

6th ANNUAL ASCOPE LABORATORY TEST CORRELATION

by

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ABSTRACT

In ASEAN we have the ASCOPE correlation programme on CFR engine laboratory to obtain precision data in the gasoline by CFR test research method. Member countries taking part in the 6th laboratory test correlation program for CFR engine are Indonesia as coordinator with seven laboratories participating, Malaysia with one laboratory, Philippines and Thailand with two laboratories each, Singapore and USA with one laboratory each.

I. INTRODUCTION

The need of having a CFR engine laboratory to serve near each refinery, poses the problem of reproducibility of test results for the same identical material tested by the 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 program for CFR engine laboratories.

The ASCOPE work program for 1983 was approved by the Eighth Council Meeting in Kuala Lumpur Malaysia October 22 - 23, 1982, directed its technical committee to conduct the 6th ASCOPE laboratory test correlation programs for CFR engines. The Ethyl Long Beach laboratory (USA) is participating for the second times in the Ascope laboratory test correlation program on CFR engine this year in 1983.

Member countries taking parts in the CFR engine correlation program are Indonesia as coordinator with seven laboratories participating, Malaysia with two laboratories each, and Singapore and USA with one laboratory each. (see Table 2.) The Singapore laboratory is participating for the first time in the 6th Ascope laboratory test correlation program on CFR engines. The coordinator in this correlation program is responsible in preparing the correlation samples and sending them by air to each participating laboratory through the respective country coordinator according to schedule.

After being tested by the participating laboratories,

the test results were sent to the program coordinator who process the results for the determination of standard deviation and rejection of outliers according to precision and statistics. Based on the statistic, conclusion can be drawn concerning deviation of laboratory test results.

For better analysis of the results for each of the sampels 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 accured during transportation and storage.

II. CORRELATION PROGRAM EXECUTION

A. Correlation samples.

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

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

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

Table 1
6th ASCOPE laboratory test correlation programmes
on CFR engines
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-02

Table 2.

Contry	Laboratory
MALAYSIA	1) ESSO Malaysia Berhard Port Dickson
PHILIPPINES	1) Bataan Refining Corporation (BRC) P.O. Box. 1053 MCC Makati Metro Manila 2) Petrophil Corporation Pandacan Laboratory P.O. Box 1031 MCC Makati Metro Manila
SINGAPORE	*1) ESSO Singapore Pte Ltd Pulau Ayer Chawan Singapore
THAILAND	1) Defence Energy Department Bangchack Refinery Laboratories Bangchack Bangkok 2) Science Division Oil Distribution and Supply Petroleum Authority of Thailand Prakanong Bangkok
USA	1) Ethyl Corporation Long Beach Laboratory c/o Harper Robinson & Co. 9520 La Cienega Blvd Inglewood, California 90301

Table 2
6th ASPOCE laboratory test correlation
programmes on CFR engines
List of participating laboratories

Country	Laboratory
INDONESIA	1. Pertamina Refining Unit I Lab Pangkalan Brandan 2. Pertamina Refining Unit II Lab Dumai 3. Pertamina Refining Unit III Lab Sungai Gerong 4. Pertamina Refining Unit III Lab Plaju 5. Pertamina Refining Unit IV Lab Cilacap 6. Pertamina Refining Unit V Lab Balikpapan 7. Lemigas Oil and Gas Technology Deve- lopment Centre P.O. Box 89/JKT. Jakarta.

* This lab participated in 6th Correlation Programme only.

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 6th CFR correlation programs

were prepared by the program coordinator and who distributed them to the participating laboratories through their respective country coordinators. Samples for the 6th correlation programs 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. Dispatch.

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 unchanged 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

The 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 = $x_1, x_2, x_3, \dots, x_n$

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

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

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

The results for sample SC-01 for the 6th correlation program are listed in Table 3 and 4, with show respectively the ambient temperature and engine

operation condition and general properties and sample deviation and calculation (see table 5, 6 and 7).

This results are summarized visually in Figure 1 and 2, which plot the laboratory test results, the rejections of outliers for sample SC-01, respectively (see page 12 through 14).

VII. CONCLUSION

From the results of test conducted by participating laboratories and the evaluation of standard deviation, rejection of outliers (see Fig 1 and 2) the following conclusions can be drawn.

Concerning sample SC-01, 2 (two) ratings exceed standard deviation, viz the ratings coming from LC-09 and LC-13, exceed outliers rejection criterion.

As shown in Table 5 and Figure 1 the deviation from average in this laboratory (LC-13) is -1,9. Second calculation, after excluding LC-13 from test results, points out that required conditions are satisfied by all test results (see Table 6).

TABLE 3.
6th ASCOPE Laboratory test correlation programme
for CFR engines
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
Motor number	4	4-62 1131197	—	1131181	—	363616	207441	—	1104852
Total hours	6354.9	—	—	6221.7	—	57.1	1370.4	—	14876
Running hours after last overhaul	14	50	—	214	—	57.1	151.5	—	—
Use test tower, Yes/No	No	Yes	—	No	—	No	Yes	—	Yes
Intake air temperature, °F	125	125	—	125	—	120	125	—	125
Ambient temperature, °C	29.1	36	—	25	—	28	32	—	25
Barometric pressure, mm Hg	736.4	760	—	759	—	777.5	760	—	761
RPM	600	600	—	600	—	600	600	—	598
Altitude, m	3.65	2.5	—	5	—	3.5	4	—	41
Knockmeter sensitivity	24	23	—	15	—	35	21	—	—
Cylinder position	DC	—	—	—	—	771	—	—	778
	NS	0.467	0.470	—	0.466	—	0.469	—	—

Table 3.
6th ASCOPE laboratory test correlation programme
for CFR engines sample no. SC-01

Continued from table 3

Lab. No.	LC-10	LC-11	LC-12	LC-13	LC-14	LC-15			
Motor number	G-32755/ 75	9-60 178812	G-26560 1972	CFR-48	J-17183	10943			
Total hours	3786.9	2065	3136.5	11714	37464	4701			
Running hours after last overhaul	509.2	3	45.2	109	088	530			
Use ice tower, Yes/No	No	No	Yes	Yes	No	Yes			
Intake air temperature, °F	125	125	125	125	125	125			
Ambient temperature, °C	27	23.0	33-34	29.5	25	23.8			
Barometric pressure, mm Hg	760	760.5	755.5	759	758.7	759			
RPM	600	600	600	600	600	600			
Altitude, m	6.0	2.5	5	0	15	0			
Knockmeter sensitivity	23	28	13	25	13	27.7			
Cylinder position	DC	-	-	-	751	770	-		
	MS	0.455	0.490	0.473	-	-	0.555		

Table 4.
6th ASCOPE laboratory test correlation programme
for CFR engines
Test results sample no. SC - 01

Lab. No.	LC-01	LC-04	LC-03	LC-04	LC-05	LC-06	LC-07	LC-08	LC-09
Motor number	4	4-62 1131197	-	1131181	-	365616	207441	-	1104852
Knock Rating F-1 ASTM D-2699	CN 92.7	92.9	-	92.5	-	93.1	92.9	-	93.4
Spec. gravity 60/60° ASTM D-1298	0. 0.7508	0.7535	-	0.7499	-	0.7517	0.7586	-	0.7515
RVP, ASTM D-323	psia 6.3	5.6	-	6.8	-	6.0	5.8	-	6.3
Distillation ASTM D-86									
IEP	°C 42	40.5	-	40.5	-	44	43.5	-	42
10%	°C 65	64.0	-	65.0	-	65	65.6	-	66.5
50%	°C 98	97.0	-	98.0	-	99	99.0	-	96
90%	°C 140	140.5	-	144.0	-	145.5	140.0	-	137.5
EP EP	°C 178	175.5	-	178.0	-	182	176.5	-	181
TEL content, ASTM D-526/IP-116	ml/USG 2.27	2.34	-	0.30	-	0.48	2.37	-	2.35

Table 4.
6th ASCOPE laboratory test correlation programme
for CFR engines
Test results sample no. SC - 01

Continued from table 4

Lab. No.		LC-10	LC-11	LC-12	LC-13	LC-14	LC-15	Average		
Motor number		G-32755/ 75	9-69 178812	G-26560 1972	CFR-48	3-17183	10943	-		
Knock rating F-1 ASTM D-2699	CN	93.3	92.6	92.4	90.8	93.0	92.8	92.7		
Spec. gravity 60/60P = ASTM D-1298	°P	0.7506	0.7531	0.7515	0.7515	0.7503	0.7518	0.7521		
RVP, ASTM D-323	psi	6.8	7.4	6.0	6.8	6.2	5.9	6.3		
Distillation ASTM D-86										
IBP	°C	42	49.0	44	48	43.3	36.7	43.0		
10%	°C	65	66.0	67	66	62.2	60.8	64.8		
50%	°C	99	98.0	98	99	97.2	95.3	97.8		
90%	°C	143	134.0	139	142	138.3	136.3	140.0		
EP	°C	180	186.0	175	183	178.9	176.7	179.2		
TEL content, ASTM D-526/IP-116	m/USG	217	2.68	2.54	2.40	2.31	2.35	2.05		

Table 5.
6TH ASCOPE laboratory test correlation programme
for CFR engines
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	4	92.7	0.0	0.0
LC-02	4-62-1131197	92.9	+0.2	0.04
LC-03		-	-	-
LC-04	1131181	92.5	-0.2	0.04
LC-05		-	-	-
LC-06	365616	93.1	+0.4	0.16
LC-07	207441	92.9	+0.2	0.04
LC-08		-	-	-
LC-09	1104852	93.4	+0.7	0.49
LC-10	G-32755-75	93.3	+0.6	0.36
LC-11	9-69-178812	92.6	-0.1	0.01
LC-12	G-26560-1972	92.4	-0.3	0.09
LC-13	CFR-48	90.8	-1.9	3.61
LC-14	3-17183	93.0	+0.3	0.09
LC-15	10943	92.8	+0.1	+
	Sum No. of Results (n)	1112.4 12	5.0 12	4.94 12

Step 1 :

Average Octane Number : $\frac{\text{sum of results}}{\text{no. of results}} = \frac{1112}{12} = 92.7$

Step 2 :

Average Deviation : $\frac{\text{sum of deviation}}{\text{no. of deviation}} = \frac{5.0}{12} = 0.42$

Step 3 :

Variance : $\frac{\text{sum of dev. squared}}{(\text{no. of dev. squared} - 1)} = \frac{4.94}{12-1} = \frac{4.94}{11} = 0.45$

Step 4 :

Standard Deviation : $\text{square root of variance} = \sqrt{\text{variance}} = \sqrt{0.45} = 0.67$

Step 5 :

Rejection of Outliers : "T" factor x std. deviation = $2.55 \times 0.67 = 1.71$

Laboratory No. LC-13 is not rejected

Table 6.
6th ASCOPE laboratory test correlation programme
for CFR engines
Calculation SC-01
(Second calculation)

Col. A laboratory	Motor Number F-1 O	Col. B Octane number	Col. C Deviation of average	Col. D Deviation squared
LC-01	4	92.7	- 0.2	0.04
LC-02	4-62-1131197	92.9	0.0	0.0
LC-03	-	-	-	-
LC-04	1131181	92.5	- 0.4	0.16
LC-05	-	-	-	-
LC-06	365616	93.1	- 0.2	0.041
LC-07	207441	92.9	0.0	0.0
LC-08	-	-	-	-
LC-09	1104852	93.4	+ 0.5	0.25
LC-10	G-32755-75	93.3	+ 0.4	0.16
LC-11	9-69-178812	92.6	- 0.3	0.09
LC-12	G-26560-1972	92.4	- 0.5	0.25
LC-13	CFR-48	-	-	-
LC-14	3-17183	93.0	+ 0.1	0.01
LC-15	10943	92.8	- 0.1	0.01
	Sum	1021.6	2.7	1.01
	No. of Results (n)	11	11	11

Step 1 :
Average Octane Number : $\frac{\text{sum of results}}{\text{no. of results}} = \frac{1021.6}{11} = 92,9$

Step 2 :
Average Deviation : $\frac{\text{sum of deviation}}{\text{no. of deviation}} = \frac{2.7}{11} = 0.24$

Step 3 :
Variance : $\frac{\text{sum of dev. squared}}{(\text{no. of dev. squared} - 1)} = \frac{1.01}{11-1} = \frac{1.01}{10} = 0.101$

Step 4 :
Standard Deviation : square root of variance = $\sqrt{\text{variance}} = \sqrt{0.101} = 0.32$

Step 5 :
Rejection of Outliers : "T" factor x std. deviation = $2.48 \times 0.32 = 0.79$

All results are not rejected.

Table 7.
6th ASCOPE laboratory test correlation programme
for CFR engine
Individual rating reported by ASCOPE lab. participant

Lab. No.	Research method SC-01	
	O.N.	Dev.
LC-01	92.7	0.2
LC-02	92.9	0.0
LC-03	-	-
LC-04	92.5	- 0.4
LC-05	-	-
LC-06	93.1	+ 0.2
LC-07	92.9	0.0
LC-08	-	-
LC-09	93.4	+ 0.5
LC-10	93.3	- 0.4
LC-11	92.6	- 0.3
LC-12	92.4	- 0.5
LC-13	(*)	-
LC-14	93.0	+ 0.1
LC-15	92.8	- 0.1
n	11	-
Average	92.9	± 0.24
Standard deviation		± 0.32
Minimum	92.4	- 0.5
Maximum	93.4	+ 0.5
Grubbs' limits		± 0.79

* Rejected by Grubbs' criterion for 90% probability. Results not included in computation.

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

Figure 1.
CFR 6th correlation
Deviation VS. lab. code (sample No. SC-01)
first calculation

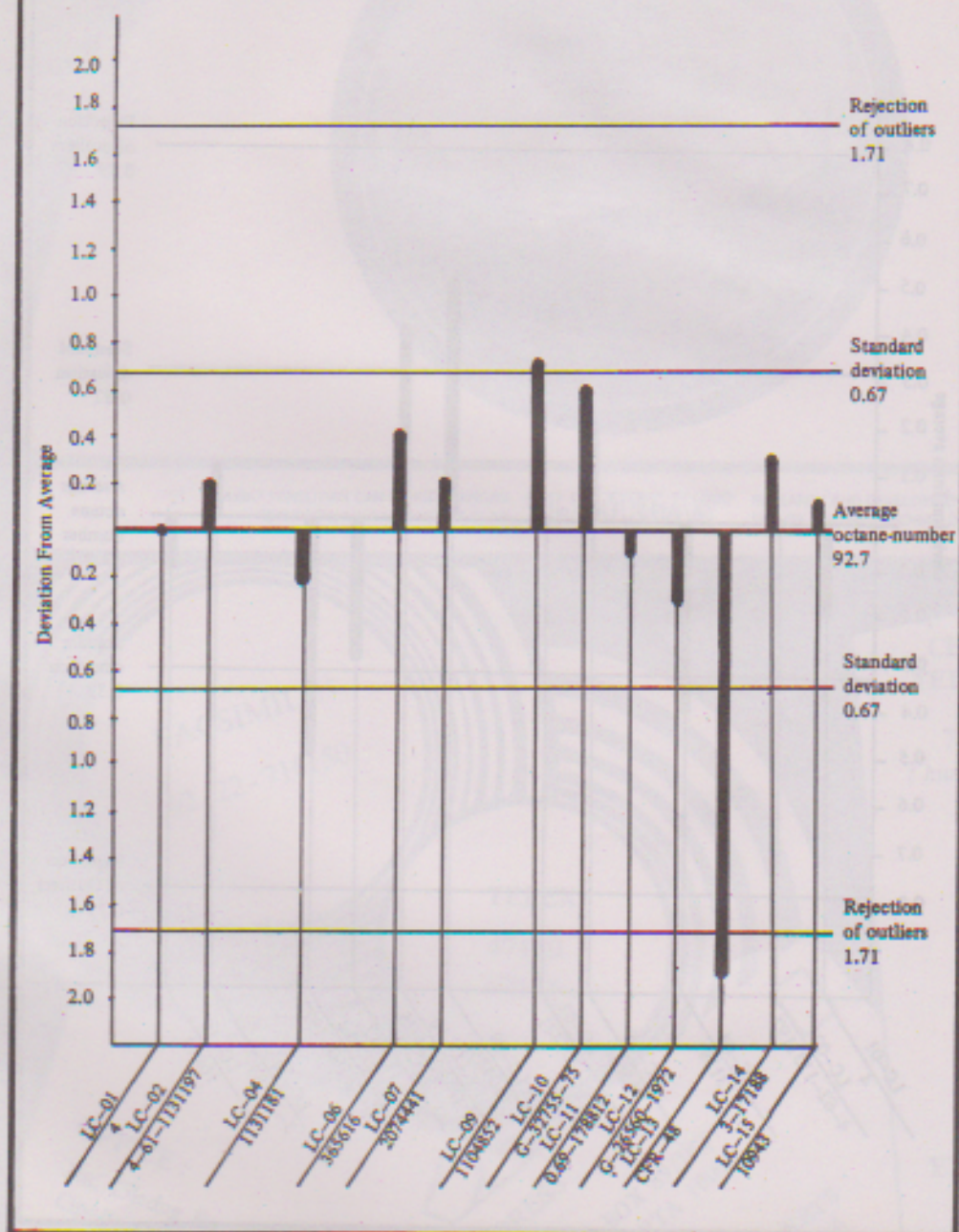
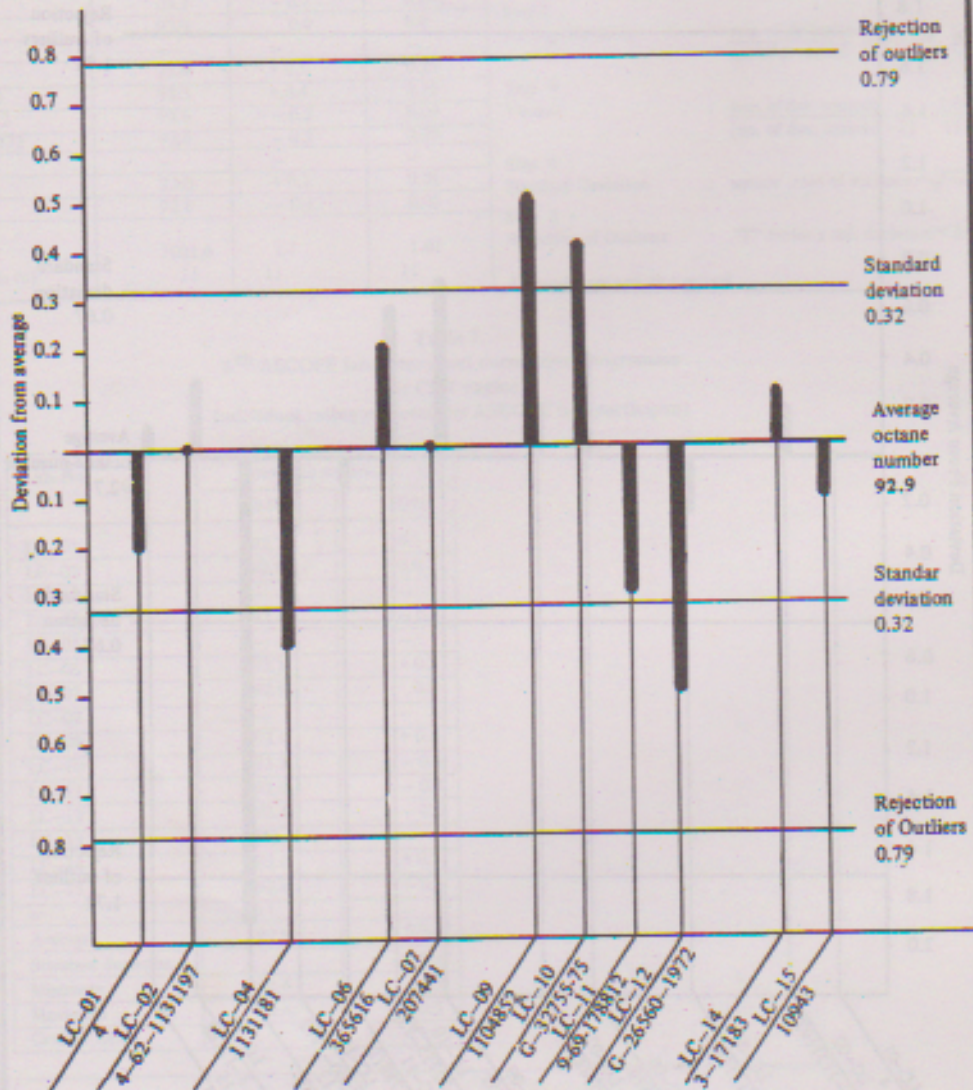


Figure 2
CFR 6th correlation
Deviation VS. lab. code (sample No. SC-01)
second calculation





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