Results of Proficiency Test
Gas Condensate
November 2010

CONTENTS

Appendices:

1   INTRODUCTION

Since 2008, the Institute for Interlaboratory Studies organizes a proficiency test for Gas Condensate every year. During the annual proficiency testing program 2010/2011, it was decided to continue the round robin for the analysis of Gas Condensate. In this Interlaboratory study, 56 laboratories from 19 different countries have participated. See appendix 3 for the number of participating laboratories per country. In this report, the results of the Gas Condensate proficiency test are presented and discussed.

2   SET UP

The Institute for Interlaboratory Studies (i.i.s.) in Spijkenisse, the Netherlands, was the organiser of this proficiency test. Sample analyses for fit-for-use and homogeneity testing were subcontracted to an accredited laboratory. It was decided to send 2 samples of condensate (1* 0.5 L bottle labelled #1081 and 1* 0.25 L bottle labelled #1082, especially for DVPE purpose). Participants were requested to report rounded and unrounded results. The unrounded results were preferably used for statistical evaluation.

2.1   QUALITY SYSTEM

The Institute for Interlaboratory Studies in Spijkenisse, the Netherlands, has implemented a quality system based on ISO guide 43, ILAC-G13:2007 and ISO17043:2010. This ensures 100% confidentiality of participant's data. In addition, customer's satisfaction is measured on a regular basis by sending out questionnaires.

2.2   PROTOCOL

The protocol followed in the organisation of this proficiency test was the one as described for proficiency testing in the report 'i.i.s. Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of January 2010 (iis-protocol, version 3.2).

2.3   CONFIDENTIALITY STATEMENT

All data present 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

The necessary bulk material for the samples #1081 and #1082 was obtained from a local refinery in the Netherlands. The bulk material was split for preparation for both samples. After homogenisation, the Gas Condensate was transferred to 90 amber glass bottles of 0.5 litre and to 90 amber glass bottles of 0.25 litre that were labelled #1081 and #1082 respectively.

The homogeneity of the subsamples #1081 was checked by determination of Density @ 15°C in accordance with ASTM D4052:02e1 on 6 stratified randomly selected samples. The homogeneity of the subsamples #1082 was checked by determination of DVPE in accordance with ASTM D5191:10 on 5 stratified randomly selected samples. The homogeneity testing was performed by a subcontracted ISO17025 accredited laboratory.

	Density @ 15 °C in kg/L (#1081)		DVPE in psi (#1082)
Sample #1081-1	0.74345	Sample #1082-1	9.56
Sample #1081-2	0.74352	Sample #1082-2	9.59
Sample #1081-3	0.74351	Sample #1082-3	9.59
Sample #1081-4	0.74352	Sample #1082-4	9.51
Sample #1081-5	0.74351	Sample #1082-5	9.50
Sample #1081-6	0.74342	-----------------	------

Table 1: homogeneity test of subsamples #1081 and subsamples #1082

From the above test results, the repeatabilities were calculated and compared with 0.3 times the corresponding target reproducibility in agreement with the procedure of ISO 13528, Annex B2 in the next table:

	Density @ 15 ^{o}C in kg/L (#1081)	DVPE in psi (#1082)
r sample	0.00012	0.1134
reference method	ASTM D4052:02e1	ASTM D5191:10
0.3xR(reference method)	0.00015	0.1197

Table 2: repeatability of subsamples #1081 and #1082

Each of the calculated repeatabilities was less than 0.3 times the reproducibility of the respective reference method. Therefore, homogeneity of the subsamples #1081 and subsamples #1082 was assumed.

To each of the participating laboratories 1 * 0.5 L bottle (labelled #1081) and 1 * 0.25 L bottle (labelled #1082) were sent on October 13, 2010.

2.5 STABILITY OF THE SAMPLES

The stability of Gas Condensate, packed in the brown glass bottles, was checked.
The material was found sufficiently stable for the period of the proficiency test.

2.6 ANALYSES

The participants were requested to determine on sample #1081: Density @ 15°C, total Sulphur, Distillation (IBP, 10%, 50%, 90% evaporated and FBP), Colour Saybolt, Water by KF and Mercury. Sample #1082 was for Total Vapour Pressure and DVPE only.

To get maximum information for the statistical calculations, the participants were requested to report unrounded results and results below the usual lower reporting limits, where possible. To get comparable results a detailed report form, on which the units were prescribed as well as some of the required standards, was sent together with each set of samples. In addition, a letter of instructions and a SDS were added to the package.

3 RESULTS

During four weeks after sample despatch, the results of the individual laboratories were gathered. The original data are tabulated per determination in appendix 1 of this report. The laboratories are presented by their code numbers.

Directly after the deadline, a reminder fax was sent to the laboratories that had not reported results at that moment. Shortly after the deadline, the available results were screened for suspect data. A 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 results. Additional or corrected results are used for data analysis and original results are placed under 'Remarks' in the result tables in appendix 1.

3.1 STATISTICS

Statistical calculations were performed as described in the report 'iis Interlaboratory Studies: Protocol for the Organisation, Statistics and Evaluation' of January 2010 (iis-protocol, version 3.2).
For the statistical evaluation the *unrounded* (when available) figures were used instead of the rounded results. 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. After removal of outliers, this check was repeated. Not all data sets proved to have a normal distribution, in which cases the statistical evaluation of the results should be used with due care.

In accordance to ISO 5725 (1986 and 1994) the original results per determination were submitted subsequently to Dixon and Grubbs outlier tests. Outliers are marked by D(0.01) for the Dixon test, by G(0.01) or DG(0.01) for the Grubbs test. Stragglers are marked by D(0.05) for the Dixon test, by G(0.05) or DG(0.05) for the Grubbs test. Both outliers and stragglers were not included in the calculations of averages and standard deviations.
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 analysis results are plotted. The corresponding laboratory numbers are under 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 standard. 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 (see appendix 4; nr.12 and 13)

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, e.g. ASTM reproducibilities, the z-scores were calculated using a target standard deviation. The target standard deviation was calculated from the literature reproducibility by division with 2.8. The z-scores were calculated in accordance with:

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

The $z_{(target)}$ scores are listed in the 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:

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

4 EVALUATION

In this proficiency test, some problems were encountered during the transport of the samples to the laboratories in Australia, Malaysia, Mozambique, Nigeria, Norway, Philippines, Poland, U.S.A, U.A.E, UK and Vietnam. The samples took an unexpected long time to reach a number of laboratories due to problems with custom clearance.
Only 25 (!) participants reported results. The 25 reporting laboratories did send in 215 numerical results. Observed were 25 outlying results, which is 11.6%. In proficiency studies outlier percentages of 3% - 7.5% are quite normal.

4.1   EVALUATION PER TEST

In this section, the results are discussed per test. All data sets proved to have a normal distribution, except for the determination of Colour Saybolt. In this case the statistical evaluation should be used with care.

Density @ 15°C: This determination was problematic. Five statistical outliers were observed. Also the calculated reproducibility, after rejection of the statistical outliers, is not in agreement with the requirements of ASTM D4052:02e1.
The reproducibility requirement, mentioned in the latest version ASTM D4052:09 is surprisingly large and consequently very easy to meet.

Sulphur: This determination was problematic for a number of laboratories. Four statistical outliers were observed. However, the calculated reproducibility is, after rejection of the statistical outliers, is in agreement with the requirements of ASTM D5453:09.

Distillation: This determination was problematic. Eight statistical outliers were observed. Four of the five reported test results of laboratory 1160 appeared to be statistical outliers. As the five test results are not independent, it was decided not to use also the test results for 10% evaporated for the statistical evaluation.
After rejection of the statistical outliers, none of the calculated reproducibilities is in agreement with the requirements for manual mode or automated mode of ASTM D86:10a, except for 50% evaporated for manual mode.

Saybolt Color: This determination was very problematic. No statistical outliers were observed. However, the calculated reproducibility is not at all in agreement with the requirements of ASTM D156:07a.

Water: This determination was problematic. Three statistical outliers were observed and the calculated reproducibility is not in agreement with the requirements of ASTM D4928:10.

Mercury: Regretfully, there are no precision requirements in UOP938 available for evaluation. Therefore, the Horwitz equation was used. This determination was problematic at this concentration level (149 µg/kg). One statistical outlier was observed. The calculated reproducibility, after rejection of the statistical outlier, is not in agreement with the strict estimated reproducibility calculated using the Horwitz equation. The low number of test results may (partly) explain the large spread.

TVP & DVPE: This determination was problematic. Two statistical outliers were observed and one participating laboratory probably made a calculation error. The calculated reproducibility is after rejection of the statistical outliers not in agreement with the requirements of ASTM D5191:07.

4.2   PERFORMANCE EVALUATION FOR THE GROUP OF LABORATORIES

A comparison has been made between the reproducibility as declared by the relevant standard and the reproducibility as found for the group of participating laboratories. The average results of sample #1081 and #1082, calculated reproducibilities and reproducibilities, derived from literature standards (in casu ASTM standards) are compared in the next table.

Parameter	unit	n	mean	2.8 * sd	R (lit)
Density @ 15 ^{o}C	kg/m^3	18	743.51	0.67	0.50 (2.12)
Sulphur	mg/kg	10	11.61	3.56	3.65
Initial Boiling Point	°C	14	33.23	8.71	5.02(A)–5.60(M)
10%-evaporated	°C	15	63.03	11.55	3.20(A)–4.94(M)
50%-evaporated	°C	14	117.75	5.58	1.88(A)–5.67(M)
90%-evaporated	°C	13	231.85	25.22	5.54(A)–7.06(M)
Final Boiling Point	°C	14	297.57	11.35	6.78(A)–7.20(M)
Saybolt Color		14	20.9	6.1	2.0
Water content by KF	mg/kg	18	50.76	47.24	31.01
Mercury as Hg	µg/kg	5	149.5	104.2	76.9
Total vapour pressure	psi	13	10.44	0.61	0.40
DVPE acc. to ASTM D5191	psi	12	9.49	0.63	0.40

Table 3: performance evaluation sample #1081 and #1082

Without further statistical calculations it can be concluded from the overview given in table 3 that for several tests there is not a good compliance of the group of participants with the relevant standards. The problematic tests have been discussed in paragraph 4.1.

4.3   COMPARISON OF THE PROFICIENCY TEST OF NOVEMBER 2010 WITH THE PREVIOUS PTS

	November 2010	November 2009	November 2008
Number of reporting participants	25	32	17
Number of results reported	215	167	121
Number of statistical outliers	25	13	7
Percentage of statistical outliers	11.6%	7.8%	5.8%

Table 4: comparison with previous proficiency tests

The performance of the determinations of the proficiency tests was compared against the requirements of the respective standards. The conclusions are given the following table:

Determination	November 2010	November 2009	November 2008
Density @ 15 ^{o}C	-	--	-
Sulphur	+	--	--
Distillation (ASTM D86)	--	-	+/-
Saybolt Color	--	n.e.	n.e.
Water content by KF	-	--	+
Mercury as Hg	--	++	+
Total vapour pressure	--	n.e.	n.e.
DVPE acc. to ASTM D5191	--	n.e.	n.e.

Table 5: comparison of the performance per determination against the target requirements

The performance of the determinations against the requirements of the respective standards is listed in the above table. The following performance categories were used:

        ++:   group performed much better than the standard
        + :   group performed better than the standard
        +/-:   group performance equals the standard
        - :   group performed worse than the standard
        -- :   group performed much worse than the standard
        n.e.:   not evaluated

APPENDIX 1

Determination of Density @ 15°C on sample #1081; results in kg/m^3

lab	method	value	mark	z(targ)	remarks
150	D4052	743.8		1.61	
171	D4052	743.5		-0.07	
258	D1298	744.4	C, G(0.05)	4.97	First reported 745.0
311	D4052	743.4		-0.63	
442	D4052	743.6		0.49	
444	D4052	743.53		0.09	
449		-----		-----	
602		-----		-----	
608	D4052	743.7		1.05	
609	D4052	743.4		-0.63	
631	D4052	743.9		2.17	
657	D4052	743.3		-1.19	
840	D4052	743.50		-0.07	
974		-----		-----	
1023	D4052	743.4		-0.63	
1160	IP365	744.9	C, DG(0.05)	7.77	First reported 0.7449
1164	D4052	743.93		2.33	
1214		-----		-----	
1267	D4052	743		-2.87	
1368	D4052	743.6		0.49	
1616		-----		-----	
1800	in house	744.3	ex	4.41	Measured at 15.6°C
1815		-----		-----	
1842		-----		-----	
2124	D4052	743.2		-1.75	
9050		-----		-----	
9054		-----		-----	
9055		-----		-----	
9056		-----		-----	
9057		-----		-----	
9058		-----		-----	
9061		-----		-----	
9100		-----		-----	
9101		-----		-----	
9102		-----		-----	
9103		-----		-----	
9104		-----		-----	
9106		-----		-----	
9107		-----		-----	
9108		-----		-----	
9109	D4052	746.0	G(0.01)	13.93	
9110		-----		-----	
9111		-----		-----	
9116		-----		-----	
9117		-----		-----	
9121	D4052	744.5	U, DG(0.05)	5.53	Reported 0.7445
9122	D4052	743.69	U	0.99	Reported 0.74369
9123		-----		-----	
9125		-----		-----	
9126		-----		-----	
9127	D4052	743.39		-0.69	
9129		-----		-----	
9132		-----		-----	
9141	D5002	739.56	U, G(0.01)	-22.14	Reported 0.73956
9144	D4052	743.4		-0.63	
9145		-----		-----	

normality	OK	
n	18	
outliers	5	
mean (n)	743.513	
st.dev. (n)	0.2377	
R(calc.)	0.666	
R(D4052:02e1)	0.500	Compare (D4052:09) = 2.123
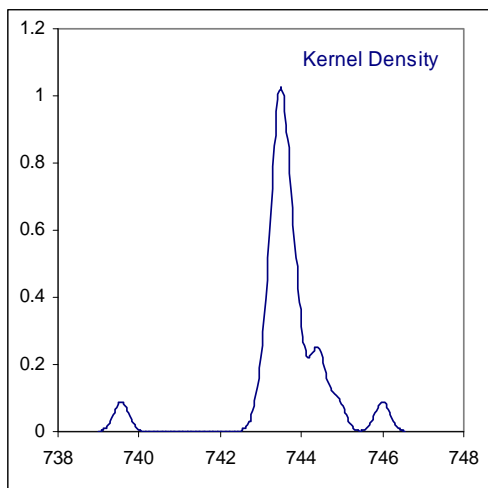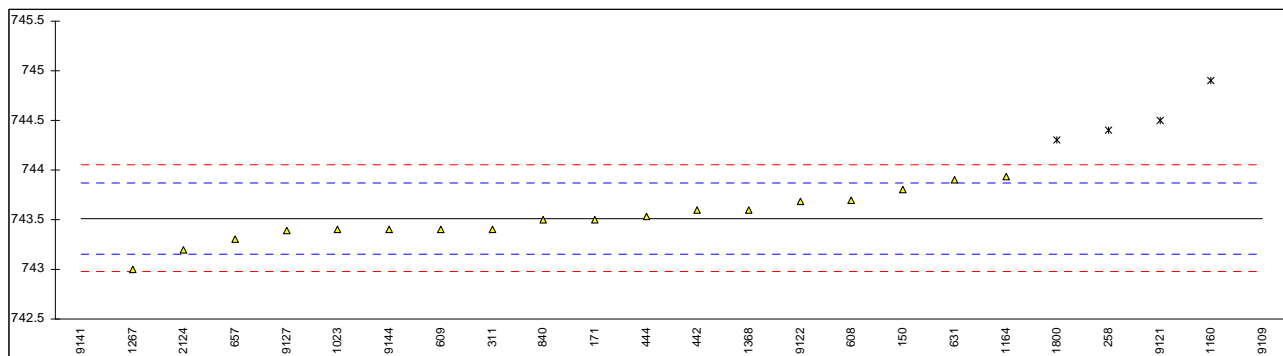
Determination of Sulphur on sample #1081; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150	D5453	12		0.30	
171	D5453	11.3		-0.24	
258		-----		-----	
311	D5453	12		0.30	
442		-----		-----	
444	D5453	12.47		0.66	
449		-----		-----	
602		-----		-----	
608	D5453	12.44		0.64	
609		-----		-----	
631		-----		-----	
657	D5453	13.0		1.07	
840	D4294	36.6	G(0.01)	19.19	
974		-----		-----	
1023	D2622	46.7	G(0.05)	26.94	
1160		-----		-----	
1164	D5453	11.9		0.22	
1214		-----		-----	
1267		-----		-----	
1368		-----		-----	
1616		-----		-----	
1800		-----		-----	
1815	D5453mod.	20.52	DG(0.01)	6.84	
1842		-----		-----	
2124	D5453	11		-0.47	
9050		-----		-----	
9054		-----		-----	
9055		-----		-----	
9056		-----		-----	
9057		-----		-----	
9058		-----		-----	
9061		-----		-----	
9100		-----		-----	
9101		-----		-----	
9102		-----		-----	
9103		-----		-----	
9104		-----		-----	
9106		-----		-----	
9107		-----		-----	
9108		-----		-----	
9109		-----		-----	
9110		-----		-----	
9111		-----		-----	
9116		-----		-----	
9117		-----		-----	
9121		-----		-----	
9122	D5453	11.6		-0.01	
9123		-----		-----	
9125		-----		-----	
9126		-----		-----	
9127	D5453	21.5	DG(0.01)	7.59	
9129		-----		-----	
9132		-----		-----	
9141		-----		-----	
9144	D5453	8.4		-2.47	
9145		-----		-----	

normality	OK	
n	10	
outliers	4	
mean (n)	11.611	
st.dev. (n)	1.2702	
R(calc.)	3.557	
R(D5453:09)	3.646	

Kernel Density
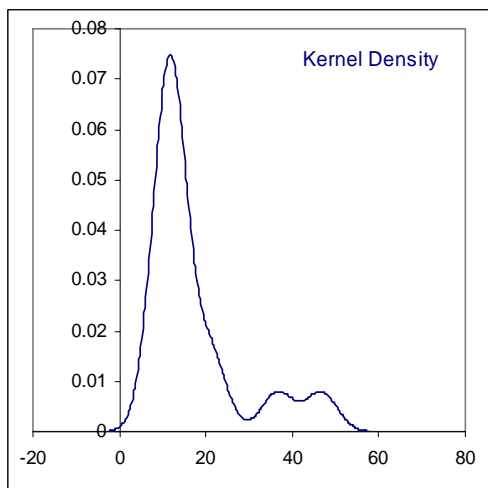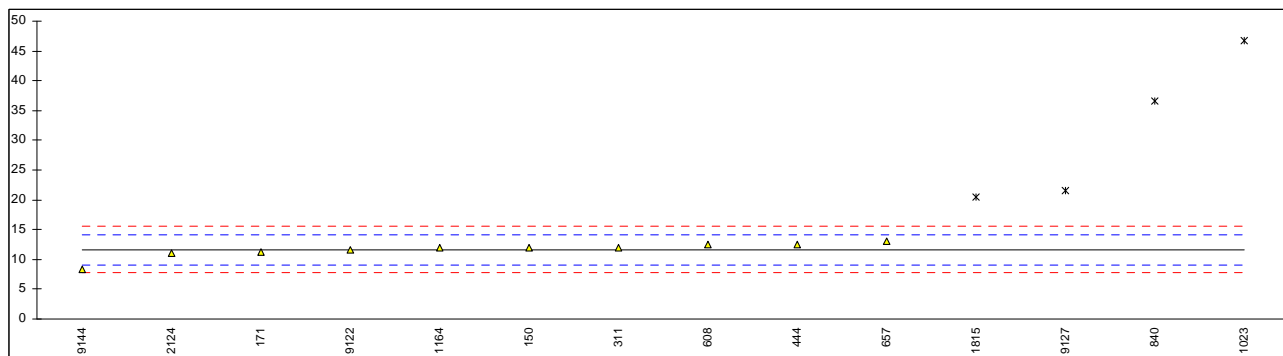
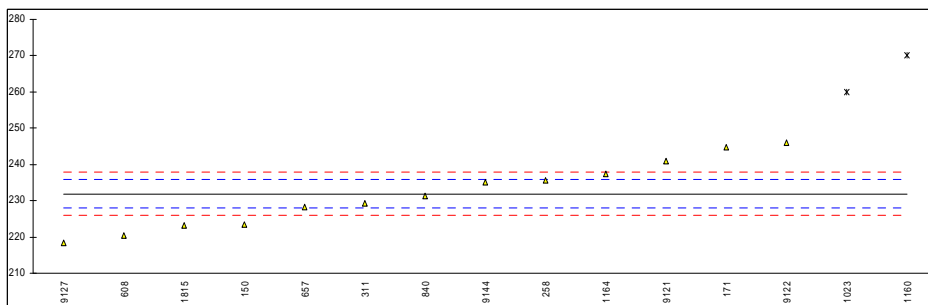Determination of Distillation on sample #1081; results in °C

lab	method	IBP	mark	10%	mark	50%	mark	90%	mark	FBP	Mark	remarks
150	D86-A	33.9		61.1		116.0		223.4		297.2		
171	D86	30.9		67.2		120.4		244.7		295.1		
258	D86-A	36.8		60.8		120.1		235.5		278.0	G(0.01)	
311	D86-A	32.4		69.8		116.6		229.4		300.4		
442		-----		-----		-----		-----		-----		
444		-----		-----		-----		-----		-----		
449		-----		-----		-----		-----		-----		
602		-----		-----		-----		-----		-----		
608	D86-M	36.0		62.5		117.0		220.5		293.0		
609		-----		-----		-----		-----		-----		
631	D86-M	38.0		66.0		120.0		-----		290.0	C	fr. 280.0
657	D86-A	33.5		60.9		116.5		228.2		294.6		
840	D86-A	28.75		62.45		118.85		231.35		304.40		
974		-----		-----		-----		-----		-----		
1023	D86-M	32.0		70.0		125.0	DG(0.05)	260.0	DG(0.05)	295.0		
1160	IP123-M	48.0	G(0.05)	72.0	ex	125.5	DG(0.05)	270.0	DG(0.05)	270.0	G(0.05)	
1164	D86-A	33.0		63.5		119.0		237.5		297.0		
1214		-----		-----		-----		-----		-----		
1267		-----		-----		-----		-----		-----		
1368		-----		-----		-----		-----		-----		
1616		-----		-----		-----		-----		-----		
1800		-----		-----		-----		-----		-----		
1815	ISO3405-A	36.0		57.3		115.6		223.3		299.5		
1842		-----		-----		-----		-----		-----		
2124		-----		-----		-----		-----		-----		
9050		-----		-----		-----		-----		-----		
9054		-----		-----		-----		-----		-----		
9055		-----		-----		-----		-----		-----		
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9110		-----		-----		-----		-----		-----		
9111		-----		-----		-----		-----		-----		
9116		-----		-----		-----		-----		-----		
9117		-----		-----		-----		-----		-----		
9121	D86-M	28.7		59.1		115.6		240.9		304.4		
9122	D86-M	36.2		61.7		119.4		245.9		299.2		
9123		-----		-----		-----		-----		-----		
9125		-----		-----		-----		-----		-----		
9126		-----		-----		-----		-----		-----		
9127	D86-A	29.1		56.6		114.4		218.4		299.6		
9129		-----		-----		-----		-----		-----		
9132		-----		-----		-----		-----		-----		
9141		-----		-----		-----		-----		-----		
9144	D86-M	42.0	G(0.05)	66.5		119.0		235.0		296.5		
9145		-----		-----		-----		-----		-----		
	normality	OK		OK		OK		OK		OK		
	n	14		15		14		13		14		
	outliers	2		0		2		2		2		
	mean (n)	33.23		63.03		117.75		231.85		297.57		
	st.dev. (n)	3.111		4.124		1.993		9.006		4.054		
	R(calc.)	8.71		11.55		5.58		25.22		11.35		
	R(D86:10a) - A	5.02		3.20		1.88		5.54		6.78		
	R(D86:10a) - M	5.60		4.94		5.67		7.06		7.20		

Automated R (D86:10a) (Paragraph 13.1.2)
IBP:　　5.023　　=0.0595 (mean + 51.19)
10%:　　3.20
50%:　　1.88
90%:　　5.54　　= 0.019 (mean + 59.77)
FBP:　　6.780

Manual R (D86:10a) (Table A4.4)
IBP:　　5.6
10%:　　4.94　　$= 2.0 + 1.74 \times C/\%V$ and $C/\%V = 1.69$
50%:　　5.67　　$= 2.0 + 1.74 \times C/\%V$ and $C/\%V = 2.11$
90%:　　7.06　　$= 0.8 + 1.74 \times C/\%V$ and $C/\%V = 3.60$
FBP:　　7.2
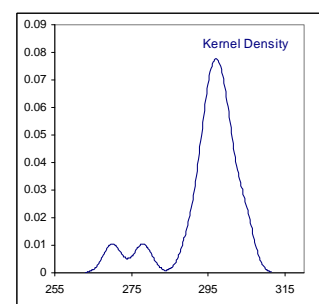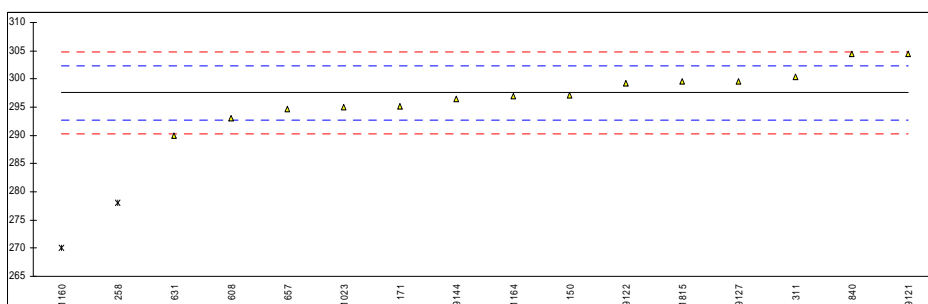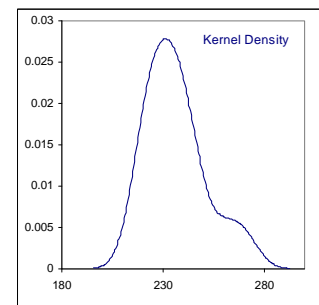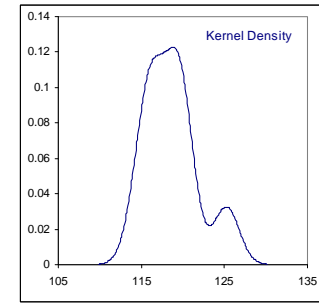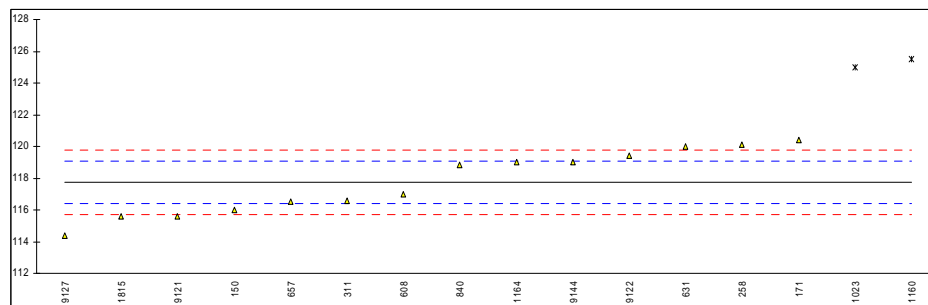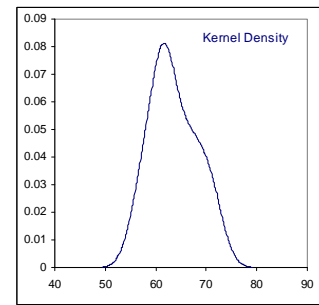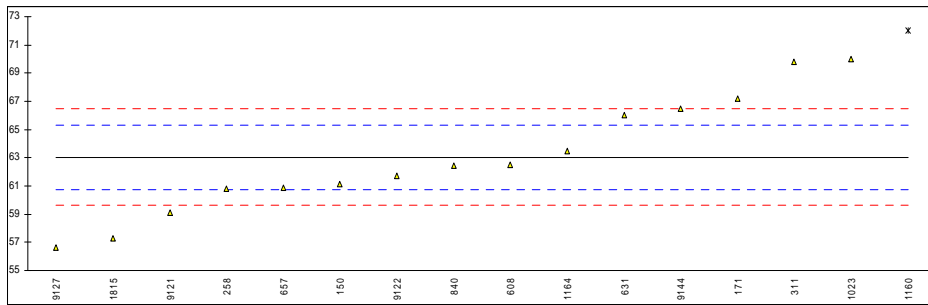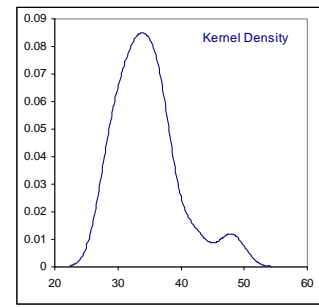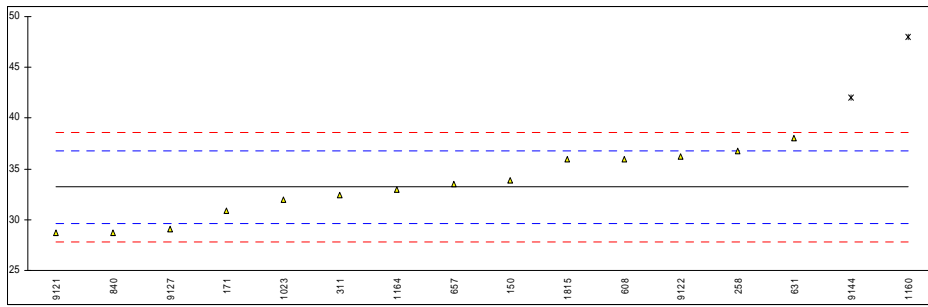
Determination of Saybolt Color on sample #1081;

lab	method	value	mark	z(targ)	remarks
150	D156	22		1.50	
171	D156	22		1.50	
258	D156	26		7.10	
311	D156	20		-1.30	
442		-----		-----	
444	D156	22		1.50	
449		-----		-----	
602		-----		-----	
608	D156	22		1.50	
609	D156	17		-5.50	
631	D156	20		-1.30	
657	D156	19		-2.70	
840	D156	19		-2.70	
974		-----		-----	
1023		-----		-----	
1160	D156	22		1.50	
1164		-----		-----	
1214		-----		-----	
1267		-----		-----	
1368		-----		-----	
1616		-----		-----	
1800		-----		-----	
1815		-----		-----	
1842		-----		-----	
2124	D156	22		1.50	
9050		-----		-----	
9054		-----		-----	
9055		-----		-----	
9056		-----		-----	
9057		-----		-----	
9058		-----		-----	
9061		-----		-----	
9100		-----		-----	
9101		-----		-----	
9102		-----		-----	
9103		-----		-----	
9104		-----		-----	
9106		-----		-----	
9107		-----		-----	
9108		-----		-----	
9109		-----		-----	
9110		-----		-----	
9111		-----		-----	
9116		-----		-----	
9117		-----		-----	
9121	D156	21		0.10	
9122	D156	19		-2.70	
9123		-----		-----	
9125		-----		-----	
9126		-----		-----	
9127		-----		-----	
9129		-----		-----	
9132		-----		-----	
9141		-----		-----	
9144		-----		-----	
9145		-----		-----	

normality	not OK	
n	14	
outliers	0	
mean (n)	20.93	
st.dev. (n)	2.165	
R(calc.)	6.06	
R(D156:07a)	2.00	
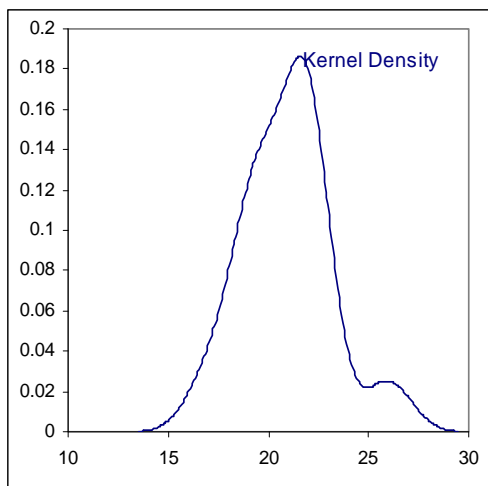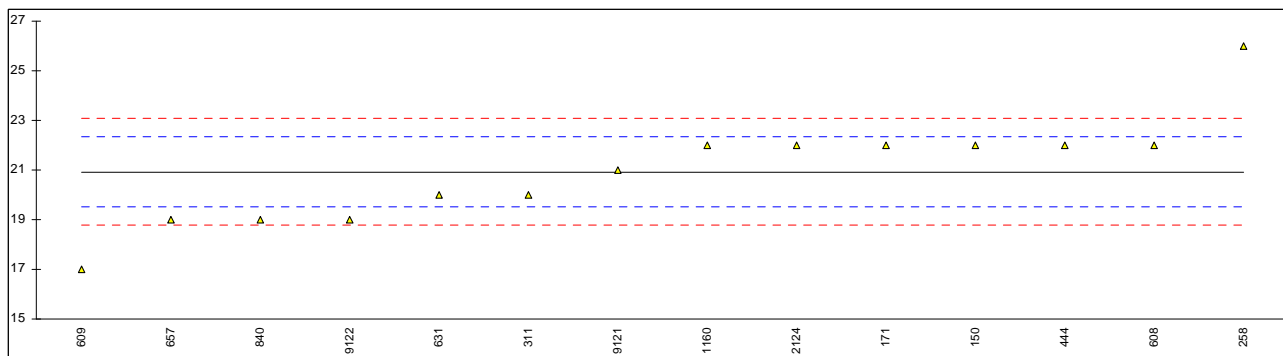
Determination of Water on sample #1081; results in mg/kg

lab	method	value	mark	z(targ)	remarks
150	D4928	43		-0.70	
171	D4928	19.7		-2.80	
258		-----		-----	
311	D4928	<0.02	U	<-4.35	Probably reported in different unit
442	IP386	51.89		0.10	
444	E203	63		1.11	
449		-----		-----	
602		-----		-----	
608	D4928	94		3.90	
609	D4928	63.5		1.15	
631	D6304	124	C, DG(0.05)	6.61	First reported 694
657	D4928	58.25		0.68	
840	D4928	54.0		0.29	
974		-----		-----	
1023		-----		-----	
1160	IP386	50	C	-0.07	First reported 0.005
1164	D6304	30.4		-1.84	
1214		-----		-----	
1267	D4928	44.20		-0.59	
1368	D1744	50.146		-0.06	
1616		-----		-----	
1800	in house	63.2		1.12	
1815	ISO12937	115.8	DG(0.05)	5.87	
1842		-----		-----	
2124	in house	24.99		-2.33	
9050		-----		-----	
9054		-----		-----	
9055		-----		-----	
9056		-----		-----	
9057		-----		-----	
9058		-----		-----	
9061		-----		-----	
9100		-----		-----	
9101		-----		-----	
9102		-----		-----	
9103		-----		-----	
9104		-----		-----	
9106		-----		-----	
9107		-----		-----	
9108		-----		-----	
9109	D4928	36.5		-1.29	
9110		-----		-----	
9111		-----		-----	
9116		-----		-----	
9117		-----		-----	
9121	D4928	53		0.20	
9122	D4928	58		0.65	
9123		-----		-----	
9125		-----		-----	
9126		-----		-----	
9127	D6304	55.9		0.46	
9129		-----		-----	
9132		-----		-----	
9141		-----		-----	
9144	D4928	165.5	G(0.05)	10.36	
9145		-----		-----	

normality	OK	
n	18	
outliers	3	
mean (n)	50.76	
st.dev. (n)	16.872	
R(calc.)	47.24	
R(D4928:10)	31.01	
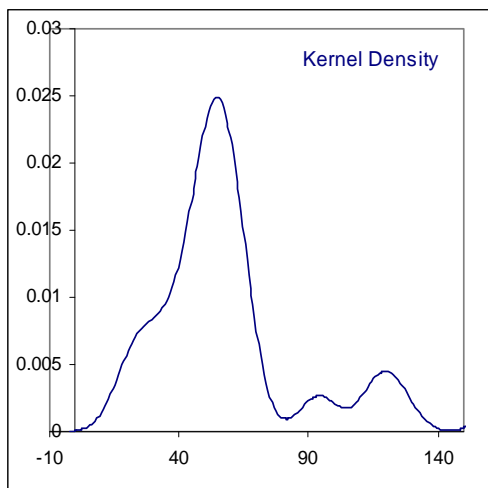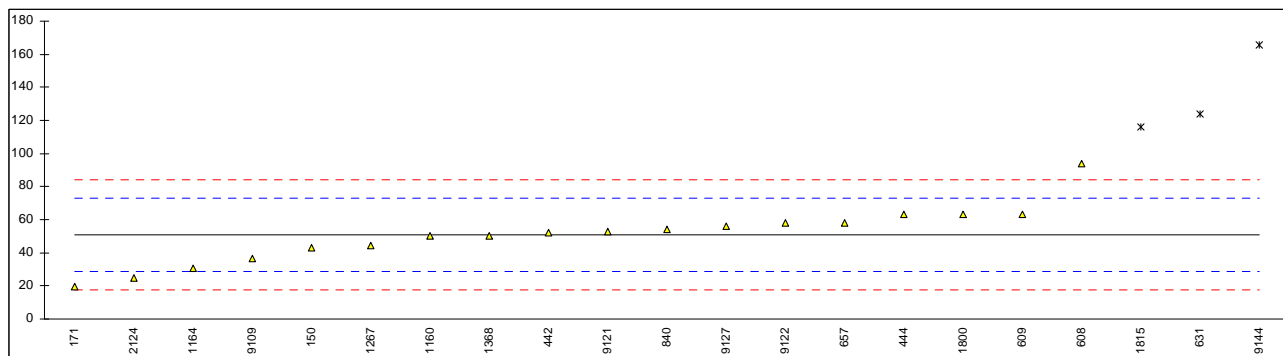
Determination of Mercury as Hg on sample #1081; results in µg/kg

lab	method	value	mark	z(targ)	remarks
150		-----		-----	
171		-----		-----	
258		-----		-----	
311		-----		-----	
442		-----		-----	
444	UOP938	112.8		-1.15	
449		-----		-----	
602		-----		-----	
608	INH-010	6.049	G(0.05)	-4.51	
609	UOP938	169.7230		0.64	
631		-----		-----	
657	UOP938	200.47	C	1.60	First reported 22.3
840		-----		-----	
974		-----		-----	
1023		-----		-----	
1160		-----		-----	
1164		-----		-----	
1214		-----		-----	
1267		-----		-----	
1368		-----		-----	
1616		-----		-----	
1800	in house	149.5		0.00	
1815		-----		-----	
1842		-----		-----	
2124	in house	115		-1.08	
9050		-----		-----	
9054		-----		-----	
9055		-----		-----	
9056		-----		-----	
9057		-----		-----	
9058		-----		-----	
9061		-----		-----	
9100		-----		-----	
9101		-----		-----	
9102		-----		-----	
9103		-----		-----	
9104		-----		-----	
9106		-----		-----	
9107		-----		-----	
9108		-----		-----	
9109		-----		-----	
9110		-----		-----	
9111		-----		-----	
9116		-----		-----	
9117		-----		-----	
9121		-----		-----	
9122		-----		-----	
9123		-----		-----	
9125		-----		-----	
9126		-----		-----	
9127		-----		-----	
9129		-----		-----	
9132		-----		-----	
9141		-----		-----	
9144		-----		-----	
9145		-----		-----	

normality	n/a
n	5
outliers	1
mean (n)	149.5
st.dev. (n)	37.23
R(calc.)	104.2
R(Horwitz)	76.9
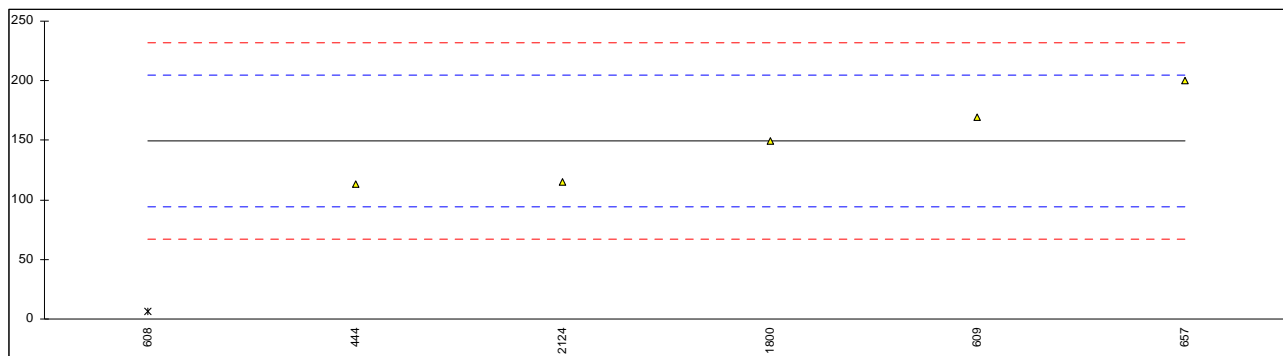
Determination of Total Vapour Pressure (TVP) on sample #1082; results in psi

lab	method	value	mark	z(targ)	remarks
150	D5191	10.44		0.01	
171	D5191	10.52		0.57	
258	D5191	10.268		-1.20	
311	D5191	10.46		0.15	
442		-----		-----	
444		-----		-----	
449		-----		-----	
602		-----		-----	
608	D5191	9.98		-3.21	
609		-----		-----	
631	D5191	10.77		2.32	
657	D5191	10.60		1.13	
840		-----		-----	
974		-----		-----	
1023	D5191	10.57		0.92	
1160		-----		-----	
1164	D6378	10.22		-1.53	
1214		-----		-----	
1267		-----		-----	
1368	D5191	10.2107		-1.60	
1616		-----		-----	
1800		-----		-----	
1815	D6378mod.	10.46		0.15	
1842		-----		-----	
2124	D5191	9.46	G(0.05)	-6.85	
9050		-----		-----	
9054		-----		-----	
9055		-----		-----	
9056		-----		-----	
9057		-----		-----	
9058		-----		-----	
9061		-----		-----	
9100		-----		-----	
9101		-----		-----	
9102		-----		-----	
9103		-----		-----	
9104		-----		-----	
9106		-----		-----	
9107		-----		-----	
9108		-----		-----	
9109		-----		-----	
9110		-----		-----	
9111		-----		-----	
9116		-----		-----	
9117		-----		-----	
9121	D323	9.0	G(0.05)	-10.07	
9122	D5191	10.52		0.57	
9123		-----		-----	
9125		-----		-----	
9126		-----		-----	
9127	D5191	10.689		1.75	
9129		-----		-----	
9132		-----		-----	
9141		-----		-----	
9144		-----		-----	
9145		-----		-----	

normality	OK	
n	13	
outliers	2	
mean (n)	10.439	
st.dev. (n)	0.2178	
R(calc.)	0.610	
R(D5191:07)	0.400	
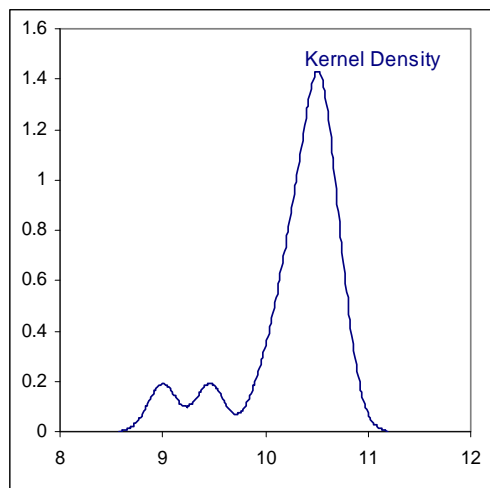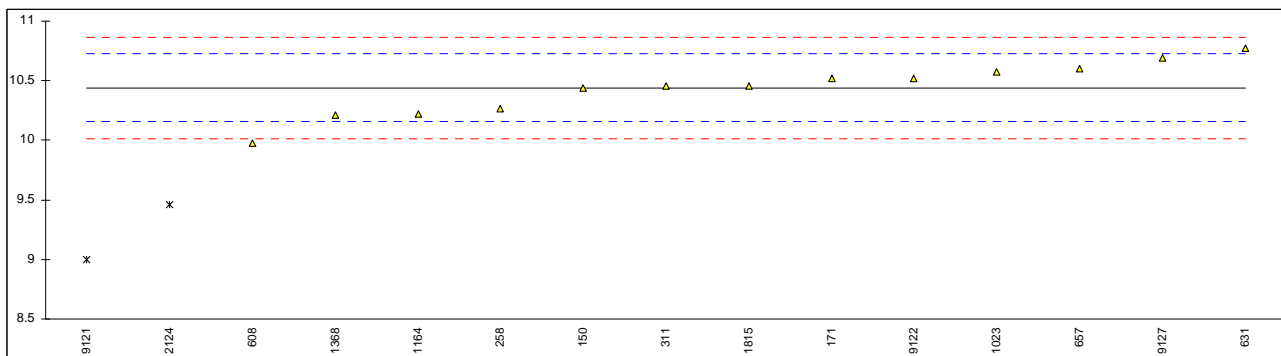
Determination of DVPE (ASTM D5191 calculation) on sample #1082; results in psi

lab	method	value	mark	z(targ)	remarks
150	D5191	9.53		0.27	
171	D5191	9.604		0.79	
258	D5191	9.391		-0.70	
311	D5191	9.54		0.34	
442		-----		-----	
444		-----		-----	
449		-----		-----	
602		-----		-----	
608	D5191	9.08		-2.88	
609		-----		-----	
631	D5191	9.84		2.44	
657	D5191	9.68		1.32	
840		-----		-----	
974		-----		-----	
1023	D5191	9.20	ex, E	-2.04	Recalculate by iis 9.65 (z = 7.55)
1160		-----		-----	
1164	D6378	9.31		-1.27	
1214		-----		-----	
1267		-----		-----	
1368	D5191	9.30504	C	-1.30	First Reported 8.8908
1616		-----		-----	
1800		-----		-----	
1815		-----		-----	
1842		-----		-----	
2124	D5191	8.55	G(0.05)	-6.59	
9050		-----		-----	
9054		-----		-----	
9055		-----		-----	
9056		-----		-----	
9057		-----		-----	
9058		-----		-----	
9061		-----		-----	
9100		-----		-----	
9101		-----		-----	
9102		-----		-----	
9103		-----		-----	
9104		-----		-----	
9106		-----		-----	
9107		-----		-----	
9108		-----		-----	
9109	D5191	9.25		-1.69	
9110		-----		-----	
9111		-----		-----	
9116		-----		-----	
9117		-----		-----	
9121		-----		-----	
9122	D5191	9.60		0.76	
9123		-----		-----	
9125		-----		-----	
9126		-----		-----	
9127	D5191	9.761		1.89	
9129		-----		-----	
9132		-----		-----	
9141	D5191	59.9500	G(0.01)	353.21	Probably reported in Kpa
9144		-----		-----	
9145		-----		-----	

normality	OK	
n	12	
outliers	2	
mean (n)	9.491	
st.dev. (n)	0.2263	
R(calc.)	0.634	
R(D5191:07)	0.400	

Kernel Density
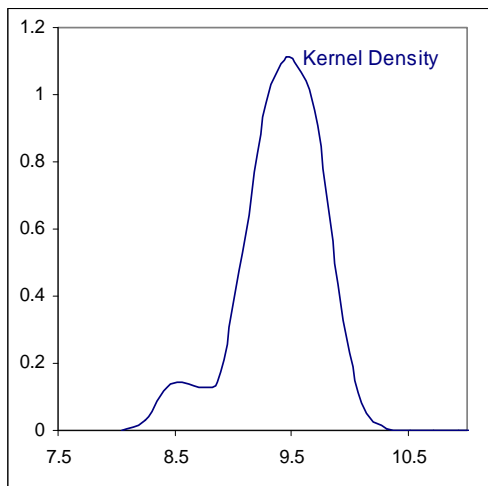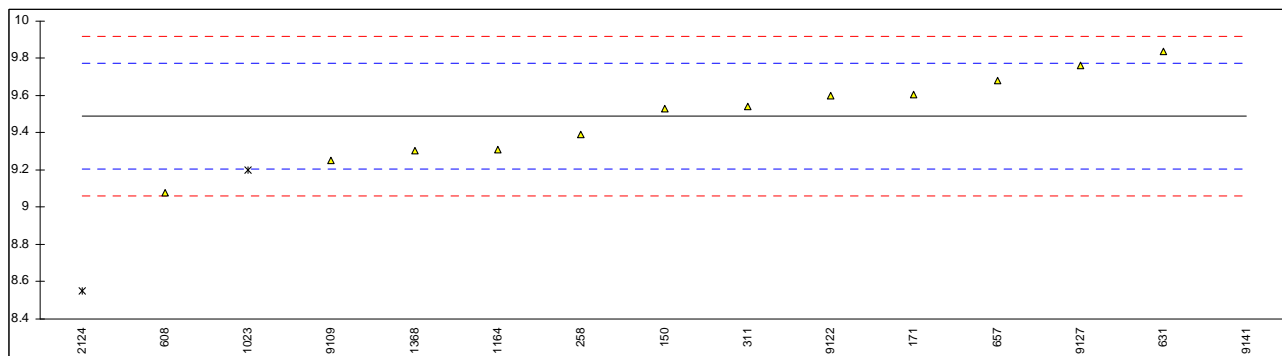
APPENDIX 2:

Z-scores distillation ASTM D86 (automated and manual mode used for calculation)

lab	method	Automated mode					Manual mode				
		IBP	10%	50%	90%	FBP	IBP	10%	50%	90%	FBP
150	D86-A	0.37	-1.69	-2.60	-4.27	-0.15	0.34	-1.09	-0.86	-3.35	-0.14
171	D86	-1.30	3.65	3.95	6.49	-1.02	-1.16	2.36	1.31	5.10	-0.96
258	D86-A	1.99	-1.95	3.51	1.84	-8.08	1.79	-1.26	1.16	1.45	-7.61
311	D86-A	-0.46	5.92	-1.71	-1.24	1.17	-0.41	3.84	-0.57	-0.97	1.10
442		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
444		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
449		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
602		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
608	D86-M	1.54	-0.46	-1.11	-5.74	-1.89	1.39	-0.30	-0.37	-4.50	-1.78
609		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
631	D86-M	2.66	2.60	3.36	-----	-3.13	2.39	1.68	1.11	-----	-2.94
657	D86-A	0.15	-1.86	-1.86	-1.84	-1.23	0.14	-1.21	-0.62	-1.45	-1.15
840	D86-A	-2.50	-0.51	1.64	-0.25	2.82	-2.24	-0.33	0.54	-0.20	2.66
974		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1023	D86-M	-0.69	6.10	10.80	14.23	-1.06	-0.61	3.95	3.58	11.17	-1.00
1160	IP123-M	8.23	7.85	11.55	19.28	-11.38	7.39	5.08	3.83	15.14	-10.72
1164	D86-A	-0.13	0.41	1.87	2.86	-0.23	-0.11	0.27	0.62	2.24	-0.22
1214		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1267		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1368		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1616		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1800		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1815	ISO3405-A	1.54	-5.01	-3.20	-4.32	0.80	1.39	-3.25	-1.06	-3.39	0.75
1842		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2124		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9050		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9054		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9055		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9056		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9057		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9058		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9061		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9100		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9101		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9102		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9103		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9104		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9106		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9107		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9108		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9109		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9110		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9111		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9116		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9117		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9121	D86-M	-2.54	-3.43	-3.20	4.57	2.84	-2.28	-2.22	-1.06	3.59	2.67
9122	D86-M	1.66	-1.16	2.46	7.10	0.67	1.49	-0.75	0.82	5.57	0.64
9123		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9125		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9126		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9127	D86-A	-2.30	-5.63	-4.98	-6.80	0.84	-2.06	-3.64	-1.65	-5.34	0.79
9129		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9132		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9141		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
9144	D86-M	4.89	3.04	1.87	1.59	-0.44	4.39	1.97	0.62	1.25	-0.41
9145		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

APPENDIX 3:

Number of participating laboratories per country

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 2 labs in AUSTRALIA
 3 labs in CANADA
 6 labs in MALAYSIA
  1 lab in MOZAMBIQUE
  1 lab in NEGARA BRUNEI DARUSSALAM
 7 labs in NIGERIA
 2 labs in NORWAY
 2 labs in OMAN
  1 lab in P.R. of CHINA
 3 labs in PHILIPPINES
  1 lab in POLAND
  1 lab in QATAR
  1 lab in RUSSIA
  1 lab in SINGAPORE
 4 labs in THE NETHERLANDS
  1 lab in U.A.E.
 7 labs in U.S.A.
11 labs in UNITED KINGDOM
  1 lab in VIETNAM
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APPENDIX 4

Abbreviations:

C   = final result after checking of first reported suspect 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
ex   = excluded from calculations
E   = error in calculations
n.a.   = not applicable
W   = withdrawn on request participant
U   = reported in deviating unit
SDS   = Safety Data Sheet

Literature:

1   i.i.s. Interlaboratory Studies, Protocol for the Organisation, Statistics & Evaluation, January 2010
2   ASTM E178-02
3   ASTM E1301-03
4   ISO 5725-86
5   ISO 5725, parts 1-6, 1994
6   ISO 13528-05
7   M. Thompson and R. Wood, J. AOAC Int, 76, 926, (1993)
8   W.J. Youden and E.H. Steiner, Statistical Manual of the AOAC, (1975)
9   IP367/96
9   DIN 38402 T41/42
10   P.L. Davies, Fr. Z. Anal. Chem, 331, 513, (1988)
11   J.N. Miller, Analyst, 118, 455, (1993)
12   Analytical Methods Committee Technical Brief, No4 February 2001
13   The Royal Society of Chemistry 2002, Analyst 2002, 127 page1359-1364, P.J. Lowthian and M. Thompson. (see http://www.rsc.org/suppdata/an/b2/b205600n/)