• 5th ANNUAL ASCOPE LABORATORY TEST CORRELATION PROGRAMME ON CFR ENGINE (1983)

by

Bustami Mustafa and E Jasjfi

ABSTRACT

A high precision CFR Engine Laboratory operating according to standard requirement is a must in the oil industry. It is also of very high importance within work of research activities on the use of hydrocarbon fuels.

In ASEAN we have the ASCOPE correlation program on CFR engine laboratory to obtain precision data in the gasoline by CFR test research method. Member countries taking part in the 5th laboratory test correlation program for CFR engines are Indonesia as coordinator with six laboratories participating, Malaysia, Philippines, Singapore and Thailand with two laboratories each and USA with are laboratory.

The 5th correlation program was started by sending sample by the program correlation in January, 1983 after being tested the participating laboratories, the test result were sent to the program coordinator who procured the result for the determination of standard deviation according to precision and statistics. Based on result, conclusion can be drawn about the deviation of laboratory test results.

I. INTRODUCTION

A high precision CFR engine laboratory operating according to standard requirements is a must in the oil industry. It is very important to back up the refineries in the production of motor fuels according to specifications. It is also of very high importance within the framework of research activities on the uses of hydrocarbon fuels and on alcohol as a substitute for gasoline.

The need of having a CFR engine laboratory to serve near each refinery, however, posed the problem of reproducibility of test results, if the same identical materials is tested by different laboratories. It is in facing these problems, that the CFR engine laboratories in ASEAN and other countries should continuously and regularly compare their test results through a test correlation programme for CFR engine laboratories. The ASCOPE Work Programme for 1983 as approved by the Eighth Council Meeting in Kualalumpur, Malaysia, October 22 – 23, 1982, directed the Technical Committee to conduct the 5th and 6th ASCOPE laboratory test correlation programmes for CFR engines.

Member countries taking part in the 5th ASCOPE laboratory test correlation programme for CFR engines are Indonesia as coordinator with seven participating laboratories, Malaysia with one laboratory, the Philippines and Thailand with two laboratories each, and Ethyl Corporation Long Beach Laboratory of USA. The Ethyil Long Beach (USA) laboratory is participating for the first time in the ASCOPE laboratory test correlation programme on CFR engines this year and participated in both the 5th and 6th correlation programmes.

Member countries taking part in the CFR engines are Indonesia as coordinator with seven laboratories participating, Malaysia with one laboratory, Philippines and Thailand with two laboratories each, and Singapore and USA with one laboratory each.

The Singapore laboratory is participating for the first time in the 6th ASCOPE laboratory test correlation programme on CFR engines.

The coordinator in their correlation programme is responsible in preparing the correlation samples and sending them by air to each participating laboratory through the respective country coordinator according to schedule.

The first of this 1983 programmes (5th correlation programme) was started by sending samples in January 1983, and the second (6th correlation programme) was started by sending samples in May 1983. After being tested by the participating laboratories, the test results were sent to the programme coordinator who procured the results for the determination of the standard deviation rejection of outliers according to precision and statistics. Based on these results, conclusion can be drawn about the deviation of laboratory test results.

For better analysis of the results, for each of the samples for correlation, it was also required to report physical and chemical test results such as specific gravity, RVP, distillation and lead (TEL) content by receiving laboratories. This is necessary in order to take into account any possible changes in the sample properties which might have occured during transportation and storage.

II. CORRELATION PROGRAMME EXECUTION

A. Correlation Samples

Lemigas as coordinator, provided and prepared the correlation samples shown in Table 1.

The correlation samples were sent to each participating laboratory. The amount of the correlation sample, was two liters for each grade, put into two one-litre cans; one litre cans were used in order to comply with IATA air transport regulations concerning the maximum fuel container volumes permitted for air transport of inflammable materials.

To facilitate and simplify the conduct of this programme, each sample was coded alpha-numerically according to sample type as follows : "SC-number", where SC indicates sample code and number, indicates sample type.

Tabel 1
5th ASCOPE LABORATORY TEST CORRELATION PROGRAMMES ON CFR ENGINES (1983)
Types and Codes of Sample

Type	Grade	Code
1. Commercial	Fuel High Grade	SC-01
2. Commercial	Fuel Low Grade	SC-02
3. Standardization	Toluene-Heptane	SC-03

B. Participating Laboratories

The participating laboratories were similarly coded alpha-numerically as follows : "LC-number", where LC indicates laboratory code and participant's number in this correlation programme.

In order to facilitate communication, laboratories in each country were coordinated through a Country Coordinator.

III. SAMPLE PREPARATION

Test samples for the 5th and 6th CFR Correlation Programmes were prepared by the Programme Coordinator and who distributed them to the participating laboratories through their respective Country Coordinators. Samples for the 5th CFR Correlation Programme were prepared and sent to the participating laboratories in January 1983, while for the 6th CFR Correlation Programme samples were prepared to be sent in May 1983.

In each case, sample preparation consisted of five stages, viz :

1. Acquisition of substances for sample preparation, materials and equipment
2. Blending of sample

3. Filling of sample into containers
4. Packing
5. Dispacth.

Each of these steps was carried out in the routine manner, but with utmost care, by LEMIGAS as the coordinating laboratory.

IV. ROUNDING RULES FOR THE TEST RESULTS

The ASA rules for rounding as pertained to this procedure can be stated simply as follows :

1. The value of the number is unchange when the last digit to be dropped is less than 5
2. The digit proceeding the digit to be dropped is raised by one when the last digit is greater than 5
3. When the last digit to be dropped is exactly 5 and the digit proceeding it is an even digit, the 5 is dropped without change to the number
4. When the digit to be dropped is exactly 5 and the digit proceeding it is an odd digit, the digit proceeding is raised by one.

Example :

Number	Nearest Hundredth	Nearest Tenth
1. 97.642	97.64	97.6
2. 97.237	97.24	97.2
3. 97.355	97.36	97.4
4. 97.985	97.98	98.0

When rounding from the three digits to one digit the last two digit to be dropped must be considered together and the rule applies to values greater or less than 50.

97.449	97.4
97.540	97.5
97.551	97.6
97.549	97.5
97.550	97.6

V. PROCEDURE FOR TEST DATA ANALYSIS

Test results were analysed according to the following procedure for calculating basic statistical data for analysing programme results.

The data obtained by this procedure include average of results, average of deviations, standard deviations, and rejection of outliers, which are basic to other statistical treatment such as trend etc.

The data thus obtained also provide sufficient parameters for comparing like data from individual laboratories or groups of laboratories performing the same test. The procedure is presented in a step manner to standardize procedure and to simplify the calculations and evaluation. The following steps are taken to calculate the basic statistical data :

. Step I Number of result = n

Results = $x_1, x_2, x_3, \ldots x_n$

Sum of results = $\sum_{i=1}^{n} x_i$

. Step II Average of results = $\frac{\sum_{i=1}^{n} x_i}{n} = \bar{x}$

. Step III Deviation = $x_i - \bar{x}$

Sum of deviation = $\sum_{i=1}^{n} x_i - \bar{x}$

Average deviation = $\frac{\sum_{i=1}^{n} x_i - \bar{x}}{n}$

. Step IV Deviation squared = $(x_i - \bar{x})^2$

. Step V Variance = $\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}$

. Step VI Standard deviation = $\sqrt{\text{Variance}}$

$= \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$

. Step VII Rejection of outliers

"T" factor times standard deviation

$$= T \times \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1}}$$

"T" factor is obtained from Table of Grubb's rejection criterion.

In the computation of standard deviation the use (n – 1) is statistically more correct than n.

VI. TEST RESULTS

A. 5th ASCOPE CFR Engines Correlation Programme

The results submitted by the participating laboratories were compiled and evaluated following the procedure described above.

For 5th CFR engine programme, results for sample SC-01 are listed in Table 2 and 3, which show respectively the ambient temperature and engine oper-

Table 2
5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1985)
Test Conditions Sample No. SC-01

Lab. No.		LC-01	LC-02	LC-03	LC-04	LC-05	LC-06	LC-07	LC-08	LC-09	LC-10	LC-11	LC-12	LC-13	LC-14
Motor Number		8	4-26 1131197	E-1814	1061150	F-1	6 (F1)	207441		1104652	G-37747 /78	9-69 178812	9-73 252382	CFR-48	3-17183
Total Hours		1143.8	-	3748.6	5912	1173	174	1332.0		-	2656.2	1920.2	1910.4	11354	3205
Running Hours after Last Overhaul		323.2	25	331.1	146	431	42	113.1		666	1185.2	47.9	93.7	520	268
Use Ice Tower, Yes/No		No	Yes	Yes	No	Yes	No	Yes		No	No	No	Yes	Yes	No
Intake Air Temperature, °F		125	128	125	125	125	122	123		125	125	125	125	125	126
Ambient Temperature, °C		28	30	29	25	29	30	30		26.7	29	23.9	32-33	27	16
Barometric Pressure, mm Hg		763.9	766	760	760	764	756	761		762	760	759.5	755.5	757	752.9
R P M		600	600	600	600	600	600	600		598	600	600	600	600	600
Altitude, m		3.65	2.5	3.61	5	4.2	3.5	4		41	6	2.5	4	0	-
Knockmeter Sensitivity		29	30	11	15	25	-	18		-	14	30	20	47	-
Cylinder Position	DC						814			838				822	818
	MS	0.426	0.435	0.441	0.425	0.421		0.434			0.418	0.447	0.413		

Table 3
5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1985)
Test Results Sample No. SC-01

Lab. No.		LC-01	LC-02	LC-03	LC-04	LC-05	LC-06	LC-07	LC-08	LC-09	LC-10	LC-11	LC-12	LC-13	LC-14	Average
Motor Number		8	4-62 1131197	E-1814	1061150	F-1	6 (F1)	207441		1104652	G-37747 /78	9-69 178812	9-73 252382	CFR-48	3-17183	
Knock Rating F-1 ASTM D-2699	ON	95.9	96.0	95.9	96.1	95.7	95.5	95.8		95.6	96.0	95.8	96.7	95.7	95.7	95.9
Spec. Gravity 60/60° ASTM D-1298	°F	0.7582	0.7591	0.7573	0.7563	0.7579	0.7597	0.7600		0.7599	0.7581	0.7599	0.7579	0.7586	-	0.7586
RVP, ASTM D-323	psi	6.8	6.5	7.8	6.6	6.8	6.8	7.5		5.6	7.2	7.1	7.0	6.1	-	6.8
Distillation ASTM D-86																
I B P	°C	43	43.5	39	43	39	45	42		48.9	42	52	42	45	-	43.7
10 %	°C	64	60	66	66	64	66	62		65	64	70	63	64	-	64.7
50 %	°C	100	95.5	100	102	101	102	99.5		96.7	100	100	100	101	-	99.8
90 %	°C	145	141	145	148	150	150	146.5		143.3	147	142	143	145	-	145.5
E P	°C	183	183.5	185	183	181	186	176.5		181.1	179	171	182	181	-	181.3
TEL Content, ASTM D-526/IP-116	ml/USG	2.39	2.38	2.33	0.93	2.31	2.01	1.58		2.41	2.39	2.80	2.52	2.5	-	2.21

ating conditions, general properties of sample deviation of general properties of sample deviation of general properties and calculation.

average octane number, standard deviations and rejection of outliers for sample SC-01, SC-02, SC-03, respectively (see page 42 through 45).

Table 4
5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)
Test Conditions Sample No. SC-02

Lab. No.		LC-01	LC-02	LC-03	LC-04	LC-05	LC-06	LC-07	LC-08	LC-09	LC-10	LC-11	LC-12	LC-13	LC-14
Motor Number		8	4-76 1131197	E-1814	1061150	F-1	6 (F1)	207441		1104652	G-37347 /78	9-69 178812	6-72 230541	CFR-48	3-17183
Total Hours		1144.7	-	3749.6	5914	1172	175	1333.0		-	2656.8	1920.2	3090.2	11355	3205
Running Hours after Last Overhaul		324.1	25	331.9	148	431	43	114.1		666	1185.8	47.9	3.0	521	268
Use Ice Towel, Yes/No		No	Yes	Yes	No	Yes	No	Yes		No	No	No	Yes	Yes	No
Intake Air Temperature, °F		125	120	125	125	125	122	125		125	125	125	125	125	126
Ambient Temperature, °C		28.5	30	29	25	29	30	30		26.7	29	23.9	32-33	27	16
Barometric Pressure, mm Hg		764.1	766	760	760	764	756	761		762	760	759.5	755.5	757	752.9
R P M		600	600	600	600	600	600	600		598	600	600	600	600	600
Altitude, m		3.65	2.5	3.61	5	4.2	3.5	4		41	6	2.5	4	0	-
Knockmeter Sensitivity		22	23	12	15	20	-	22		-	14	28	16	67	-
Cylinder Position	DC						824			761				750	764
	MS	0.483	0.495	0.490	0.485	0.635		0.478			0.475	0.518	0.484		

Table 5
5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)
Test Results Sample No. SC-02

Lab. No.		LC-01	LC-02	LC-03	LC-04	LC-05	LC-06	LC-07	LC-08	LC-09	LC-10	LC-11	LC-12	LC-13	LC-14	Average
Motor Number		8	4-62 1131197	E-1814	1061150	F-1	6 (F1)	207441		1104652	G-37347 /78	9-69 178812	6-72 230541	CFR-48	3-17183	
Knock Rating F-1 ASTM D-2699	ON	90.9	91.0	91.0	91.5	91.3	91.0	91.5		90.8	91.4	91.1	91.2	90.8	91.3	91.1
Spec. Gravity 60/60° ASTM D-1298	°F	0.7407	0.7401	0.7409	0.7397	0.7401	0.7412	0.7649		0.7420	0.7412	0.7428	0.7424	0.7410	-	0.7414
RVP, ASTM D-323	psi	7.4	7.4	7.7	7.8	7.8	7.5	6.4		6.3	7.7	8.1	7.8	7.5	-	7.4
Distillation ASTM D-86																
I.B.P	°C	40	36.5	36	41	38	40	43		44.4	43	46	40	43	-	40.9
10 %	°C	59	55.5	60	61	59	61	64.5		60	62	60	60	60	-	60.2
50 %	°C	97	94.5	97	101	98	98	100		94.4	97	98	97	99	-	97.6
90 %	°C	147	150	149	151	154	155	153		145.5	152	154	153	155	-	151.4
E.P	°C	192	189	188	188	190	192	185.5		185.6	187	180	187	186	-	187.3
TEL Content, ASTM D-526/IP-116	ml/USG	2.55	2.28	2.61	1.84	2.56	2.21	1.81		2.32	2.45	2.75	2.62	3.2	-	2.42

Results for sample SC-02 are similarly listed in Table 4 and 5.

Similarly, the results for sample SC-03 are shown in Table 6 and 7 (see page 37).

The results are summarized visually in Fig. 1, 2, 3 and 4, which plot the laboratory test results, the

VII. CONCLUSION

A. 5th ASCOPE CFR Engines Correlation Programme

From the results of test conducted by all participating laboratories and the evaluation of standard

deviation/rejection of outliers (see Fig. 1, Fig. 2, Fig. 3, Fig. 4, page 42 through 45) the following conclusions can be drawn.

1. Test Results

Concerning sample SC-01, 1 (One) rating exceeds standard deviation, viz the ratings coming from LC-06, and LC-12 exceeds outliers rejection criteria.

As shown in Fig. 1 (page 42) the deviation from average in this laboratory (LC-12) is + 0,8.

Second calculation, after excluding LC-12 from test results, points out that required conditions are satisfied by all test results.

Concerning sample SC-02, 5 (five) ratings exceed standard deviation, coming from LC-04, LC-07, LC-10 and LC-13, which are however not to be rejected as outliers being still within acceptable limits based on Grubb's Criteria for 99 percent probability. Hence, the ratings from all the participating laboratories concerning sample SC-02 are satisfactory.

Table 6

5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)

Test Conditions Sample No. SC-03

Lab. No.		LC-01	LC-02	LC-03	LC-04	LC-05	LC-06	LC-07	LC-08	LC-09	LC-10	LC-11	LC-12	LC-13	LC-14
Motor Number		8	4-28 1131197	E-1814	1061150	F-1	6 (F1)	207441		1104652	G-37747 /78	9-69 178812	6-72 230541	CFR-48	3-17183
Total Hours		1145.3	-	2750.3	5916	1172	176	1334.0		-	2657.6	1920.2	3090.2	11356	3205
Running Hours after Last Overhaul		324.9	25	332.8	150	431	64	115.1		666	1186.4	47.9	3.0	522	268
Use Ice Tower,	Yes/No	No	Yes	Yes	No	Yes	No	Yes		No	No	No	Yes	Yes	No
Intake Air Temperature,	°F	125	128	125	125	125	122	125		125	125	125	125	125	126
Ambient Temperature,	°C	29.5	30	29	25	29	30	30		26.7	29	23.9	32-33	27	16
Barometric Pressure,	mm Hg	764.9	768	760	760	764	756	761		762	760	759.5	755.5	757	757.9
R P M		600	600	600	600	600	600	600		598	600	600	600	600	600
Altitude,	m	7.65	2.5	3.61	5	4.2	3.5	4		41	6	7.5	4	0	-
Knockmeter Sensitivity		26	24	13	15	25	-	21			14	30	16	34	-
Cylinder Position	DC						614			707					770
	MS	0.462	0.470	0.468	0.466	0.466		0.465			0.451	0.469	0.458		

Table 7

5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)

Test Results Sample No. SC-03

Lab. No.		LC-01	LC-02	LC-03	LC-04	LC-05	LC-06	LC-07	LC-08	LC-09	LC-10	LC-11	LC-12	LC-13	LC-14	Average
Motor Number		8	4-62 1131197	E-1814	1061150	F-1	6 (F-1)	207441		1104652	G-37747 /78	9-69 178812	6-72 230541	CFR-48	3-17183	
Knock Rating F-1 ASTM D-2699	ON	93.2	93.2	92.8	93.6	93.3	93.1	93.0		92.9	93.6	93.1	93.6	93.3	93.0	93.2
Spec. Gravity 60/60° ASTM D-1298	°F	0.8214	0.8232	0.8219	0.8193	0.8232	0.8213	0.8255		0.8251	0.8213	0.8222	0.8212	0.8237	-	0.8224
RVP, ASTM D-323	psi	1.2	1.2	1.4	1.4	0.8	1.2	1.4		0.5	0.4	1.3	1.6	1.0	-	1.1
Distillation ASTM D-86																
I B P	°C	100	101	100	104.3	100	101	102		101.1	101	103	100	102	-	101.3
10 %	°C	103	104	103	105.8	104	104	104.5		103.9	103	104	104	104	-	103.9
50 %	°C	105	105.5	104	107.2	106	106	106		105.6	105	105	105.5	106	-	105.6
90 %	°C	108	109	107	110.2	108	109	108		108.9	107	108	108.5	109	-	108.4
E P	°C	118	125.3	121	111.2	120	120	112		110	110	130	124	113	-	117.9
TEL Content, ASTM D-526/IP-116	ml/USG	0.01	Nil	0.01	0.003	Nil	0.02	Nil		Nil	Nil	Nil	Nil	<0.01	-	0.004

Table 8

5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)

Calculation SC-01

(First Calculation)

Col. A Laboratory	Motor Number F-1	Col. B Octane Number	Col. C Deviation of Average	Col. D Deviation squared
LC-01	8	95.9	0.0	0.0
LC-02	4-62-1131197	96.0	+0.1	0.01
LC-03	E - 1814	95.9	0.0	0.0
LC-04	1061150	96.1	+0.2	0.04
LC-05	F - 1	95.7	- 0.2	0.04
LC-06	6 (F 1)	95.5	- 0.4	0.16
LC-07	207441	95.8	- 0.1	0.01
LC-08	-	-	-	-
LC-09	1104652	95.6	- 0.3	0.09
LC-10	G-37747-78	96.0	+0.1	0.01
LC-11	9-69-178812	95.8	- 0.1	0.01
LC-12	9-73-252382	96.7	+0.8	0.64
LC-13	CFR - 48	95.7	- 0.2	0.04
LC-14	3 - 17183	95.7	- 0.2	0.04
	Sum No. of Results (n)	1246.4 13	2.7 13	1.09 13

Step 1 :
Average Octane Number : $\frac{\text{sum of results}}{\text{no. of results}} = \frac{1246.4}{13} = 95.9$

Step 2 :
Average Deviation : $\frac{\text{sum of deviation}}{\text{no. of deviation}} = \frac{2.7}{13} = 0.21$

Step 3 :
Variance : $\frac{\text{sum of dev. squared}}{(\text{no. of dev. squared}-1)} = \frac{1.09}{(13-1)} = \frac{1.09}{12} = 0.091$

Step 4 :
Standard Deviation : square root of variance $= \sqrt{\text{variance}} = \sqrt{0.091} = 0.30$

Step 5 :
Rejection of Outliers : "T" factor x std. deviation = 2.61 x 0.30 = 0.78

Laboratory No. LC-12 is rejected.

Table 9

5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)

Calculation SC-01

(Second Calculation)

Col. A Laboratory	Motor Number F-1	Col. B Octane Number	Col. C Deviation of Average	Col. D Deviation squared
LC-01	8	95.9	+ 0.1	0.01
LC-02	4-62-1131197	96.0	+ 0.2	0.04
LC-03	E - 1814	95.9	+ 0.1	0.01
LC-04	1061150	96.1	+ 0.3	0.09
LC-05	F - 1	95.7	- 0.1	0.01
LC-06	6 (F 1)	95.5	- 0.3	0.09
LC-07	207441	95.8	0.0	0.0
LC-08	-	-	-	-
LC-09	1104652	95.6	- 0.2	0.04
LC-10	G-37747-78	96.0	+ 0.2	0.04
LC-11	9-69-178812	95.8	0.0	0.0
LC-12	-	-	-	-
LC-13	CFR - 48	95.7	- 0.1	0.01
LC-14	3 - 17183	95.7	- 0.1	0.01
	Sum No. of Results (n)	1149.7 12	1.7 12	0.35 12

Step 1 :

Average Octane Number : $\frac{\text{sum of results}}{\text{no. of results}} = \frac{1149.7}{12} = 95.8$

Step 2 :

Average Deviation : $\frac{\text{sum of deviation}}{\text{no. of deviation}} = \frac{1.7}{12} = 0.14$

Step 3 :

Variance : $\frac{\text{sum of dev. squared}}{\text{(no. of dev. squared-1)}} = \frac{0.35}{12\text{-}1} = \frac{0.35}{12} = 0.032$

Step 4 :

Standard Deviation : square root of variance = $\sqrt{\text{variance}} = \sqrt{0.032} = 0.18$

Step 5 :

Rejection of Outliers : "T" factor x std. deviation = 2.55 x 0.18 = 0.46

All results are not rejected.

Table 10

5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)

Calculation SC-02

Col. A Laboratory	Motor Number F-1	Col. B Octane Number	Col. C Deviation of Average	Col. D Deviation squared
LC-01	8	90.9	- 0.2	0.04
LC-02	4-62-1131197	91.0	- 0.1	0.01
LC-03	E - 1814	91.0	- 0.1	0.01
LC-04	1061150	91.5	+ 0.4	0.16
LC-05	F - 1	91.1	0.0	0.0
LC-06	6 (F 1)	91.0	- 0.1	0.01
LC-07	207441	91.5	+ 0.4	0.16
LC-08	-	-	-	-
LC-09	1104652	90.8	- 0.3	0.09
LC-10	G-37747-78	91.4	+ 0.3	0.09
LC-11	9-69-178812	91.1	0.0	0.0
LC-12	6-72-230541	91.2	+ 0.1	0.01
LC-13	CFR - 48	90.8	- 0.3	0.09
LC-14	3 - 17183	91.3	+ 0.2	0.04
	Sum No. of Results (n)	1184.6 13	2.5 13	0.71 13

Step 1 :
Average Octane Number : $\frac{\text{sum of results}}{\text{no. of results}} = \frac{1184.6}{13} = 91.1$

Step 2 :
Average Deviation : $\frac{\text{sum of deviation}}{\text{no. of deviation}} = \frac{2.5}{13} = 0.19$

Step 3 :
Variance : $\frac{\text{sum of dev. squared}}{\text{(no. of dev. squared-1)}} = \frac{0.17}{(13-1)} = \frac{0.71}{12} = 0.059$

Step 4 :
Standard Deviation : square root of variance = $\sqrt{\text{variance}} = \sqrt{0.059} = 0.24$

Step 5 :
Rejection of Outliers : "T" factor x std. deviation = 2.61 x 0.24 = 0.63

All results are not rejected.

Table 11

5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)

Calculation SC-03

Col. A Laboratory	Motor Number F-1	Col. B Octane Number	Col. C Deviation of Average	Col. D Deviation squared
LC-01	8	93.2	0.0	0.0
LC-02	4-62-1131197	93.2	0.0	0.0
LC-03	E - 1814	92.8	- 0.4	0.16
LC-04	1061150	93.6	+ 0.4	0.16
LC-05	F - 1	93.3	+ 0.1	0.01
LC-06	6 (F 1)	93.1	- 0.1	0.01
LC-07	207441	93.0	- 0.2	0.04
LC-08	-	-	-	-
LC-09	1104652	92.9	- 0.3	0.09
LC-10	G-37747-78	93.6	+ 0.4	0.16
LC-11	9-69-178812	93.1	- 0.1	0.01
LC-12	6-72-230541	93.6	+ 0.4	0.16
LC-13	CFR - 48	93.3	+ 0.1	0.01
LC-14	3 - 17183	93.0	- 0.2	0.04
	Sum No. of Results (n)	1211.7 13	2.7 13	0.85 13

Step 1 :

Average Octane Number : $\frac{\text{sum of results}}{\text{no. of results}} = \frac{1211.7}{13} = 93.2$

Step 2 :

Average Deviation : $\frac{\text{sum of deviation}}{\text{no. of deviation}} = \frac{2.7}{13} = 0.21$

Step 3 :

Variance : $\frac{\text{sum of dev. squared}}{(\text{no. of dev. squared} - 1)} = \frac{0.85}{(13-1)} = \frac{0.85}{12} = 0.071$

Step 4 :

Standard Deviation : square root of variance = $\sqrt{\text{variance}} = \sqrt{0.071} = 0.27$

Step 5 :

Rejection of Outliers : "T" factor x std. deviation = 2.61 x 0.27 = 0.70

All results are not rejected.

Figure 1

CFR 5th Correlation

Deviation vs Lab. Code (Sample No. SC-01)

First Calculation

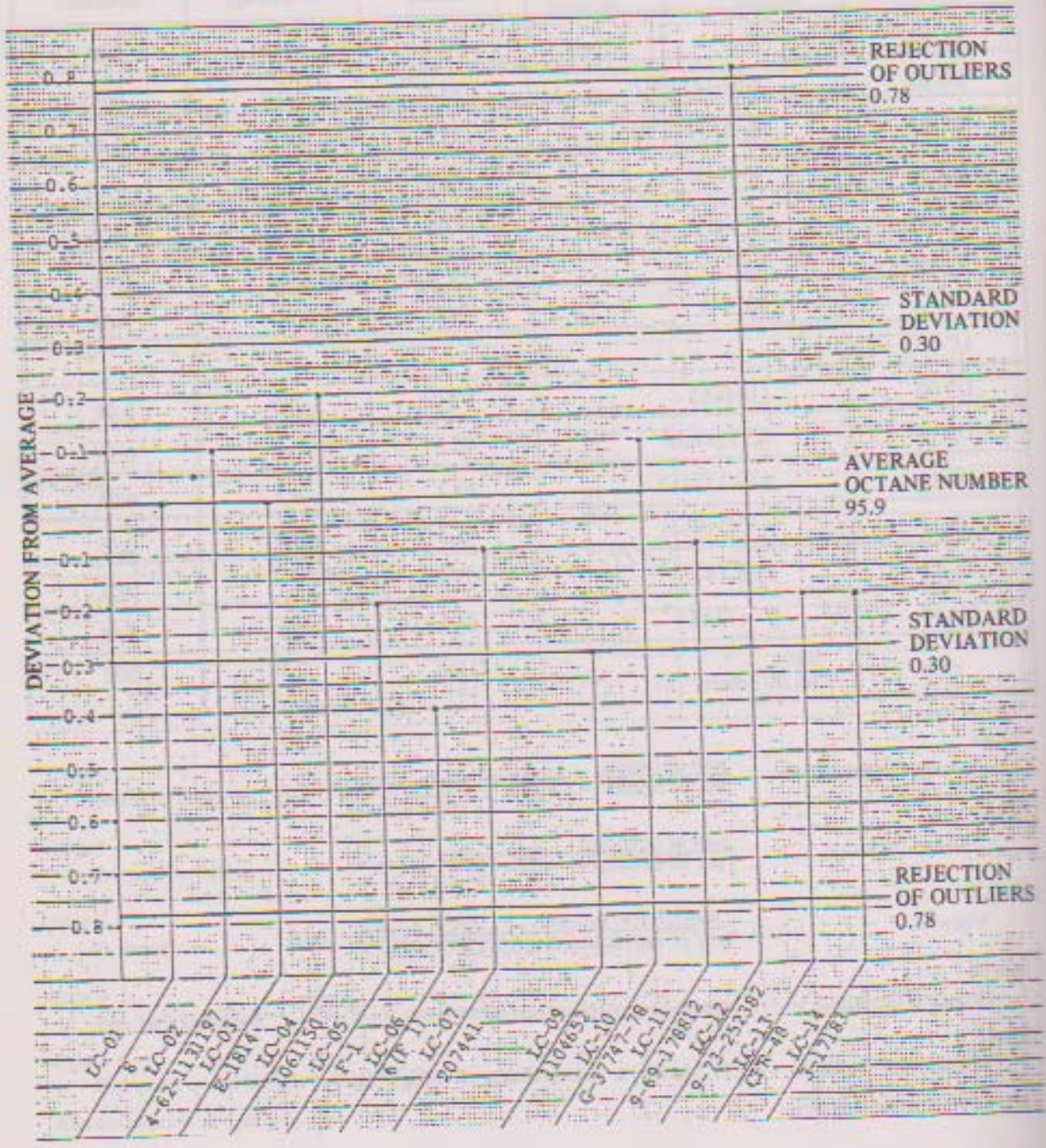


Figure 2

CFR 5th Correlation

Deviation vs Lab. Code (Sample No. SC-01)

Second Calculation

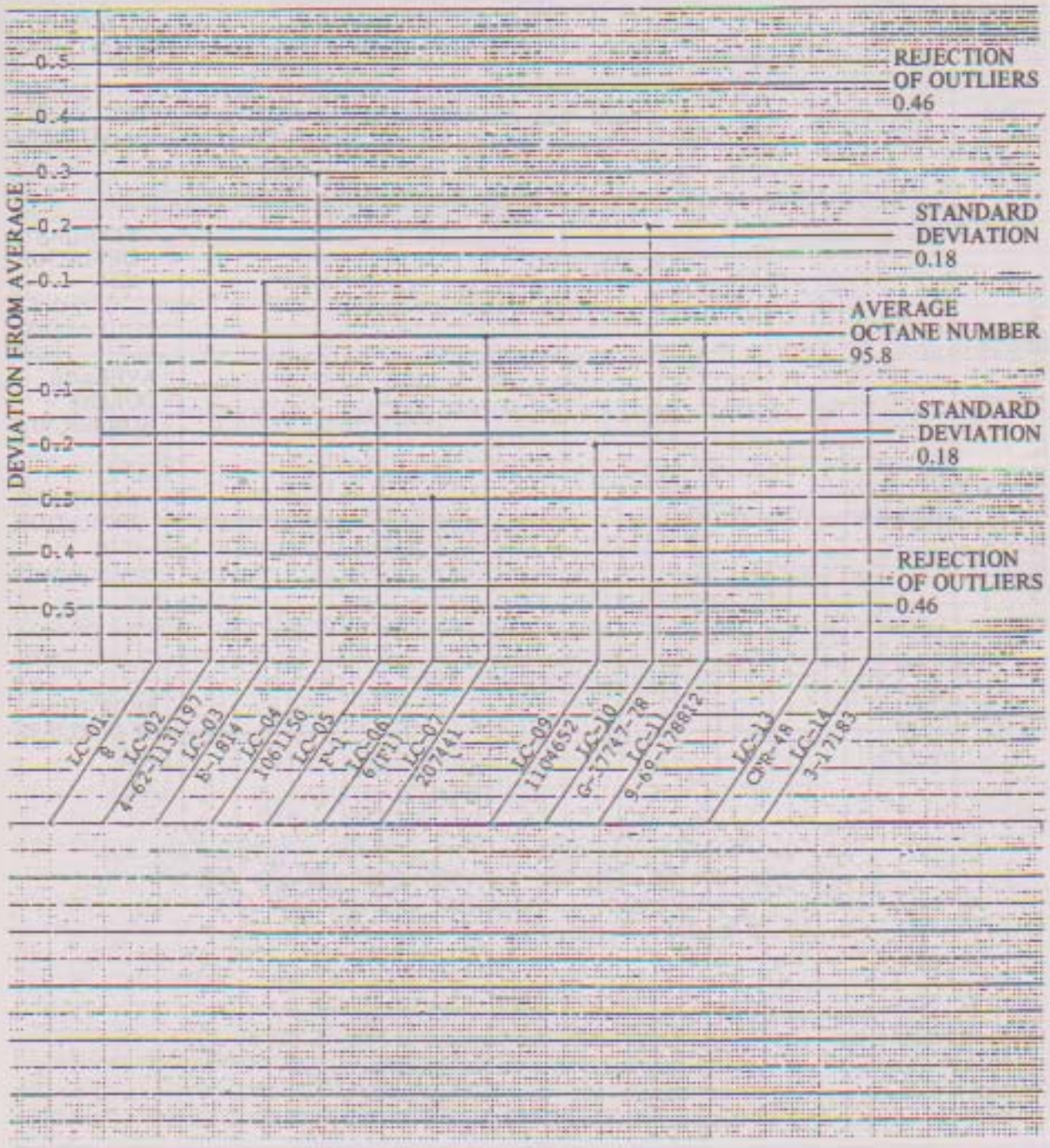


Figure 3

CFR 5th Correlation

Deviation vs Lab. Code (Sample No. SC-02)

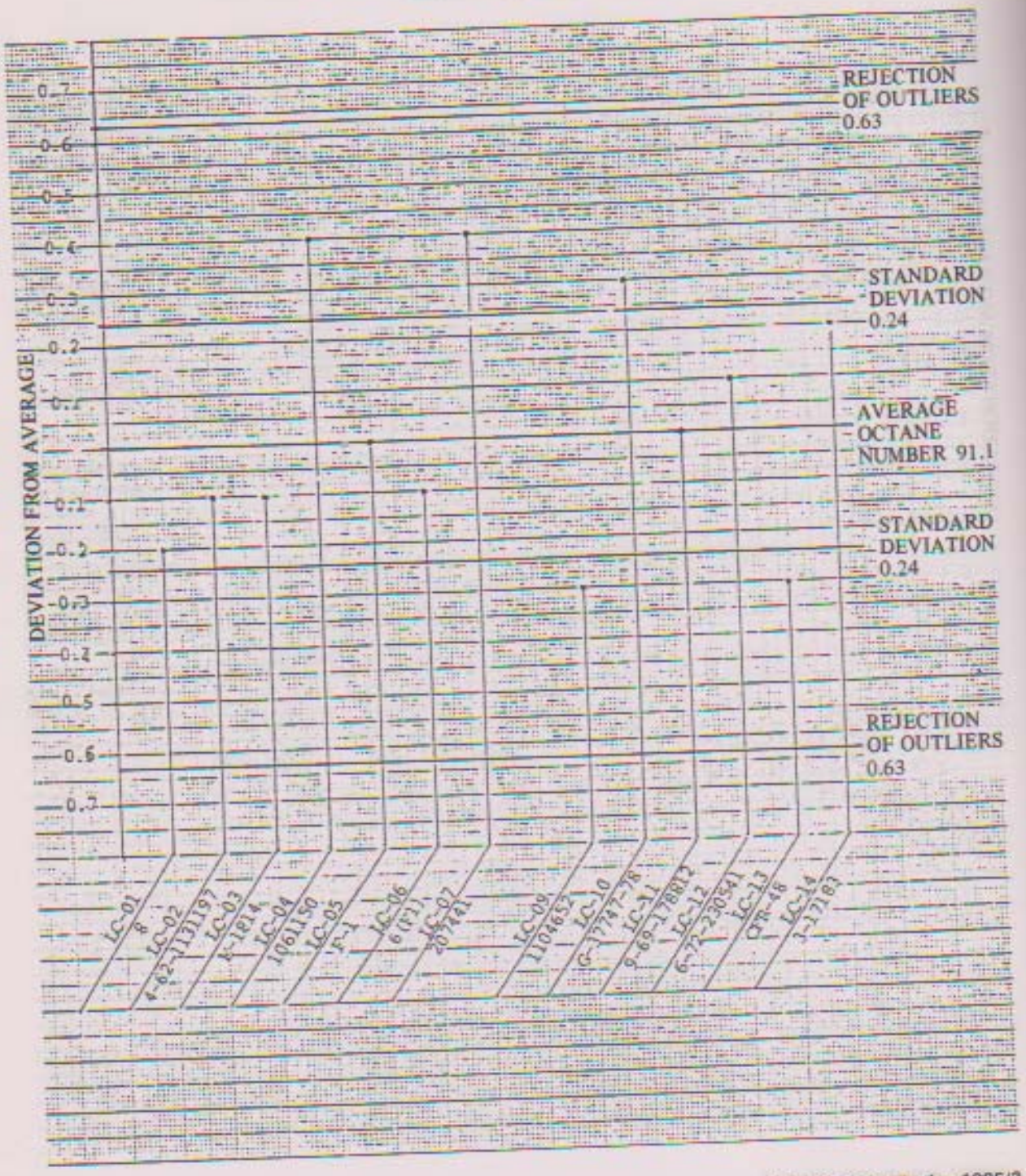
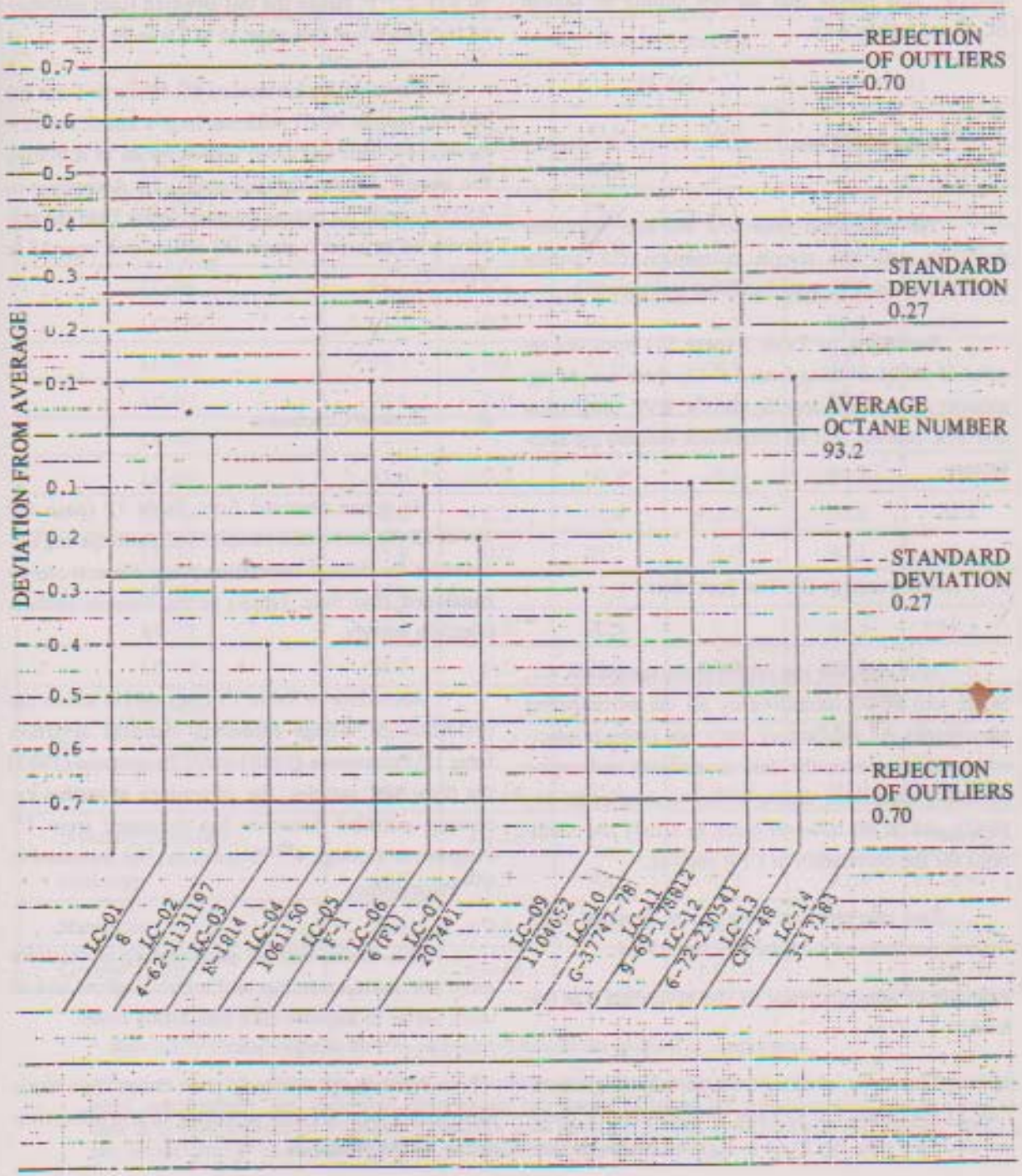


Figure 4

CFR 5th Correlation

Deviation vs Lab. Code (Sample No. SC-03)



Concerning sample SC-03, 5(five) ratings exceed standard deviation, coming from LC-03, LC-04, LC-09, LC-10 and LC-12. Which are however are still within acceptable limits based on Grubb's rejection criteria. This means that all test results of sample SC-03 are satisfactory.

2. Inspection Tests

The inspection tests data can also point out problems with the sample correlation (i.e. poorly mixed, evaporation, poor handling, leaking etc.).

According to Table 3 (page 35) from test results of SC-01 coming from LC-12, there are no significant deviation in specific gravity, RVP, distillation and TEL content that all correlation samples are satisfactory.

3. Adherence to the Test Procedure

Although, the test results of the samples SC-01, SC-02 and SC-03 submitted by all the participating laboratories are satisfactory, only one rating is rejected as outlier. From the data on ambient and engine operating conditions, during testing on samples SC-01, SC-02, and SC-03 however it can be satisfy the conditions for the correlation of CFR engines.

Two participating laboratories deviated from the test procedure established by the ASTM.

Example of non-adherence to the procedure is as follows :

Concerning sample SC-01, participating laboratory LC-14 carried out the test with barometric pressure at 752,9 mm Hg(29,64 in Hg) and intake air temperature at 126°F. According to Table 2 of ASTM manual barometric pressure at 29,64 in Hg. Hence intake air temperature has to be at 121 ± 2°F. According to the ASTM manual intake air temperature has to be 121 ± 2°F. Hence the test deviated from established test procedure (see page 35 in Table 2).

Participating laboratory LC-13 carried out the test for sample SC-01 with too large a knock sensitivity viz. 47. This can cause inaccurancies in acquiring the octane number by interpolation. According to ASTM manual for octane numbers lower than the sensitivity to be used is about 30 or less (see page 35 in Table 2).

B. General Conclusion

As it can observed from Table 12 (page 47) out of all the correction samples and participating laboratories for the 5th correlation programme, it can be concluded that only 1(one) rating exceeds outliers rejection criteria.

According to Table 13 (page 48) in which the evaluation of ratings exceeding standard deviation from 1st Programme (1980) to 6th Programme (1983) for three test samples, the percentage of ratings exceeding standard deviation has decreased from 1st Programme through 4th Programme, but increased in 5th Programme.

This means that all participating laboratories must put more attention and remain vigilant and to work better to improve each correlation result.

Particularly attention must be paid to some participants who are still persisting in non-adherence to the ASTM procedure.

Table 12

5th ASCOPE LABORATORY TEST CORRELATION PROGRAMME FOR CFR ENGINES (1983)

Individual Rating Reported by ASCOPE Lab. Participant

Lab. No.	Research Method					
	SC-01		SC-02		SC-03	
	O.N.	Dev.	O.N.	Dev.	O.N.	Dev.
LC-01	95.9	+ 0.1	90.9	- 0.2	93.2	0.0
LC-02	96.0	+ 0.2	91.0	- 0.1	93.2	0.0
LC-03	95.9	+ 0.1	91.0	- 0.1	92.8	- 0.4
LC-04	96.1	+ 0.3	91.5	+ 0.4	93.6	+0.4
LC-05	95.7	- 0.1	91.1	0.0	93.3	+0.1
LC-06	95.5	- 0.3	91.0	- 0.1	93.1	- 0.1
LC-07	95.8	0.0	91.5	+ 0.4	93.0	- 0.2
LC-08	-	-	-	-	-	-
LC-09	95.6	- 0.2	90.8	- 0.3	92.9	- 0.3
LC-10	96.0	+ 0.2	91.4	+ 0.3	93.6	+0.4
LC-11	95.8	0.0	91.1	0.0	93.1	- 0.1
LC-12	(*)		91.2	+ 0.1	93.6	+0.4
LC-13	95.7	- 0.1	90.8	- 0.3	93.3	+0.1
LC-14	95.7	- 0.1	91.3	+ 0.2	93.0	- 0.2
LC-15						
n	12		13		13	
Average	95.8	± 0.14	91.1	± 0.19	93.2	±0.21
Standard Deviation		± 0.18		± 0.24		±0.27
Minimum	95.5	- 0.3	90.8	- 0.3	92.8	- 0.4
Maximum	96.1	+ 0.3	91.5	+ 0.4	93.6	+0.4
Grubbs' Limits		± 0.46		± 0.63		±0.70

* Rejected by Grubbs' criterian for 99% probability. Results not included in computation.

Note : All ratings that fall within plus or minus two standar deviation the group average are to be considered statistically equal, precision-wise. Any underlined values exceed two standar deviations but are within acceptable limits on the basis of Grubbs' criterian for 99 percent probability. Such values are included in the computations. Rejected values, if any, are indicated by an asterisk (*) and are not included in computations.

Table 13

EVALUATION OF THE ASCOPE CFR ENGINE CORRELATION PROGRAMMES

Conducted from 1980 tp 1983

Percentage of ratings exceeding Standard Deviation

Sample Correlation	1st Programme (1980)	2nd Programme (1981)	3rd Programme (1982)	4th Programme (1983)	5th Programme (1984)
SC-01	30.8	33.3	25	25	41.7
SC-02	38.5	16.7	25	16.7	38.5
SC-03	38.5	25	25	16.7	38.5

Note : One of the caused of unsatisfactory test results is non adherence to the test procedure established by ASTM.

REFERENCES

Weissmann, Dr. J., 1972, *Fuel for Internal Combustion Engine and Furnaces.*

1974, *Ethyl Corporation Technical Service Laboratories Precision and Statistic.*

1980, *Manual Book of ASTM Standard.*

ERRATA

Several mistake have occured in an S.C. article entitled "Generation and Maturation of Hydrocarbons in Cepu Area, Central Java", appeared on S.C. No. 1/1985 on pages 14, 16, 17, 18, 19, and 21. The breakdowns are as follows :

Page	Line	Column	Written	It should read
14	1	2	information	informations
16	5	1	in depth to reverse faults are	in depth to reverse faults with northward displacement of the upthrown block. Those reverse faults are .....
	2	2	to related	to be related .....
17	4	1	more 5000 m.	more than 5000 m.
	5	2	to prevailed	to be prevailed
18			**Example of program prinout .....**	**Example of pyrogram printout ....**
	19	2	(0.26 0.13 kg/ton).	(0.26 + 0.13 kg/ton).
	23	2	dept	depth
19	6	1	T-Max	T-max .....
	7	2	TOOC	TOC

In table 3, page 21 the Potential Yield column in kg/ton should read 0.34 instead of 0,34

The Editor