*0.988*	*1.023*	*1.009*	*0.987*	*0.044*	*0.026*	*0.033*	*0.039*	*0.027*	*0.028*	*0.042*	*0.034*
23	Y	0.978	0.959	0.983	0.981	0.991	1.022	0.987	0.986	0.027	0.052	0.029	0.042	0.030	0.037	0.029	0.035
24	Y	0.986	0.973	0.998	0.985	0.985	1.023	1.009	0.994	0.026	0.030	0.018	0.026	0.031	0.027	0.033	0.027

Table F.10: Machine 30 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	***1.149***	***1.207***	***1.150***	***1.110***	*1.049*	*1.052*	***1.263***	***1.140***	***0.449***	***0.397***	***0.322***	***0.242***	***0.198***	***0.179***	***0.167***	***0.279***
2	*N*	*0.985*	*1.005*	*1.004*	*0.999*	*0.983*	*1.016*	***1.209***	*1.029*	*0.026*	*0.026*	*0.028*	*0.039*	***0.077***	*0.050*	*0.065*	*0.044*
21	*N*	*0.957*	*0.969*	*0.968*	*0.977*	*0.960*	*0.982*	***1.155***	*0.995*	*0.041*	*0.021*	*0.027*	*0.028*	*0.035*	*0.034*	*0.041*	*0.032*
22	*N*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	Y	0.942	0.959	0.959	0.962	0.956	0.963	0.983	0.960	0.019	0.010	0.017	0.014	0.012	0.025	0.040	0.020
24	Y	0.964	0.968	0.968	0.967	0.964	0.968	0.979	0.968	0.022	0.011	0.018	0.023	0.020	0.035	0.050	0.026

Table F.11: Machine 32 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.062*	*1.055*	*1.042*	*1.038*	*1.028*	*1.033*	*1.011*	*1.038*	*0.036*	*0.027*	*0.030*	*0.041*	*0.046*	*0.046*	***0.075***	*0.043*
2	*N*	*1.064*	*1.056*	*1.042*	*1.035*	*1.030*	*1.039*	*1.036*	*1.043*	*0.043*	*0.026*	*0.028*	*0.036*	*0.046*	*0.046*	*0.058*	*0.040*
21	*N*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	*N*	*1.048*	*1.053*	*1.042*	*1.033*	*1.027*	*1.036*	*1.026*	*1.038*	*0.028*	*0.022*	*0.032*	*0.043*	*0.043*	*0.051*	***0.084***	*0.043*
23	*N*	*1.081*	*1.072*	*1.049*	*1.047*	*1.035*	*1.047*	*1.045*	***1.054***	*0.039*	*0.035*	*0.036*	*0.048*	*0.049*	*0.059*	*0.058*	*0.046*
24	*N*	*1.075*	*1.059*	*1.046*	*1.033*	*1.027*	*1.047*	*1.031*	*1.045*	*0.048*	*0.031*	*0.035*	*0.044*	*0.058*	*0.050*	*0.058*	*0.046*
31	*N*	*1.034*	*1.047*	*1.030*	*1.025*	*1.014*	*1.017*	*1.007*	*1.025*	*0.050*	*0.030*	*0.035*	*0.047*	*0.046*	*0.063*	*0.062*	*0.047*
32	Y	1.040	1.036	1.024	1.014	1.005	1.004	1.010	1.019	0.049	0.033	0.034	0.035	0.044	0.057	0.059	0.045
33	Y	1.039	1.029	1.014	1.013	1.002	1.001	0.999	1.014	0.036	0.029	0.031	0.044	0.052	0.049	**0.082**	0.046

Table F.12: Machine 33 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.019*	*1.017*	*1.008*	*1.011*	*1.014*	*0.997*	*0.960*	*1.004*	*0.039*	*0.015*	*0.017*	*0.017*	*0.020*	*0.024*	*0.052*	*0.026*
2	*N*	*0.989*	*1.019*	*1.010*	*1.009*	*1.012*	*0.992*	*0.982*	*1.002*	*0.062*	*0.015*	*0.014*	*0.021*	*0.022*	*0.025*	*0.043*	*0.029*
21	*N*	*1.030*	*1.028*	*1.023*	*1.014*	*1.024*	*0.992*	*0.965*	*1.011*	*0.024*	*0.017*	*0.018*	*0.020*	*0.026*	*0.024*	*0.033*	*0.023*
22	*N*	*1.005*	*1.033*	*1.029*	*1.022*	*1.026*	*1.001*	*0.991*	*1.015*	*0.038*	*0.014*	*0.018*	*0.017*	*0.020*	*0.036*	*0.033*	*0.025*
23	Y	1.022	1.023	1.020	1.013	1.016	0.982	0.958	1.005	0.020	0.017	0.021	0.015	0.022	0.041	**0.073**	0.030
24	Y	1.008	1.027	1.020	1.020	1.027	1.010	0.978	1.013	0.058	0.013	0.016	0.019	0.019	0.041	**0.070**	0.034

Table F.13: Machine 34 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	***1.157***	***1.112***	***1.112***	***1.109***	*1.093*	***1.103***	*1.047*	***1.105***	*0.041*	*0.023*	*0.033*	*0.042*	*0.048*	*0.045*	*0.065*	*0.042*
2	*N*	***1.118***	*1.092*	*1.096*	*1.097*	*1.099*	*1.091*	*1.080*	***1.096***	*0.046*	*0.026*	*0.030*	*0.037*	*0.040*	*0.047*	*0.064*	*0.041*
21	*N*	*1.066*	*1.057*	*1.073*	*1.060*	*1.058*	*1.076*	*1.026*	***1.059***	*0.033*	*0.021*	*0.035*	*0.025*	*0.048*	*0.044*	***0.084***	*0.042*
22	*N*	*1.071*	*1.064*	*1.072*	*1.065*	*1.061*	*1.071*	*1.036*	***1.063***	*0.034*	*0.025*	*0.031*	*0.030*	*0.043*	*0.047*	*0.066*	*0.039*
23	Y	1.042	1.020	1.038	1.034	1.023	1.012	0.999	1.024	0.039	0.027	0.034	0.030	0.044	0.033	0.055	0.037
24	Y	1.064	1.039	1.050	1.038	1.037	1.015	1.020	1.038	0.045	0.033	0.040	0.038	0.052	0.060	**0.087**	**0.051**

Table F.14: Machine 37 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.029*	*1.016*	*1.007*	*1.006*	*1.008*	*0.991*	*1.002*	*1.008*	*0.034*	*0.016*	*0.020*	*0.023*	*0.026*	*0.043*	*0.048*	*0.030*
2	*N*	*1.014*	*1.015*	*1.011*	*1.006*	*1.009*	*1.000*	*1.026*	*1.012*	*0.033*	*0.030*	*0.028*	*0.029*	*0.032*	*0.047*	*0.060*	*0.037*
21	*N*	*1.016*	*1.012*	*1.009*	*1.001*	*1.007*	*1.002*	*1.016*	*1.009*	*0.023*	*0.017*	*0.016*	*0.015*	*0.022*	*0.029*	*0.046*	*0.024*
22	*N*	*1.007*	*1.021*	*1.018*	*1.017*	*1.025*	*1.014*	*1.034*	*1.020*	*0.048*	*0.029*	*0.030*	*0.036*	*0.033*	*0.049*	*0.062*	*0.041*
23	Y	1.024	1.018	1.010	1.009	1.014	1.012	1.020	1.015	0.027	0.024	0.023	0.027	0.024	0.038	0.037	0.029
24	Y	1.023	1.021	1.014	1.010	1.014	1.015	1.020	1.017	0.029	0.028	0.030	0.034	0.039	0.049	0.060	0.039

Table F.15: Machine 39 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.996*	*0.999*	*1.000*	*1.018*	*1.016*	*1.025*	*1.062*	*1.016*	*0.031*	*0.014*	*0.028*	*0.022*	*0.018*	*0.040*	*0.035*	*0.027*
2	*N*	*1.012*	*0.999*	*0.984*	*1.003*	*1.002*	*1.006*	*1.036*	*1.006*	*0.035*	*0.027*	*0.028*	*0.029*	*0.035*	*0.040*	*0.051*	*0.035*
21	*N*	*1.015*	*1.003*	*1.009*	*1.018*	*1.007*	*1.017*	*1.034*	*1.015*	*0.015*	*0.016*	*0.014*	*0.017*	*0.013*	*0.018*	*0.028*	*0.017*
22	*N*	*1.005*	*1.009*	*1.004*	*1.020*	*1.010*	*1.020*	*1.044*	*1.016*	*0.017*	*0.009*	*0.009*	*0.013*	*0.012*	*0.018*	*0.027*	*0.015*
23	Y	1.006	1.007	1.001	1.013	1.004	1.015	1.042	1.012	0.026	0.017	0.018	0.023	0.023	0.032	0.057	0.028
24	Y	1.008	0.999	0.997	1.009	1.002	1.015	1.059	1.013	0.021	0.012	0.015	0.019	0.018	0.027	0.053	0.024

Table F.16: Machine 45 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.967*	*0.976*	*0.973*	*0.962*	*0.951*	*0.941*	*0.933*	*0.958*	*0.067*	*0.015*	*0.018*	*0.026*	*0.028*	*0.029*	*0.021*	*0.029*
2	*N*	*0.984*	*0.977*	*0.971*	*0.965*	*0.954*	*0.944*	*0.939*	*0.962*	*0.035*	*0.011*	*0.013*	*0.023*	*0.027*	*0.030*	*0.031*	*0.024*
21	*N*	*0.961*	*0.960*	*0.958*	*0.941*	*0.941*	*0.946*	*0.953*	*0.951*	*0.040*	*0.009*	*0.012*	*0.012*	*0.020*	*0.020*	*0.021*	*0.019*
22	*N*	*0.968*	*0.962*	*0.960*	*0.949*	*0.941*	*0.934*	*0.929*	***0.949***	*0.036*	*0.017*	*0.019*	*0.022*	*0.025*	*0.026*	*0.029*	*0.025*
23	Y	0.974	0.970	0.966	0.954	0.949	0.949	0.949	0.959	0.040	0.013	0.013	0.018	0.021	0.021	0.030	0.022
24	Y	0.968	0.977	0.973	0.961	0.950	0.951	0.943	0.960	**0.077**	0.017	0.016	0.019	0.024	0.025	0.030	0.030

Table F.17: Machine 47 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.986*	*0.981*	*0.966*	*0.977*	*0.989*	*0.996*	*1.007*	*0.986*	*0.011*	*0.013*	*0.020*	*0.022*	*0.022*	*0.039*	***0.091***	*0.031*
2	*N*	*0.986*	*0.971*	*0.963*	*0.974*	*0.979*	*0.994*	*1.002*	*0.981*	*0.015*	*0.018*	*0.026*	*0.022*	*0.030*	*0.046*	***0.089***	*0.035*
21	*N*	*0.987*	*0.970*	*0.973*	*0.977*	*0.988*	*0.985*	*1.012*	*0.984*	*0.014*	*0.015*	*0.013*	*0.018*	*0.025*	*0.040*	*0.069*	*0.028*
22	*N*	*0.983*	*0.956*	*0.960*	*0.983*	*0.977*	*0.972*	*1.034*	*0.981*	*0.025*	*0.024*	*0.016*	*0.036*	*0.026*	*0.044*	***0.083***	*0.036*
23	*N*	*0.983*	*0.956*	*0.958*	*0.957*	*0.965*	*0.975*	*0.999*	*0.970*	*0.017*	*0.039*	*0.032*	*0.063*	*0.040*	*0.043*	***0.110***	*0.049*
24	*N*	*0.998*	*0.963*	*0.962*	*0.965*	*0.974*	*1.001*	*1.007*	*0.982*	*0.029*	*0.021*	*0.028*	*0.036*	*0.024*	*0.060*	*0.060*	*0.037*
31	*N*	*0.967*	*0.976*	*0.965*	*0.982*	*0.979*	*0.986*	*1.006*	*0.980*	*0.027*	*0.023*	*0.017*	*0.020*	*0.024*	*0.050*	*0.065*	*0.032*
32	Y	0.993	0.971	0.962	0.973	0.976	0.984	1.007	0.981	0.010	0.017	0.019	0.034	0.030	0.068	**0.071**	0.036
33	Y	0.999	0.971	0.961	0.978	0.984	0.984	1.020	0.985	0.023	0.026	0.031	0.028	0.032	0.054	**0.071**	0.038

Table F.18: Machine 48 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.004*	*0.987*	*0.982*	*0.982*	*0.987*	*0.991*	*1.005*	*0.991*	*0.025*	*0.020*	*0.023*	*0.022*	*0.025*	*0.033*	*0.047*	*0.028*
2	*N*	*0.978*	*0.975*	*0.973*	*0.974*	*0.980*	*0.990*	*0.999*	*0.981*	*0.029*	*0.012*	*0.016*	*0.016*	*0.025*	*0.032*	*0.038*	*0.024*
21	*N*	*0.984*	*0.978*	*0.981*	*0.976*	*0.977*	*0.991*	*1.001*	*0.984*	*0.028*	*0.023*	*0.024*	*0.022*	*0.030*	*0.035*	*0.040*	*0.029*
22	*N*	*0.985*	*0.979*	*0.981*	*0.979*	*0.986*	*0.994*	*1.007*	*0.987*	*0.010*	*0.014*	*0.014*	*0.014*	*0.018*	*0.031*	*0.036*	*0.019*
23	Y	0.984	0.985	0.983	0.980	0.983	0.992	0.993	0.986	0.031	0.015	0.018	0.016	0.024	0.025	0.034	0.023
24	Y	0.988	0.977	0.976	0.974	0.981	0.991	1.003	0.984	0.038	0.021	0.020	0.019	0.026	0.033	0.034	0.027

Table F.19: Machine 50 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
2	*N*	*0.923*	*1.019*	*0.983*	*1.024*	*1.019*	*1.031*	*1.021*	*1.003*	*0.030*	*0.029*	*0.024*	*0.024*	*0.031*	*0.035*	*0.049*	*0.032*
21	*N*	*0.947*	*1.028*	*0.984*	*1.023*	*1.016*	*1.033*	*1.056*	*1.012*	*0.031*	*0.023*	*0.026*	*0.029*	*0.033*	*0.032*	*0.047*	*0.032*
22	*N*	*0.940*	*1.017*	*0.979*	*1.019*	*1.010*	*1.019*	*1.053*	*1.005*	*0.021*	*0.017*	*0.024*	*0.022*	*0.026*	*0.029*	*0.060*	*0.028*
23	Y	0.936	1.029	0.984	1.026	1.020	1.035	1.063	1.013	0.021	0.016	0.019	0.020	0.019	0.024	0.058	0.025
24	Y	0.945	1.037	0.993	1.034	1.026	1.041	1.059	1.019	0.015	0.013	0.014	0.012	0.018	0.022	**0.070**	0.024

Table F.20: Machine 52 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.053*	*1.041*	*1.041*	*1.040*	*1.038*	*1.038*	*1.017*	*1.038*	*0.024*	*0.024*	*0.025*	*0.027*	*0.028*	*0.033*	*0.036*	*0.028*
2	*N*	*1.034*	*1.030*	*1.030*	*1.027*	*1.033*	*1.035*	*1.010*	*1.028*	*0.021*	*0.014*	*0.017*	*0.018*	*0.023*	*0.028*	*0.030*	*0.022*
21	*N*	*1.037*	*1.019*	*1.026*	*1.022*	*1.026*	*1.032*	*1.021*	*1.026*	*0.029*	*0.016*	*0.020*	*0.024*	*0.027*	*0.033*	*0.040*	*0.027*
22	*N*	*1.041*	*1.029*	*1.037*	*1.040*	*1.038*	*1.054*	*1.031*	*1.039*	*0.032*	*0.015*	*0.018*	*0.019*	*0.026*	*0.030*	*0.031*	*0.024*
23	Y	1.036	1.024	1.029	1.028	1.026	1.041	1.029	1.031	0.024	0.009	0.015	0.017	0.017	0.026	0.028	0.019
24	Y	1.029	1.018	1.027	1.023	1.027	1.036	1.024	1.026	0.032	0.012	0.018	0.019	0.020	0.030	0.034	0.024

Table F.21: Machine 53 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*0.998*	*0.991*	*1.005*	*1.005*	*1.008*	*0.989*	*0.991*	*0.998*	*0.038*	*0.021*	*0.017*	*0.013*	*0.016*	*0.016*	*0.023*	*0.021*
2	*N*	*0.999*	*0.986*	*1.001*	*0.996*	*1.004*	*0.987*	*0.986*	*0.994*	*0.038*	*0.010*	*0.012*	*0.012*	*0.014*	*0.017*	*0.031*	*0.019*
21	*N*	*1.013*	*0.999*	*1.014*	*1.013*	*1.011*	*0.992*	*0.994*	*1.005*	*0.022*	*0.016*	*0.021*	*0.015*	*0.025*	*0.022*	*0.030*	*0.021*
22	*N*	*1.014*	*0.996*	*1.003*	*1.008*	*1.013*	*0.995*	*0.998*	*1.004*	*0.032*	*0.020*	*0.022*	*0.016*	*0.020*	*0.017*	*0.029*	*0.022*
23	Y	1.016	1.003	1.012	1.012	1.014	0.995	0.997	1.007	0.019	0.017	0.018	0.018	0.021	0.024	0.038	0.022
24	Y	0.995	0.992	1.003	1.006	1.002	0.989	0.997	0.998	0.034	0.023	0.026	0.026	0.019	0.026	0.048	0.029

Table F.22: Machine 54 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	*N*	*1.071*	*1.040*	*1.035*	*1.026*	*1.030*	*0.970*	*0.980*	*1.022*	*0.026*	*0.009*	*0.011*	*0.015*	*0.023*	*0.024*	*0.029*	*0.020*
21	*N*	*1.059*	*1.034*	*1.027*	*1.023*	*1.020*	*1.002*	*0.991*	*1.022*	*0.027*	*0.013*	*0.015*	*0.015*	*0.027*	*0.031*	*0.032*	*0.023*
22	*N*	*1.064*	*1.034*	*1.027*	*1.018*	*1.017*	*0.983*	*0.989*	*1.019*	*0.027*	*0.012*	*0.014*	*0.014*	*0.018*	*0.022*	*0.016*	*0.018*
23	Y	1.067	1.042	1.035	1.021	1.023	0.976	0.988	1.022	0.015	0.006	0.007	0.010	0.013	0.018	0.018	0.013
24	Y	1.079	1.044	1.039	1.028	1.029	0.983	0.996	1.028	0.035	0.016	0.018	0.021	0.029	0.035	0.029	0.026

Table F.23: Machine 56 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	*1.021*	*1.011*	*1.015*	*1.020*	*1.008*	*1.011*	*0.975*	*1.009*	*0.024*	*0.012*	*0.010*	*0.012*	*0.012*	*0.017*	*0.021*	*0.015*
2	*N*	*1.021*	*1.005*	*1.010*	*1.013*	*1.005*	*1.009*	*0.979*	*1.006*	*0.019*	*0.016*	*0.017*	*0.021*	*0.025*	*0.032*	*0.036*	*0.024*
21	*N*	*1.029*	*1.008*	*1.013*	*1.010*	*1.000*	*1.001*	*0.973*	*1.005*	*0.023*	*0.013*	*0.013*	*0.013*	*0.012*	*0.011*	*0.016*	*0.015*
22	*N*	*1.017*	*1.006*	*1.013*	*1.012*	*1.002*	*1.002*	*0.983*	*1.005*	*0.026*	*0.012*	*0.010*	*0.013*	*0.015*	*0.015*	*0.019*	*0.016*
23	Y	1.032	1.012	1.014	1.017	1.005	1.003	0.983	1.010	0.018	0.011	0.013	0.013	0.014	0.019	0.020	0.015
24	Y	1.023	1.010	1.011	1.012	1.003	1.006	0.976	1.006	0.023	0.013	0.013	0.013	0.012	0.017	0.017	0.015

Table F.24: Machine 57 - All reproducibility trial data (no data point removed)

Lap	Lap Used	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean
1	*N*	***1.103***	*1.097*	*1.081*	*1.083*	*1.089*	*1.071*	*1.023*	***1.078***	*0.025*	*0.017*	*0.014*	*0.023*	*0.027*	*0.061*	***0.091***	*0.037*
2	*N*	*1.096*	*1.099*	*1.098*	*1.087*	*1.093*	*1.074*	*1.025*	***1.082***	*0.039*	*0.016*	*0.019*	*0.022*	*0.028*	*0.044*	***0.114***	*0.040*
21	*N*	***1.111***	***1.101***	*1.093*	*1.080*	*1.080*	*1.065*	*1.014*	***1.078***	*0.023*	*0.022*	*0.017*	*0.020*	*0.042*	*0.066*	***0.109***	*0.043*
22	*N*	***1.105***	*1.097*	*1.097*	*1.091*	*1.090*	*1.074*	*1.047*	***1.086***	*0.031*	*0.023*	*0.025*	*0.031*	*0.049*	***0.074***	***0.122***	***0.051***
23	*N*	*1.050*	*1.045*	*1.041*	*1.035*	*1.042*	*1.029*	*0.971*	*1.030*	*0.030*	*0.019*	*0.023*	*0.031*	*0.036*	*0.038*	***0.104***	*0.040*
24	*N*	*1.059*	*1.051*	*1.045*	*1.041*	*1.039*	*1.029*	*0.986*	*1.036*	*0.023*	*0.023*	*0.026*	*0.034*	*0.042*	***0.071***	***0.110***	*0.047*
31	*N*	*1.033*	*1.057*	*1.046*	*1.045*	*1.046*	*1.035*	*1.006*	*1.038*	*0.045*	*0.018*	*0.018*	*0.031*	*0.041*	*0.058*	***0.098***	*0.044*
32	Y	1.069	1.048	1.039	1.034	1.035	1.027	0.981	1.033	0.026	0.030	0.030	0.037	0.048	0.062	**0.113**	0.050
33	Y	1.051	1.039	1.029	1.030	1.035	1.026	0.983	1.028	0.023	0.020	0.018	0.028	0.041	0.042	**0.109**	0.040

F.2 Final reproducibility trial data for selected laps

Table F.25: Final trial data for reproducibility (analysed laps – single data point removed where appropriate)

DPT ID	Lap	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean	Excluded Geophone and test station
2	23	0.989	0.990	0.995	0.988	1.000	1.011	1.022	0.999	0.027	0.014	0.015	0.017	0.023	0.032	0.036	0.023	Station 4 D2
2	24	0.982	0.985	0.990	0.978	1.001	1.005	1.021	0.995	0.019	0.011	0.014	0.024	0.015	0.029	0.036	0.021	
5	23	1.045	1.033	1.042	1.043	1.035	1.033	1.006	1.034	0.039	0.018	0.020	0.023	0.027	0.044	0.062	0.033	Station 4 D7
5	24	1.041	1.025	1.033	1.034	1.029	1.037	1.026	1.032	0.035	0.017	0.017	0.019	0.026	0.040	0.051	0.029	
6	23	1.039	1.028	1.035	1.039	1.046	1.043	1.033	1.038	0.027	0.015	0.017	0.017	0.024	0.032	0.068	0.029	
6	24	1.035	1.030	1.033	1.034	1.036	1.042	1.031	1.035	0.053	0.029	0.034	0.035	0.041	0.057	0.060	0.044	
10	23	0.978	0.999	1.004	0.990	0.988	0.985	0.975	0.989	0.059	0.011	0.012	0.022	0.014	0.016	0.045	0.026	
10	24	0.985	1.003	1.000	0.987	0.997	0.989	0.958	0.989	0.029	0.011	0.013	0.015	0.022	0.033	0.043	0.024	
11	23	0.981	0.958	0.967	0.965	0.955	0.955	0.936	0.959	0.038	0.039	0.017	0.024	0.030	0.043	0.047	0.034	Station 1 D7

DPT ID	Lap	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean	Excluded Geophone and test station
11	24	0.987	0.970	0.976	0.974	0.947	0.956	0.969	0.968	0.013	0.013	0.012	0.016	0.029	0.021	0.057	0.023	Station 4 D7
13	**22**	1.022	1.048	1.045	1.042	1.028	1.040	1.040	1.038	0.031	0.021	0.021	0.026	0.027	0.031	0.039	0.028	
13	**23**	1.006	1.050	1.047	1.045	1.033	1.052	1.028	1.037	0.026	0.016	0.016	0.020	0.023	0.035	0.049	0.026	
15	23	0.966	0.965	0.965	0.966	0.959	0.966	0.969	0.965	0.027	0.021	0.019	0.019	0.030	0.037	0.058	0.030	
15	24	0.973	0.973	0.968	0.972	0.962	0.973	0.970	0.970	0.030	0.025	0.024	0.024	0.024	0.030	0.051	0.030	
16	23	0.973	0.969	0.969	0.969	0.964	0.983	0.965	0.970	0.020	0.011	0.011	0.013	0.014	0.015	0.030	0.016	
16	24	0.986	0.973	0.969	0.968	0.965	0.978	0.994	0.976	0.024	0.020	0.011	0.023	0.025	0.033	0.038	0.025	
28	23	0.978	0.959	0.983	0.981	0.991	1.022	0.987	0.986	0.027	0.052	0.029	0.042	0.030	0.037	0.029	0.035	
28	24	0.986	0.973	0.998	0.985	0.985	1.023	1.009	0.994	0.026	0.030	0.018	0.026	0.031	0.027	0.033	0.027	
30	23	0.942	0.959	0.959	0.962	0.956	0.963	0.983	0.960	0.019	0.010	0.017	0.014	0.012	0.025	0.040	0.020	
30	24	0.964	0.968	0.968	0.967	0.964	0.968	0.979	0.968	0.022	0.011	0.018	0.023	0.020	0.035	0.050	0.026	
32	**32**	1.040	1.036	1.024	1.014	1.005	1.004	1.010	1.019	0.049	0.033	0.034	0.035	0.044	0.057	0.059	0.045	
32	**33**	1.039	1.029	1.014	1.013	1.002	1.001	0.984	1.012	0.036	0.029	0.031	0.044	0.052	0.049	0.070	0.044	Station 3 D7
33	23	1.022	1.023	1.020	1.013	1.016	0.982	0.958	1.005	0.020	0.017	0.021	0.015	0.022	0.041	0.032	0.024	Station 5 D7
33	24	1.008	1.027	1.020	1.020	1.027	1.010	0.978	1.013	0.058	0.013	0.016	0.019	0.019	0.041	0.047	0.030	Station 4 D7
34	23	1.042	1.020	1.038	1.034	1.023	1.012	0.999	1.024	0.039	0.027	0.034	0.030	0.044	0.033	0.055	0.037	
34	24	1.064	1.039	1.050	1.038	1.037	1.015	1.020	1.038	0.045	0.033	0.040	0.038	0.052	0.060	0.067	0.048	Station 5 D7
37	23	1.024	1.018	1.010	1.009	1.014	1.012	1.020	1.015	0.027	0.024	0.023	0.027	0.024	0.038	0.037	0.029	
37	24	1.023	1.021	1.014	1.010	1.014	1.015	1.020	1.017	0.029	0.028	0.030	0.034	0.039	0.049	0.060	0.039	
39	23	1.006	1.007	1.001	1.013	1.004	1.015	1.042	1.012	0.026	0.017	0.018	0.023	0.023	0.032	0.057	0.028	
39	24	1.008	0.999	0.997	1.009	1.002	1.015	1.059	1.013	0.021	0.012	0.015	0.019	0.018	0.027	0.053	0.024	
45	23	0.974	0.970	0.966	0.954	0.949	0.949	0.949	0.959	0.040	0.013	0.013	0.018	0.021	0.021	0.030	0.022	
45	24	0.968	0.977	0.973	0.961	0.950	0.951	0.943	0.960	0.029	0.017	0.016	0.019	0.024	0.025	0.030	0.023	Station 9 D1
47	**32**	0.993	0.971	0.962	0.973	0.976	0.984	0.992	0.979	0.010	0.017	0.019	0.034	0.030	0.068	0.057	0.034	Station 5 D7
47	**33**	0.999	0.971	0.961	0.978	0.984	0.984	1.010	0.984	0.023	0.026	0.031	0.028	0.032	0.054	0.067	0.037	Station 11 D7
48	23	0.984	0.985	0.983	0.980	0.983	0.992	0.993	0.986	0.031	0.015	0.018	0.016	0.024	0.025	0.034	0.023	
48	24	0.988	0.977	0.976	0.974	0.981	0.991	1.003	0.984	0.038	0.021	0.020	0.019	0.026	0.033	0.034	0.027	
50	23	0.936	1.029	0.984	1.026	1.020	1.035	1.063	1.013	0.021	0.016	0.019	0.020	0.019	0.024	0.058	0.025	

DPT ID	Lap	FCF D1	FCF D2	FCF D3	FCF D4	FCF D5	FCF D6	FCF D7	FCF Mean	SDDR D1	SDDR D2	SDDR D3	SDDR D4	SDDR D5	SDDR D6	SDDR D7	SDDR Mean	Excluded Geophone and test station
50	24	0.945	1.037	0.993	1.034	1.026	1.041	1.059	1.019	0.015	0.013	0.014	0.012	0.018	0.022	0.048	0.020	Station 5 D7
52	23	1.036	1.024	1.029	1.028	1.026	1.041	1.029	1.031	0.024	0.009	0.015	0.017	0.017	0.026	0.028	0.019	
52	24	1.029	1.018	1.027	1.023	1.027	1.036	1.024	1.026	0.032	0.012	0.018	0.019	0.020	0.030	0.034	0.024	
53	23	1.016	1.003	1.012	1.012	1.014	0.995	0.997	1.007	0.019	0.017	0.018	0.018	0.021	0.024	0.038	0.022	
53	24	0.995	0.992	1.003	1.006	1.002	0.989	0.997	0.998	0.034	0.023	0.026	0.026	0.019	0.026	0.048	0.029	
54	23	1.067	1.042	1.035	1.021	1.023	0.976	0.988	1.022	0.015	0.006	0.007	0.010	0.013	0.018	0.018	0.013	
54	24	1.079	1.044	1.039	1.028	1.029	0.983	0.996	1.028	0.035	0.016	0.018	0.021	0.029	0.035	0.029	0.026	
56	23	1.032	1.012	1.014	1.017	1.005	1.003	0.983	1.010	0.018	0.011	0.013	0.013	0.014	0.019	0.020	0.015	
56	24	1.023	1.010	1.011	1.012	1.003	1.006	0.976	1.006	0.023	0.013	0.013	0.013	0.012	0.017	0.017	0.015	
57	**32**	1.069	1.048	1.039	1.034	1.035	1.027	0.996	1.035	0.026	0.030	0.030	0.037	0.048	0.062	**0.100**	0.048	Station 6 D7
57	**33**	1.051	1.039	1.029	1.030	1.035	1.026	0.999	1.030	0.023	0.020	0.018	0.028	0.041	0.042	**0.087**	0.037	Station 5 D7

Appendix G Accreditation trial overall results

DPT ID	Make, model and serial number	Repeatability	FCF Mean	FCF Individual	SDDR Mean	SDDR Individual	Elapsed distance	Temperature at depth	Surface temperature	Air Temperature	OSGR
2	Dynatest FWD 8002 SN 102	Pass	Pass	Pass	Pass	Pass	Pass	High	No Data Supplied	No Data Supplied	No Data Supplied
5	Dynatest HWD 8082 SN 050	Pass	Pass	Pass	Pass	Pass	Pass	Medium	No Data Supplied	No Data Supplied	No Data Supplied
6	Dynatest HWD 8082 SN 018	Pass	Pass	Pass	Pass	Pass	Pass	Medium	High	High	High
10	Dynatest FWD 8002 SN 192	Pass	Pass	Pass	Pass	Pass	Pass	High	No Data Supplied	No Data Supplied	No Data Supplied
11	Dynatest FWD 8002 SN 187	Pass	Pass	Pass	Pass	Pass	Pass	High	Not Suitable	Not Suitable	Medium
13	Dynatest HWD 8082 SN 029	Pass	Pass	Pass	Pass	Pass	Pass	Medium	No Data Supplied	No Data Supplied	High
15	Dynatest FWD 8002 SN 203	Pass	Pass	Pass	Pass	Pass	Pass	Medium	Not Assessed	Not Assessed	No Data Supplied
16	Dynatest FWD 8002 SN 214	Pass	Pass	Pass	Pass	Pass	Pass	Medium	No Data Supplied	No Data Supplied	High
28	Dynatest FWD 8002 SN 271	Pass	Pass	Pass	Pass	Pass	Pass	High	Not Suitable	Not Suitable	High
30	Dynatest FWD 8002 SN173	Pass	Pass	Pass	Pass	Pass	Pass	High	High	Medium	High
32	Dynatest HWD 8082 SN 069	Pass	Pass	Pass	Pass	Pass	Pass	Low	Not Suitable	Not Assessed	High
33	Dynatest HWD 8082 SN 070	Pass	Pass	Pass	Pass	Pass	Pass	Medium	Not Assessed	Not Assessed	High
34	Dynatest HWD 8082 SN 108	Pass	Pass	Pass	Pass	Pass	Pass	Medium	Not Suitable	Not Suitable	High

DPT ID	Make, model and serial number	Repeatability	FCF Mean	FCF Individual	SDDR Mean	SDDR Individual	Elapsed distance	Temperature at depth	Surface temperature	Air Temperature	OSGR
37	Dynatest FWD 8002 SN 352	Pass	Pass	Pass	Pass	Pass	Pass	Medium	Low	High	No Data Supplied
39	Dynatest FWD 8002 SN 388	Pass	Pass	Pass	Pass	Pass	Pass	Medium	Medium	High	High
45	Sweco FWD PRI2100 SN 0903-088	Pass	Pass	Pass	Pass	Pass	Pass	Medium	Not Suitable	Medium	No Data Supplied
47	Dynatest FWD 8002 SN 452	Pass	Pass	Pass	Pass	Pass	Pass	High	Medium	High	Medium
48	Dynatest FWD 8002 SN 424	Pass	Pass	Pass	Pass	Pass	Pass	High	High	Low	High
50	Rincent HeavyDyn HVY-101A	Pass	Pass	Pass	Pass	Pass	Pass	High	Not Suitable	Not Suitable	Medium
52	Dynatest FFWD 8012 SN 057	Pass	Pass	Pass	Pass	Pass	Pass	Not Suitable	Not Assessed	Not Assessed	Medium
53	Dynatest FWD 8002 SN 098	Pass	Pass	Pass	Pass	Pass	Pass	Low	Medium	Medium	No Data Supplied
54	Sweco PRI1500 0822-664	Pass	Pass	Pass	Pass	Pass	Pass	Medium	Medium	Not Suitable	Medium
56	Dynatest FWD 8002 SN 033	Pass	Pass	Pass	Pass	Pass	Pass	Low	High	High	Medium
57	Dynatest HWD 8082 SN 010	Pass	Pass	Pass	Pass	Fail	Pass	High	Not Suitable	Not Suitable	No Data Supplied

National Highways 2025 UK Dynamic Plate Test Device Accreditation Trial

A Key element for the successful maintenance of a road network is accurate reliable and consistent survey data. To this aim National Highways commissions annual accreditation trials for the Dynamic Plate test devices (FWDs and HWDs) supported by ongoing QA. In order to undertake accredited surveys, the survey devices are required to meet the mandatory criteria of the trial.

This report covers the 2025 trial run by TRL held on the Horiba-MIRA proving ground in the week beginning the 29th September 2025.

Other titles from this subject area

PPR2055 National Highways 2024 Dynamic Plate Test device Accreditation Trial. S Brittain. 2026

PPR2054 National Highways 2023 Dynamic Plate Test device Accreditation Trial. S Brittain. 2026

PPR2053 National Highways 2022 Dynamic Plate Test device Accreditation Trial. S Brittain. 2026

PPR2052 National Highways 2021 Dynamic Plate Test device Accreditation Trial. S Brittain, 2026

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