**Institute for
Interlaboratory Studies**

Results of Proficiency Test
Naphtha
April 2022

CONTENTS

1   INTRODUCTION

Since 1994 the Institute for Interlaboratory Studies (iis) organizes a proficiency scheme for the analysis of Naphtha every year. During the annual proficiency testing program of 2021/2022 it was decided to continue the round robin for the analysis of Naphtha.
In 2021 it was decided to prepare a separate proficiency test for Oxygenates/PIONA/PNA/DHA analyses in Naphtha. This round robin is reported in iis22N02PIONA.

In this interlaboratory study registered for participation:
- 91 laboratories in 38 countries for Naphtha iis22N01
- 46 laboratories in 22 countries for Mercury in Naphtha iis22N01Hg
- 32 laboratories in 16 countries for Arsenic and Lead in Naphtha iis22N01AsPb
- 51 laboratories in 23 countries for Vapor Pressure iis22N01DVPE

In total 95 laboratories in 38 countries registered for participation in one or more proficiency tests, see appendix 2 for the number of participants per country. In this report the results of the Naphtha proficiency tests are presented and discussed. This report is also electronically available through the iis website www.iisnl.com.

2   SET UP

The Institute for Interlaboratory Studies (iis) in Spijkenisse, the Netherlands, was the organizer of this proficiency test (PT). Sample analyzes for fit-for-use and homogeneity testing were subcontracted to an ISO/IEC17025 accredited laboratory.
In this proficiency test the participants received, depending on the registration, from one up to six different samples of Naphtha, see table below.

Sample ID	PT ID	Quantity	Purpose	Matrix
#22045	iis22N01	1x 500 mL	Regular analyzes	Real Naphtha
#22046	iis22N01Hg	1x 500 mL	Mercury	Artificial Naphtha
#22047	iis22N01Hg	1x 500 mL	Mercury	Real Naphtha
#22048	iis22N01AsPb	1x 500 mL	Arsenic and Lead	Artificial Naphtha
#22049	iis22N01AsPb	1x 500 mL	Arsenic and Lead	Real Naphtha
#22050	iis22N01DVPE	1x 250 mL	Vapor Pressure	Real Naphtha

Table 1: six different Naphtha samples used in iis22N01

Participants were requested to report rounded and unrounded test results. The unrounded test results were preferably used for statistical evaluation.

2.1 ACCREDITATION

The Institute for Interlaboratory Studies in Spijkenisse, the Netherlands, is accredited in agreement with ISO/IEC17043:2010 (R007), since January 2000, by the Dutch Accreditation Council (Raad voor Accreditatie). This PT falls under the accredited scope. This ensures strict adherence to protocols for sample preparation and statistical evaluation and 100% confidentiality of participant's data. Feedback from the participants on the reported data is encouraged and customer's satisfaction is measured on regular basis by sending out questionnaires.

2.2 PROTOCOL

The protocol followed in the organization of this proficiency test was the one as described for proficiency testing in the report 'iis Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5). This protocol is electronically available through the iis website www.iisnl.com, from the FAQ page.

2.3 CONFIDENTIALITY STATEMENT

All data presented in this report must be regarded as confidential and for use by the participating companies only. Disclosure of the information in this report is only allowed by means of the entire report. Use of the contents of this report for third parties is only allowed by written permission of the Institute for Interlaboratory Studies. Disclosure of the identity of one or more of the participating companies will be done only after receipt of a written agreement of the companies involved.

2.4 SAMPLES

For the preparation of the sample for the regular analyses in Naphtha a batch of approximately 100 liters of Naphtha was obtained from a local refinery. After homogenization 115 amber glass bottles of 0.5 L were filled and labelled #22045.
The homogeneity of the subsamples was checked by the determination of Density at 15 °C in accordance with ISO12185 on 8 stratified randomly selected subsamples.

	Density at 15 °C in kg/L
sample #22045-1	0.71875
sample #22045-2	0.71872
sample #22045-3	0.71872
sample #22045-4	0.71873
sample #22045-5	0.71874
sample #22045-6	0.71871
sample #22045-7	0.71876
sample #22045-8	0.71876

Table 2: homogeneity test results of subsamples #22045

From the above test results the repeatability was calculated and compared with 0.3 times the reproducibility of the reference test method in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Density at 15 °C in kg/L
r (observed)	0.00005
reference test method	ISO12185:96
0.3 x R (reference test method)	0.00015

Table 3: evaluation of the repeatability of subsamples #22045

The calculated repeatability is in agreement with 0.3 times the reproducibility of the reference test method. Therefore, homogeneity of the subsamples was assumed.

For the preparation of the sample for the Mercury analysis in Naphtha a batch of approximately 45 liters of Naphtha was obtained from a local refinery and spiked with Mercury Chloride and a Mercury Conostan standard. After homogenization 75 amber glass bottles of 0.5 L were filled and labelled #22047.
The homogeneity of the subsamples was checked by the determination of Mercury in accordance with UOP938 on 8 stratified randomly selected subsamples.

	Mercury in µg/kg
sample #22047-1	162
sample #22047-2	170
sample #22047-3	168
sample #22047-4	171
sample #22047-5	165
sample #22047-6	169
sample #22047-7	168
sample #22047-8	170

Table 4: homogeneity test results of subsamples #22047

From the above test results the repeatability was calculated and compared with 0.3 times the estimated reproducibility calculated with the Horwitz equation in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Mercury in µg/kg
r (observed)	8
reference method	Horwitz
0.3 x R (reference method)	30

Table 5: evaluation of the repeatability of subsamples #22047

The calculated repeatability is in agreement with 0.3 times the estimated reproducibility calculated with the Horwitz equation. Therefore, homogeneity of the subsamples was assumed.

For the preparation of the sample for the analyses of Arsenic and Lead in Naphtha a batch of approximately 30 liters of Naphtha was obtained from a local refinery and spiked with an Arsenic Conostan standard and Aviation Gasoline for Lead. After homogenization 60 amber glass bottles of 0.5 L were filled and labelled #22049.
The homogeneity of the subsamples was checked by the determination of Lead in accordance with UOP952 on 8 stratified randomly selected subsamples.

	Lead in µg/kg
sample #22049-1	61
sample #22049-2	62
sample #22049-3	68
sample #22049-4	61
sample #22049-5	63
sample #22049-6	64
sample #22049-7	69
sample #22049-8	62

Table 6: homogeneity test results of subsamples #22049

From the above test results the repeatability was calculated and compared with 0.3 times the estimated reproducibility calculated with the Horwitz equation in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Lead in µg/kg
r (observed)	9
reference method	Horwitz
0.3 x R (reference method)	13

Table 7: evaluation of the repeatability of subsamples #22049

The calculated repeatability is in agreement with 0.3 times the estimated reproducibility calculated with the Horwitz equation. Therefore, homogeneity of the subsamples was assumed.

For the preparation of the sample for the analyses of Vapor Pressure in Naphtha a batch of approximately 25 liters of Naphtha was obtained from a local refinery. After homogenization 85 amber glass bottles of 0.25 L were filled and labelled #22050.
The homogeneity of the subsamples was checked by the determination of DVPE in accordance with ASTM D5191 on 8 stratified randomly selected subsamples.

	DVPE in psi
sample #22050-1	6.27
sample #22050-2	6.27
sample #22050-3	6.27
sample #22050-4	6.28
sample #22050-5	6.27
sample #22050-6	6.28
sample #22050-7	6.27
sample #22050-8	6.28

Table 8: homogeneity test results of subsamples #22050

From the above test results the repeatability was calculated and compared with 0.3 times the reproducibility of the reference test method in agreement with the procedure of ISO13528, Annex B2 in the next table.

	DVPE in psi
r (observed)	0.01
reference test method	ASTM D5191:20
0.3 x R (reference test method)	0.07

Table 9: evaluation of the repeatability of subsamples #22050

The calculated repeatability is in agreement with 0.3 times the reproducibility of the reference test method. Therefore, homogeneity of the subsamples was assumed.

A batch of approximately 45 liters artificial Naphtha was prepared and spiked with Mercury Chloride and Mercury Conostan for the Mercury determination in (artificial) Naphtha. After homogenization 75 amber glass bottles of 0.5 L were filled and labelled #22046.
The homogeneity of the subsamples was checked by determination of Mercury in accordance with UOP938 on 8 stratified randomly selected subsamples.

	Mercury in µg/kg
sample #22046-1	46
sample #22046-2	47
sample #22046-3	47
sample #22046-4	53
sample #22046-5	44
sample #22046-6	48
sample #22046-7	44
sample #22046-8	45

Table 10: homogeneity test results of subsamples #22046

From the above test results the repeatability was calculated and compared with 0.3 times the estimated reproducibility calculated with the Horwitz equation in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Mercury in µg/kg
r (observed)	8
reference method	Horwitz
0.3 x R (reference method)	10

Table 11: evaluation of the repeatability of subsamples #22046

The calculated repeatability is in agreement with 0.3 times the estimated reproducibility calculated with the Horwitz equation. Therefore, homogeneity of the subsamples was assumed.

A batch of approximately 30 liters artificial Naphtha was prepared and spiked with an Arsenic Conostan standard and Aviation Gasoline for the Arsenic and Lead analyses in (artificial) Naphtha. After homogenization 60 amber glass bottles of 0.5 L were filled and labelled #22048.
The homogeneity of the subsamples was checked by the determination of Lead in accordance with UOP952 on 8 stratified randomly selected subsamples.

	Lead in µg/kg
sample #22048-1	48
sample #22048-2	49
sample #22048-3	52
sample #22048-4	49
sample #22048-5	47
sample #22048-6	51
sample #22048-7	52
sample #22048-8	49

Table 12: homogeneity test results of subsamples #22048

From the above test results the repeatability was calculated and compared with 0.3 times the estimated reproducibility calculated with the Horwitz equation in agreement with the procedure of ISO13528, Annex B2 in the next table.

	Lead in µg/kg
r (observed)	5
reference method	Horwitz
0.3 x R (reference method)	10

Table 13: evaluation of the repeatability of subsamples #22048

The calculated repeatability is in agreement with 0.3 times the estimated reproducibility calculated with the Horwitz equation. Therefore, homogeneity of the subsamples was assumed.

Depending on the registration of the participant the appropriate set of samples was sent on March 09, 2022. An SDS was added to the sample package.

2.5 STABILITY OF THE SAMPLES

The stability of Naphtha packed in amber glass bottles was checked. The material was found sufficiently stable for the period of the proficiency test.

2.6 ANALYZES

The participants were requested to determine on sample #22045: Organic Chlorides, Color Saybolt (automated and manual), Copper Corrosion 3 hrs at 50 °C, Density at 15 °C, Distillation at 760 mmHg (IBP, 50% recovered and FBP), Mercaptan Sulfur as S and Sulfur.
On samples #22046 and #22047 it was requested to determine Mercury as Hg.
On samples #22048 and #22049 it was requested to determine Arsenic as As and Lead as Pb. There was also an extra question about rinsing of the bottle with strong acid.
On sample #22050 it was requested to determine Total Vapor Pressure and DVPE acc. to ASTM D5191.

It was explicitly requested to treat the samples as if they were routine samples and to report the test results using the indicated units on the report form and not to round the test results, but report as much significant figures as possible. It was also requested not to report 'less than' test results, which are above the detection limit, because such test results cannot be used for meaningful statistical evaluations.

To get comparable test results a detailed report form and a letter of instructions are prepared. On the report form the reporting units are given as well as the reference test methods (when applicable) that will be used during the evaluation. The detailed report form and the letter of instructions are both made available on the data entry portal www.kpmd.co.uk/sgs-iis/. The participating laboratories are also requested to confirm the sample receipt on this data entry portal. The letter of instructions can also be downloaded from the iis website www.iisnl.com.

3 RESULTS

During five weeks after sample dispatch, the test results of the individual laboratories were gathered via the data entry portal www.kpmd.co.uk/sgs-iis/. The reported test results are tabulated per determination in appendix 1 of this report. The laboratories are presented by their code numbers.

Directly after the deadline, a reminder was sent to those laboratories that had not reported test results at that moment. Shortly after the deadline, the available test results were screened for suspect data. A test result was called suspect in case the Huber Elimination Rule (a robust outlier test) found it to be an outlier.

The laboratories that produced these suspect data were asked to check the reported test results (no reanalyzes). Additional or corrected test results are used for data analysis and the original test results are placed under 'Remarks' in the result tables in appendix 1. Test results that came in after the deadline were not taken into account in this screening for suspect data and thus these participants were not requested for checks.

3.1   STATISTICS

The protocol followed in the organization of this proficiency test was the one as described for proficiency testing in the report 'iis Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of June 2018 (iis-protocol, version 3.5).
For the statistical evaluation the *unrounded* (when available) figures were used instead of the rounded test results. Test results reported as '<…' or '>…' were not used in the statistical evaluation.

First, the normality of the distribution of the various data sets per determination was checked by means of the Lilliefors-test, a variant of the Kolmogorov-Smirnov test and by the calculation of skewness and kurtosis. Evaluation of the three normality indicators in combination with the visual evaluation of the graphic Kernel density plot, lead to judgement of the normality being either 'unknown', 'OK', 'suspect' or 'not OK'. After removal of outliers, this check was repeated. If a data set does not have a normal distribution, the (results of the) statistical evaluation should be used with due care.

The assigned value is determined by consensus based on the test results of the group of participants after rejection of the statistical outliers and/or suspect data.

According to ISO13528 all (original received or corrected) results per determination were submitted to outlier tests. In the iis procedure for proficiency tests, outliers are detected prior to calculation of the mean, standard deviation and reproducibility. For small data sets, Dixon (up to 20 test results) or Grubbs (up to 40 test results) outlier tests can be used. For larger data sets (above 20 test results) Rosner's outlier test can be used. Outliers are marked by D(0.01) for the Dixon's test, by G(0.01) or DG(0.01) for the Grubbs' test and by R(0.01) for the Rosner's test. Stragglers are marked by D(0.05) for the Dixon's test, by G(0.05) or DG(0.05) for the Grubbs' test and by R(0.05) for the Rosner's test. Both outliers and stragglers were not included in the calculations of averages and standard deviations.

For each assigned value the uncertainty was determined in accordance with ISO13528. Subsequently the calculated uncertainty was evaluated against the respective requirement based on the target reproducibility in accordance with ISO13528. In this PT, the criterion of ISO13528, paragraph 9.2.1. was met for all evaluated tests, therefore, the uncertainty of all assigned values may be negligible and need not be included in the PT report.

Finally, the reproducibilities were calculated from the standard deviations by multiplying them with a factor of 2.8.

3.2 GRAPHICS

In order to visualize the data against the reproducibilities from literature, Gauss plots were made, using the sorted data for one determination (see appendix 1). On the Y-axis the reported test results are plotted. The corresponding laboratory numbers are on the X-axis. The straight horizontal line presents the consensus value (a trimmed mean). The four striped lines, parallel to the consensus value line, are the +3s, +2s, -2s and -3s target reproducibility limits of the selected reference test method. Outliers and other data, which were excluded from the calculations, are represented as a cross. Accepted data are represented as a triangle.

Furthermore, Kernel Density Graphs were made. This is a method for producing a smooth density approximation to a set of data that avoids some problems associated with histograms. Also, a normal Gauss curve (dotted line) was projected over the Kernel Density Graph (smooth line) for reference. The Gauss curve is calculated from the consensus value and the corresponding standard deviation.

3.3 Z-SCORES

To evaluate the performance of the participating laboratories the z-scores were calculated. As it was decided to evaluate the performance of the participants in this proficiency test (PT) against the literature requirements (derived from e.g. ISO or ASTM test methods), the z-scores were calculated using a target standard deviation. This results in an evaluation independent of the variation in this interlaboratory study.

The target standard deviation was calculated from the literature reproducibility by division with 2.8. In case no literature reproducibility was available, other target values were used, like Horwitz or an estimated reproducibility based on former iis proficiency tests.

When a laboratory did use a test method with a reproducibility that is significantly different from the reproducibility of the reference test method used in this report, it is strongly advised to recalculate the z-score, while using the reproducibility of the actual test method used, this in order to evaluate whether the reported test result is fit-for-use.

The z-scores were calculated according to:

$z_{(target)}$ = (test result - average of PT) / target standard deviation

The $z_{(target)}$ scores are listed in the test result tables in appendix 1.

Absolute values for z<2 are very common and absolute values for z>3 are very rare. Therefore, the usual interpretation of z-scores is as follows:

$$|z| \; < 1 \quad \text{good}$$
$$1 < |z| \; < 2 \quad \text{satisfactory}$$
$$2 < |z| \; < 3 \quad \text{questionable}$$
$$3 < |z| \qquad \text{unsatisfactory}$$

4   EVALUATION

Large problems were encountered with the dispatch of the samples due to COVID-19 pandemic. Therefore, the reporting time on the data entry portal was extended with another three weeks.

For the regular analyses in Naphtha PT fifteen participants reported test results after the extended reporting date and eleven other participants did not report any test results.

For the Mercury analyses in Naphtha PT six participants reported test results after the extended reporting date and eight other participants did not report any test results.

For the Arsenic and Lead analyses in Naphtha PT four participants reported test results after the extended reporting date and thirteen other participants did not report any test results.

For the Vapor Pressure analyses in Naphtha PT ten participants reported test results after the extended reporting date and six other participants did not report any test results.

Not all participants were able to report all tests requested.

In total 85 participants reported 682 numerical test results. Observed were 21 outlying test results, which is 3.1%. In proficiency tests outlier percentages of 3% - 7.5% are quite normal.

Not all data sets proved to have a normal Gaussian distribution. These are referred to as "not OK" or "suspect". The statistical evaluation of these data sets should be used with due care, see also paragraph 3.1.

4.1   EVALUATION PER SAMPLE AND PER TEST

In this section the reported test results are discussed per sample and per test. The test methods which were used by the various laboratories were taken into account for explaining the observed differences when possible and applicable. These test methods are also in the tables together with the original data in appendix 1. The abbreviations, used in these tables, are explained in appendix 3.

Unfortunately, a suitable reference test method providing the precision data is not available for all determinations. For those tests the calculated reproducibility was compared against the estimated reproducibility calculated with the Horwitz equation.

In the iis PT reports ASTM test methods are referred to with a number (e.g. D6045) and an added designation for the year that the test method was adopted or revised (e.g. D6045:20).

sample #22045

Organic Chlorides: This determination was very problematic. Three statistical outliers were observed. It was decided not to calculate z-scores due to the large variation of the group compared to the target reproducibility.

Color Saybolt: This determination was problematic for the automated and manual mode. No statistical outliers were observed. However, the calculated reproducibilities for the automated and the manual modes are both not in agreement with the respective requirements of ASTM D6045:20 and ASTM D156:15.

Copper Corrosion: This determination was not problematic. All reporting laboratories except one agreed on a result of 1 (1a/1b).

Density at 15 °C: This determination was problematic for a number of laboratories. Five statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirement of ISO12185:96.

Distillation: This determination was not problematic. In total two statistical outliers were observed over three parameters. All calculated reproducibilities after rejection of the statistical outliers are in agreement with the requirements of ASTM D86:20b for the automated and manual mode.

Mercaptan Sulfur: This determination was problematic. Two statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the requirement of ASTM D3227:16.

Sulfur: This determination was not problematic. Two statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in agreement with the requirement of ASTM D4294:21, ASTM D2622:21 and ASTM D5453:19a.

samples #22046 and #22047

Mercury: This determination was not problematic for both samples. In total three statistical outliers were observed. The calculated reproducibilities after rejection of the statistical outliers are in agreement with the estimated reproducibilities calculated with the Horwitz equation, but not with the strict requirements of UOP938:20.

samples #22048 and #22049

Arsenic: This determination is problematic for both samples. No statistical outliers were observed. Both calculated reproducibilities are not at all in agreement with the estimated reproducibilities calculated with the Horwitz equation. It was decided not to calculate z-scores due to the large variation of the group compared to the target reproducibility. It is assumed that Arsenic had adsorbed to the wall of the glass bottle. It is recommended to rinse the bottle with strong acid to get all Arsenic released before the determination. In this PT it was asked whether the bottle was rinsed with strong acid for the first time. Eight of the thirteen reporting participants have answered this question. The laboratories that rinsed the bottle found much higher amounts of Arsenic than the laboratories that did not rinse the bottle. This underpin the recommendation to rinse a glass bottle of a sample when this determination has been performed routinely.

Lead: This determination was not problematic for sample #22048 (artificial Naphtha). Two statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is in full agreement with the estimated reproducibility calculated with the Horwitz equation.

For sample #22049 (real Naphtha) this determination may be problematic. Two statistical outliers were observed. The calculated reproducibility after rejection of the statistical outliers is not in agreement with the estimated reproducibility calculated with the Horwitz equation.

sample #22050

Total Vapor Pressure: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in full agreement with the requirements of ASTM D5191:20.

DVPE: This determination was not problematic. No statistical outliers were observed. The calculated reproducibility is in full agreement with the requirements of ASTM D5191:20.

4.2   PERFORMANCE EVALUATION FOR THE GROUP OF LABORATORIES

A comparison has been made between the reproducibility as declared by the reference test method and the reproducibility as found for the group of the participating laboratories. The number of significant test results, the average, the calculated reproducibility (2.8 * standard deviation) and the target reproducibility derived from reference methods are presented in the next tables.

Parameter	unit	n	average	2.8 * sd	R(lit)
Organic Chlorides	mg/kg	26	0.48	0.56	(0.11)
Color Saybolt (automated)		35	28.7	2.5	1.2
Color Saybolt (manual)		30	28.7	3.1	2
Copper Corrosion		54	1(1a/1b)	n.a.	n.a.
Density at 15°C	kg/L	72	0.7188	0.0004	0.0005
Initial Boiling Point	°C	67	37.5	4.7	4.7
50% recovered	°C	66	107.9	1.5	4.1
Final Boiling Point	°C	66	165.9	6.2	7.1
Mercaptan Sulfur as S	mg/kg	45	74.3	7.5	6.2
Sulfur	mg/kg	59	258.8	39.1	68.9

Table 14: reproducibilities of tests on sample #22045

For results between brackets no z-scores are calculated

Parameter	unit	n	average	2.8 * sd	R(target)
Mercury as Hg #22046	µg/kg	36	53.7	22.7	37.3
Mercury as Hg #22047	µg/kg	35	158	59	94

Table 15: reproducibilities of tests on sample #22046 and #22047

Parameter	unit	n	average	2.8 * sd	R(target)
Arsenic as As #22048	µg/kg	11	27.1	57.9	(20.9)
Arsenic as As #22049	µg/kg	10	29.9	74.2	(22.7)

Parameter	unit	n	average	2.8 * sd	R(target)
Lead as Pb #22048	µg/kg	16	38.6	28.6	28.2
Lead as Pb #22049	µg/kg	15	41.5	37.6	30.0

Table 16: reproducibilities of tests on sample #22048 and #22049

For results between brackets no z-scores are calculated

Parameter	unit	n	average	2.8 * sd	R(lit)
TVP	psi	31	7.07	0.22	0.23
DVPE	psi	41	6.27	0.23	0.23

Table 17: reproducibilities of tests on sample #22050

Without further statistical calculations, it can be concluded that for a number of tests there is a good compliance of the group of participants with the reference test methods. The problematic tests have been discussed in paragraph 4.1.

4.3   COMPARISON OF THE PROFICIENCY TEST OF APRIL 2022 WITH PREVIOUS PTS

	April 2022	April 2021	April 2020	April 2019	April 2018
Number of reporting laboratories	85	90	74	93	104
Number of test results	682	753	1446	1635	1831
Number of statistical outliers	21	17	130	73	88
Percentage of statistical outliers	3.1%	2.3%	9.0%	4.5%	4.8%

Table 18: comparison with previous proficiency tests

In proficiency tests, outlier percentages of 3% - 7.5% are quite normal.

The performance of the determinations of the proficiency tests was compared to the requirements of the reference test methods. The conclusions are given in the following table.

Parameter	April 2022	April 2021	April 2020	April 2019	April 2018
Organic Chlorides	(--)	-	--	--	n.e.
Color Saybolt	-	--	--	+	--
Density at 15 °C	+	+	+/-	+	+
Distillation	+	+	+/-	+/-	+/-
Mercaptan Sulfur as S	-	-	-	-	--
Sulfur	+	+	+	+	+
Mercury	+	+	+	+	+
Arsenic	(--)	--	--	+/-	+/-
Lead	-	-	-	+/-	+/-
Total Vapor Pressure	+/-	-	-	-	+
DVPE acc. to D5191	+/-	-	-	-	+

Table 19: comparison of determinations to the reference test methods

For results between brackets no z-scores are calculated

The following performance categories were used:

++   : group performed much better than the reference test method

+   : group performed better than the reference test method

+/-   : group performance equals the reference test method

-      : group performed worse than the reference test method

--   : group performed much worse than the reference test method

n.e.   : not evaluated

APPENDIX 1
Determination of Organic Chlorides on sample #22045; results in mg/kg

lab	method	value	mark	z(targ)	remarks
140		-----		-----	
150		-----		-----	
158		-----		-----	
171	UOP779	<0.3		-----	
225		-----		-----	
237		-----		-----	
238		-----		-----	
311	D5808	<1		-----	
323	UOP779	< 1		-----	
328		-----		-----	
333	D5808	0.9		-----	
334		-----		-----	
337	UOP779	0.9		-----	
349		-----		-----	
360	UOP779	1.66	R(0.05)	-----	
399		-----		-----	
444	IP510	0.4		-----	
445		-----		-----	
492		-----		-----	
495		-----		-----	
541		-----		-----	
608		-----		-----	
657	UOP779	<1		-----	
663		-----		-----	
750	D4929B	0.455		-----	
753		-----		-----	
754	UOP779	0.41		-----	
779		-----		-----	
781		-----		-----	
785	UOP779	0.40		-----	
798	UOP779	0.66		-----	
824	UOP779	0.69		-----	
855		-----		-----	
862		-----		-----	
864		-----		-----	
868	D5808	0.4		-----	
872		-----		-----	
873	UOP779	0.47		-----	
874	UOP779	0.44		-----	
875	UOP779	0.48		-----	
912	D4929B	<1		-----	
914		-----		-----	
922		-----		-----	
962		-----		-----	
963	UOP779	0.4		-----	
971	UOP779	0.44		-----	
974		-----		-----	
982		-----		-----	
994		-----		-----	
1012		-----		-----	
1016		-----		-----	
1039		-----		-----	
1062	In house	0.91		-----	
1065		-----		-----	
1066	UOP779	<0.3		-----	
1081		-----		-----	
1097		-----		-----	
1108		-----		-----	
1145	D5808	1.26	R(0.05)	-----	
1191	UOP779	0.45		-----	
1284		-----		-----	
1362	UOP779	0.51		-----	
1381		-----		-----	
1397	D4929B	1.2	R(0.05)	-----	
1585		-----		-----	
1586	UOP779	0.4		-----	
1603	In house	<0.4		-----	
1656		-----		-----	
1669		-----		-----	
1737		-----		-----	
1741	D4929/D5808	<1,0		-----	
1788	D5808	0.16859		-----	
1823		-----		-----	
1849	D7359	0.27		-----	
1857	UOP779	0.36		-----	

lab	method	value	mark	z(targ)	remarks
1862		-----		-----	
1950	UOP779	0.44		-----	
1960		-----		-----	
1995	D4929	0.1		-----	
6056	In house	0.62		-----	
6134	D4929	0.30		-----	
6185		-----		-----	
6198		-----		-----	
6200		-----		-----	
6229		-----		-----	
6299		-----		-----	
6344		-----		-----	
6438	D5808	<0.7		-----	
6444	D5808	0.47		-----	
6447		-----		-----	
9061		-----		-----	

normality	OK
n	26
outliers	3
mean (n)	0.479
st.dev. (n)	0.2010
R(calc.)	0.563
st.dev.(UOP779:08)	(0.0400)
R(UOP779:08)	(0.112)
Compare	
R(Horwitz)	(0.240)
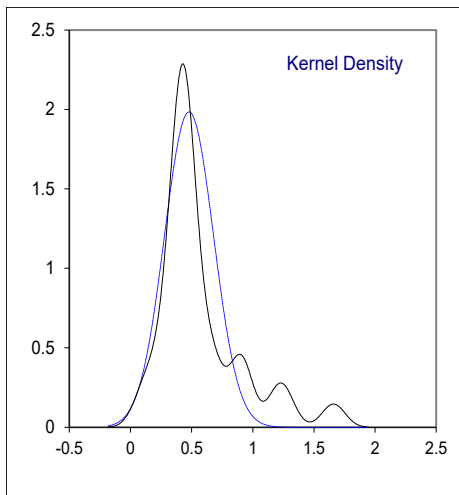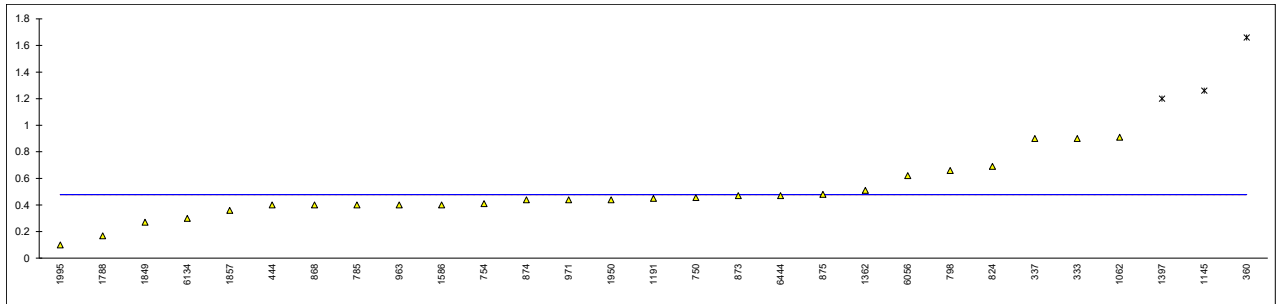
Determination of Color Saybolt (automated) on sample #22045

lab	method	value	mark	z(targ)	cuvette	remarks
140		-----		-----		
150	D6045	28		-1.68	100 mm	
158		-----		-----		
171	D6045	30		2.84		
225		-----		-----		
237		-----		-----		
238		-----		-----		
311		-----		-----		
323	D6045	27.5		-2.81	50 mm	
328		-----		-----		
333		-----		-----		
334		-----		-----		
337		-----		-----		
349	D6045	29		0.58	50 mm	
360		-----		-----		
399		-----		-----		
444	D6045	29.0		0.58	100 mm	
445		-----		-----		
492		-----		-----		
495		-----		-----		
541	D6045	29		0.58		
608		-----		-----		
657	D6045	29		0.58	100 mm	
663	D6045	28		-1.68	50 mm	
750		-----		-----		
753	D6045	29		0.58	100 mm	
754		-----		-----		
779	D6045	29		0.58	50 mm	
781	D6045	28		-1.68	100 mm	
785	D6045	28		-1.68	50 mm	
798	D6045	28		-1.68	100 mm	
824	D6045	29		0.58	50 mm	
855		-----		-----		
862		-----		-----		
864		-----		-----		
868	D6045	27.5		-2.81		
872	D6045	28		-1.68	100 mm	
873	D6045	28		-1.68	100 mm	
874	D6045	28		-1.68	100 mm	
875	D6045	28		-1.68	50 mm	
912	D6045	30		2.84	50 mm	
914		-----		-----		
922	D6045	28		-1.68	100 mm	
962		-----		-----		
963	D6045	30		2.84		
971		-----		-----		
974	D6045	29		0.58	100 mm	
982		-----		-----		
994		-----		-----		
1012		-----		-----		
1016		29		0.58	10 mm	
1039		-----		-----	100 mm	
1062		-----		-----		
1065		-----		-----		
1066	D6045	30		2.84	50 mm	
1081		-----		-----		
1097		-----		-----		
1108		-----		-----		
1145		-----		-----		
1191	D6045	29		0.58	100 mm	
1284	D6045	30		2.84	50 mm	
1362		-----		-----		
1381		-----		-----		
1397		-----		-----		
1585	D6045	29		0.58	100 mm	
1586	D6045	29		0.58	50 mm	
1603		-----		-----	10 mm	
1656		28		-1.68	50 mm	
1669	D6045	30		2.84		
1737		-----		-----		
1741	D6045	28		-1.68	100 mm	
1788		-----		-----		
1823		-----		-----		
1849		-----		-----		
1857		-----		-----		

lab	method	value	mark	z(targ)	cuvette	remarks
1862		-----		-----		
1950		-----		-----	10 mm	
1960		-----		-----		
1995	D6045	30		2.84	100 mm	
6056		-----		-----		
6134		-----		-----		
6185		-----		-----		
6198		-----		-----		
6200	D6045	27		-3.94	100 mm	
6229		-----		-----		
6299		-----		-----		
6344		-----		-----	100 mm	
6438	D6045	30		2.84	50 mm	
6444		-----		-----		
6447		-----		-----		
9061		-----		-----		

normality	OK
n	35
outliers	0
mean (n)	28.743
st.dev. (n)	0.8776
R(calc.)	2.457
st.dev.(D6045:20)	0.4429
R(D6045:20)	1.24
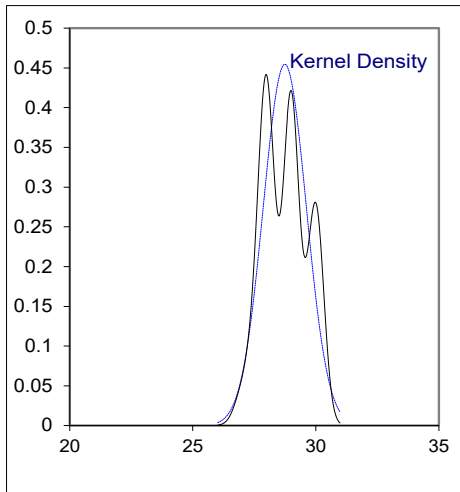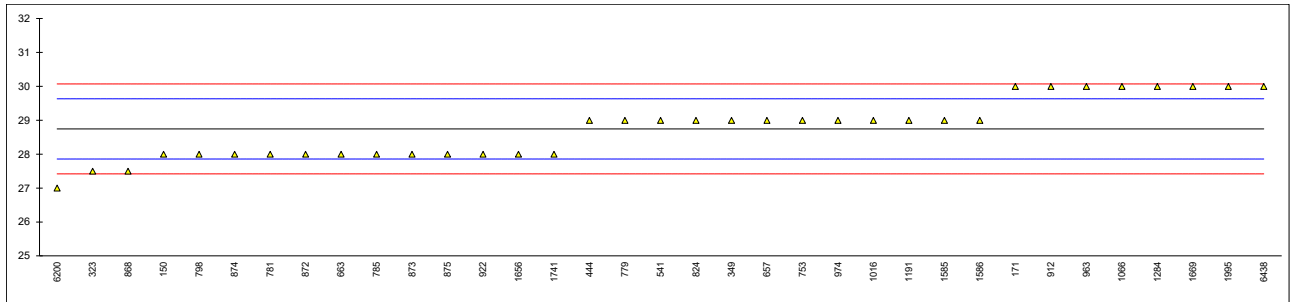
Determination of Color Saybolt (manual) on sample #22045

lab	method	value	mark	z(targ)	filter	remarks
140	D156	30		1.87		
150		-----		-----		
158		-----		-----		
171	D156	30		1.87		
225		-----		-----		
237	D156	28		-0.93		
238	D156	28		-0.93		
311		-----		-----		
323		-----		-----		
328	D156	28		-0.93		
333		-----		-----		
334	D156	26	C	-3.73	0.5	Reported first as automated
337		-----		-----		
349		-----		-----		
360	D156	29		0.47	0.5	
399	D156	28		-0.93		
444		-----		-----		
445		-----		-----		
492	D156	31		3.27		
495		-----		-----		
541		-----		-----		
608	D156	28		-0.93		
657	D156	29		0.47	0.5	
663		-----		-----		
750	D156	27		-2.33	0.5	
753		-----		-----		
754		-----		-----		
779		-----		-----		
781		-----		-----		
785		-----		-----		
798		-----		-----		
824	D156	29		0.47	0.5	
855		-----		-----		
862		-----		-----		
864		-----		-----		
868		-----		-----		
872		-----		-----		
873		-----		-----		
874		-----		-----		
875		-----		-----		
912		-----		-----		
914		-----		-----		
922	D156	28		-0.93	0.5	
962		-----		-----		
963		-----		-----		
971	D156	29		0.47	0.5	
974	D156	29		0.47	0.5	
982		-----		-----		
994	D156	28		-0.93		
1012		-----		-----		
1016		-----		-----		
1039	D156	30		1.87		
1062		-----		-----		
1065		-----		-----		
1066	D156	30		1.87		
1081		-----		-----		
1097		-----		-----		
1108	D156	30		1.87	0.5	
1145	D156	30		1.87		
1191		-----		-----		
1284		-----		-----		
1362		-----		-----		
1381		-----		-----		
1397		-----		-----		
1585	D156	29		0.47	0.5	
1586		-----		-----		
1603	In house	28		-0.93		
1656		-----		-----		
1669		-----		-----		
1737		-----		-----		
1741	D156	27		-2.33	0.5	
1788		-----		-----		
1823		-----		-----		
1849	TS2991	28		-0.93	0.5	
1857	D156	29		0.47	0.5	

lab	method	value	mark	z(targ)	filter	remarks
1862		-----		-----		
1950	D156	29		0.47		
1960		-----		-----		
1995		-----		-----		
6056		-----		-----		
6134	D156	28		-0.93		
6185	D156	28		-0.93		
6198		-----		-----		
6200		-----		-----		
6229		-----		-----		
6299		-----		-----		
6344	D156	29		0.47		
6438		-----		-----		
6444		-----		-----		
6447		-----		-----		
9061		-----		-----		

normality	OK
n	30
outliers	0
mean (n)	28.667
st.dev. (n)	1.0933
R(calc.)	3.061
st.dev.(D156:15)	0.7143
R(D156:15)	2
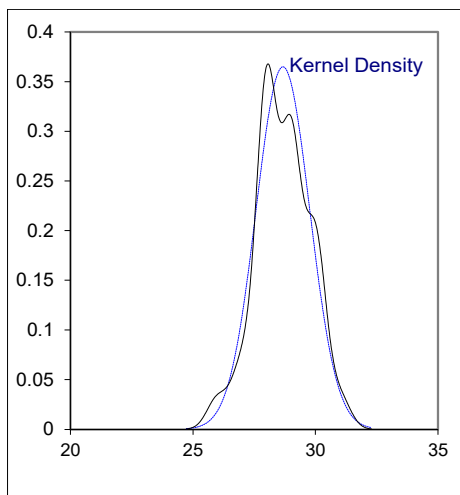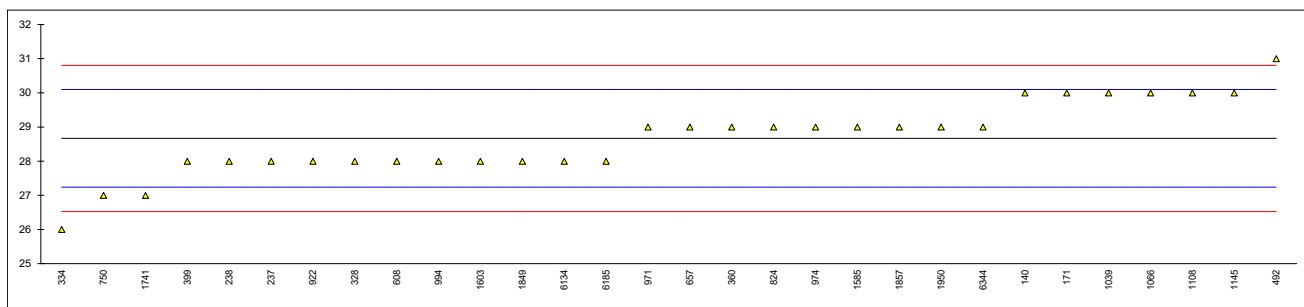
Determination of Copper Corrosion 3 hrs at 50°C on sample #22045

lab	method	value	mark	z(targ)	remarks
140	D130	1a		-----	
150	D130	1A		-----	
158	D130	1a		-----	
171	D130	1a		-----	
225	D130	1a		-----	
237	D130	1A		-----	
238	D130	1a		-----	
311	D130	1A		-----	
323		-----		-----	
328	D130	1		-----	
333		-----		-----	
334	D130	1a		-----	
337		-----		-----	
349		-----		-----	
360	ISO2160	1A		-----	
399	D130	1A		-----	
444		-----		-----	
445		-----		-----	
492		-----		-----	
495		-----		-----	
541	D130	1a		-----	
608	D130	1a		-----	
657	D130	1A		-----	
663	D130	1a		-----	
750	ISO2160	1A		-----	
753	D130	1a		-----	
754	D130	1a		-----	
779	D130	1a		-----	
781	D130	1b		-----	
785	D130	1a		-----	
798	D130	1a		-----	
824	D130	1a		-----	
855		-----		-----	
862		-----		-----	
864		-----		-----	
868	D130	1a		-----	
872		-----		-----	
873	D130	1a		-----	
874	D130	1a		-----	
875	D130	1a		-----	
912	D130	1a		-----	
914		-----		-----	
922	D130	1a		-----	
962		-----		-----	
963	D130	1a		-----	
971	D130	1a		-----	
974	D130	1a		-----	
982		-----		-----	
994	D130	1a		-----	
1012	D130	1a		-----	
1016	D130	1A		-----	
1039		-----		-----	
1062		-----		-----	
1065		-----		-----	
1066	D130	1A		-----	
1081		-----		-----	
1097	ISO2160	1a		-----	
1108	ISO2160	1A		-----	
1145		-----		-----	
1191	ISO2160	1a		-----	
1284		-----		-----	
1362	D130	1a		-----	
1381		-----		-----	
1397		-----		-----	
1585	D130	1a		-----	
1586	D130	1A		-----	
1603	In house	1A		-----	
1656	IP154	1a		-----	
1669	D130	2a		-----	
1737		-----		-----	
1741	D130	1a		-----	
1788	D130	1A		-----	
1823		-----		-----	
1849	ISO2160	1A		-----	
1857	ISO2160	1a		-----	

lab	method	value	mark	z(targ)	remarks
1862		-----		-----	
1950	D130	1a		-----	
1960		-----		-----	
1995	D130	1A		-----	
6056		-----		-----	
6134		-----		-----	
6185		-----		-----	
6198		-----		-----	
6200		-----		-----	
6229		-----		-----	
6299	ISO2160	1a		-----	
6344	ISO2160	1a		-----	
6438	D130	1A		-----	
6444		-----		-----	
6447		-----		-----	
9061		-----		-----	

	n	54
	mean (n)	1 (1a/1b)

Determination of Density at 15°C on sample #22045; results in kg/L

lab	method	value	mark	z(targ)	remarks
140	D4052	0.7187		-0.76	
150	D4052	0.7203	C,R(0.01)	8.20	First reported 0.7183
158	D4052	0.7187		-0.76	
171	D4052	0.7190		0.92	
225	D4052	0.7190		0.92	
237	D4052	0.7191		1.48	
238	D4052	0.7186		-1.32	
311	ISO12185	0.7187		-0.76	
323	D4052	0.7188		-0.20	
328	ISO12185	0.7188		-0.20	
333	ISO12185	0.7188		-0.20	
334	ISO12185	0.7188		-0.20	
337	ISO12185	0.7189		0.36	
349	D4052	0.7192	C	2.04	First reported 0.7087
360	ISO12185	0.7188		-0.20	
399	D4052	0.7189		0.36	
444	D4052	0.7188		-0.20	
445		-----		-----	
492	D4052	0.7192		2.04	
495	ISO12185	0.71874		-0.53	
541	ISO12185	0.7191		1.48	
608	D4052	0.7188		-0.20	
657	ISO12185	0.7189		0.36	
663	D4052	0.71892		0.48	
750	D4052	0.7194	R(0.01)	3.16	
753	D4052	0.7187	C	-0.76	Reported 718.7 kg/L
754	D4052	0.71905		1.20	
779	D4052	0.7187		-0.76	
781	ISO12185	0.7188		-0.20	
785	ISO12185	0.7187		-0.76	
798	D4052	0.7190		0.92	
824	ISO12185	0.7186		-1.32	
855		-----		-----	
862		-----		-----	
864		-----		-----	
868	D4052	0.71888		0.25	
872	ISO12185	0.7187		-0.76	
873	D4052	0.7187	C	-0.76	Reported 718.7 kg/L
874	ISO12185	0.7187		-0.76	
875	ISO12185	0.7188		-0.20	
912	D4052	0.7207	R(0.01)	10.44	
914		-----		-----	
922	D4052	0.7190		0.92	
962		-----		-----	
963	ISO12185	0.7188		-0.20	
971	D4052	0.7188		-0.20	
974	D4052	0.7189		0.36	
982		-----		-----	
994	D4052	0.7190		0.92	
1012	D4052	0.7191		1.48	
1016	D4052	0.7188		-0.20	
1039	ISO12185	0.7187		-0.76	
1062	D4052	0.7188		-0.20	
1065	D4052	0.7187		-0.76	
1066	D4052	0.7188		-0.20	
1081	D4052	0.7188		-0.20	
1097	ISO12185	0.71892		0.48	
1108	ISO12185	0.7188		-0.20	
1145	D4052	0.7190		0.92	
1191	ISO12185	0.7187		-0.76	
1284	D4052	0.71879		-0.25	
1362	ISO12185	0.71875		-0.48	
1381	ISO12185	0.71908		1.37	
1397		-----		-----	
1585	ISO12185	0.71870		-0.76	
1586	D4052	0.7188		-0.20	
1603	In house	0.7191		1.48	
1656	D4052	0.7188		-0.20	
1669	D4052	0.7188		-0.20	
1737	D4052	0.7182	R(0.01)	-3.56	
1741	D4052	0.7188		-0.20	
1788	D4052	0.71876		-0.42	
1823	ISO12185	0.7166	R(0.01)	-12.52	
1849	ISO12185	0.71876		-0.42	
1857	ISO12185	0.7187		-0.76	

lab	method	value	mark	z(targ)	remarks
1862		-----		-----	
1950	D4052	0.71874		-0.53	
1960	D4052	0.718832		-0.02	
1995	D4052	0.7190		0.92	
6056		-----		-----	
6134	D4052	0.7188		-0.20	
6185	D4052	0.7187		-0.76	
6198		-----		-----	
6200	D4052	0.7188		-0.20	
6229		-----		-----	
6299	ISO12185	0.71883		-0.03	
6344	ISO12185	0.7188		-0.20	
6438	D4052	0.7187		-0.76	
6444		-----		-----	
6447		-----		-----	
9061		0.718855		0.11	

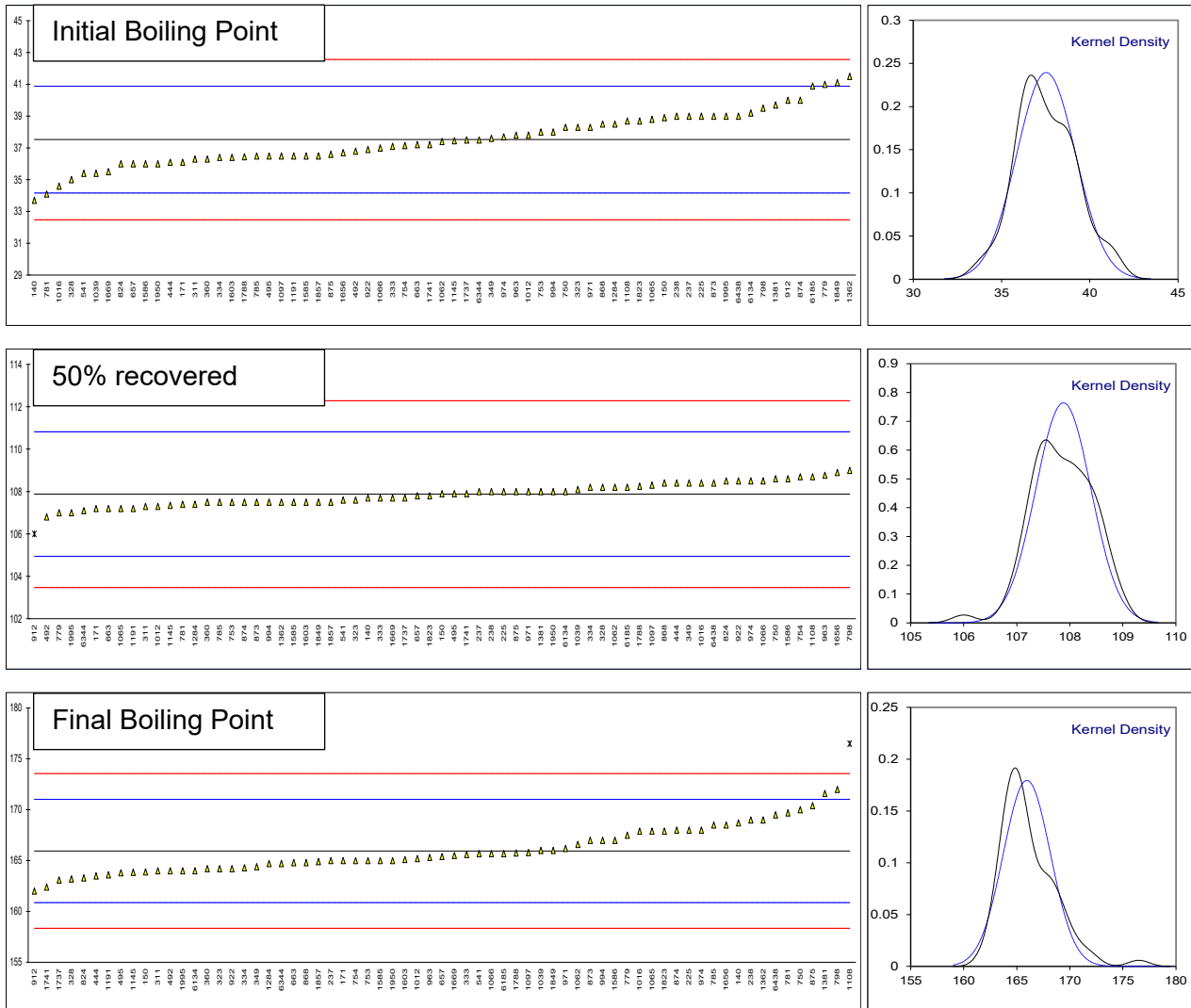|	
normality	OK
n	72
outliers	5
mean (n)	0.71883
st.dev. (n)	0.000138
R(calc.)	0.00039
st.dev.(ISO12185:96)	0.000179
R(ISO12185:96)	0.0005
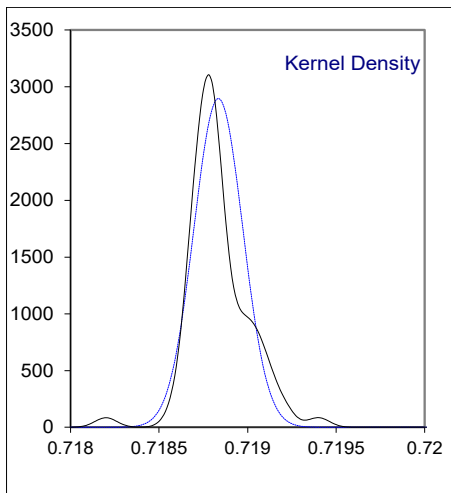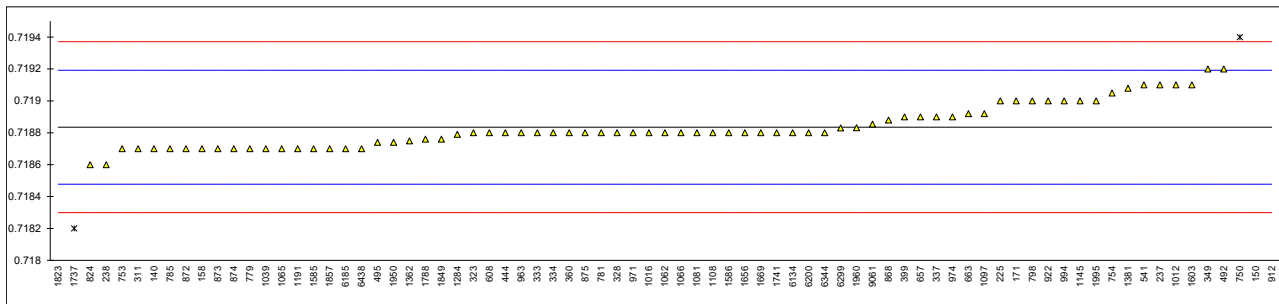
Determination of Distillation at 760 mmHg on sample #22045; results in °C

lab	method	IBP	mark	z(targ)	50%rec	mark	z(targ)	FBP	mark	z(targ)
140	D86-automated	33.7		-2.28	107.7		-0.12	168.7		1.09
150	D86-automated	38.9		0.82	107.9		0.01	163.9		-0.81
158		-----		-----	-----		-----	-----		-----
171	D86-automated	36.1		-0.85	107.2		-0.46	165.0		-0.37
225	D86-manual	39.0		0.88	108.0		0.08	168.0		0.81
237	D86-manual	39.0		0.88	108.0		0.08	165.0		-0.37
238	D86-manual	39.0		0.88	108		0.08	169		1.20
311	D86-automated	36.3		-0.73	107.3		-0.39	164.0		-0.77
323	D86-automated	38.3		0.46	107.6		-0.19	164.2		-0.69
328	D86-automated	35.0		-1.50	108.2		0.22	163.2		-1.08
333	D86-automated	37.1		-0.25	107.7		-0.12	165.6		-0.14
334	D86-automated	36.4		-0.67	108.2		0.22	164.3		-0.65
337		-----		-----	-----		-----	-----		-----
349	D86-automated	37.6		0.05	108.4		0.35	164.4		-0.61
360	D86-automated	36.3		-0.73	107.5		-0.26	164.2		-0.69
399		-----		-----	-----		-----	-----		-----
444	D86-automated	36.1		-0.85	108.4		0.35	163.5		-0.97
445		-----		-----	-----		-----	-----		-----
492	D86-manual	36.8		-0.43	106.8		-0.73	164.0		-0.77
495	D86-automated	36.5		-0.61	107.9		0.01	163.8		-0.85
541	D86-automated	35.4		-1.26	107.6		-0.19	165.7		-0.10
608		-----		-----	-----		-----	-----		-----
657	D86-automated	36.0		-0.91	107.8		-0.05	165.4		-0.22
663	D86-automated	37.2		-0.19	107.2		-0.46	164.8		-0.45
750	ISO3405A	38.3		0.46	108.6		0.49	170.0		1.60
753	ISO3405-manual	38.0		0.28	107.5		-0.26	165.0		-0.37
754	D86-automated	37.15		-0.22	108.7		0.56	165.0		-0.37
779	D86-manual	41.0		2.07	107.0		-0.60	167.5		0.61
781	D86-automated	34.1		-2.04	107.4		-0.33	169.7		1.48
785	D86-automated	36.5		-0.61	107.5		-0.26	168.5		1.01
798	D86-automated	39.5		1.18	109.0		0.76	172.0		2.39
824	D86-automated	36.0		-0.91	108.5		0.42	163.3		-1.04
855		-----		-----	-----		-----	-----		-----
862		-----		-----	-----		-----	-----		-----
864		-----		-----	-----		-----	-----		-----
868	D86	38.5		0.58	108.4		0.35	164.8		-0.45
872		-----		-----	-----		-----	-----		-----
873	D86-manual	39.0		0.88	107.5		-0.26	167.0		0.42
874	D86-manual	40.0		1.48	107.5		-0.26	168.0		0.81
875	D86-automated	36.6		-0.55	108.0		0.08	170.4		1.76
912	D86-manual	40		1.48	106	R(0.05)	-1.28	162		-1.56
914		-----		-----	-----		-----	-----		-----
922	D86-automated	36.9		-0.37	108.5		0.42	164.2		-0.69
962		-----		-----	-----		-----	-----		-----
963	D86-automated	37.80		0.16	108.77		0.61	165.31		-0.25
971	D86-automated	38.3		0.46	108.0		0.08	166.2		0.10
974	D86-automated	37.7		0.11	108.5		0.42	168.0		0.81
982		-----		-----	-----		-----	-----		-----
994	D86-manual	38.0		0.28	107.5		-0.26	167.0		0.42
1012	D86-automated	37.8		0.16	107.3		-0.39	165.2		-0.29
1016	D86-automated	34.6		-1.74	108.4		0.35	167.9		0.77
1039	ISO3405-automated	35.4		-1.26	108.1		0.15	166.0		0.02
1062	D86-automated	37.4		-0.07	108.2		0.22	166.6		0.26
1065		38.8		0.76	107.2		-0.46	167.9		0.77
1066	D86-automated	37.0		-0.31	108.5		0.42	165.7		-0.10
1081		-----		-----	-----		-----	-----		-----
1097	ISO3405-automated	36.5		-0.61	108.3		0.29	165.8		-0.06
1108	D86-automated	38.7		0.70	108.7		0.56	176.5	R(0.01)	4.16
1145	D86-automated	37.45		-0.04	107.35		-0.36	163.85		-0.83
1191	ISO3405-automated	36.5		-0.61	107.2		-0.46	163.6		-0.93
1284	D86-automated	38.5		0.58	107.4		-0.33	164.7		-0.49
1362	D86-manual	41.5		2.37	107.5		-0.26	169.0		1.20
1381	ISO3405-automated	39.7		1.30	108.0		0.08	171.6		2.23
1397		-----		-----	-----		-----	-----		-----
1585	D86-automated	36.5		-0.61	107.5		-0.26	165.0		-0.37
1586	D86-automated	36.0		-0.91	108.6		0.49	167.0		0.42
1603	D86-automated	36.4		-0.67	107.5		-0.26	165.1		-0.33
1656	IP123-automated	36.7		-0.49	108.9		0.69	168.5	C	1.01
1669	D86-automated	35.5		-1.21	107.7		-0.12	165.5		-0.18
1737	D86-automated	37.5		-0.01	107.7		-0.12	163.1		-1.12
1741	D86-automated	37.2		-0.19	107.9		0.01	162.4		-1.40
1788		36.45		-0.64	108.25		0.25	165.75		-0.08
1823	D86	38.7		0.70	107.8		-0.05	167.9		0.77
1849	D86-automated	41.1		2.13	107.5		-0.26	166		0.02
1857	D86-automated	36.5		-0.61	107.5		-0.26	164.9		-0.41
1862		-----		-----	-----		-----	-----		-----

lab	method	IBP	mark	z(targ)	50%rec	mark	z(targ)	FBP	mark	z(targ)
1950	D86-manual	36.0		-0.91	108.0		0.08	165.0		-0.37
1960		-----		-----	-----		-----	-----		-----
1995	D86-automated	39		0.88	107		-0.60	164		-0.77
6056		-----		-----	-----		-----	-----		-----
6134	D86-automated	39.2		1.00	108.0		0.08	164.0		-0.77
6185		40.9		2.01	108.2		0.22	165.7		-0.10
6198		-----		-----	-----		-----	-----		-----
6200		-----		-----	-----		-----	-----		-----
6229		-----		-----	-----		-----	-----		-----
6299		-----		-----	-----		-----	-----		-----
6344	ISO3405-automated	37.5		-0.01	107.1		-0.53	164.7		-0.49
6438	D86-automated	39.0		0.88	108.4		0.35	169.5		1.40
6444		-----		-----	-----		-----	-----		-----
6447		-----		-----	-----		-----	-----		-----
9061		-----		-----	-----		-----	-----		-----

	normality	OK	OK	OK
	n	67	66	66
	outliers	0	1	1
	mean (n)	37.52	107.88	165.95
	st.dev. (n)	1.667	0.522	2.222
	R(calc.)	4.67	1.46	6.22
	st.dev.(D86-A:20b)	1.679	1.471	2.536
	R(D86-A:20b)	4.7	4.12	7.1
Compare				
	R(D86-M:20b)	5.6	4.23	7.2

Lab 1656 first reported 170.4

Initial Boiling Point — Kernel Density

50% recovered — Kernel Density

Final Boiling Point — Kernel Density

Determination of Mercaptan Sulfur as S on sample #22045; results in mg/kg

lab	method	value	mark	z(targ)	remarks
140	UOP163	76		0.75	
150		-----		-----	
158		-----		-----	
171	D3227	72		-1.05	
225		-----		-----	
237		-----		-----	
238		-----		-----	
311	UOP163	68.7		-2.54	
323	UOP163	74.8		0.21	
328		-----		-----	
333	D3227	68		-2.85	
334	D3227	69		-2.40	
337		-----		-----	
349		-----		-----	
360	D3227	73.7		-0.29	
399	D3227	74.91		0.26	
444		-----		-----	
445		-----		-----	
492		-----		-----	
495		-----		-----	
541		-----		-----	
608		-----		-----	
657	UOP163	73		-0.60	
663		-----		-----	
750	UOP163	75.25		0.41	
753	UOP163	76		0.75	
754	UOP163	73		-0.60	
779	UOP163	74		-0.15	
781	D3227	75		0.30	
785	UOP163	75.5		0.52	
798	UOP163	71.673		-1.20	
824	D3227	71		-1.50	
855		-----		-----	
862		-----		-----	
864		-----		-----	
868	D3227	78.0		1.65	
872		-----		-----	
873	D3227	77		1.20	
874	UOP163	75		0.30	
875	UOP163	70		-1.95	
912	D3227	80		2.55	
914		-----		-----	
922	D3227	78		1.65	
962		-----		-----	
963	D3227	71.6		-1.23	
971	D3227	77		1.20	
974	D3227	75		0.30	
982		-----		-----	
994	D3227	76.0		0.75	
1012		-----		-----	
1016	UOP163	76.5		0.97	
1039	UOP163	75		0.30	
1062		-----		-----	
1065	D3227	73		-0.60	
1066	UOP163	75		0.30	
1081		-----		-----	
1097	ISO3012	73.6		-0.33	
1108	D3227	75.5		0.52	
1145		-----		-----	
1191	UOP163	70		-1.95	
1284	D3227	73		-0.60	
1362	UOP163	76.1		0.79	
1381	UOP163	74.13		-0.09	
1397		-----		-----	
1585	UOP163	74.88		0.25	
1586	D3227	60	C,R(0.01)	-6.45	Reported 0.0060 mg/kg
1603	In house	78		1.65	
1656		-----		-----	
1669	UOP163	86.7	C,R(0.01)	5.56	First reported 14.7
1737		-----		-----	
1741	UOP163	72		-1.05	
1788		-----		-----	
1823	D3227	75.6		0.57	
1849		-----		-----	
1857	UOP163	78.7		1.96	

lab	method	value	mark	z(targ)	remarks
1862		-----		-----	
1950	D3227	76		0.75	
1960		-----		-----	
1995	UOP163	74.5		0.07	
6056		-----		-----	
6134		-----		-----	
6185		-----		-----	
6198		-----		-----	
6200		-----		-----	
6229		-----		-----	
6299		-----		-----	
6344		-----		-----	
6438	D3227	74.4		0.03	
6444		-----		-----	
6447		-----		-----	
9061		-----		-----	

normality	OK
n	45
outliers	2
mean (n)	74.334
st.dev. (n)	2.6779
R(calc.)	7.498
st.dev.(D3227:16)	2.2222
R(D3227:16)	6.222
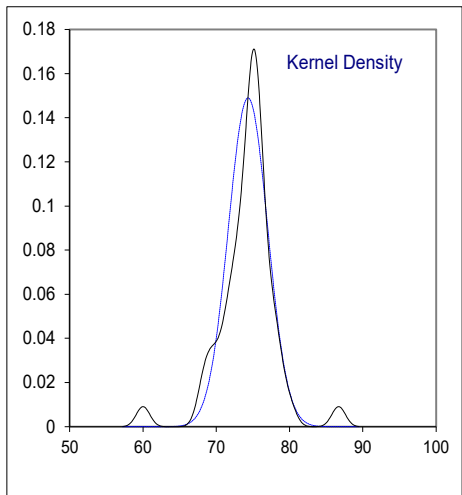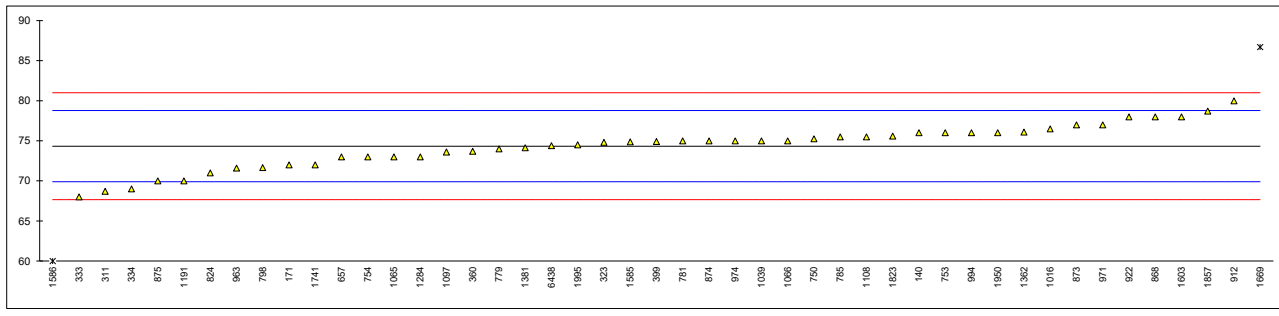
Determination of Sulfur on sample #22045; results in mg/kg

lab	method	value	mark	z(targ)	remarks
140		-----		-----	
150	D2622	<3.0		<-10.39	Possibly a false negative test result?
158	D2622	243		-0.64	
171	D4294	244		-0.60	
225		-----		-----	
237	D4294	239		-0.80	
238		-----		-----	
311		-----		-----	
323	D5453	247		-0.48	
328	ISO20847	264		0.21	
333	D5453	295	C	1.47	First reported 341
334	D4294	>100		-----	
337	D5453	256		-0.11	
349		-----		-----	
360	D5453	257.2		-0.06	
399	D4294	253		-0.24	
444	D5453	275.60		0.68	
445		-----		-----	
492		-----		-----	
495		-----		-----	
541	D4294	172	R(0.01)	-3.53	
608	D5453	242.44		-0.66	
657	D4294	260		0.05	
663	D5453	247.8		-0.45	
750		-----		-----	
753	D4294	269		0.41	
754	D4294	271.5		0.52	
779	D4294	260		0.05	
781	D4294	270.5		0.48	
785	D4294	271		0.50	
798	D4294	258		-0.03	
824	D5453	247		-0.48	
855		-----		-----	
862		-----		-----	
864		-----		-----	
868	D5453	270		0.46	
872	D4294	265		0.25	
873	D4294	253		-0.24	
874	D4294	247		-0.48	
875	D4294	266		0.29	
912	D5453	255		-0.15	
914		-----		-----	
922	D4294	267		0.33	
962		-----		-----	
963	D4294	255	C	-0.15	First reported 300
971	D5453	260		0.05	
974	D4294	250		-0.36	
982		-----		-----	
994	D4294	249		-0.40	
1012		-----		-----	
1016	D2622	276.4		0.72	
1039	D2622	271		0.50	
1062	D4294	244		-0.60	
1065	D4294	250		-0.36	
1066	D2622	266		0.29	
1081		-----		-----	
1097	D5453	250.68		-0.33	
1108	D5453	496	R(0.01)	9.64	
1145	D5453	263.71		0.20	
1191	ISO8754	255.9		-0.12	
1284	D2622	261		0.09	
1362	D4294	300		1.67	
1381	ISO8754	249.15		-0.39	
1397		-----		-----	
1585	D4294	247.5		-0.46	
1586	D4294	264		0.21	
1603	In house	275		0.66	
1656	IP336	255		-0.15	
1669	D4294	258.1		-0.03	
1737		-----		-----	
1741	D5453	245.7		-0.53	
1788	D5453	278.37		0.80	
1823	D4294	244.2		-0.59	
1849		-----		-----	
1857	D4294	255.0		-0.15	

lab	method	value	mark	z(targ)	remarks
1862		-----		-----	
1950	D4294	252		-0.28	
1960	D5453	247.173		-0.47	
1995	D4294	229		-1.21	
6056		-----		-----	
6134	D5453	252.52	C	-0.25	First reported 170.1
6185		298.0		1.59	
6198		-----		-----	
6200		-----		-----	
6229		-----		-----	
6299	D5453	266		0.29	
6344		-----		-----	
6438	D4294	242		-0.68	
6444	D5453	263.28		0.18	
6447		-----		-----	
9061		-----		-----	

normality	Suspect
n	59
outliers	2
mean (n)	258.792
st.dev. (n)	13.9708
R(calc.)	39.118
st.dev.(D4294:21)	24.6107
R(D4294:21)	68.910
Compare	
R(D2622:21)	36.704
R(D5453:19a)	37.404
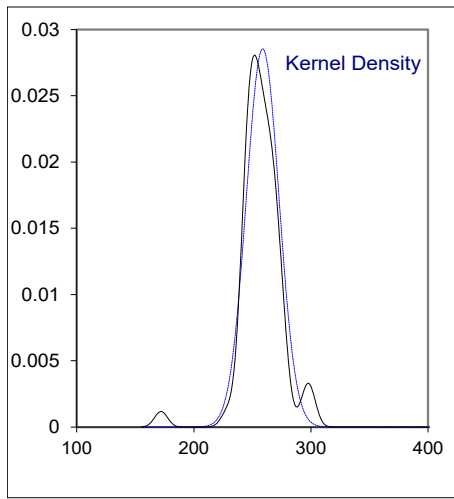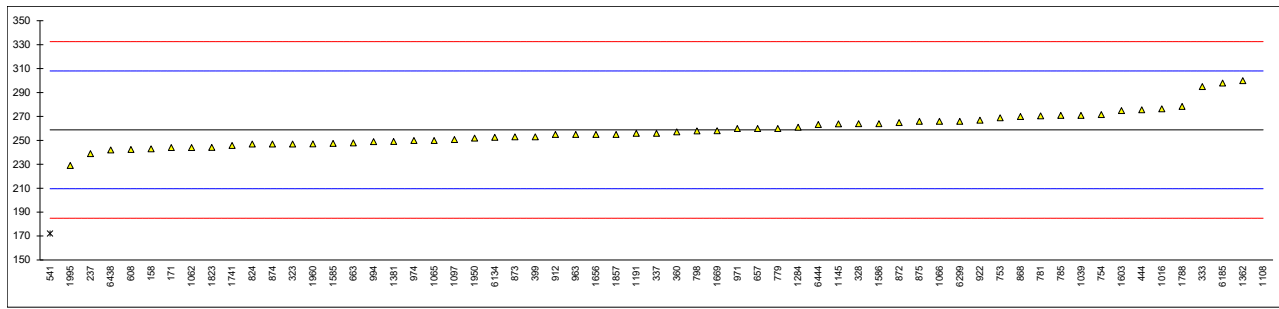
## Determination of Mercury as Hg on sample #22046 and #22047; results in µg/kg

lab	method	#22046	mark	z(targ)	#22047	mark	z(targ)	remarks
140		-----		-----	-----		-----	
171	UOP938	51.2		-0.19	108		-1.51	
311	UOP938	45		-0.65	161		0.08	
323	UOP938	63		0.70	138		-0.61	
333	INH-09003	53		-0.05	158		-0.01	
334	INH-09003	40		-1.03	100		-1.74	
349	UOP938	98	R(0.01)	3.32	238	R(0.05)	2.38	
444	UOP938	53.89		0.02	154.53		-0.11	
541		-----		-----	-----		-----	
657	UOP938	45.062		-0.65	166.347		0.24	
663		-----		-----	-----		-----	
750	UOP938	43.900		-0.73	145.78		-0.37	
754	UOP938	60.598		0.52	170.877		0.38	
781	D7622	45.19		-0.64	146.11		-0.37	
798		-----		-----	-----		-----	
824	UOP938	57.45		0.28	160.82		0.07	
855		-----		-----	-----		-----	
862		-----		-----	-----		-----	
868	UOP938	46.4		-0.55	126.9		-0.94	
873	UOP938	60		0.47	165		0.20	
874		-----		-----	-----		-----	
912		-----		-----	-----		-----	
922	UOP938	52		-0.13	173		0.44	
963	UOP938	50.4		-0.25	-----			
974	UOP938	61.7		0.60	183.7		0.76	
1016	UOP938	43.96		-0.73	172.45		0.42	
1039	UOP938	43		-0.80	150		-0.25	
1062	UOP938	50		-0.28	156		-0.07	
1066	UOP938	66		0.92	183		0.74	
1081	In house	186	R(0.01)	9.92	-----		-----	
1088	D6350	51.07		-0.20	156.62		-0.05	
1397	In house	72.05		1.38	175.47		0.51	
1586	UOP938	68		1.07	180		0.65	
1603	UOP938	54.7		0.08	163.4		0.15	
1635	In house	60.69		0.53	159.5		0.04	
1656	UOP938	58		0.32	165		0.20	
1669	UOP938	56.01	C	0.18	151.13		-0.21	first reported 158.095
1857	UOP938	64.56		0.82	173.5		0.45	
1950	UOP938	51.9		-0.13	150.4		-0.24	
1960	UOP938	51.305		-0.18	148.519		-0.29	
1995	UOP938	56		0.17	175.5		0.51	
6185	In house	45.5		-0.61	212		1.61	
6200	UOP938	51.664		-0.15	163.783		0.16	
6447	UOP938	40		-1.03	133		-0.76	
9054	UOP938	62.625		0.67	152.7		-0.17	
9061		56.5		0.21	161		0.08	
	normality	OK			not OK			
	n	36			35			
	outliers	2			1			
	mean (n)	53.676			158.315			
	st.dev. (n)	8.1188			20.8944			
	R(calc.)	22.733			58.504			
	st.dev.(Horwitz)	13.3378			33.4293			
	R(Horwitz)	37.346			93.602			
Compare								
	R(UOP938:20)	7.010			20.677			
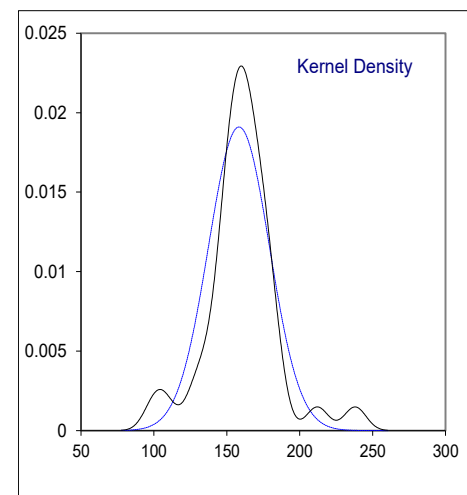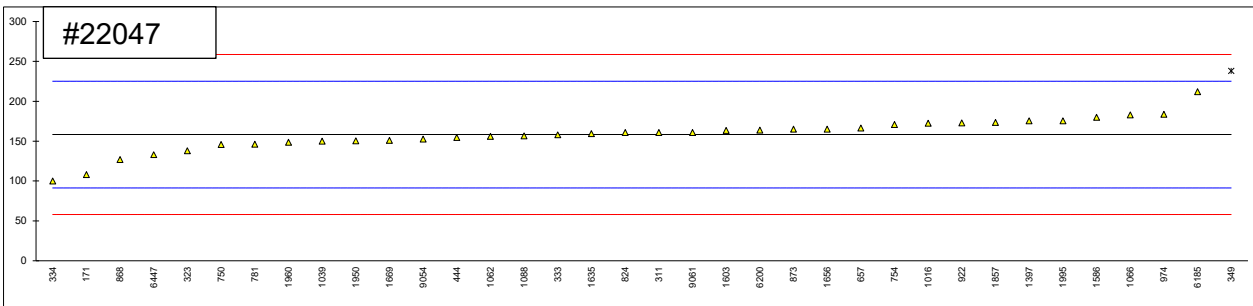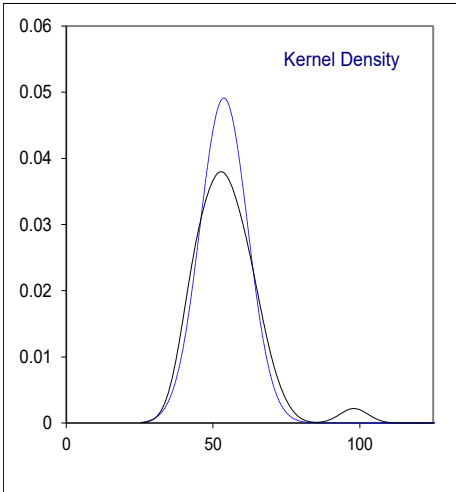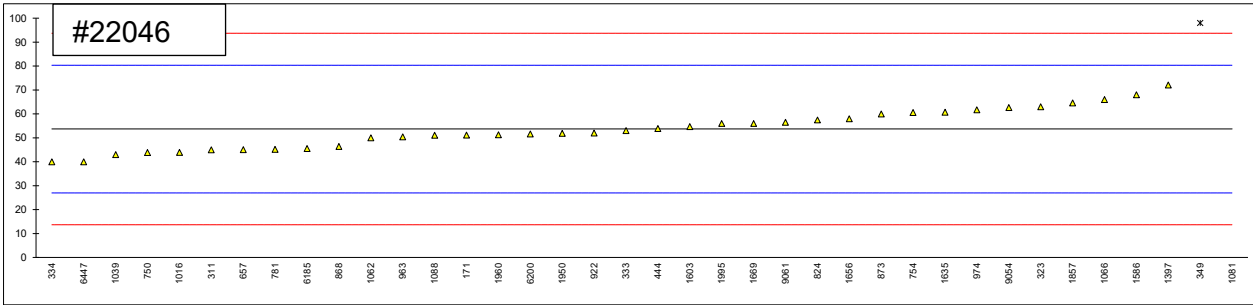
Determination of Arsenic as As on sample #22048 and #22049; results in µg/kg

| lab	method	#22048	mark	z(targ)	#22049	mark	z(targ)	remarks	bottle rinsed *)
140		-----		-----	-----		-----		---
150		-----		-----	-----		-----		---
171	D8110	<5		-----	<5		-----		---
237		-----		-----	-----		-----		---
311	INH-006	55		-----	45		-----		---
323	In house	60		-----	71		-----		---
349	IFP9312	13.60	C	-----	14.00	C	-----	First reported 8.65, 10.86	---
360		-----		-----	-----		-----		---
444		-----		-----	-----		-----		---
445		-----		-----	-----		-----		---
657		-----		-----	-----		-----		---
750	UOP946	5.25		-----	10.04		-----		No
781	UOP946	25.0		-----	34.4		-----		Yes
824		-----		-----	-----		-----		---
855		-----		-----	-----		-----		---
862		-----		-----	-----		-----		---
864		-----		-----	-----		-----		---
868		-----		-----	-----		-----		---
874	UOP946	46.0		-----	64.0		-----		Yes
912		-----		-----	-----		-----		---
963		-----		-----	-----		-----		---
971	UOP946	28		-----	5	C	-----	First reported <5	No
1016		-----		-----	-----		-----		---
1066		-----	W	-----	-----	W	-----	Reported for both <5	---
1081	In house	7		-----	-----		-----		No
1603		-----		-----	-----		-----		---
1669	UOP296	5.39	C	-----	3.76		-----	First reported <20	No
1857	UOP946	42.7		-----	50.8		-----		Yes
1950		-----		-----	-----		-----		---
1995		-----		-----	-----		-----		---
6134	In house	10.67	C	-----	0.95	C	-----	Fr. 7.455, 2.525	No
6447		-----		-----	-----		-----		

|			
normality	OK	OK	
n	11	10	
outliers	0	0	
mean (n)	27.146	29.895	
st.dev. (n)	20.6677	26.5115	
R(calc.)	57.870	74.232	
st.dev.(Horwitz)	(7.4745)	(8.1127)	
R(Horwitz)	(20.929)	(22.715)	

*) Rinsed with strong acid
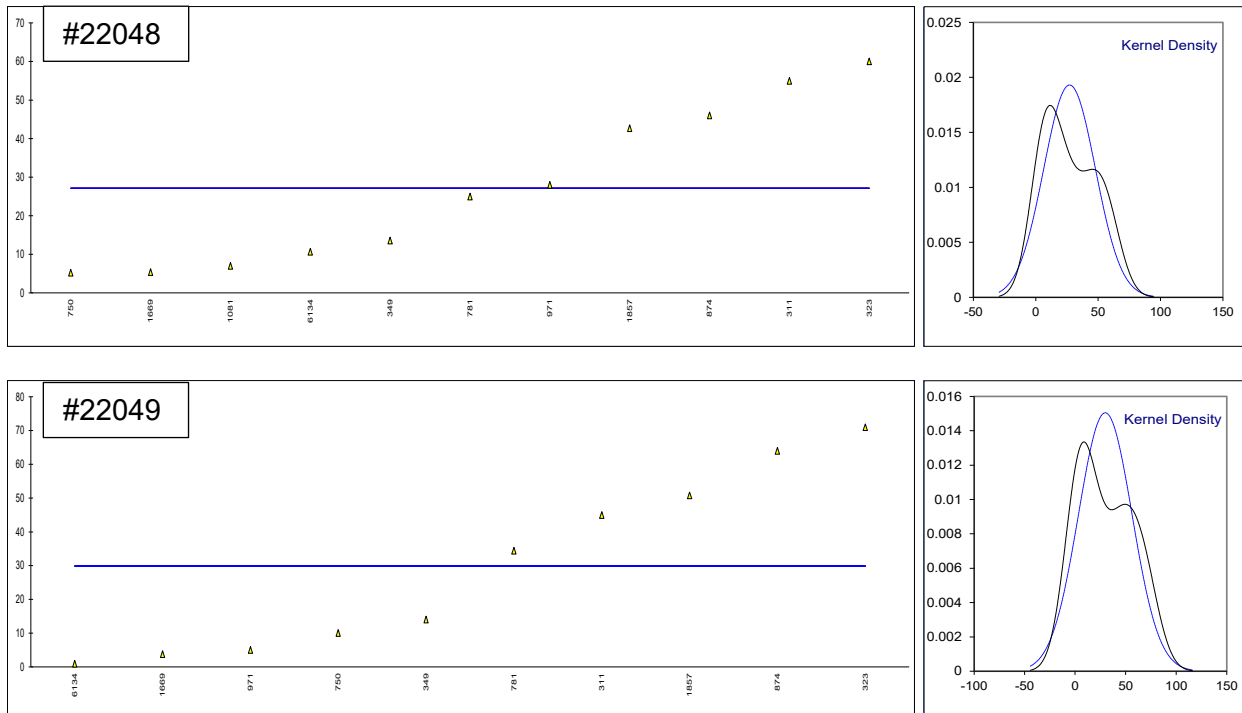
Determination of Lead as Pb on sample #22048 and #22049; results in µg/kg

lab	method	#22048	mark	z(targ)	#22049	mark	z(targ)	remarks
140		-----		-----	-----		-----	
150		-----		-----	-----		-----	
171	D8110	34		-0.46	48		0.61	
237		-----		-----	-----		-----	
311	UOP952	40		0.14	40		-0.14	
323	In house	61		2.22	92	D(0.05)	4.72	
349	UOP952	43		0.44	40		-0.14	
360	INH-06-15	45.66		0.70	56.90		1.44	
444		-----		-----	-----		-----	
445		-----		-----	-----		-----	
657		-----		-----	-----		-----	
750	UOP952	34.74		-0.38	40.60		-0.08	
781	UOP952	32.4		-0.62	30.2		-1.05	
824	UOP952	36.80	C	-0.18	45.75	C	0.40	First reported 67.55,16.57
855		-----		-----	-----		-----	
862		-----		-----	-----		-----	
864		-----		-----	-----		-----	
868	UOP952	50.1		1.14	62.0		1.92	
874		-----		-----	-----		-----	
912		-----		-----	-----		-----	
963		-----		-----	-----		-----	
971	UOP952	32		-0.65	32		-0.88	
1016	UOP952	37.19		-0.14	41.63		0.02	
1066	In house	44		0.54	30		-1.07	
1081	In house	85	D(0.05)	4.60	-----		-----	
1603		-----		-----	-----		-----	
1669	UOP952	0.67	C,D(0.05)	-3.76	0.39	D(0.05)	-3.83	First reported <20
1857	UOP952	41.3		0.27	53.1		1.09	
1950	UOP952	43.9		0.53	56.0		1.36	
1995		-----		-----	-----		-----	
6134	In house	16.52	C	-2.19	8.61	C	-3.07	First reported 11.17, 15.9
6447	In house	25		-1.35	37		-0.42	

	normality	suspect		suspect		
	n	16		15		
	outliers	2		2		
	mean (n)	38.601		41.453		
	st.dev. (n)	10.2160		13.4165		
	R(calc.)	28.605		37.566		
	st.dev.(Horwitz)	10.0798		10.7091		
	R(Horwitz)	28.224		29.985		
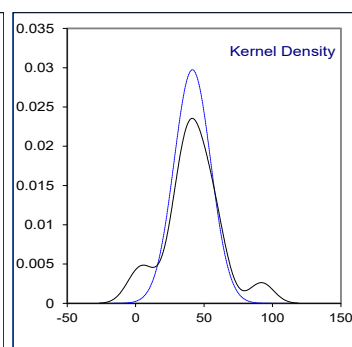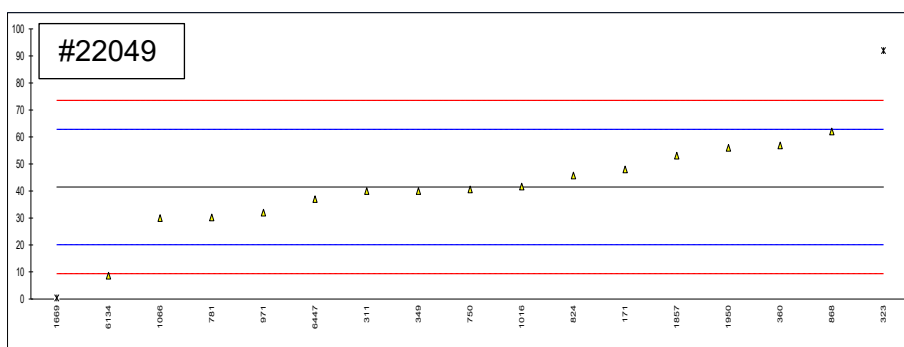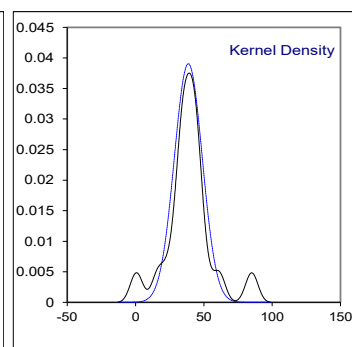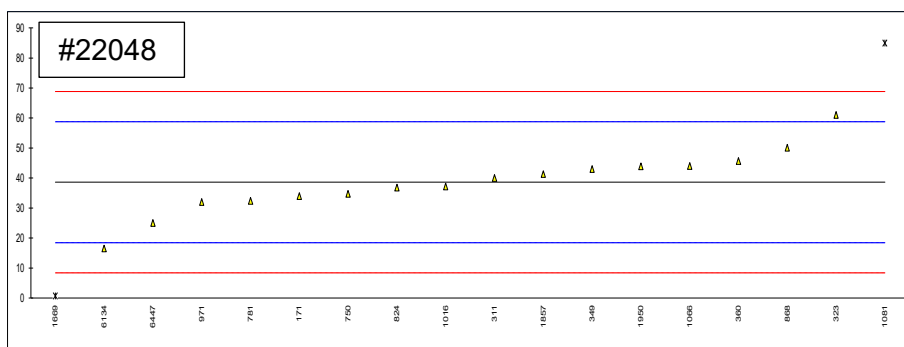
Determination of Total Vapor Pressure on sample #22050; results in psi

lab	method	value	mark	z(targ)	remarks
140	D5191	6.90		-2.04	
150	D5191	7.15		1.00	
158	D5191	7.09		0.27	
171	D5191	7.12		0.64	
237	D5191	7.11		0.52	
238		-----		-----	
323	D5191	7.22		1.86	
328	D5191	7.25		2.22	
334	EN13016-1	7.18		1.37	
360	D5191	7.11		0.52	
399		-----		-----	
445		-----		-----	
495		-----		-----	
541		-----		-----	
608	D5191	6.96		-1.31	
657	D5191	7.09		0.27	
750	EN13016-1	7.034		-0.41	
753	D5191	7.06		-0.09	
754	D5191	7.077		0.11	
779	D5191	7.07		0.03	
785	D5191	7.0198		-0.58	
798		-----		-----	
824	D5191	7.09		0.27	
855		-----		-----	
862		-----		-----	
864		-----		-----	
868	D5191	7.041		-0.32	
873	D5191	7.08		0.15	
874	D5191	7.12		0.64	
875	D5191	7.063		-0.06	
963		-----		-----	
971	D5191	7.04		-0.34	
974	D5191	7.05		-0.21	
1016		-----		-----	
1066	D5191	7.08		0.15	
1081		-----		-----	
1191	EN13016-1	7.02		-0.58	
1381	EN13016-1	7.125		0.70	
1429		-----		-----	
1585	D5191	6.950		-1.43	
1669		-----	W	-----	Test result withdrawn, reported 6.7958
1788	D5191	7.06		-0.09	
1857	D5191	7.016		-0.63	
1862		-----		-----	
1950	D5191	6.96		-1.31	
6185		-----		-----	
6200		-----		-----	
6229		-----		-----	
6299	EN13016-1	6.96		-1.31	
9054		-----		-----	
9061		-----		-----	

normality	OK	
n	31	
outliers	0	
mean (n)	7.068	
st.dev. (n)	0.0768	
R(calc.)	0.215	
st.dev.(D5191:20)	0.0821	
R(D5191:20)	0.23	

Kernel Density
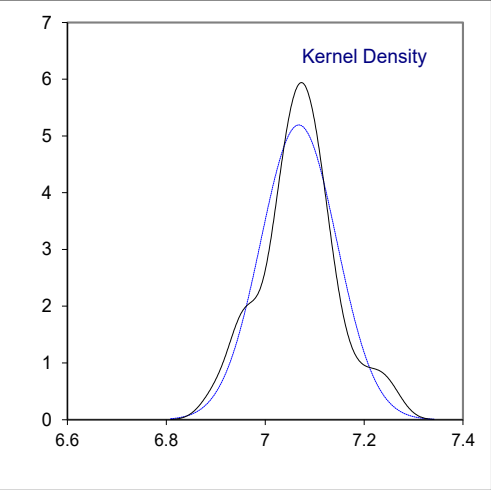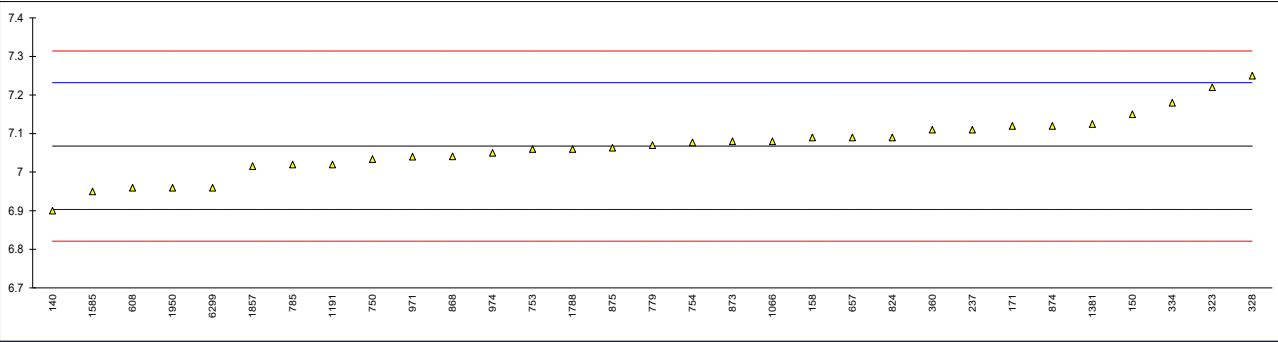
Determination of DVPE acc. to D5191 on sample #22050; results in psi

lab	method	value	mark	z(targ)	remarks
140		-----		-----	
150	D5191	6.35		0.91	
158		-----		-----	
171		-----		-----	
237	D5191	6.31		0.43	
238	D5191	6.10		-2.13	
323	D5191	6.43		1.89	
328	D5191	6.45		2.13	
334	EN13016-1	6.38		1.28	
360	D5191	6.31		0.43	
399	D5191	6.25		-0.30	
445		-----		-----	
495	EN13016-1	6.34		0.79	
541	D5191	6.08		-2.37	
608	D5191	6.17		-1.28	
657	D5191	6.29		0.18	
750	EN13016-1	6.237		-0.46	
753	D5191	6.27		-0.06	
754	D5191	6.28		0.06	
779	D5191	6.28		0.06	
785	D5191	6.2261		-0.60	
798	D5191	6.25		-0.30	
824	D5191	6.30		0.30	
855		-----		-----	
862		-----		-----	
864		-----		-----	
868	D5191	6.244		-0.38	
873	D5191	6.29		0.18	
874	D5191	6.32		0.55	
875	D5191	6.266		-0.11	
963	D5191	6.3		0.30	
971	D5191	6.25		-0.30	
974	D5191	6.25		-0.30	
1016	D5191	6.37		1.16	
1066	D5191	6.28		0.06	
1081	D5191	6.29		0.18	
1191	EN13016-1	6.24		-0.43	
1381	EN13016-1	6.327		0.63	
1429	D5191	6.31		0.43	
1585	D5191	6.160		-1.40	
1669		-----	W	-----	Test result withdrawn, reported 6.0099
1788	D5191	6.27		-0.06	
1857	D5191	6.222		-0.64	
1862		-----		-----	
1950	D5191	6.17		-1.28	
6185	D5191	6.17		-1.28	
6200	D5191	6.352		0.94	
6229		-----		-----	
6299	EN13016-1	6.16		-1.40	
9054	D5191	6.40		1.52	
9061	D5191	6.33		0.67	

normality	OK	
n	41	
outliers	0	
mean (n)	6.275	
st.dev. (n)	0.0805	
R(calc.)	0.225	
st.dev.(D5191:20)	0.0821	
R(D5191:20)	0.23	
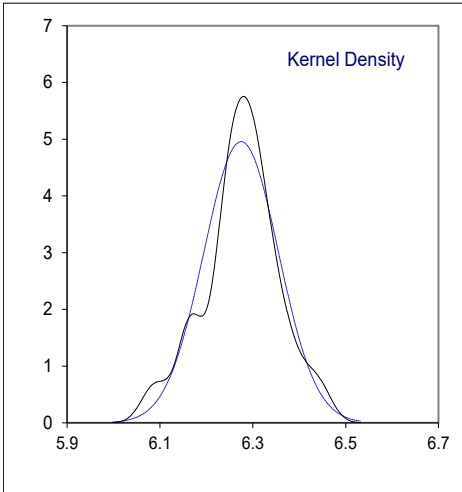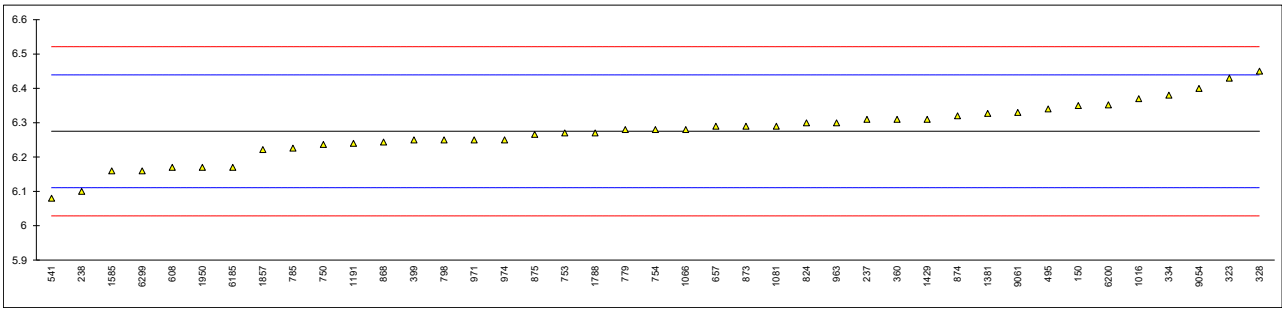
APPENDIX 2

Number of participants per country

1 lab in ARGENTINA
2 labs in AUSTRALIA
1 lab in AZERBAIJAN
2 labs in BELGIUM
1 lab in BULGARIA
6 labs in CHINA, People's Republic
1 lab in COTE D'IVOIRE
2 labs in CROATIA
1 lab in EGYPT
1 lab in ESTONIA
1 lab in FINLAND
7 labs in FRANCE
3 labs in GERMANY
1 lab in GREECE
3 labs in INDIA
1 lab in IRAN, Islamic Republic of
1 lab in ISRAEL
2 labs in ITALY
1 lab in KOREA, Republic of
1 lab in MALAYSIA
1 lab in MALTA
7 labs in THE NETHERLANDS
3 labs in NIGERIA
2 labs in NORWAY
1 lab in PAKISTAN
1 lab in PORTUGAL
1 lab in QATAR
16 labs in RUSSIAN FEDERATION
3 labs in SAUDI ARABIA
1 lab in SERBIA
1 lab in SINGAPORE
1 lab in SLOVAKIA
3 labs in SPAIN
2 labs in THAILAND
1 lab in TURKEY
2 labs in UNITED ARAB EMIRATES
6 labs in UNITED KINGDOM
4 labs in UNITED STATES OF AMERICA

APPENDIX 3

Abbreviations

C	= final test result after checking of first reported suspect test result
D(0.01)	= outlier in Dixon's outlier test
D(0.05)	= straggler in Dixon's outlier test
G(0.01)	= outlier in Grubbs' outlier test
G(0.05)	= straggler in Grubbs' outlier test
DG(0.01)	= outlier in Double Grubbs' outlier test
DG(0.05)	= straggler in Double Grubbs' outlier test
R(0.01)	= outlier in Rosner's outlier test
R(0.05)	= straggler in Rosner's outlier test
E	= calculation difference between reported test result and result calculated by iis
W	= test result withdrawn on request of participant
ex	= test result excluded from statistical evaluation
n.a.	= not applicable
n.e.	= not evaluated
n.d.	= not detected
fr.	= first reported
SDS	= Safety Data Sheet

Literature

1. iis Interlaboratory Studies, Protocol for the Organisation, Statistics & Evaluation, June 2018
2. ISO5725:86
3. ISO5725 parts 1-6:94
4. ISO13528:05
5. M. Thompson and R. Wood, J. AOAC Int, 76, 926, (1993)
6. W.J. Youden and E.H. Steiner, Statistical Manual of the AOAC, (1975)
7. P.L. Davies, Fr. Z. Anal. Chem, 331, 513, (1988)
8. J.N. Miller, Analyst, 118, 455, (1993)
9. Analytical Methods Committee, Technical Brief, No 4, January 2001
10. P.J. Lowthian and M. Thompson, The Royal Society of Chemistry, Analyst, 127, 1359-1364, (2002)
11. W. Horwitz and R. Albert, J. AOAC Int, 79.3, 589-621, (1996)
12. Bernard Rosner, Percentage Points for a Generalized ESD Many-Outlier Procedure, Technometrics, 25(2), 165-172, (1983)