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Ford-EPA Emission Laboratory Correlation Study

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Environmental Protection Agency
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Office of Mobile Source Air Pollution Control
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Standards Development and Support Branch
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Abstract

A specific emissions correlation program between the EPA Motor Vehicle Emissions Laboratory and the Ford Motor Company AEO facility has been completed. This report summarizes emission and cross check results for this program.

Examination of the Ford mass simulator results, gas cross check results, and emission and fuel economy comparisons do not indicate a serious correlation problem exists between laboratories.

Introduction

Analysis of paired 1977 model year durability emission test data from January through March have produced significant differences between Ford and EPA results. The problem has been most severe in the measurement of CO where EPA consistently reported cold start 1977 FTP values 20% higher than Ford results. Several pairs of test data have produced HC and CO differences in excess of 50%, although these large percent differences are most often observed at or below statutory standards.

Ford and EPA have conducted gas cross checks, mass emission simulator tests, and a vehicle correlation program. The results of these tests are part of a larger program to locate and correct or account for the discrepancies in emission results between manufacturers facilities and the EPA-MVEL based on paired emission differences.

1. Test Design

Three checks were made between facilities: a gas cross check analysis, tests with the Ford mass emission simulator, and a vehicle cross check using a 1977 Ford durability vehicle.

Mass Emission Simulator: On March 3, 1976, the Ford emissions simulator was tested using EPA CVS's 21 and 22 (analytical train #9). A CO analyzer failure prevented additional tests on CVS's 23 and 24 (analytical train #19).

Gas Cross Check: On March 4, 1976, a gas cross check was made at EPA to verify analyses of Ford supplied reference gases. The gases were read on EPA certification analysis systems 9 and 19, with the exception of the high concentration CO sample which was named on analysis train 9 only.

Vehicle Cross Check: A series of vehicle correlation tests were arranged using a 1977 Ford durability vehicle. A vehicle with a known history of emissions repeatability, REPCA III, supplied to EPA by General Motors, was used as a confirmatory test vehicle.

The Ford vehicle cross check consisted of cold start 1977 type tests, highway fuel economy tests, and hot start 1974 type tests. Each test day included one cold start test, 2 HFET's, and 2 hot start tests. This series of tests was completed on two successive days at each facility. The vehicle was then exchanged between laboratories until each laboratory had completed 6 cold starts, 12 HFET's, and 12 hot starts. All tests were scheduled for a single dynamometer with each facility supplying its test driver. Testing with the Ford durability vehicle began on March 25 and ended on April 14.

The GM REPCA III vehicle was tested two times at each facility using the same dynamometer and analysis equipment that were used for testing the Ford vehicle. Emission and torque data from the REPCA III vehicle were collected and statistically analyzed.

2. Test Vehicles

The Ford vehicle, I.D. No. 7A1-400-5AINP, had completed 50,000 miles durability testing in March. The vehicle was tested three times at EPA during its mileage accumulation and a summary of the emissions history of this vehicle is presented below:

		Composite Emission Results				
Test Site	Mileage	HC	CO	CO_2	NOx	F.E.
Ford	22,866	0.405	5.88	710	1.72	12.31
EPA		0.408	7.75	697	1.73	12.49
Ford	46,052	0.333	3.64	695	1.57	12.64
EPA		0.498	7.60	702	1.65	12.40
Ford	51,033	0.518	6.26	700	1.72	12.47
EPA		0.454	7.98	722	1.83	12.06
Ford	Average of	0.460	6.20	694	1.66	12.56
EPA	5 tests	0.377	5.57	686	1.77	12.78

The last set of data summarize the FTP results of this study. The vehicle is in the 5000 pound inertia class and has a 400 CID engine with automatic transmission. Emission controls include: engine modifications, an oxidation catalyst with secondary air injection, exhaust recirculation, and canister evaporative control.

The vehicle was equipped to measure carburetor inlet temperature, air cleaner inlet temperature, engine speed, change in engine speed, and manifold vacuum.

The repeatable emissions vehicle, REPCA III, is a 350 CID, 4500 pound inertia weight vehicle which has been modified to produce stable hot start emissions at approximately 1974 federal standards. REPCA III is equipped with torque wheels and a fifth wheel speed pickup. The digital recording system is designed to measure and display positive and negative torque and calculate and display positive and negative horsepower. The Ford-EPA correlation program summed torque and horsepower over the 1372 second LA-4 cycle.

2.1 Preconditioning:

Preconditioning for the first cold start at each test facility consisted of AMA, LA-4 dynamometer preconditioning, a 12 to 20 hour soak, and a one hour heat build. Evaporative emissions were not measured for the emission tests. Emission and fuel economy tests served as preconditioning for the second cold start test at each facility.

Dynamometer preconditioning consisting of steady state warmup was necessary to achieve a stable engine temperature before sampling emissions from REPCA III.

2.2 Facilities:

2.2-1 Equipment: Gas cross checks at EPA were conducted using analytical trains #9 and 19. Mass simulator tests were made on CVS's 21 and 22 (analytical train #9). Vehicle emission and fuel economy tests were run using test cells 2, 4, and 5 at Ford, while all tests were run using cell 5 and analytical train #33 at EPA.

2.2-2 Calibration: Dynamometers, CVS's, and analytical systems were determined to be operating properly when tests were conducted at Ford and EPA. Equipment checks and calibrations at EPA and Ford are performed at least as often as specified in the Federal Register.

3. Test Results

3.1 Mass Emissions Simulator Results

Mass emission results were obtained on only two sites due to a CO chopper motor failure on train #19 and a malfunctioning solenoid valve on the Ford emissions simulator. Results of the emissions simulator tests are shown in Tables 1 and 2.

3.2 Gas Cross Check Analyses

Ford reference gases were named within 2.6 percent on analytical systems 9 and 19. These results are presented in Table 3.

3.3 Exhaust Emission Results

The results of the exhaust emissions and fuel economy test are presented in Appendix A. HC, CO, CO_2 results are plotted in Figures 1-3. All emission and fuel economy results are composite values with units of gm/mile. NOx emissions were not plotted because the composite results are approximately equal for cold start, fuel economy, and hot start tests.

Changes in engine speed were measured and examined to determine if notable differences among test drivers at Ford and EPA could be detected. No significant variations could be observed.

3.4 REPCA III Results

The emission results from REPCA III exhibited much more variability than the baseline data supplied by GM and the vehicle was not judged useful for comparisons between laboratories. A baseline of twelve tests were run at GM to verify its repeatibility before its delivery to EPA. HC and CO emissions from the second sample bag of the LA-4 cycle have coefficients of variation of 1.5 and 2.7%, while 30 tests at EPA have variability of 8.5 and 16.0% for HC and CO respectively. The vehicle is now at the GM Proving Grounds to correct several mechanical problems and determine why the repeatability is poor.

Torque and horsepower data from the vehicle are valid and comparisons of two dynamometers are summarized in Table 4.

4. Analysis of Test Results

HC, CO, and CO_2 mass values from the Ford emission simulator are within $\pm$ 5% of the expected results. NOx values measured by EPA are slightly higher than expected theoretical limits. The reason for higher NOx values is not known, but the gas cross check and vehicle cross checks do not show similar NOx correlation problems.

Six gas cylinders were read on analysis trains #9 and #19: 1 HC, 2 CO, 1 CO_2, and 2 NOx. The high concentration CO cylinder was not read on train 19 because of an instrument failure. All gases were determined to be within 2.6% of their named concentrations.

Ford and EPA exhaust emission and fuel economy results are compared by using a statistical "t" test. As shown in Tables 5, 6, and 7 for cold start, fuel economy and hot start emission tests, statistically significant differences were proven at high confidence levels.

A statistical difference between Ford and EPA HC results exists at the 90% C.L. for cold start, fuel economy, and hot start tests. The differences are not believed to be important, however, because the magnitude of the differences are small; 0.08, 0.02, and 0.04 gm/mi for cold start, fuel economy, and hot start tests, respectively. Ford measured higher average HC values for all three types of tests and generally had higher variability for all emission and fuel economy tests. For CO, cold start tests showed differences between facilities of over 11%, with the Ford results higher. No significant CO differences are proven at the 90% C.L. for fuel economy or hot start tests. Statistical differences are not proven for NOx results from cold start, fuel economy, or hot start tests. A statistical difference between Ford and EPA measurements of CO_2 (8 gm/mi) is evident from an analysis of cold start tests at the

90% C.L. No other differences between measurements of CO_2 are observed, indicating the CO_2 differences between facilities are not serious. A difference of 0.2 mi/gal for urban fuel economy is statistically significant at the 90% C.L. This reflects the slight measurement differences in CO_2.

The effects of ambient conditions have not been accounted for in the analysis, although differences between facilities are significant. The notable differences are:

	P_B	T_D	R_H	K_H
$\bar{x}$ Ford	29.35	82.3	20.6	0.841
$\bar{x}$ EPA	29.02	73.0	41.0	0.901

Corrections for barometric pressure would be expected to produce a larger difference between Ford and EPA HC and CO measurements but the correlation between ambient conditions and HC and CO results is very poor. The significance of dry bulb temperature differences cannot be assessed from this program. Slightly lower Ford NOx measurements are probably related to their low levels of relative amd absolute humidity.

An analysis of the torque and horsepower results show statistical differences between facilities at the 90% C.L. but the importance of these differences can be assessed in terms of the differences between Ford and EPA values of NOx, CO_2 and fuel economy. Only slight differences in cold start measurements of NOx and calculated urban fuel economy were proven. The differences between torque measurements at Ford and EPA are less than previous measurements from the 1975 MVMA-EPA correlation program. The trends in dynamometer differences for torque and horsepower are more important than the statistical differences between Ford and EPA.

Conclusions

1) Based on this program the correlation between Ford and EPA test sites is acceptable. Emission and fuel economy tests and checks of dynamometers and analysis equipment do not indicate serious correlation problems.

2) The effect of ambient test conditions for this particular correlation vehicle are relatively unknown. Ford ambient test conditions are significantly different from average EPA ambient conditions but emissions measurements and calculated fuel economy results between facilities correlate well.

3) This program was unable to determine the causes for the poor correlation between Ford-EPA paired test results, or the reasons why the Ford-EPA correlation has now improved.

Recommendations

1) An MVMA-EPA correlation program would have identified correlation problems among the participating manufacturers much more efficiently. A

mutually acceptable correlation program between MVMA and EPA test laboratories would have been useful in determining the extent of suspected emissions correlation problems. Such a program should be conducted in the future.

2) Humidity control at Ford and EPA should be improved, particularly at Ford.

Table 1

AEO VEHICLE EXHAUST SIMULATOR RESULTS ON EPA CVS SYSTEM #1

March 3, 1976 - One Test

Bag	Orifice Bank	Constituent	Measured Gram Value	Time Adjusted Gram Value[1]	AEO 5% Upper Limit	AEO 5% Lower Limit
#1	#1 & #2	HC	3.01	2.46	2.63	2.38
		CO	41.1	33.6	34.9	32.2
		CO_2	827	677	726	656
		[2] NOx	5.49	4.48	4.54	4.10
#2	#2	HC	1.81	1.48	1.54	1.40
		CO	28.3	23.2	23.6	21.3
		CO_2	832	681	727	657
		[2] NOx	3.54	2.90*	2.80	2.53
#3	#1	HC	1.24	1.01	1.11	1.00
		CO	13.7	11.2	11.5	10.4
		CO_2	839	686	729	659
		[2] NOx	2.21	1.80*	1.78	1.61

1. Multiplied by 180 sec./220 sec for 180 sec. test.
2. Corrected NOx values have been divided by the humidity correction factor of 0.884 to yeild uncorrected results.

*Out of 5% Limits.

Table 2

AEO VEHICLE EXHAUST SIMULATOR RESULTS ON EPA CVS SYSTEM #2

March 3, 1976 - One Test

Bag	Orifice Bank	Constituent	Measured Gram Valve	Time Adjusted[1] Gram Value	AEO 5% Upper Limit	AEO 5% Lower Limit
#1	#1 & #2	HC	3.04	2.49	2.63	2.38
		CO	41.0	33.5	34.9	32.2
		CO_2	822	672	726	656
		[2] NOx	5.59	4.57*	4.54	4.10
#2	#2	HC	1.83	1.50	1.54	1.40
		CO	29.0	23.7*	23.6	21.3
		CO_2	832	681	727	657
		[2] NOx	3.56	2.91*	2.80	2.53
#3	#1	HC	1.27	1.04	1.11	1.00
		CO	14.0	11.4	11.5	10.4
		CO_2	849	695	729	659
		[2] NOx	2.27	1.85*	1.78	1.61

1. Multiplied by 180 sec/220 sec for 180 sec. test.
2. Corrected NOx values have been divided by the humidity correction factor of 0.877 to yeild uncorrected results.

*Out of 5% limits.

Table 3

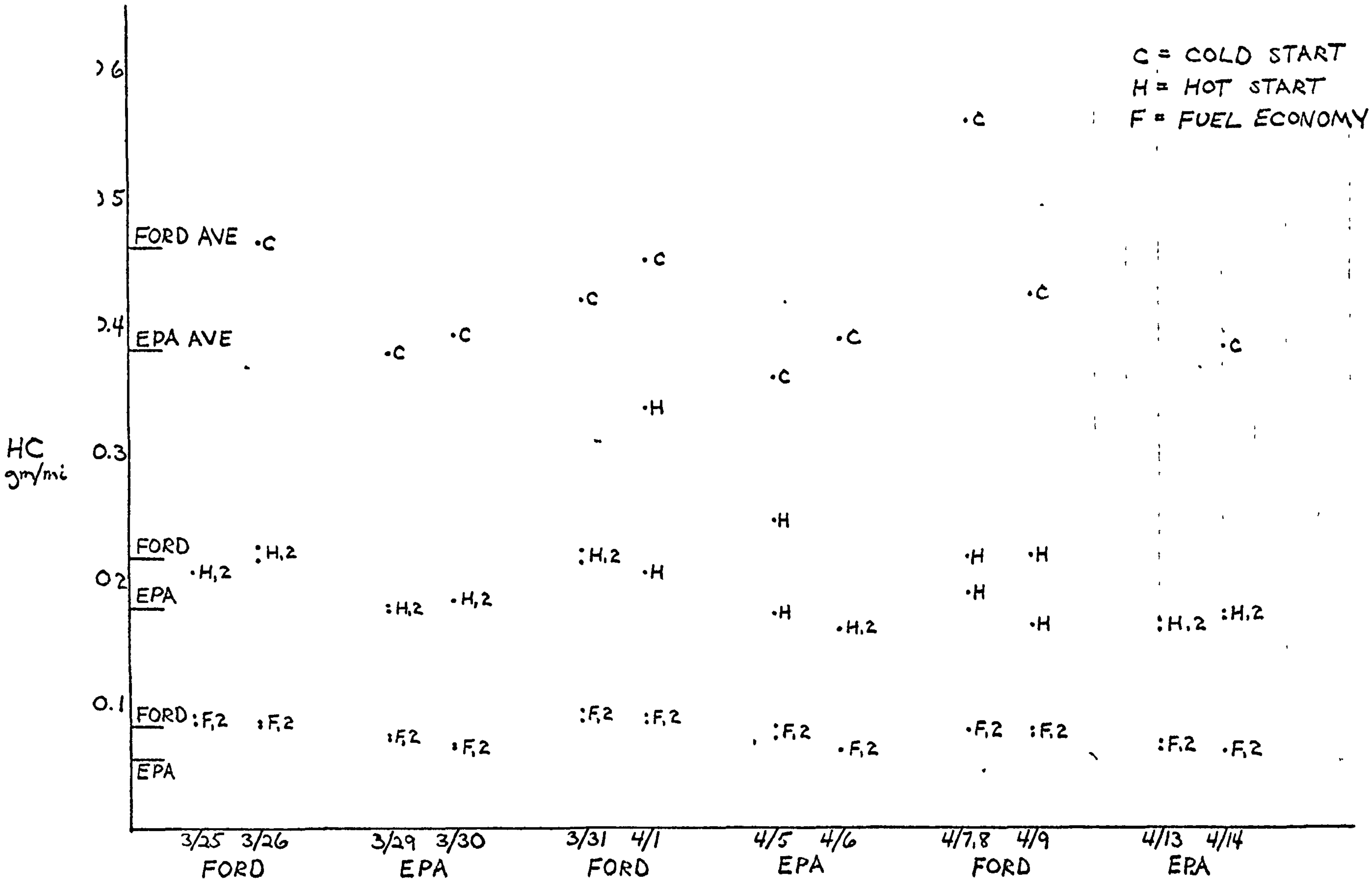
Ford-EPA Gas Cross Check

Ford Results	EPA Results		% Difference*	
	Train 19	Train 9	Train 19	Train 9
A 3470 CO 675	684.0	692.7	-1.3	-2.5
A 1563 CO 1275	——**	1250.4	——	+2.0
A 10817 HC 50.82	51.30	50.24	-0.9	+1.2
A 14870 CO_2 1.93	1.92	1.90	+0.5	+1.6
A 5482 NO_x 44.7	44.6	44.9	+0.2	-0.4
A 4969 NO_x 81.2	80.7	83.4	+0.6	-2.6

* % Difference = $\frac{\text{Ford - EPA}}{\text{EPA}}$

** High CO Range on Train 19 Inoperative

Figure 1



C = COLD START
H = HOT START
F = FUEL ECONOMY
HC
gm/mi
0.3
0.2
0.1
FORD AVE
EPA AVE
FORD
EPA
FORD
EPA
3/25 3/26
FORD
3/29 3/30
EPA
3/31 4/1
FORD
4/5 4/6
EPA
4/7,8 4/9
FORD
4/13 4/14
EPA

Figure 2

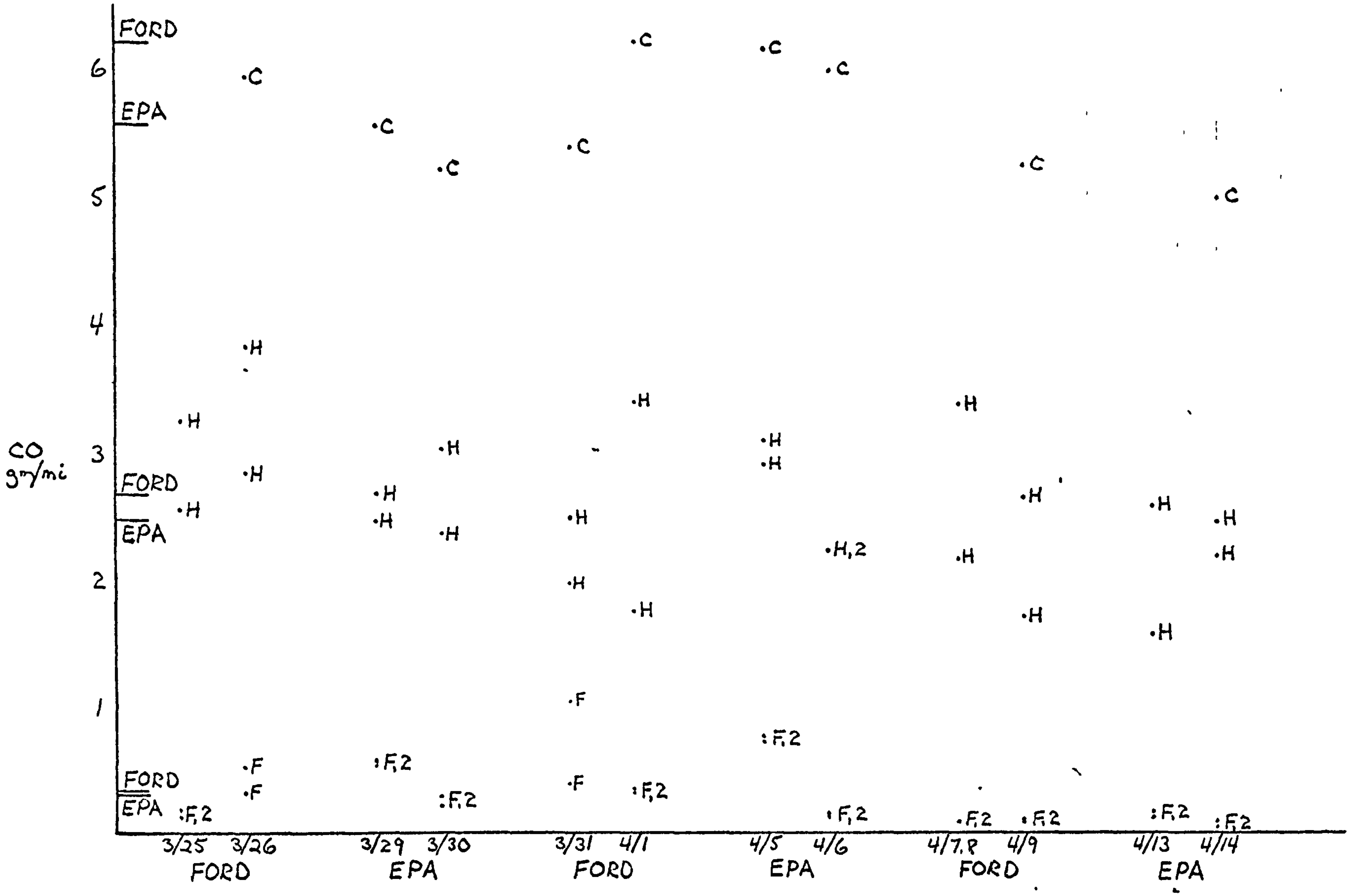
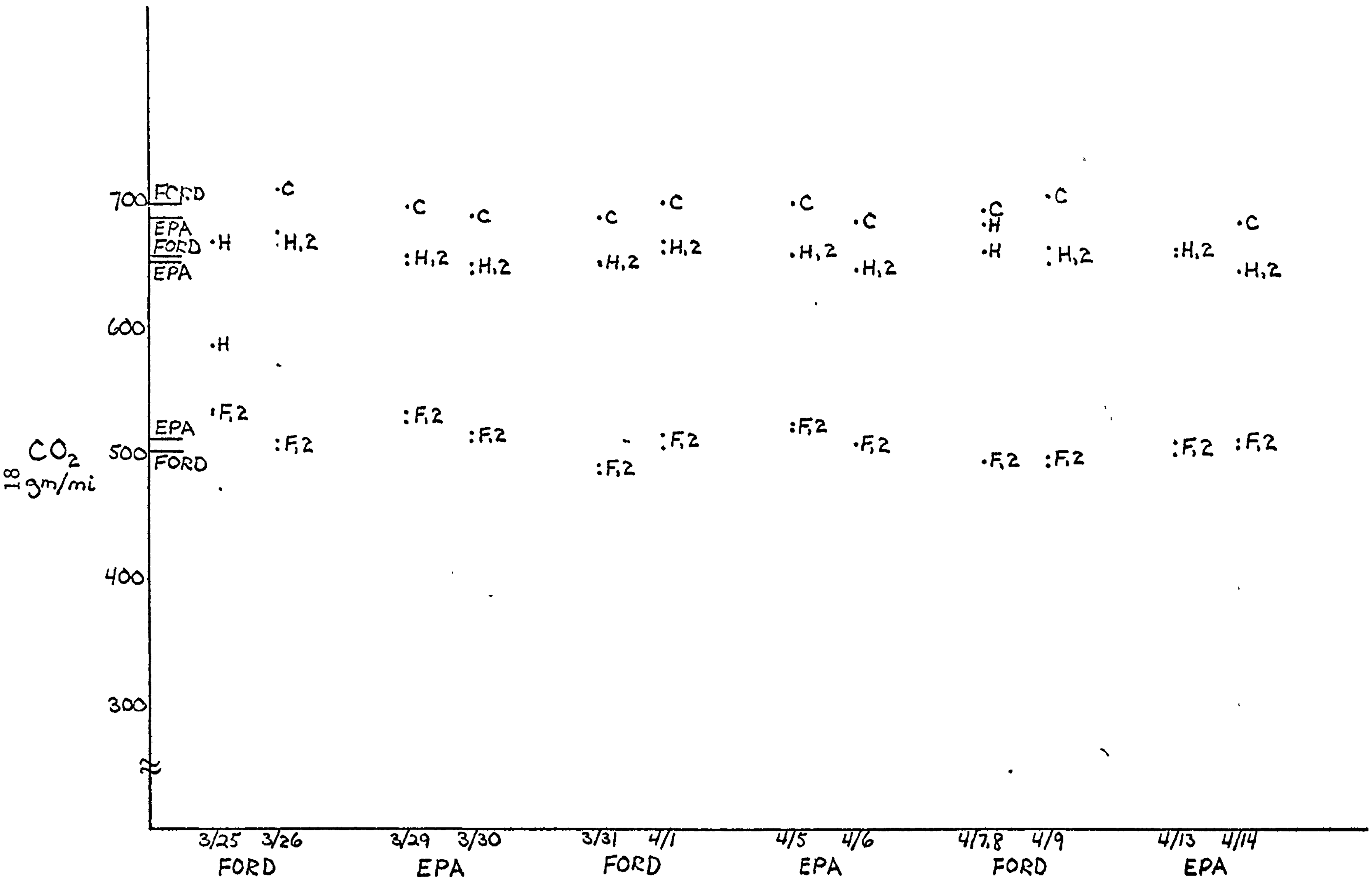

CO
gm/mi
FORD
EPA
FORD
EPA
FORD
EPA
6
5
4
3
2
1
3/25 3/26
FORD
3/29 3/30
EPA
3/31 4/1
FORD
4/5 4/6
EPA
4/7,8 4/9
FORD
4/13 4/14
EPA

Figure 3



CO2 gm/mi
700
600
500
400
300
FORD
EPA
FORD
EPA
EPA
FORD
C
H
H,2
F,2
3/25
3/26
3/29
3/30
3/31
4/1
4/5
4/6
4/7,8
4/9
4/13
4/14
FORD
EPA
FORD
EPA
FORD
EPA

Table 4

Dynamometer Correlation

FORD

Site 4 n = 3	+Torque ft-lbf-sec	-Torque	Roll Ft.	+Horsepower horsepower-sec	-Horsepower
$\overline{X}$	208,750	114,837	38,619	10,203	3,806
σ	1,129	1,126	117	64	20
CV	0.5	1.0	0.3	0.6	0.5

EPA

Site 5 n = 6	+Torque	-Torque	Roll Ft.	+Horsepower	-Horsepower
$\overline{X}$	206,535	110,856	38,281	9,994	3,645
σ	1,576	1,113	111	95	25
CV	0.8	1.0	0.3	1.0	0.7

	+Torque	-Torque	Roll Ft.	+Horsepower	-Horsepower
$\overline{X}_F - \overline{X}_E$	2,215	3,981	338	209	161
$\frac{\overline{X}_F - \overline{X}_E}{\overline{X}_E} \times 100\%$	1.1	3.6	0.9	2.1	4.4
t - statistic	2.14	5.04	4.24	3.38	9.54
t - values					
99% C.L.	ND	D	D	ND	D
3.50					
90% C.L.	D	D	D	D	D
1.90					

Table 5

Cold Start Correlation

<u>Ford</u>

n = 5	HC	CO	NO_x	CO_2	FE
$\overline{X}$	0.460	6.201	1.664	694.2	12.56
σ	0.051	1.041	0.107	8.9	0.15
CV	11.0	16.8	6.4	1.3	1.2
Min.	0.419	5.23	1.54	685	12.4
Max.	0.556	7.64	1.79	706	12.8

<u>EPA</u>

n = 5					
$\overline{X}$	0.377	5.570	1.766	686.4	12.78
σ	0.015	0.497	0.090	7.5	0.13
CV	4.0	8.9	5.1	1.1	1.0
Min.	0.356	4.97	1.68	678	12.6
Max	0.390	6.15	1.86	694	12.9
$\overline{X}_F - \overline{X}_E$	0.083	0.631	-0.102	7.8	-0.22
$\frac{\overline{X}_F - \overline{X}_E}{\overline{X}_E} \times 100\%$	+22.0	+11.3	-5.8	+1.1	-1.7
t = statistic	3.26	0.92	-1.63	1.88	-1.99
t - values					
99% C.L. 3.36	ND*	ND	ND	ND	ND
90% C.L. 1.86	D**	ND	ND	D	D

*No difference exists
**Difference exists

Table 6

Fuel Economy Correlation

FORD n = 12	HC	CO	NO_x	CO_2	FE
$\overline{X}$	0.082	0.298	1.610	502.2	17.67
σ	0.006	0.273	0.106	17.1	0.58
CV	7.3	91.5	6.6	3.4	3.4
Min.	0.072	0.077	1.46	483	16.6
Max.	0.093	1.03	1.86	534	18.3
EPA n = 12					
$\overline{X}$	0.066	0.309	1.645	512.6	17.33
σ	0.007	0.26	0.162	10.1	0.36
CV	10.3	85.0	9.8	2.0	2.1
Min.	0.059	0.042	1.47	502	16.7
Max.	0.08	0.76	1.86	531	17.9
$\overline{X}_F - \overline{X}_E$	0.016	-0.011	-0.035	-10.4	0.3
$\frac{\overline{X}_F - \overline{X}_E}{\overline{X}_E} \times 100\%$	+24.2	-3.6	-2.1	- 2.0	+1.7
t - statistic	6.18	-0.10	-0.63	- 1.68	+1.72
t - values					
99% C.L.	D	ND	ND	ND	ND
90% C.L. 1.72	D	ND	ND	ND	ND

Table 7

Hot Start Correlation

<u>FORD</u>

n = 12	HC	CO	NO_x	CO_2
$\overline{X}$	0.215	2.656	1.538	654.3
σ	0.041	0.692	0.080	24.3
CV	19.0	26.0	5.2	3.7
Min.	0.159	1.70	1.43	583
Max.	0.333	3.82	1.67	678

<u>EPA</u>

n = 12	HC	CO	NO_x	CO_2
$\overline{X}$	0.174	2.470	1.583	648.8
σ	0.023	0.421	0.067	6.7
CV	13.0	17.1	4.2	1.0
Min.	0.155	1.56	1.49	641
Max.	0.243	3.08	1.70	659
$\overline{X}_F - \overline{X}_E$	0.041	0.186	-0.045	5.5
$\frac{\overline{X}_F - \overline{X}_E}{\overline{X}_E} \times 100\%$	+23.6	+7.5	-2.8	+0.8
t - statistic	3.05	0.79	-1.47	0.76
t - values				
99% C.L. 2.82	D	ND	ND	ND
90% C.L. 1.72	D	ND	ND	ND

APPENDIX A

Composite Emission Results from Correlation Vehicle 7A1-400-5A1NP

Date	Test Type	Site	HC	CO	CO_2	NOx	F.E.	T_d/T_w	P_B	R_H	NOx K_H
Ford											
3/25	CVS-C	5	VOID								
	HFET		0.089	0.117	534	1.65	16.6	80.0/57.0	29.30	21	0.833
	HFET		0.084	0.175	532	1.72	16.7	80.0/57.0	29.30	21	0.833
	CVS-H		0.204	2.54	583	1.59	15.1	80.0/57.0	29.31	21	0.833
	CVS-H		0.204	3.24	666	1.49	13.2	80.0/57.0	29.33	21	0.833
3/26	CVS-C	2	0.464	5.94	706	1.54	12.4	80.0/60.0	29.31	29	0.878
	HFET		0.085	0.512	509	1.63	17.4	84.0/62.0	29.28	27	0.887
	HFET		0.082	0.315	501	1.86	17.7	88.0/65.0	29.27	28	0.917
	CVS-H		0.213	2.83	664	1.64	13.3	86.0/64.0	29.23	29	0.911
	CVS-H		0.224	3.82	672	1.47	13.1	82.0/64.0	29.15	37	0.939
EPA											
3/29	CVS-C	5	0.376	5.55	694	1.86	12.6	75.0/60.5	29.05	43	0.921
	HFET		0.072	0.575	531	1.86	16.7	72.0/60.0	29.06	49	0.932
	HFET		0.074	0.533	524	1.91	16.9	73.5/60.5	29.06	47	0.930
	CVS-H		0.172	2.67	655	1.57	13.4	74.0/61.5	29.02	49	0.947
	CVS-H		0.176	2.46	649	1.60	13.6	74.0/61.2	29.01	48	0.941
3/30	CVS-C	5	0.390	5.21	686	1.86	12.8	76.0/63.5	28.74	50	0.977
	HFET		0.064	0.253	516	1.79	17.2	74.5/62.0	28.72	49	0.957
	HFET		0.066	0.216	509	1.80	17.4	73.0/62.0	28.73	54	0.968
	CVS-H		0.18	2.35	649	1.70	13.6	74.5/63.0	28.73	53	0.978
	CVS-H		0.18	3.02	642	1.65	13.7	75.5/62.5	28.73	48	0.960

Date	Test Type	Site	HC	CO	CO_2	NOx	F.E.	T_d/T_w	P_B	R_H	NOx K_H
Ford											
3/31	CVS-C	2	0.419	5.38	685	1.60	12.8	80.0/57.0	29.18	21	0.834
	HFET		0.085	0.378	489	1.46	18.1	82.0/57.0	29.17	18	0.824
	HFET		0.093	1.03	483	1.51	18.3	83.0/57.0	29.17	16	0.819
	CVS-H		0.220	1.97	650	1.43	13.6	84.0/58.0	29.10	17	0.827
	CVS-H		0.211	2.49	648	1.50	13.6	80.0/57.0	29.31	21	0.833
4/1	CVS-C	2	0.449	6.20	697	1.63	12.5	83.0/58.0	29.12	19	0.832
	HFET		0.084	0.351	514	1.50	17.2	83.0/58.0	29.14	19	0.832
	HFET		0.082	0.354	503	1.61	17.6	83.0/58.0	29.15	19	0.832
	CVS-H		0.333	3.39	666	1.57	13.2	83.0/58.0	29.14	19	0.832
	CVS-H		0.201	1.74	658	1.44	13.4	83.0/58.0	29.16	19	0.832
EPA											
4/5	CVS-C	5	0.356	6.15	694	1.75	12.6	73.5/58.5	29.02	40	0.896
	HFET		0.07	0.76	522	1.68	16.9	72.0/57.5	29.00	40	0.889
	HFET		0.08	0.72	516	1.67	17.1	72.0/57.0	29.00	39	0.882
	CVS-H		0.169	2.89	655	1.67	13.4	72.5/56.5	28.96	36	0.871
	CVS-H		0.237	3.08	653	1.74	13.4	72.5/57.0	28.97	38	0.879
4/6	CVS-C	5	0.386	5.97	680	1.68	12.8	70.5/58.5	28.94	49	0.916
	HFET		0.06	0.15	506	1.53	17.5	72.0/58.0	28.94	42	0.898
	HFET		0.06	0.12	505	1.51	17.6	74.0/57.5	28.94	35	0.878
	CVS-H		0.156	2.23	641	1.53	13.7	73.0/56.5	28.94	34	0.869
	CVS-H		0.157	2.22	643	1.50	13.7	72.5/56.5	28.93	36	0.872

Date	Test Type	Site	HC	CO	CO_2	NOx	F.E.	T_d/T_w	P_B	R_H	NOx K_H
Ford											
4/7	CVS-C	4	0.556	7.64	690	1.76	12.6	81/57	29.53	19	0.826
	HFET		0.076	0.086	491	1.58	18.1	81/57	29.54	19	0.826
	HFET		0.076	0.086	490	1.61	18.1	81/57	29.54	19	0.826
4/8	CVS-H		0.215	3.36	657	1.48	13.4	83/57	29.61	16	0.815
	CVS-H		0.185	2.16	678	1.58	13.0	83/58	29.62	18	0.829
4/9	CVS-C	4	0.420	5.23	702	1.79	12.5	84/57	29.68	14	0.810
	HFET		0.077	0.100	493	1.60	18.0	85/60	29.66	20	0.846
	HFET		0.072	0.077	487	1.59	18.2	85/58	29.64	15	0.818
	CVS-H		0.159	2.63	648	1.60	13.6	80/56	29.61	18	0.818
	CVS-H		0.216	1.70	661	1.67	13.4	81/56	29.60	17	0.813
EPA											
4/13	CVS-C	5	VOID								
	HFET		0.061	0.109	507	1.49	17.5	73.0/55.5	29.31	31	0.851
	HFET		0.066	0.160	496	1.47	17.9	72.5/55.0	29.31	30	0.847
	CVS-H		0.163	2.56	659	1.54	13.4	72.5/55.0	29.31	30	0.847
	CVS-H		0.155	1.56	653	1.59	13.5	72.0/55.0	29.31	32	0.850
4/14	CVS-C	5	0.379	4.97	678	1.68	12.9	72.0/56.5	29.18	37	0.872
	HFET		0.059	0.068	508	1.56	17.5	72.0/57.0	29.17	39	0.880
	HFET		0.059	0.042	502	1.47	17.7	73.0/57.0	29.17	36	0.874
	CVS-H		0.165	2.43	642	1.49	13.7	72.0/56.5	29.17	37	0.872
	CVS-H		0.169	2.17	641	1.54	13.7	72.0/57.0	29.17	39	0.880