EPA-AA-SDSB-87-6

Technical Report

Heavy-Duty Engine Testing Report - Correlation Testing of Isuzu 5.79L/JAMA Engine

By

Thomas M. Baines

June, 1987

Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Sources
Office of Air and Radiation
U. S. Environmental Protection Agency

I. Background

The correlation between the heavy-duty test facilities of a manufacturer and EPA's test facilities is of significant interest to both the manufacturer and EPA. It is especially important to establish correlation in this timeframe in that relatively new transient heavy-duty engine testing procedures have been implemented. Thus, EPA/MVEL conducted testing on an Isuzu engine with the intent of providing correlation data for comparison with similar data developed by four Japanese Automobile Manufacturers Association (JAMA) member companies. The intent of this report is to summarize this testing program.

II. Engine, Fuels, Test Procedures and Test Plan

The engine that was used in this program was supplied by Isuzu specifically for this correlation testing. It was a 165 horsepower, in-line six cylinder HD diesel which displaces 353 cubic inches (5.79L). The engine is rated at 3000 RPM and peak torque of 335 ft-lb occurs at 1900 RPM.

The fuel used was a Phillips Reference DF2 known as lot G-463. A copy of the fuel analysis is included in the Appendix. The fuel was presented to the engine at 0 to 0.5 psi and at a temperature less than 100°F. All Federal Test Procedure regulations were used in this testing. The engine was shutdown using the fuel shut off lever and simultaneous dynamometer dial-down. The restrictions were set at an inlet depression of 15.7 inches water and an exhaust backpressure of 3.9 inches mercury. The restrictions were checked after testing was completed and found to be very close to the initial settings.

The test plan for this engine (a copy of which is included in the Appendix) called for setting up the engine using the normal engine set-up procedures. This was followed by three sets of: a) one cold start and three hot starts, b) check restrictions and c) natural cool down. Emissions were also measured during four steady state conditions.

III. Results

The results from this work are presented in Tables 1 through 4. The reader is encouraged to review these tables, using the following narrative to assist in interpreting the data highlights contained therein.

Table 1 presents the key torque lug map data and resultant integrated reference brake horsepower from all five labs. There is good agreement in all the data categories for all the testing facilities. Whereas of course close correlation is desirable for all key torque lug map data, one of the more important measures is the integrated reference horsepower.

Table 1

Table of Engine Performance Data
From Isuzu 5.79L JAMA Correlation Engine

Lab	Idle rpm	Peak Torque		Peak Power		Ref. BHP-hr
		ft-lb	Peak torque speed-rpm	HP	Peak power speed-rpm	
EPA	590	345.8	2595	173	3027	11.068
Nissan	580*	336	2080*	169	2950*	10.97
HINO	600*	341	2065*	172	2980*	11.07
Mitsubishi	600*	341	2100*	172	3070*	11.27
Isuzu	580*	338	1994*	164	3040*	10.81

* Approximate values read from analogue map.

This number reflects not only the torque map results but also the process of cycle denormalization and integration. All labs were within 2.3 percent of EPA on this measure. Note that EPA reports a higher speed at which peak torque occurs than the other laboratories. This is not considered to be significant, given the flatness of the torque curve across this speed range.

Tables 2, 3, and 4 present the composite, cold start and hot start transient results, respectively. These tables present the usual brake specific HC, CO, NOx and particulate results. However, instead of presenting brake specific fuel consumption (BSFC), CO_2 is given because no BSFC results were provided by the JAMA participants. (Carbon dioxide, or CO_2, emission results are major component of the BSFC calculation.) Carbon dioxide or BSFC values are interesting to compare between labs because they tend to be a sensitive measure of how the engine was operated at the facility in question, which in turn can influence emissions.

All of the data contained in Tables 2 through 4 will be discussed collectively by laboratory. However, the hot start will be emphasized because: 1) there are more such data, and 2) hot start numbers makeup about 86 percent of the composite emissions test results and composite results are the most important data for comparison analyses.

There are two general types of analyses that can be made regarding correlation data. The first is the repeatability of a given set of data, which if below a given level (which is pollutant specific) can be an indicator of the quality of the data set. In other words, a quality set of repeat hot start tests (the major component of composite test results and less variable than the cold start segment) within one lab will have a maximum variability as measured by the coefficient of variation which is the standard deviation divided by the mean (times 100 to give percent). Such variability will primarily be reflective of engine repeatability and less reflective measurement variability. In various HDD labs,for many types of engines, these maximum variabilities have been found to be the following:

Emission	(s/x) (100), Max.
HC	12
CO	7
NOx	5
Particulate	7
BSFC	3

The other analysis that can be made on a set of correlation data is how a different lab's data compares to that developed by EPA. Here, a percent difference relative to EPA less than the within-lab variability maximum would be considered good correlation where as a percent difference relative to EPA in

Table 2

Table of Composite Transient Results
From Isuzu 5.79L JAMA Correlation Engine

Lab	Emissions, g/BHP-hr HC	CO	NOx	CO_2	Part
EPA					
3311***	.62	1.84	6.44	645.4	.52
3312	.61	1.84	6.31	638.4	.53
3317	.61	1.75	6.10	636.7	.55
3318	.60	1.73	5.89	634.8	.56
$\bar{X}$	.61	1.79	6.19	638.8	.54
COV**	1.3	3.3	3.9	0.7	3.4
NISSAN					
$\bar{X}$	.63	1.87	6.49	637.2	.677
Δ%*	3.28	4.47	4.93	-0.25	25.37
HINO					
$\bar{X}$	.57	1.78	6.074	594.0	.551
Δ%*	-6.56	-.56	-1.79	-7.02	2.04
MITSUBISHI					
$\bar{X}$	.68	1.70	6.02	609.7	.493
Δ%*	11.5	-5.03	-2.67	-4.56	-8.70
ISUZU					
$\bar{X}$	.70	1.94	7.09	667.3	.573
Δ%*	14.8	8.38	14.63	4.46	6.11

* Relative to EPA.
** COV = Coefficient of Variation, in percent ($s/\bar{X}$ x 100).
*** EPA test number.

Table 3

Table of Cold Start Transient Results
From Isuzu 5.79L JAMA Correlation Engine

Lab	Emissions, g/BHP-hr HC	CO	NOx	CO_2	Part
EPA					
3311***	.64	2.21	6.67	658.2	.60
3312	.68	2.18	6.66	655.2	.56
3317	.66	2.16	6.04	653.3	.57
3318	.65	2.18	6.02	655.1	.64
$\bar{X}$	.66	2.18	6.35	655.5	.59
COV**	2.6	0.94	5.8	0.3	6.07
NISSAN					
$\bar{X}$	.67	2.11	6.51	653.2	.761
Δ%	1.90	-3.32	2.56	-.34	28.4
HINO					
$\bar{X}$	.67	2.04	6.10	609.1	.627
Δ%*	1.90	-6.53	-3.90	-7.07	5.82
MITSUBISHI					
$\bar{X}$	.78	1.81	6.14	625.3	.506
Δ%*	18.6	-17.07	-3.27	-4.52	-14.60
ISUZU					
$\bar{X}$	.89	2.39	7.49	707.7	.682
Δ%*	35.4	9.51	18.00	7.97	15.11

* Relative to EPA.
** COV = Coefficient of variation, in percent ($s/\bar{X}$ x 100).
*** EPA test number.

Table 4

Table of Hot Start Transient Results
From Isuzu 5.79L JAMA Correlation Engine

Lab	Emissions, g/BHP-hr HC	CO	NOx	CO_2	Part
EPA					
3300***	.52	1.82	5.82	601.0	.48
3301	.56	1.71	5.82	606.0	.50
3302	.62	1.80	6.24	603.2	.50
3303	.57	1.81	6.00	594.2	.50
3306	.66	1.78	6.17	660.1	.52
3307	.64	1.74	6.05	596.4	.50
3308	.58	1.76	6.26	599.9	.51
3311	.61	1.78	6.40	643.2	.51
3312	.59	1.79	6.25	635.5	.52
3317	.60	1.68	6.10	633.9	.55
3318	.60	1.65	5.87	636.5	.54
3305	.64	1.80	6.16	596.3	.51
$\bar{X}$	.60	1.76	6.10	617.2	.51
COV**	6.50	3.08	3.08	3.72	3.71
NISSAN					
$\bar{X}$	.60	1.83	6.48	633.8	.664
Δ%*	0	3.98	6.32	2.69	29.77
HINO					
$\bar{X}$	.55	1.73	6.07	591.5	.538
Δ%*	-8.21	-1.70	-0.41	-4.16	5.15
MITSUBISHI					
$\bar{X}$	.66	1.68	6.00	607.0	.491
Δ %*	10.2	-4.55	-1.56	-1.65	-4.04
ISUZU					
$\bar{X}$	.67	1.87	7.03	660.8	.55
Δ %*	11.67	6.25	15.3	7.07	7.49

* Percent difference relative to EPA.
** COV = Coefficient of variation, in percent ($s/\bar{X} \times 100$).
*** EPA test number.

excess of the within-lab variability maximum would indicate an area that should be investigated for improvement.

Starting with the EPA results, the variation in the data is generally low, with the coefficient of variation (COV) for each group of measurements generally being well below the COV maximum expected for such results. The Nissan results for HC, CO, and CO_2, were quite comparable to those of EPA. Their NOx results were somewhat high and their particulate results were very high; 25 to 30 percent higher than EPA's particulate data.

The Hino results were generally very comparable for CO, NOx and particulate. The Hino HC results tend to be a little bit low and CO_2 was markedly low (especially the cold start data).

The Mitsubishi data were quite high for HC and low for CO, NOx, CO_2 and particulate. The Isuzu were significantly higher than EPA for all measured values.

Steady state tests were conducted and the data are included in the Appendix (test numbers 863310 and 863319). Gas correlation analyses were also made and these results are also included in the Appendix.

Summary and Conclusions

The results from this work can be summarized as follows:

- The EPA results were very repeatable.

- The following table summarizes the trends of the individual manufacturers' data compared to that of EPA. The direction of the arrow corresponds to whether the manufacturers data is higher (↑) or lower (↓) than that of EPA. A dash (-) signifies no major difference, a single arrow signifies a trend and a double arrow signifies a significant difference.

Lab	HC	CO	NOx	CO_2	Part.
Nissan	-	-	↑	-	↑↑
Hino	↓	-	-	↓↓	-
Mitsubishi	↑	↓	-	↓	↓
Isuzu	↑↑	↑	↑↑	↑↑	↑

APPENDIX

Contents:

EPA Map Data
Nissan Torque Curve
Hino Torque Curve
Mitsubishi Torque Curve
Isuzu Torque Curve
EPA Summary Reports
JAMA Data Tables
EPA Gas Analysis Results
JAMA Gas Analysis Results
Testing Plan
Engine Set-up/Data Sheet
JAMA Letter
Fuel Data Sheet

Engine Map Data from
Isuzu ISZ35384 JAMA
Engine Correlation-EPA Lab

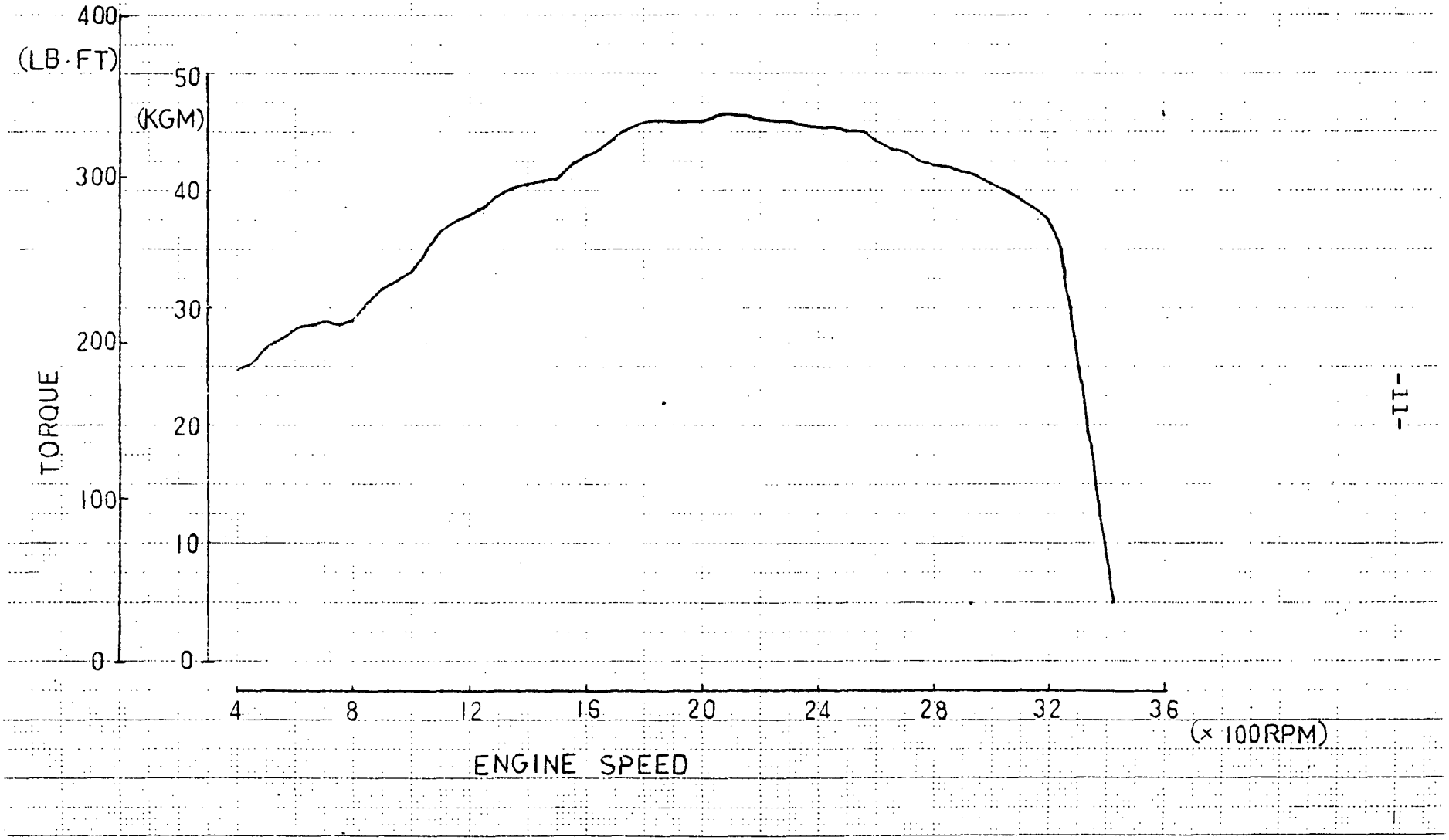
THERE ARE (368) MAPPING DATA POINTS

576.	196.2	1048.	258.6	1536.	318.6	2025.	342.6	2514.	334.6	3002.	301.4
578.	196.6	1056.	262.2	1545.	319.8	2034.	343.0	2523.	334.6	3010.	300.6
579.	198.2	1064.	264.6	1553.	320.2	2043.	343.4	2531.	334.2	3018.	299.8
584.	200.2	1072.	266.6	1560.	319.8	2050.	343.4	2539.	333.4	3027.	299.8
592.	200.6	1081.	270.6	1569.	321.0	2058.	344.2	2546.	333.0	3034.	299.0
599.	202.6	1088.	273.0	1577.	321.4	2066.	344.2	2554.	333.4	3043.	297.4
608.	203.8	1096.	274.6	1585.	321.8	2074.	344.2	2562.	333.4	3051.	295.4
616.	205.0	1105.	275.8	1592.	322.6	2082.	345.0	2570.	333.0	3059.	294.2
624.	206.2	1113.	278.6	1600.	323.0	2089.	345.8	2578.	333.0	3066.	293.4
632.	207.0	1120.	279.8	1610.	323.8	2098.	345.4	2585.	332.2	3073.	292.2
640.	207.8	1129.	281.8	1617.	325.0	2106.	345.8	2595.	331.0	3082.	291.8
648.	208.2	1137.	282.6	1624.	326.6	2114.	345.8	2602.	330.6	3090.	290.6
656.	207.4	1146.	283.4	1634.	327.4	2121.	345.4	2611.	329.4	3098.	289.8
664.	207.4	1152.	284.6	1640.	327.8	2128.	345.0	2618.	328.2	3105.	288.2
671.	207.0	1160.	285.8	1647.	329.0	2138.	345.0	2626.	328.2	3114.	288.2
679.	205.8	1168.	287.0	1657.	329.8	2146.	344.2	2634.	328.2	3122.	286.2
687.	205.8	1176.	288.6	1666.	331.0	2154.	345.0	2642.	328.2	3131.	285.4
695.	206.2	1184.	289.4	1673.	331.8	2161.	345.0	2651.	327.4	3138.	284.2
702.	207.4	1192.	291.0	1680.	332.2	2170.	345.0	2660.	326.2	3147.	284.2
711.	207.0	1199.	292.2	1689.	332.6	2177.	344.6	2667.	325.4	3154.	284.2
720.	207.4	1208.	292.6	1698.	333.8	2185.	344.6	2675.	324.6	3162.	282.6
727.	208.2	1216.	293.4	1705.	335.0	2194.	343.8	2683.	324.2	3170.	281.8
734.	208.6	1224.	294.6	1712.	335.4	2202.	343.4	2691.	323.8	3177.	280.2
743.	208.2	1232.	295.0	1721.	335.8	2209.	343.4	2698.	324.2	3186.	277.8
751.	208.2	1241.	295.0	1728.	336.6	2218.	343.8	2707.	323.0	3194.	276.2
758.	209.8	1249.	296.6	1736.	337.0	2226.	343.4	2716.	322.2	3202.	275.0
767.	210.2	1257.	297.0	1745.	337.8	2235.	343.0	2723.	321.8	3209.	273.0
776.	211.0	1263.	298.2	1752.	338.6	2242.	342.6	2732.	321.0	3216.	271.0
783.	212.6	1273.	298.6	1760.	339.0	2249.	342.2	2739.	320.2	3225.	269.4
790.	214.2	1281.	299.0	1770.	339.0	2258.	342.6	2746.	320.6	3232.	266.6
798.	214.2	1288.	300.6	1777.	339.4	2266.	341.8	2756.	320.2	3239.	262.6
809.	216.2	1296.	301.4	1785.	339.4	2274.	341.4	2763.	319.8	3248.	258.2
815.	218.2	1304.	301.4	1792.	339.8	2282.	341.4	2769.	317.8	3255.	253.0
825.	219.8	1313.	302.6	1800.	339.8	2290.	341.0	2778.	316.2	3261.	246.6
832.	221.4	1320.	303.0	1810.	339.8	2297.	341.0	2786.	315.8	3269.	237.8
839.	223.0	1328.	303.8	1817.	339.8	2307.	340.6	2795.	316.2	3277.	227.8
848.	224.6	1337.	303.4	1824.	339.8	2314.	341.0	2804.	316.2	3283.	219.0
855.	226.6	1345.	304.2	1834.	339.4	2321.	340.2	2810.	315.4	3291.	210.6
864.	227.8	1353.	305.0	1842.	339.8	2330.	340.2	2818.	315.8	3299.	202.6
872.	230.6	1360.	305.4	1849.	340.2	2337.	340.2	2827.	315.4	3308.	193.0
881.	232.6	1369.	305.8	1856.	339.8	2346.	339.4	2834.	314.6	3314.	181.8
888.	234.2	1376.	307.4	1866.	339.8	2354.	339.4	2843.	313.8	3321.	172.6
895.	235.8	1384.	307.4	1873.	340.2	2363.	339.0	2850.	313.0	3328.	163.8
905.	235.8	1392.	308.6	1881.	341.4	2370.	337.8	2858.	311.4	3336.	151.8
912.	237.4	1401.	309.4	1889.	341.0	2378.	337.0	2866.	311.0	3343.	142.2
920.	238.2	1409.	311.4	1898.	341.4	2385.	337.4	2874.	310.2	3350.	131.4
928.	239.4	1417.	311.0	1906.	341.0	2394.	337.8	2882.	309.8	3358.	124.2
934.	240.2	1424.	312.2	1914.	341.4	2402.	337.8	2890.	309.8	3365.	113.4
944.	240.2	1433.	312.6	1922.	341.8	2409.	337.8	2899.	309.8	3372.	101.8
952.	242.2	1441.	313.4	1930.	341.8	2418.	337.4	2907.	309.0	3381.	92.6
960.	243.8	1448.	313.4	1937.	341.8	2426.	337.8	2913.	308.2	3388.	85.0
968.	244.6	1457.	314.2	1945.	341.8	2434.	337.4	2923.	307.4	3394.	76.2
975.	245.4	1464.	314.6	1954.	342.6	2442.	337.8	2932.	306.2	3402.	65.4
983.	246.2	1473.	314.6	1961.	341.4	2450.	337.8	2938.	307.0	3410.	58.2
992.	247.4	1481.	315.4	1970.	341.8	2458.	336.2	2946.	305.4	3419.	49.0
999.	248.2	1489.	315.4	1978.	342.2	2466.	335.4	2955.	304.6	3425.	41.8
1008.	249.0	1497.	316.2	1984.	342.6	2474.	335.0	2964.	303.4	3434.	32.2
1016.	249.4	1505.	316.6	1993.	341.8	2482.	335.0	2971.	303.4	3440.	20.6
1025.	252.2	1513.	317.0	2003.	342.6	2491.	336.2	2978.	302.6	3447.	12.6
1032.	253.0	1519.	317.8	2009.	343.0	2497.	336.6	2987.	301.4	3454.	3.4
1041.	255.4	1529.	317.8	2017.	343.0	2506.	335.4	2995.	301.4	3459.	0.1
										3462.	-1.7
										3463.	-1.7

(COMMENT) MAX POWER: 172.8 HP @ 3027. RPM.
(COMMENT) RATED SPEED: 2998. RPM.
WANT A CALCOMP PLOT OF THE MAPPING CURVE? (Y/N), (DEFLT = N): N

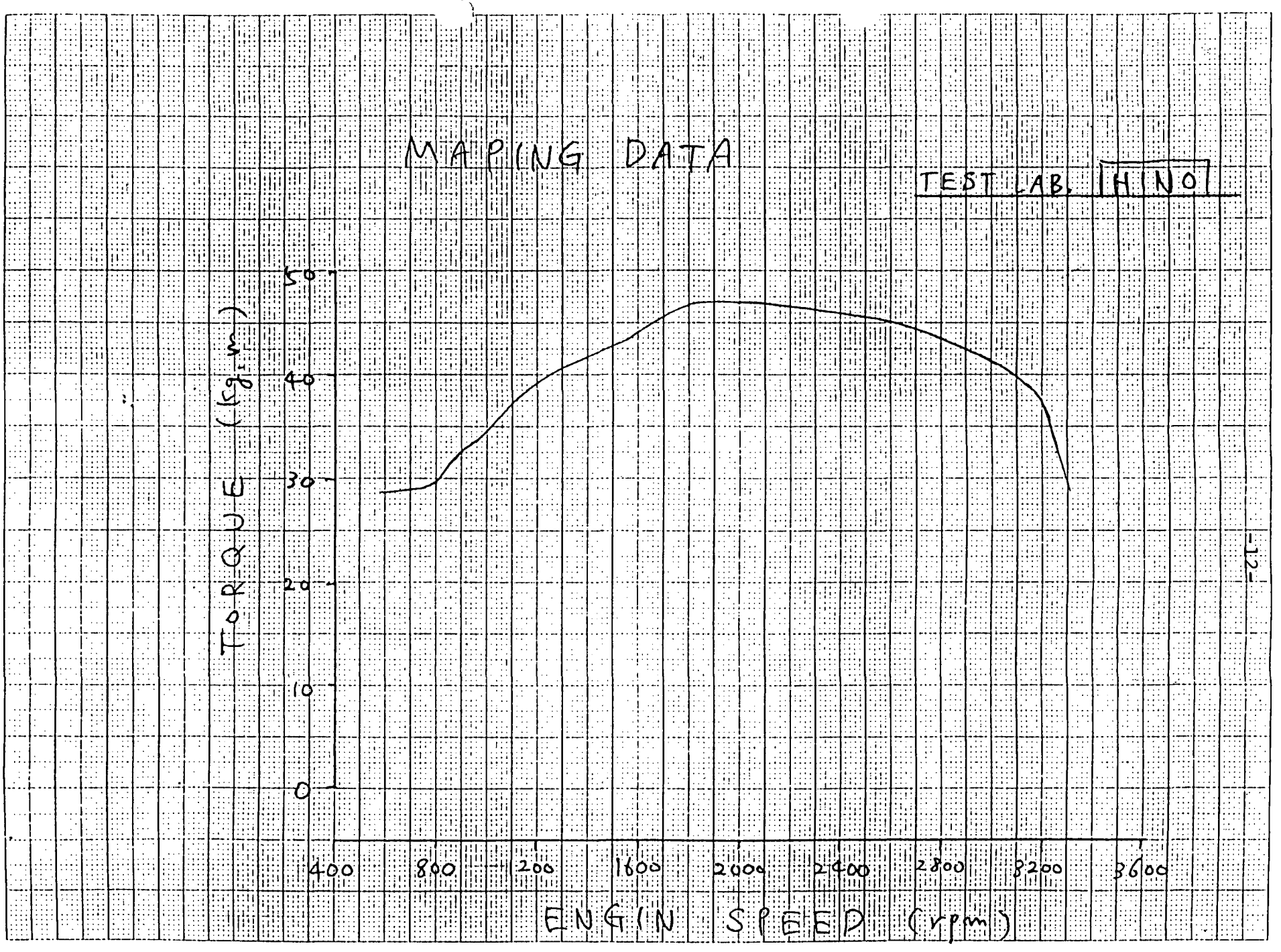
DO YOU WANT THE RPM,TQ & HP DATA LIST?(Y/N): Y

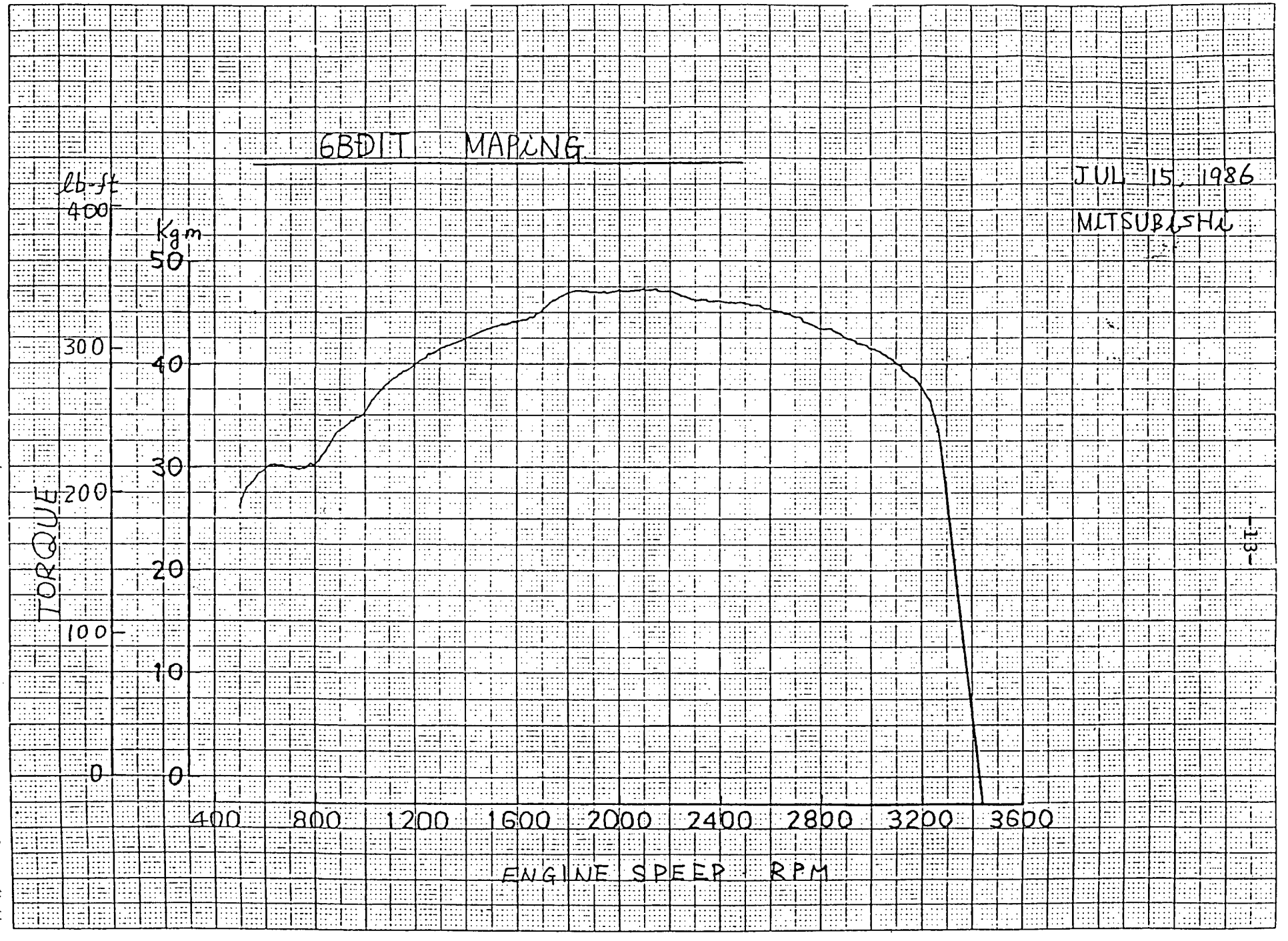
NISSAN DIESEL



MAPING DATA

TEST LAB. [H NO]




6BDIT MAPING
JUL 15, 1986
MITSUBISHI
lb-ft
Kgm
TORQUE
400
300
200
100
0
50
40
30
20
10
0
400
800
1200
1600
2000
2400
2800
3200
3600
ENGINE SPEED - RPM

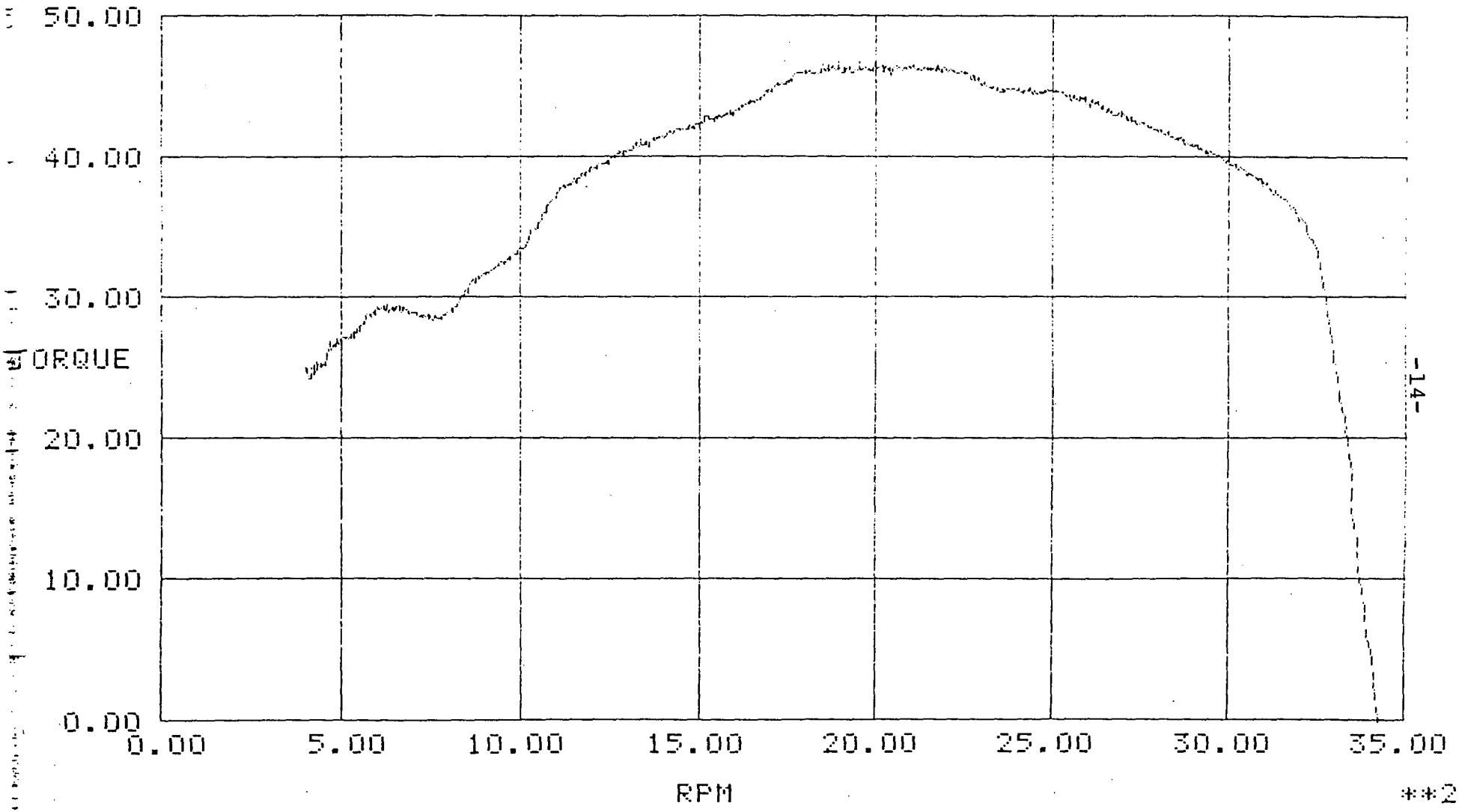
FULL LOAD MAPPING RESUL

LUB. ISUZU KAWASAKI

ENGINE NAME : 6BD1 40949 DATE : 86-7-22
TEST NO. = 5

761.1 mmHg.

PEAK TRQ = 46.7 KGM / 1994 RPM
MAX. BHP = 164.2 HP / 3020 RPM



DIESEL SUMMARY REPORT

TEST NUMBER: HD-863300 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-26-86 8:37 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 73.60 F
ABSOLUTE HUMIDITY: 56.82 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	4.39	
EXHAUST+BKG, GM	0.00	10.89	
NET, GM/BHP-HR	0.000	0.656	0.656
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	19.48	
NET, GM/BHP-HR	0.00	1.82	1.82
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.50	
EXHAUST+BKG, GM	0.00	73.16	
NET, GM/BHP-HR	0.000	6.407	6.407
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.039	
EXHAUST+BKG, GM	0.00	7492.40	
NET, GM/BHP-HR	0.0	601.0	601.0
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.171400	
SECONDARY PART, GM	0.000000	0.171500	
PRIMARY TARE, GM	0.000000	0.167700	
PRIMARY PART, GM	0.000000	0.171450	
TOTAL, GM/BHP-HR	0.00	0.48	0.48
FUEL CONSUMPTION			
LBS	0.00	4.48	4.48
LBS/BHP-HR	0.000	0.419	0.419
BRAKE HORSEPOWER-HOUR	0.000	10.686	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99627
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	11.871
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.515
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	998
SLOPE	0.00000	0.86431
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	10.257
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	8.367%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.91189
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	997
SLOPE	0.00000	0.91092
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	1.100
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.704%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.92778
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.686
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	11.068
% DIFFERENCE	0.00%	-3.45%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863301 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-26-86 9:42 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 77.10 F
ABSOLUTE HUMIDITY: 52.35 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.57	
EXHAUST+BKG, GM	0.00	10.32	
NET, GM/BHP-HR	0.000	0.679	0.679
CO (BAG)			
BACKGROUND, PPM	0.00	0.24	
EXHAUST+BKG, GM	0.00	18.51	
NET, GM/BHP-HR	0.00	1.71	1.71
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.50	
EXHAUST+BKG, GM	0.00	73.03	
NET, GM/BHP-HR	0.000	6.400	6.400
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.038	
EXHAUST+BKG, GM	0.00	7447.07	
NET, GM/BHP-HR	0.0	606.0	606.0
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.169900	
SECONDARY PART, GM	0.000000	0.170100	
PRIMARY TARE, GM	0.000000	0.166000	
PRIMARY PART, GM	0.000000	0.169600	
TOTAL, GM/BHP-HR	0.00	0.50	0.50
FUEL CONSUMPTION			
LBS	0.00	4.46	4.46
LBS/BHP-HR	0.000	0.423	0.423
BRAKE HORSEPOWER-HOUR	0.000	10.561	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99733
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	9.999
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.509
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	998
SLOPE	0.00000	0.87162
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	7.659
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	8.451%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.91164
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	997
SLOPE	0.00000	0.91190
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	0.560
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.773%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.92671
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.561
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	11.068
% DIFFERENCE	0.00%	-4.58%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863302 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-26-86 10:46 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 78.00 F
ABSOLUTE HUMIDITY: 65.85 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.72	
EXHAUST+BKG, GM	0.00	11.71	
NET, GM/BHP-HR	0.000	0.798	0.798
CO (BAG)			
BACKGROUND, PPM	0.00	0.48	
EXHAUST+BKG, GM	0.00	19.88	
NET, GM/BHP-HR	0.00	1.80	1.80
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.50	
EXHAUST+BKG, GM	0.00	72.91	
NET, GM/BHP-HR	0.000	6.611	6.611
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.038	
EXHAUST+BKG, GM	0.00	7417.39	
NET, GM/BHP-HR	0.0	603.2	603.2
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.168300	
SECONDARY PART, GM	0.000000	0.168400	
PRIMARY TARE, GM	0.000000	0.168700	
PRIMARY PART, GM	0.000000	0.172550	
TOTAL, GM/BHP-HR	0.00	0.50	0.50
FUEL CONSUMPTION			
LBS	0.00	4.44	4.44
LBS/BHP-HR	0.000	0.421	0.421
BRAKE HORSEPOWER-HOUR	0.000	10.558	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99690
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	7.753
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.635
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	997
SLOPE	0.00000	0.85055
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	10.800
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	8.584%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.90480
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	996
SLOPE	0.00000	0.90415
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	0.933
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.717%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.92622
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.558
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	11.068
% DIFFERENCE	0.00%	-4.61%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863303 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-26-86 11:11 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 76.70 F
ABSOLUTE HUMIDITY: 48.10 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	10.97	
NET, GM/BHP-HR	0.000	0.723	0.723
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	19.10	
NET, GM/BHP-HR	0.00	1.81	1.81
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	72.50	
NET, GM/BHP-HR	0.000	6.301	6.301
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	7416.88	
NET, GM/BHP-HR	0.0	594.4	594.4
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.168800	
SECONDARY PART, GM	0.000000	0.168950	
PRIMARY TARE, GM	0.000000	0.168100	
PRIMARY PART, GM	0.000000	0.171950	
TOTAL, GM/BHP-HR	0.00	0.50	0.50
FUEL CONSUMPTION			
LBS	0.00	4.37	4.37
LBS/BHP-HR	0.000	0.415	0.415
BRAKE HORSEPOWER-HOUR	0.000	10.536	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99725
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	6.807
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.420
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	998
SLOPE	0.00000	0.85291
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	10.066
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	8.603%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.90506
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	997
SLOPE	0.00000	0.90427
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	0.801
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.743%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.92609
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.536
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	11.068
% DIFFERENCE	0.00%	-4.81%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863305 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-26-86 13:41 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 75.90 F
ABSOLUTE HUMIDITY: 63.14 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	3.35	
EXHAUST+BKG, GM	0.00	10.54	
NET, GM/BHP-HR	0.000	0.725	0.725
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.79	
NET, GM/BHP-HR	0.00	1.80	1.80
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.50	
EXHAUST+BKG, GM	0.00	70.89	
NET, GM/BHP-HR	0.000	6.438	6.438
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.034	
EXHAUST+BKG, GM	0.00	7166.99	
NET, GM/BHP-HR	0.0	596.3	596.3
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.169700	
SECONDARY PART, GM	0.000000	0.169900	
PRIMARY TARE, GM	0.000000	0.165100	
PRIMARY PART, GM	0.000000	0.168750	
TOTAL, GM/BHP-HR	0.00	0.51	0.51
FUEL CONSUMPTION			
LBS	0.00	4.35	4.35
LBS/BHP-HR	0.000	0.416	0.416
BRAKE HORSEPOWER-HOUR	0.000	10.460	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99332
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	4.836
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.197
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99973
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	998
SLOPE	0.00000	0.84132
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	11.678
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	8.630%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.90214
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	997
SLOPE	0.00000	0.89543
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	0.890
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.659%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.92625
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.460
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	11.068
% DIFFERENCE	0.00%	-5.49%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863306 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-26-86 14:13 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 71.50 F
ABSOLUTE HUMIDITY: 59.42 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	11.31	
NET, GM/BHP-HR	0.000	0.784	0.784
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.71	
NET, GM/BHP-HR	0.00	1.78	1.78
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	72.35	
NET, GM/BHP-HR	0.000	6.497	6.497
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	7301.84	
NET, GM/BHP-HR	0.0	600.1	600.1
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.159400	
SECONDARY PART, GM	0.000000	0.159600	
PRIMARY TARE, GM	0.000000	0.170900	
PRIMARY PART, GM	0.000000	0.174650	
TOTAL, GM/BHP-HR	0.00	0.52	0.52
FUEL CONSUMPTION			
LBS	0.00	4.39	4.39
LBS/BHP-HR	0.000	0.419	0.419
BRAKE HORSEPOWER-HOUR	0.000	10.486	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99264
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	6.497
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.441
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	998
SLOPE	0.00000	0.84885
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	10.804
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	8.623%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.90384
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	997
SLOPE	0.00000	0.89911
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	0.857
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.671%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.92660
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.486
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	11.068
% DIFFERENCE	0.00%	-5.26%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863307 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-26-86 14:55 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 76.50 F
ABSOLUTE HUMIDITY: 50.65 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	4.61	
EXHAUST+BKG, GM	0.00	11.47	
NET, GM/BHP-HR	0.000	0.704	0.704
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.25	
NET, GM/BHP-HR	0.00	1.74	1.74
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.50	
EXHAUST+BKG, GM	0.00	73.03	
NET, GM/BHP-HR	0.000	6.401	6.401
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.036	
EXHAUST+BKG, GM	0.00	7283.72	
NET, GM/BHP-HR	0.0	596.4	596.4
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.165250	
SECONDARY PART, GM	0.000000	0.165400	
PRIMARY TARE, GM	0.000000	0.163700	
PRIMARY PART, GM	0.000000	0.167500	
TOTAL, GM/BHP-HR	0.00	0.50	0.50
FUEL CONSUMPTION			
LBS	0.00	4.38	4.38
LBS/BHP-HR	0.000	0.416	0.416
BRAKE HORSEPOWER-HOUR	0.000	10.516	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99316
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	5.281
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.180
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99973
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	998
SLOPE	0.00000	0.84623
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	11.563
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	8.590%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.90397
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	997
SLOPE	0.00000	0.89853
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	0.973
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.666%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.92658
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.516
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	11.068
% DIFFERENCE	0.00%	-4.99%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863308 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-26-86 15:40 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 73.50 F
ABSOLUTE HUMIDITY: 62.47 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	10.92	
NET, GM/BHP-HR	0.000	0.693	0.693
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	18.40	
NET, GM/BHP-HR	0.00	1.76	1.76
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	0.00	72.33	
NET, GM/BHP-HR	0.000	6.633	6.633
CO2 (BAG)			
BACKGROUND, PPM	0.000	0.000	
EXHAUST+BKG, GM	0.00	7280.28	
NET, GM/BHP-HR	0.0	599.9	599.9
PARTICULATE			
SECONDARY TARE, GM	0.000000	0.145550	
SECONDARY PART, GM	0.000000	0.145600	
PRIMARY TARE, GM	0.000000	0.141850	
PRIMARY PART, GM	0.000000	0.145800	
TOTAL, GM/BHP-HR	0.00	0.51	0.51
FUEL CONSUMPTION			
LBS	0.00	4.38	4.38
LBS/BHP-HR	0.000	0.419	0.419
BRAKE HORSEPOWER-HOUR	0.000	10.454	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	0	1176
SLOPE	0.00000	0.99283
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	0.000	6.189
(LIMIT: +-50 RPM)		
STD ERROR	0.000	16.458
(LIMIT: 100 RPM)		
R-SQUARE	0.00000	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	0	998
SLOPE	0.00000	0.84045
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.000	11.688
(LIMIT: +-15 FT-LBS)		
STD ERROR	0.000%	8.704%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.00000	0.90043
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	0	997
SLOPE	0.00000	0.89436
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.000	0.886
(LIMIT: +-5 BHP)		
STD ERROR	0.000%	7.745%
(LIMIT: 8%)		
R-SQUARE	0.00000	0.92454
(LIMIT: 0.91)		
WORK		
ACTUAL	0.000	10.454
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	0.000	11.068
% DIFFERENCE	0.00%	-5.55%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863311 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-30-86 8:14 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 77.80 F
ABSOLUTE HUMIDITY: 44.08 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	4.61	3.79	
EXHAUST+BKG, GM	15.48	10.39	
NET, GM/BHP-HR	1.096	0.682	0.742
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	23.00	18.42	
NET, GM/BHP-HR	2.21	1.78	1.84
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.25	
EXHAUST+BKG, GM	77.53	76.09	
NET, GM/BHP-HR	6.895	6.751	6.772
CO2 (BAG)			
BACKGROUND, PPM	0.034	0.034	
EXHAUST+BKG, GM	7794.91	7589.84	
NET, GM/BHP-HR	658.2	643.2	645.4
PARTICULATE			
SECONDARY TARE, GM	0.168900	0.172400	
SECONDARY PART, GM	0.169200	0.172600	
PRIMARY TARE, GM	0.143000	0.171600	
PRIMARY PART, GM	0.147300	0.175250	
TOTAL, GM/BHP-HR	0.60	0.51	0.52
FUEL CONSUMPTION			
LBS	4.79	4.63	4.66
LBS/BHP-HR	0.460	0.448	0.450
BRAKE HORSEPOWER-HOUR	10.408	10.332	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	1176
SLOPE	0.99686	0.99909
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	-11.650	-7.363
(LIMIT: +-50 RPM)		
STD ERROR	16.664	16.552
(LIMIT: 100 RPM)		
R-SQUARE	0.99971	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	997	998
SLOPE	0.83291	0.85514
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	12.761	7.596
(LIMIT: +-15 FT-LBS)		
STD ERROR	8.889%	8.673%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.89474	0.90412
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	996	998
SLOPE	0.89100	0.89513
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.925	0.432
(LIMIT: +-5 BHP)		
STD ERROR	7.695%	7.733%
(LIMIT: 8%)		
R-SQUARE	0.92457	0.92485
(LIMIT: 0.91)		
WORK		
ACTUAL	10.408	10.332
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	11.068	11.068
% DIFFERENCE	-5.96%	-6.65%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863312 MANUFACTURER: ISUZU
TEST DATE/TIME: 9-30-86 15:10 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 28.90 "HG
DRY BULB TEMPERATURE: 73.20 F
ABSOLUTE HUMIDITY: 68.91 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	3.35	3.20	
EXHAUST+BKG, GM	11.32	10.63	
NET, GM/BHP-HR	0.810	0.762	0.769
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	22.60	18.32	
NET, GM/BHP-HR	2.18	1.79	1.84
NOX (INTEGRATED)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	77.59	74.45	
NET, GM/BHP-HR	7.375	7.146	7.179
CO2 (BAG)			
BACKGROUND, PPM	0.034	0.034	
EXHAUST+BKG, GM	7730.51	7473.74	
NET, GM/BHP-HR	655.2	635.5	638.4
PARTICULATE			
SECONDARY TARE, GM	0.167700	0.167100	
SECONDARY PART, GM	0.167900	0.167100	
PRIMARY TARE, GM	0.172200	0.168300	
PRIMARY PART, GM	0.176500	0.172300	
TOTAL, GM/BHP-HR	0.56	0.52	0.53
FUEL CONSUMPTION			
LBS	4.74	4.55	4.57
LBS/BHP-HR	0.457	0.443	0.445
BRAKE HORSEPOWER-HOUR	10.357	10.256	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	1176
SLOPE	0.99867	0.99948
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	-11.556	-5.900
(LIMIT: +-50 RPM)		
STD ERROR	16.577	16.439
(LIMIT: 100 RPM)		
R-SQUARE	0.99972	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	998	998
SLOPE	0.83595	0.85691
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	11.240	5.997
(LIMIT: +-15 FT-LBS)		
STD ERROR	8.835%	8.687%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.89672	0.90420
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	997	998
SLOPE	0.88879	0.89477
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.790	0.141
(LIMIT: +-5 BHP)		
STD ERROR	7.749%	7.787%
(LIMIT: 8%)		
R-SQUARE	0.92359	0.92381
(LIMIT: 0.91)		
WORK		
ACTUAL	10.357	10.256
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	11.068	11.068
% DIFFERENCE	-6.42%	-7.34%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863317
TEST DATE/TIME: 10- 2-86 9:23
MANUFACTURER: ISUZU
ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG
DRY BULB TEMPERATURE: 71.90 F
ABSOLUTE HUMIDITY: 67.48 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	3.65	3.42	
EXHAUST+BKG, GM	13.42	11.22	
NET, GM/BHP-HR	0.956	0.770	0.797
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	23.04	17.92	
NET, GM/BHP-HR	2.16	1.68	1.75
NOX (INTEGRATED)			
BACKGROUND, PPM	0.25	0.50	
EXHAUST+BKG, GM	80.56	80.72	
NET, GM/BHP-HR	7.337	7.300	7.306
CO2 (BAG)			
BACKGROUND, PPM	0.034	0.034	
EXHAUST+BKG, GM	7930.83	7703.78	
NET, GM/BHP-HR	653.3	633.9	636.7
PARTICULATE			
SECONDARY TARE, GM	0.165200	0.165000	
SECONDARY PART, GM	0.165350	0.165100	
PRIMARY TARE, GM	0.162700	0.164700	
PRIMARY PART, GM	0.167200	0.169000	
TOTAL, GM/BHP-HR	0.57	0.55	0.55
FUEL CONSUMPTION			
LBS	4.87	4.71	4.73
LBS/BHP-HR	0.456	0.442	0.444
BRAKE HORSEPOWER-HOUR	10.674	10.648	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	1176
SLOPE	1.00020	1.00009
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	-4.364	-5.459
(LIMIT: +-50 RPM)		
STD ERROR	16.341	16.311
(LIMIT: 100 RPM)		
R-SQUARE	0.99972	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	995	997
SLOPE	0.92345	0.93674
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.853	-2.084
(LIMIT: +-15 FT-LBS)		
STD ERROR	8.229%	8.327%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.92352	0.92458
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	994	997
SLOPE	0.93049	0.93641
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.114	-0.360
(LIMIT: +-5 BHP)		
STD ERROR	7.647%	7.712%
(LIMIT: 8%)		
R-SQUARE	0.93087	0.93104
(LIMIT: 0.91)		
WORK		
ACTUAL	10.674	10.648
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	11.108	11.108
% DIFFERENCE	-3.91%	-4.14%

DIESEL SUMMARY REPORT

TEST NUMBER: HD-863318 MANUFACTURER: ISUZU
TEST DATE/TIME: 10- 2-86 13:33 ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG
DRY BULB TEMPERATURE: 73.60 F
ABSOLUTE HUMIDITY: 53.42 GRAINS H20 / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST
HC (INTEGRATED)			
BACKGROUND, PPM	3.87	3.12	
EXHAUST+BKG, GM	13.02	10.27	
NET, GM/BHP-HR	0.901	0.700	0.729
CO (BAG)			
BACKGROUND, PPM	0.00	0.00	
EXHAUST+BKG, GM	23.25	17.71	
NET, GM/BHP-HR	2.18	1.65	1.73
NOX (INTEGRATED)			
BACKGROUND, PPM	0.50	0.50	
EXHAUST+BKG, GM	81.49	80.33	
NET, GM/BHP-HR	7.107	6.962	6.982
CO2 (BAG)			
BACKGROUND, PPM	0.034	0.034	
EXHAUST+BKG, GM	7935.64	7696.87	
NET, GM/BHP-HR	655.1	631.5	634.8
PARTICULATE			
SECONDARY TARE, GM	0.162000	0.167500	
SECONDARY PART, GM	0.162000	0.167600	
PRIMARY TARE, GM	0.165100	0.166700	
PRIMARY PART, GM	0.170150	0.171000	
TOTAL, GM/BHP-HR	0.64	0.54	0.55
FUEL CONSUMPTION			
LBS	4.88	4.72	4.74
LBS/BHP-HR	0.458	0.440	0.443
BRAKE HORSEPOWER-HOUR	10.662	10.728	

CYCLE STATISTICS	CS	HS
SPEED		
NUMBER	1176	1176
SLOPE	1.00239	0.99950
(LIMIT: 0.97-1.03)		
Y-INTERCEPT	-6.699	-2.552
(LIMIT: +-50 RPM)		
STD ERROR	16.301	16.249
(LIMIT: 100 RPM)		
R-SQUARE	0.99972	0.99972
(LIMIT: 0.97)		
TORQUE		
NUMBER	995	998
SLOPE	0.92107	0.93933
(LIMIT: 0.77/0.83-1.03)		
Y-INTERCEPT	0.837	-1.881
(LIMIT: +-15 FT-LBS)		
STD ERROR	8.224%	8.394%
(LIMIT: 13% MAX ENG TQ)		
R-SQUARE	0.92325	0.92398
(LIMIT: 0.85/0.88)		
POWER		
NUMBER	994	998
SLOPE	0.93028	0.93946
(LIMIT: 0.87/0.89-1.03)		
Y-INTERCEPT	0.099	-0.237
(LIMIT: +-5 BHP)		
STD ERROR	7.647%	7.781%
(LIMIT: 8%)		
R-SQUARE	0.93085	0.93063
(LIMIT: 0.91)		
WORK		
ACTUAL	10.662	10.728
(LIMIT: -15%-5% REF BHP-HR)		
REFERENCE	11.108	11.108
% DIFFERENCE	-4.02%	-3.42%

TEST NO.: HD-863310 ENGINE: 290 ISZ35384JAMACORR 0 TEST D/T: 9-29-86 14:10 REPORT D/T: 09-30-86 10:06 P040684

WEIGHTED SUMMARY REPORT

AMBIENT DATA

AVERAGE BAROMETER (DRY) : 28.48 (" HG)
AVERAGE DRY BULB TEMPERATURE : 71.5 (DEG F)
AVERAGE ABSOLUTE HUMIDITY : 75.23 (GRAINS H2O/LB AIR)

MODE-TO-MODE RESULTS

MODE	SPEED (RPM)	TORQUE (FT-LB)	*UN* CORR BHP (HP)	MEASURED FUEL (LB/HR)	HC (GM/HR)	CO (GM/HR)	NOX (GM/HR)	CO2 (GM/HR)
1	3000	291.0	166.22	66.20	28.64	150.92	1326.29	95606.65
2	1900	332.0	120.10	42.53	14.50	89.13	923.70	63872.47
3	1900	150.0	54.26	20.92	29.63	74.34	344.53	32428.41
4	585	0.0	0.0	1.40	14.91	24.66	32.98	3998.76
WEIGHTED TOTALS			25.03	9.60	6.63	25.11	192.52	14397.75

13-MODE WEIGHTED RESULTS

HC (GM/BHPHR) : 0.26
CO (GM/BHPHR) : 1.00
NOX (GM/BHPHR) : 7.69
BSFC (LB/BHPHR) : 0.384
CO2 (GM/BHPHR) : 575.20

*** NOTE: Number of modes for this test do not equal 13

COMMENTS

TOTAL FUEL IN GALLONS = BAG 1: 0.83; BAG 2: 0.50; BAG 3: 0.25; BAG 4: 0.02;
PARTICULATE SAMPS. 10 MIN. LONG

$COPY -13RPT(850.001,*L) *PRINT*

WEIGHTED SUMMARY REPORT

AMBIENT DATA

AVERAGE BAROMETER (DRY) : 28.74 (" HG)
AVERAGE DRY BULB TEMPERATURE : 70.5 (DEG F)
AVERAGE ABSOLUTE HUMIDITY : 52.54 (GRAINS H20/LB AIR)

MODE-TO-MODE RESULTS

MODE	SPEED (RPM)	TORQUE (FT-LB)	*UN* CORR BHP (HP)	MEASURED FUEL (LB/HR)	HC (GM/HR)	CO (GM/HR)	NOX (GM/HR)	CO2 (GM/HR)
1	3000	299.5	171.07	65.68	30.00	147.05	1344.04	95829.13
2	1900	300.5	108.71	36.90	20.15	60.83	824.49	57110.63
3	1900	146.5	53.00	20.22	33.68	77.15	341.21	28807.11
4	609	0.0	0.0	1.39	15.76	27.42	28.75	3266.08
WEIGHTED TOTALS			24.34	9.06	7.57	23.03	185.16	13523.31

13-MODE WEIGHTED RESULTS

HC (GM/BHPHR) : 0.31
CO (GM/BHPHR) : 0.95
NOX (GM/BHPHR) : 7.61
BSFC (LB/BHPHR) : 0.372
CO2 (GM/BHPHR) : 555.57

*** NOTE: Number of modes for this test do not equal 13

COMMENTS

TOTAL FUEL = 1 0.79 2 0.45 3 0.25 4 0.01 GALLONS
4-MODE S/S

$COPY -PERR *PRINT*
No lines copied from -PERR to *PRINT*.

$REL *PRINT*
"*PRINT*": explicit hold has been removed.
$F -PERR LINES

REPORT

ON

EMISSION LABORATORY CORRELATION

(HEAVY DUTY DIESEL ENGINE)

SEPTEMBER 1986

JAPAN AUTOMOBILE MANUFACTURERS ASSOCIATION INC.

TEST RESULTS

1. TRANSIENT EMISSIONS

   COMP.

   COLD

   HOT-$\bar{X}$

2. SMOKE EMISSIONS

3. STEADY STATE EMISSIONS

PERCENT DIFFERENCE OF TRANSIENT (COMP) DATA

PERCENT DIFFERENCE OF SMOKE DATA

PERCENT DIFFERENCE OF STEADY STATE DATA

COEFFICIENT OF VARIANCE

TRANSIENT (COMP)

SMOKE

TRANSIENT EMISSION
** COMP **

ITEM	NO	NISSAN DIESEL		HINO		MITSUBISHI		ISUZU	
		BAG	CONT	BAG	CONT	BAG	CONT	BAG	CONT
HC (g/BHP-HR)	1		0.60		0.59		0.68		0.76
	2		0.60		0.55		0.65		0.71
	3		0.68		0.56		0.69		0.63
	$\bar{X}$		0.63		0.57		0.68		0.70
CO (g/BHP-HR)	1	1.88	1.83	1.80	1.75	1.58	1.63	1.96	
	2	1.85	1.85	1.79	1.73	1.72	1.67	1.96	
	3	1.88	1.89	1.75	1.70	1.80	1.72	1.91	
	$\bar{X}$	1.87	1.86	1.78	1.73	1.70	1.67	1.94	
CO2 (g/BHP-HR)	1	635.8	644.1	593.8	597.0	606.1	618.0	678.1	
	2	636.3	645.6	595.1	597.9	611.3	619.0	668.9	
	3	637.2	649.1	593.1	594.7	611.7	622.0	655.0	
	$\bar{X}$	636.4	646.3	594.0	596.5	609.7	619.7	667.3	
NOX (g/BHP-HR)	1	6.41	6.44	6.15	6.30	6.04	5.82	6.91	
	2	6.72	6.74	6.11	6.22	5.99	5.90	7.19	
	3	6.34	6.36	5.96	6.06	6.04	5.91	7.18	
	$\bar{X}$	6.49	6.51	6.07	6.19	6.02	5.88	7.09	
PART. (g/BHP-HR)	1		0.709		0.567		0.512		0.613
	2		0.694		0.542		0.468		0.554
	3		0.629		0.544		0.500		0.552
	$\bar{X}$		0.677		0.551		0.493		0.573

TRANSIENT EMISSION
** COLD **

ITEM	NO	NISSAN DIESEL		HINO		MITSUBISHI		ISUZU	
		BAG	CONT	BAG	CONT	BAG	CONT	BAG	CONT
HC (g/BHP-HR)	1		0.74		0.72		0.83		0.88
	2		0.77		0.61		0.81		0.98
	3		0.91		0.68		0.71		0.82
	$\bar{x}$		0.81		0.67		0.78		0.89
CO (g/BHP-HR)	1	2.10	2.09	2.03	2.00	1.72	1.93	2.24	
	2	2.12	2.13	2.02	1.98	1.81	1.81	2.63	
	3	2.11	2.18	2.08	2.05	1.90	1.70	2.31	
	$\bar{x}$	2.11	2.13	2.04	2.01	1.81	1.81	2.39	
CO2 (g/BHP-HR)	1	651.2	658.9	603.4	610.2	625.3	643.8	707.1	
	2	653.8	655.6	609.4	610.7	627.8	635.3	732.2	
	3	654.5	666.3	614.6	615.6	624.3	635.6	683.7	
	$\bar{x}$	653.2	660.3	609.1	612.2	625.8	638.2	707.7	
NOX (g/BHP-HR)	1	6.47	6.52	6.03	6.38	6.21	6.06	7.41	
	2	6.81	6.84	6.17	6.35	6.10	5.93	7.73	
	3	6.42	6.44	6.09	6.26	6.10	5.92	7.33	
	$\bar{x}$	6.57	6.60	6.10	6.33	6.14	5.97	7.49	
PART. (g/BHP-HR)	1		0.840		0.661		0.549		0.673
	2		0.731		0.632		0.470		0.706
	3		0.712		0.589		0.498		0.666
	$\bar{x}$		0.761		0.627		0.506		0.682
CYCLEWORK ACT. (BHP-HR)R)	1	11.09		11.29		10.81		10.36	
	2	11.00		11.23		10.80		9.39	
	3	11.03		11.02		10.80		10.11	
	$\bar{x}$	11.04		11.18		10.80		9.95	
NOX HUMID C.F.	1	1.079		1.023		1.017		1.058	
	2	1.060		1.037		0.993		1.055	
	3	1.030		1.006		0.978		1.036	
	$\bar{x}$	1.056		1.022		0.996		1.050	

TRANSIENT EMISSION
** HOT-$\bar{X}$ **

ITEM	NO	NISSAN DIESEL		HINO		MITSUBISHI		ISUZU	
		BAG	CONT	BAG	CONT	BAG	CONT	BAG	CONT
HC (g/BHP-HR)	1		0.58		0.57		0.66		0.74
	2		0.59		0.54		0.62		0.66
	3		0.64		0.54		0.69		0.60
	$\bar{X}$		0.60		0.55		0.66		0.67
CO (g/BHP-HR)	1	1.85	1.79	1.76	1.71	1.56	1.58	1.91	
	2	1.81	1.81	1.75	1.68	1.71	1.65	1.85	
	3	1.84	1.83	1.69	1.64	1.78	1.72	1.84	
	$\bar{X}$	1.83	1.81	1.73	1.68	1.68	1.65	1.87	
CO2 (g/BHP-HR)	1	633.5	641.8	592.2	594.8	602.9	613.7	673.2	
	2	633.7	643.5	592.7	595.8	608.6	616.3	659.0	
	3	634.3	646.3	589.5	591.8	609.6	619.7	650.1	
	$\bar{X}$	633.8	643.9	591.5	594.1	607.0	616.6	660.8	
NOX (g/BHP-HR)	1	6.40	6.43	6.17	6.28	6.01	5.78	6.83	
	2	6.72	6.73	6.10	6.19	5.97	5.89	7.10	
	3	6.33	6.34	5.93	6.03	6.03	5.91	7.15	
	$\bar{X}$	6.48	6.50	6.07	6.17	6.00	5.86	7.03	
PART. (g/BHP-HR)	1		0.688		0.552		0.506		0.603
	2		0.688		0.527		0.468		0.530
	3		0.615		0.536		0.500		0.533
	$\bar{X}$		0.664		0.538		0.491		0.555
CYCLEWORK ACT. (BHP-HR)R)	1	11.04		11.28		10.82		10.09	
	2	11.15		11.00		10.81		10.01	
	3	10.97		11.15		10.81		10.01	
	$\bar{X}$	11.05		11.14		10.81		10.04	
NOX HUMID C. F.	1	1.089		1.023		1.004		1.044	
	2	1.076		1.037		0.999		1.053	
	3	1.043		1.002		0.979		1.043	
	$\bar{X}$	1.069		1.021		0.994		1.047	

SMOKE EMISSIONS

ITEM	NO	EPA	NISSAN DIESEL	HINO	MITSU-BISHI	ISUZU
ACCEL (%)	1		9.62	12.56	14.26	11.49
	2		9.56	12.23	13.54	11.61
	3		9.86	10.51	11.71	12.57
	$\bar{x}$		9.68	11.77	13.17	11.89
LUG. (%)	1		6.00	8.74	10.90	6.47
	2		5.87	8.04	10.67	6.83
	3		6.60	6.52	10.34	8.37
	$\bar{x}$		6.16	7.77	10.64	7.22
PEAK (%)	1		18.44	23.29	24.35	21.61
	2		19.22	23.97	24.16	21.94
	3		19.00	20.03	21.93	24.28
	$\bar{x}$		18.89	22.43	23.48	22.61

STEADY STATE EMISSIONS

TEST CODE	ITEM	EPA	NISSAN DIESEL	HINO	MITSU-BISHI	ISUZU
1	ENG. SPEED	3000RPM				
	TORQUE	LB-FT	298 LB-FT	298 LB-FT	301 LB-FT	302 LB-FT
	HC (G/BHP-HR)	illegible	0.19	0.13	0.29	0.24
	CO (G/BHP-HR)	illegible	1.17	1.06	0.81	0.87
	CO2 (G/BHP-HR)	illegible	560.6	549.9	580.4	553.2
	NOX (G/BHP-HR)	illegible	7.25	6.75	7.08	7.88
	PART. (G/BHP-HR)	illegible	0.51	0.46	0.40	0.43
	NOX HUMID C.F.		1.035	1.017	1.023	1.072
2	ENG. SPEED	1900RPM				
	TORQUE	LB-FT	297 LB-FT	297 LB-FT	297 LB-FT	298 LB-FT
	HC (G/BHP-HR)	illegible	0.16	0.16	0.22	0.19
	CO (G/BHP-HR)	illegible	0.62	0.56	0.56	0.58
	CO2 (G/BHP-HR)	illegible	511.4	481.4	474.4	506.1
	NOX (G/BHP-HR)	illegible	7.38	6.64	6.70	7.95
	PART. (G/BHP-HR)	illegible	0.42	0.31	0.29	0.36
	NOX HUMID C.F.		1.045	1.016	1.016	1.064

STEADY STATE EMISSIONS

TEST CODE	ITEM	EPA	NISSAN DIESEL	HINO	MITSU-BISHI	ISUZU
3	ENG. SPEED	1900RPM				
	TORQUE	LB-FT	148 LB-FT	148 LB-FT	148 LB-FT	148 LB-FT
	HC (G/BHP-HR)	.635	0.49	0.60	0.77	0.58
	CO (G/BHP-HR)	1.456	1.40	1.44	1.45	1.36
	CO2 (G/BHP-HR)	543.55	536.6	525.2	495.8	548.3
	NOX (G/BHP-HR)	6.438	5.70	5.06	4.78	5.84
	PART. (G/BHP-HR)	.254	0.34	0.30	0.32	0.36
	NOX HUMID C.F.		1.050	1.010	0.986	1.064
4	ENG. SPEED	IDLE	IDLE 580RPM	IDLE 630RPM	IDLE 607RPM	IDLE 580RPM
	HC (G/HR)	14.985 15.615	10.88	16.81	17.29	19.64
	CO (G/HR)	27.416	21.90	25.54	23.17	25.75
	CO2 (G/HR)	38	1923.0	1738.7	1264.0	1113.7
	NOX (G/HR)	38.754	36.82	36.51	33.18	36.04
	PART. (G/HR)	---	----	----	----	----
	NOX HUMID C.F.		1.025	1.015	0.981	1.064

1.3 day on Range 17 NOx

[redacted]

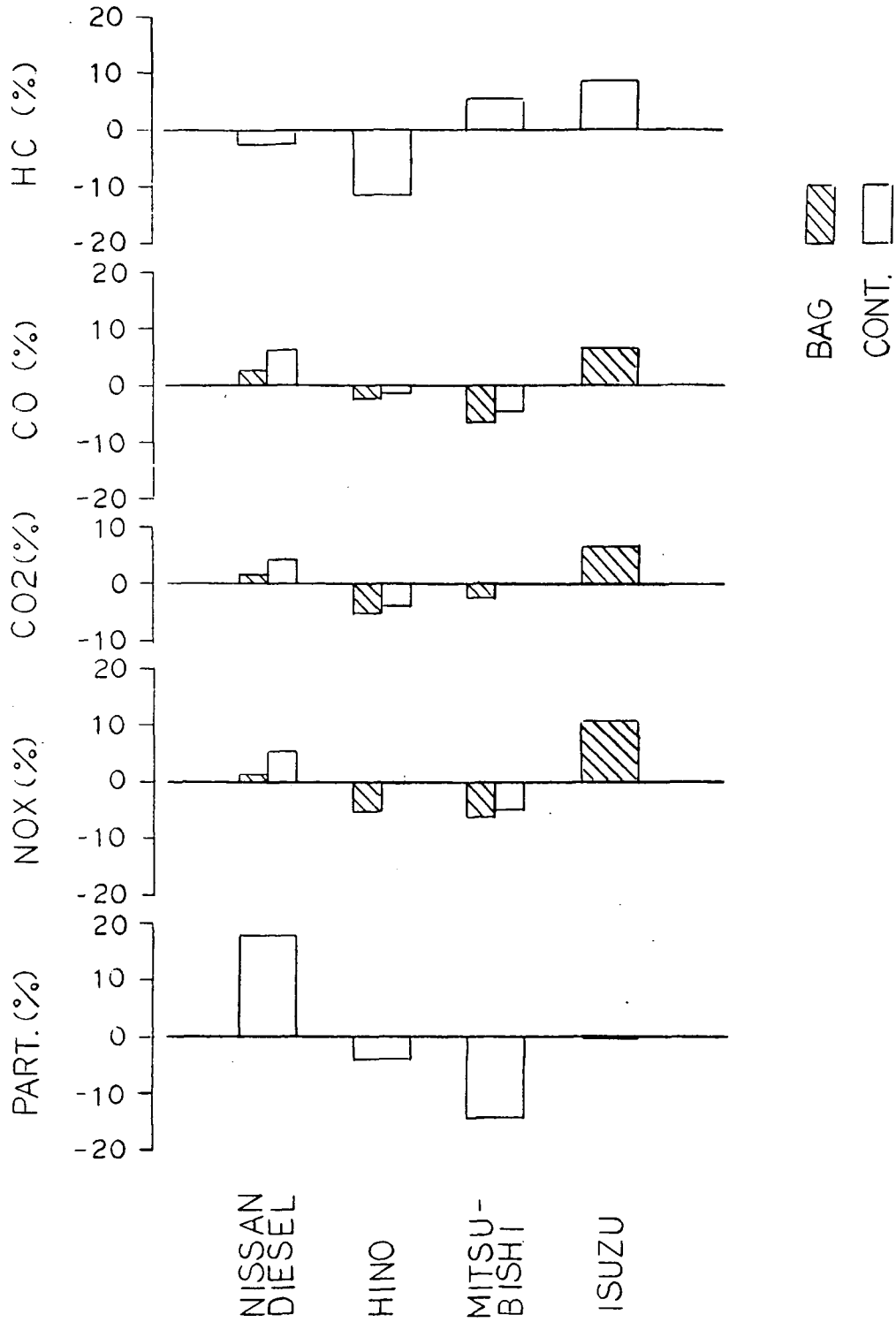
Sump was E depletion

5/6 was 3.8 - else

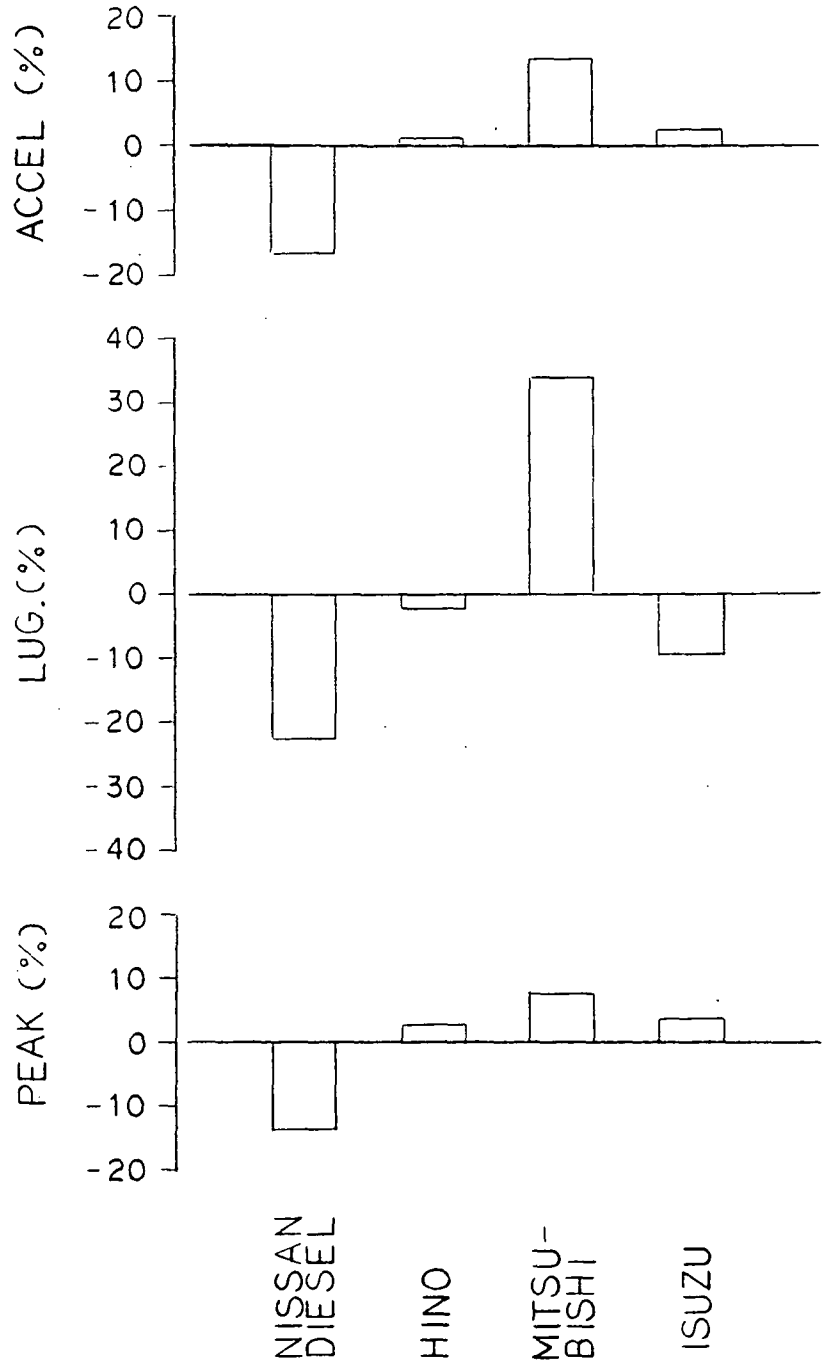
6

Plot data

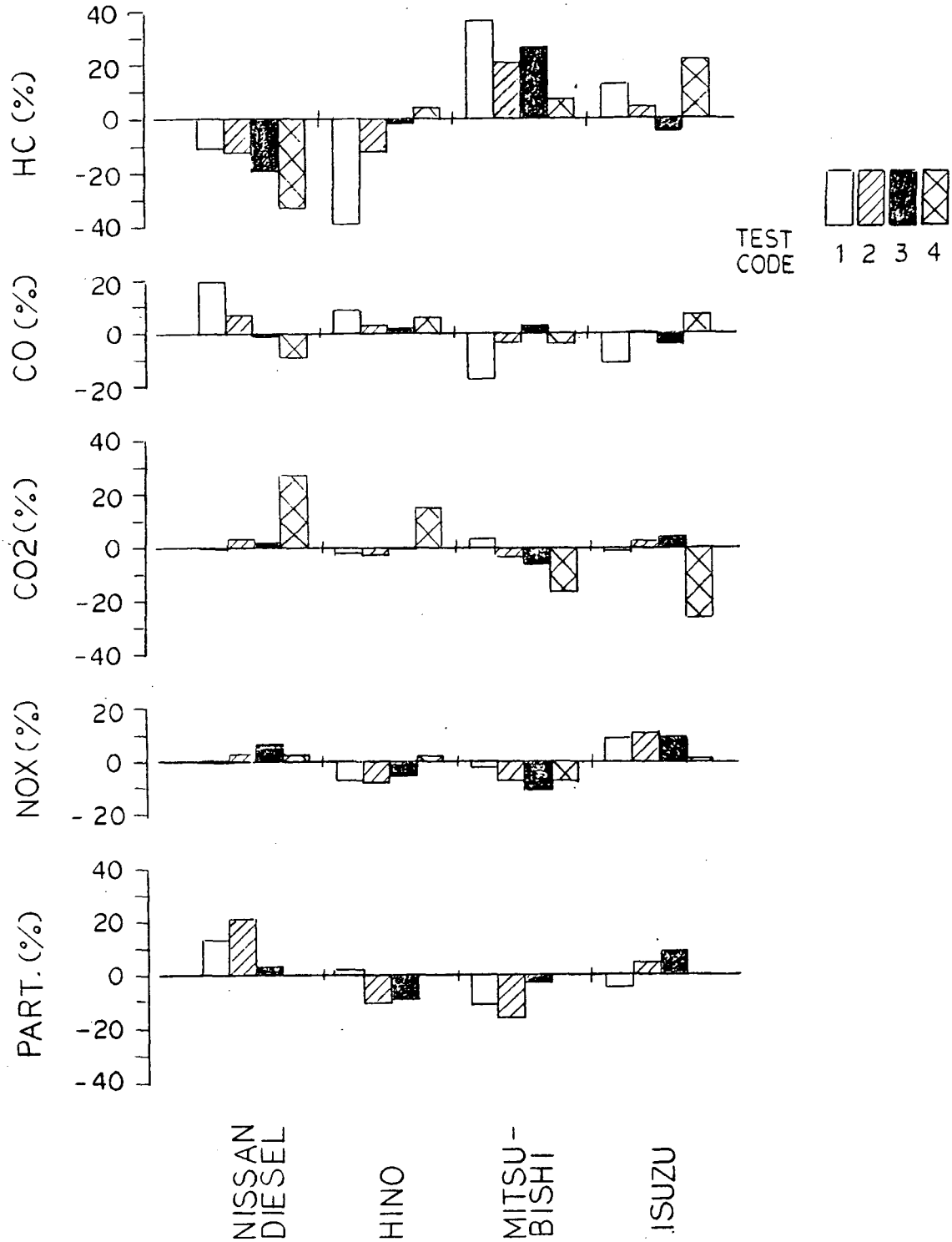
PERCENT DIFFERENCE OF TRANSIENT (COMP) DAT
(EACH LAB. - MEAN) / MEAN × 100 (%)

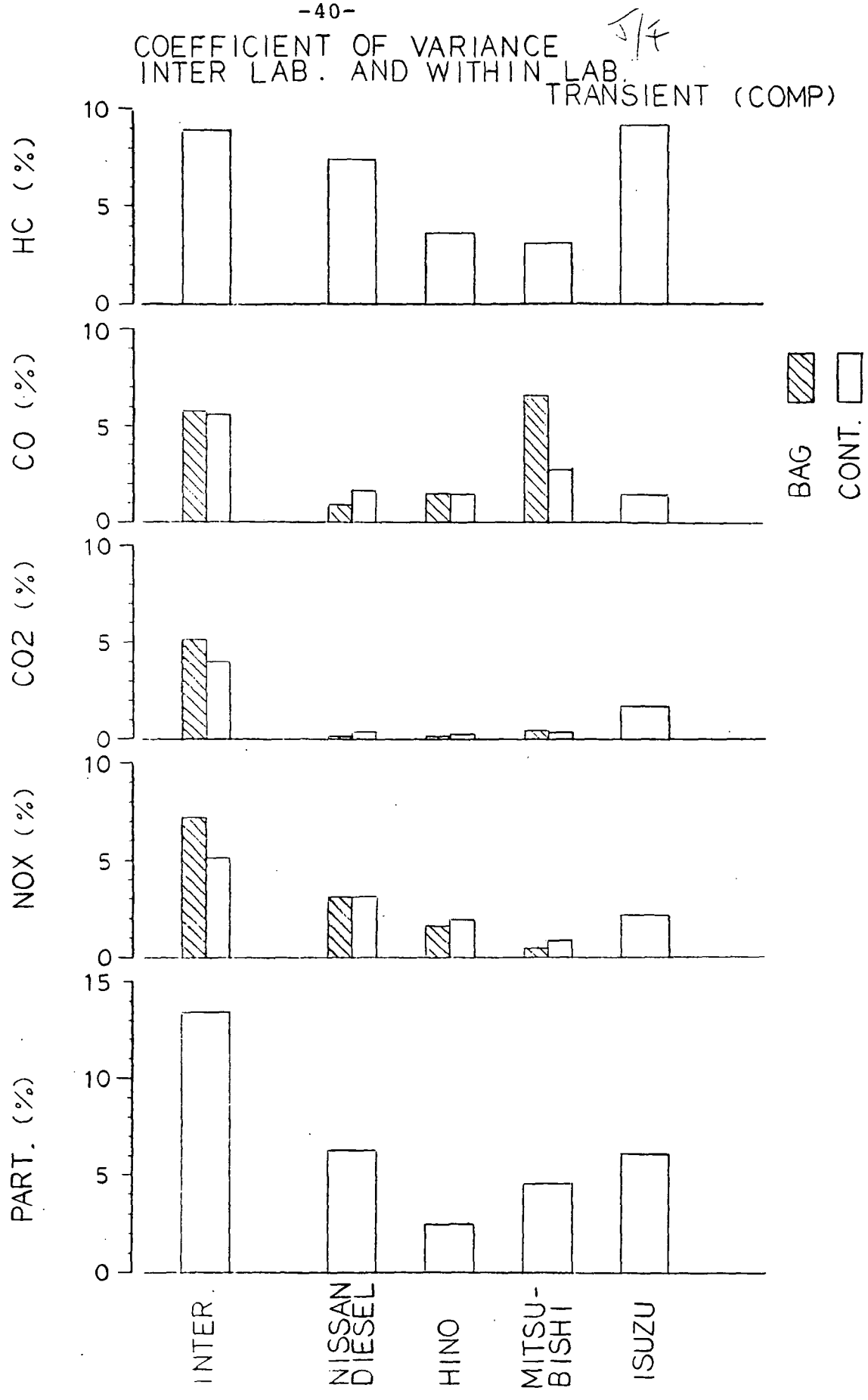


PERCENT DIFFERENCE OF SMOKE DATA
(EACH LAB. - MEAN) / MEAN × 100 (%)

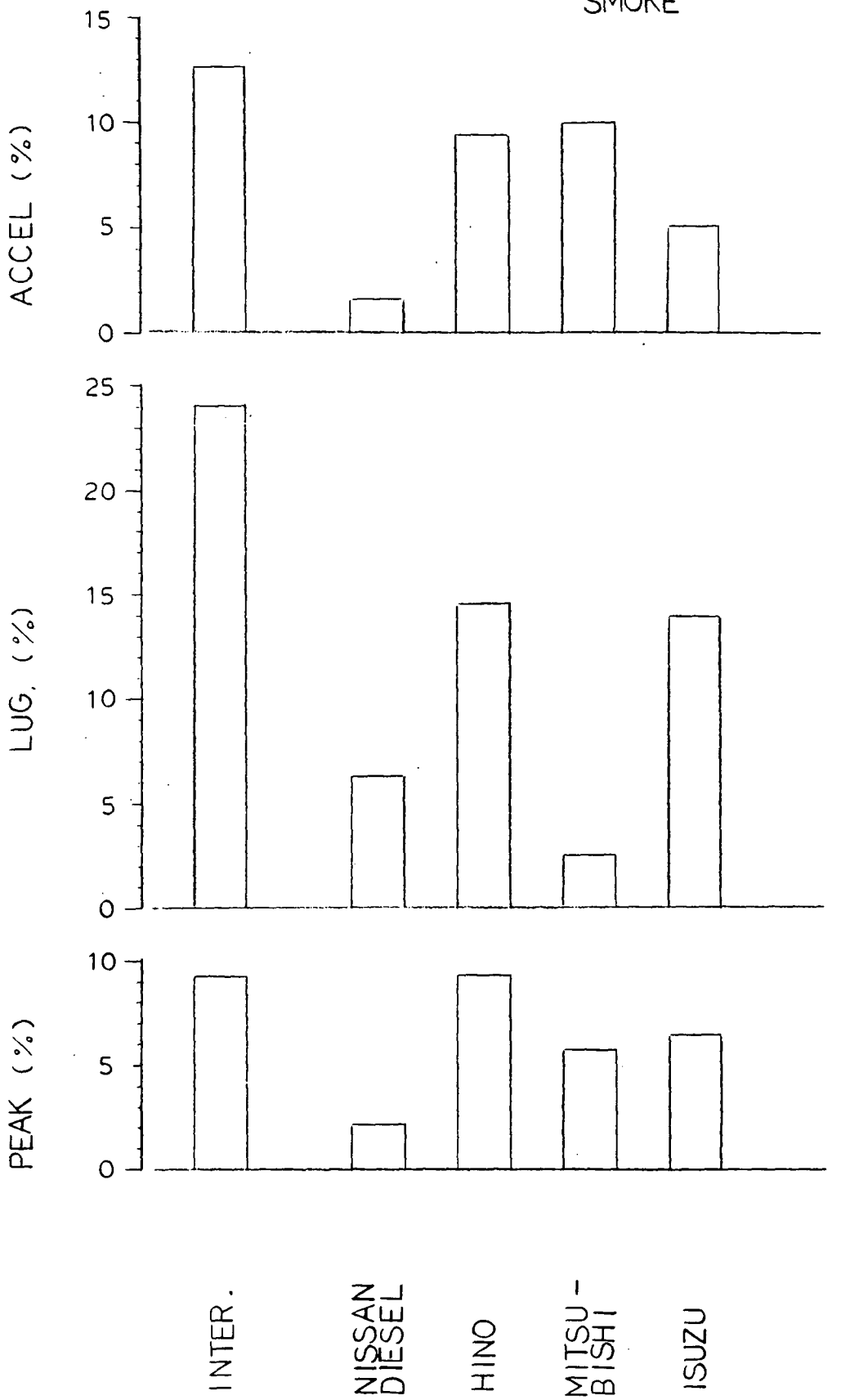


PERCENT DIFFERENCE OF STEADY STATE DATA
(EACH LAB. - MEAN) / MEAN × 100 (%)




COEFFICIENT OF VARIANCE
INTER LAB. AND WITHIN LAB.
TRANSIENT (COMP)
HC (%)
CO (%)
CO2 (%)
NOX (%)
PART. (%)
10
5
0
15
BAG
CONT.
INTER
NISSAN DIESEL
HINO
MITSU-BISHI
ISUZU

COEFFICIENT OF VARIANCE
INTER LAB. AND WITHIN LAB.
SMOKE



'86 EPA-JAMA DIESEL CROSS CHECK DATA SHEET
REFERENCE GAS

TEST LABO E.P.A.

DATE 9-25-86

ANALYST G. BECKER

G A S	Cylinder Number	Approximate Concentration	Analysis Results	Cylinder Pressure
C_3H_8 in Air [redacted] PPM	JJ 4484	30,0[redacted]	29.79	150
	JJ 4483	15,0[redacted]	14.79	120
	JJ 4482	3,0[redacted]	2.984	130
CO in N_2 (ppm)	JJ 5722	270	275.36	110
	JJ 5721	40	40.81	150
NO in N_2 (ppm)	JJ 5581	90	91.52	140
	JJ 5575	45	44.17	150
	JJ 5540	15	14.92	150
CO_2 in N_2 (%)	JJ 4468	1.3	1.289 %	140
	JJ 4467	0.5	.5090 %	120

Analyzer		
THC	Model	400
	Range	0-100 & 050
	Fuel	H_2-HE
CO(H)	Model	868
	Range	NOT USED
CO(L)	Model	8501
	Range	0-100 & 0-750
N O	Model	951-A
	Range	0-100 & 0-50
	Converter Efficiency	96 %
CO_2	Model	868
	Range	2.5 % & 1 %

1986 EPA-JAMA DIESEL CROSS CHECK REFERENCE GAS

GAS	C_3H_8(ppmc)			CO(ppm)		NO(ppm)			CO_2(%)	
Cylinder Number	JJ 4484	JJ 4483	JJ 4482	JJ 5722	JJ 5721	JJ 5581	JJ 5575	JJ 5540	JJ 4468	JJ 4467
HINO	88.7	44.1	9.0	273.3	40.4	91.4	44.6	14.8	1.295	0.510
NISSAN DIESEL	89.2	44.8	9.0	272.4	40.5	92.4	45.0	15.0	1.302	0.520
MITSUBISHI	89.2	44.9	9.1	273.6	40.8	92.8	44.6	14.7	1.316	0.508
ISUZU	89.2	44.2	8.9	278.7	40.7	94.0	45.6	15.1	1.281	0.495
MEAN VALUE	89.1	44.5	9.0	274.5	40.6	92.7	45.0	14.9	1.303	0.508
TCL	89.07	44.46	8.97	274.4	40.4	92.0	44.7	14.9	1.299	0.507
CITI	88.92	44.22	8.97	273.7	40.4	92.0	44.6	14.9	1.298	0.507

1986 EPA-JAMA DIESEL CROSS CHECK REFERENCE GAS

(Each Lab - CITI)/CITI x 100(%)

GAS	C_3H_8(ppmc)			CO(ppm)		NO(ppm)			CO_2(%)	
Cylinder Number	JJ 4484	JJ 4483	JJ 4482	JJ 5722	JJ 5721	JJ 5581	JJ 5575	JJ 5540	JJ 4468	JJ 4467
HINO	-0.25	-0.27	0.33	-0.15	0	-0.65	0	-0.67	-0.23	0.59
NISSAN DIESEL	0.31	1.31	0.33	-0.47	0.25	0.43	0.90	0.67	0.31	2.56
MITSUBISHI	0.31	1.54	1.45	-0.04	0.99	0.87	0	-1.34	1.39	0.20
ISUZU	0.31	-0.05	-0.78	1.83	0.74	2.17	2.24	1.34	-1.31	-2.37
TCL	0.17	0.54	0	0.26	0	0	0.22	0	0.08	0

1986 EPA-JAMA DIESEL CROSS CHECK REFERENCE GAS

Measured Analyzers Range

	THC		CO(H)		CO(L)		NO		CO_2	
	Model	Range (ppmc)	Model	Range (ppm)	Model	Range (ppm)	Model	Range (ppm)	Model	Range (%)
HINO	YANACO SAE7082	100	YANACO SAE7082	300	YANACO SAE7082	100	YANACO SAE7082	100	YANACO SAE7082	3
NISSAN DIESEL	HORIBA 1140TFI	100	HORIBA 8220F	300	HORIBA 8220F	100	HORIBA 8220F	100	HORIBA 8220F	2
MITSUBISHI	DEGAS 105	100	DEGAS 801	400	DEGAS 801	400	DEGAS 801	100	DEGAS 801	4
ISUZU	HORIBA FIA-22	200	HORIBA AIA23(AS)	300	HORIBA AIA23(AS)	100	HORIBA CLA-53S	100	HORIBA AIA-23	3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

SEP 12 1986

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: JAMA Correlation Engine Testing Plan

FROM: Thomas Baines, Heavy-Duty Programs Coordinator
Standards Development and Support Branch

TO: Charles L. Gray, Jr., Director
Emission Control Technology Division

THRU: Chester J. France, Chief
Standards Development and Support Branch

1. Introduction: The Selective Enforcement Audit (SEA) group in OMS/MOD places a very high importance on correlation data between a manufacturers' SEA heavy-duty cell and the EPA/MVEL heavy-duty testing cell. Thus, they have requested that EPA test a round robin engine for a program sponsored by JAMA. The results from this engine will be used to correlate, for SEA purposes, four Japanese laboratories: Hino, Mitsubishi, Nissan Diesel and Isuzu.

2. Objective: The objective of this work is to test the JAMA round robin engine for correlation purposes and supply the data to MOD/SEA and JAMA.

3. Project Scope of Work: Engine. ~~1983~~ 1984 Isuzu 6BD1-T. The remaining engine information will be supplied by the manufacturer before testing.

Work Description.

Set restrictions
Check power @ WOT, rated & peak torque ~~1500~~ 1900 rpm
Map engine
One Hot Start transient for cycle performance and data to compare to engine history
Natural cool
1 C/S, 3 H/S
rated RPM, WOT, check restrictions

Steady States

	SPEED	Torque ft. lbs
Natural Cool 1 C/S, 3 H/S rated RPM, WOT, check restrictions	3000	300
Natural Cool 1 C/S, 3 H/S rated RPM, WOT, check restrictions	1900	297
Steady states - To be determined	1900	148
	IDLE	0

Test data taken: All usual emissions and performance.

4. Output: Report memo transmitting data to MOD.

5. Timing: The engine will arrive at our facility on September 5, 1986. The engine should be immediately checked to be certain that all engine-to-stand interfaces are acceptable to EPA. The engine should be placed in the cell on September 8.

6. Level of Effort: technicians 100 hours, engineering 20 hours.

7. Additional Comments: The project area for this work should be "SEA + HD recall."

8. Review/Approval:

Review:

Lee Jones _____ Date 9-10-86

Reviewed with Technicians? _____

Approval:

Charles L. Gray, Jr. _____ Date 9-13

Priority _____

ATTACHMENT II

DIESEL MANUFACTURERS' DATA SHEET

Manufacturer ISUZU Contact _____ Phone _____

EPA Program ID No. 290 ISZ 353 B4 JAMA CORR &Q

ENGINE INFORMATION

1.	Family and/or model	ESZ0353EAB7/6BD1T
2.	Serial Number	409494
3.	Model Year	'84 MODEL YEAR
4.	Displacement	353 CUBIC INCH(5.785ℓ)
5.	Fuel type (diesel #1 or #2)	D-2
6.	List of Emission Controls	
7.	Certified injection timing	16° BTDC
8.	Accumulated hours or mileage	ABOUT 80 HOURS
9.	Vehicle application/ type of service	CORR.
10.	Certified Curb idle speed (rpm)	580

11. Rated HP 165 @ 3000 rpm (fuel rate 67.5 mm³/stroke; 66.8 lbs/hr)

12. Max torque 335 ft-lb @ 1900 rpm (fuel rate 67.5 mm³/stroke; 42.3 lbs/hr)

SPECIAL INSTRUCTIONS

Starting instructions, request for presence of company representative, intention to do restorative maintenance at EPA, engine disposition, etc. (space on back).

Shut down procedure — ---- WORKED BY HAND

Start procedure — ---- START BY DYNAMOMETER

SET-UP INFORMATION

~~1.~~	Engine Oil Type	SAE 10W-30, CD GRADE
~~2.~~	Nominal Thermostat temp (°F)	180
~~3.~~	Supply fuel pressure (if not specified; 5 psig will be used)	4.3 PSIG (= 0.3 kg/cm²)
~~4.~~	Fuel shut-off system (man., 24V, 12V)	MAN
5.	Rotation, front of engine (CW, CCW)	CW
6.	EPA observed curb idle speed (rpm)	
~~7.~~	Max. safe no load speed (rpm)	3440
~~8.~~	Max. full load gov. speed (rpm)	3000
~~9.~~	Inlet depression "H_2O Transient ~~13-Mode~~	(15.7in) 400 mm "H_2O" / 3000 RPM, FULL LOAD BETWEEN AIR CLEANER & IN. DUCT where measured どこで測っている。
~~10.~~	Exhaust backpressure "Hg Transient ~~13 Mode~~	(3.9in) 100 mm "Hg / 3000 RPM, FULL LOAD EXH. ADAPTER PKG where measured
11.	Rated HP___@____rpm (fuel rate____mm³/stroke;____ lbs/hr)	
12.	Max torque___@___rpm (fuel rate___mm³/stroke;____ lbs/hr)	
✓13.	BACK PRESSURE AT RETURN FUEL PIPE	----- 0 PSIG

September 12, 1986

Mr. T. Baines
Senior Mechanical Engineer
Heavy Duty Programs
Environmental Protection Agency
Motor Vehicle Emission Laboratory
2565 Plymouth Road
Ann Arbor, Michigan 48105

Dear Mr. Baines:

Subject: EPA - JAMA HDDE Cross Check

The following are our replies to your questions. JAMA (Japanese Automobile Manufacturers Association) would like to ask EPA to do the following requirements.

1) Loading Condition of Air Compressor

   a) Please operate by unload condition

   b) Unload condition will be made by the special valve part which will be prepared by Isuzu on September 15th. Please put it on the air compressor, before EPA will test our engine.

2) Engine Oil Supplement

   a) If the engine oil is less than its lower level, Isuzu will supply the same grade oil (10W-30, CD Grade) which is on the market. PRIMARY, no oil required now, please check tubing program. TMB

3) Back Pressure at Return Fuel Pipe

   a) We request the full load test by using the equipment of EPA test cell. After testing, we would like to confirm the data of fuel rate.

   b) If fuel rate is within the Isuzu standard, we request to continue the exhaust emission test as it is.

c) If fuel rate is out of the Isuzu standard, we request to improve the equipment to make fuel rate in the Isuzu standard.

We would appreciate your kind response.

If you have any questions, please contact us.

Sincerely yours,

T. Obara

Toshiji Obara
Japan Automobile Manufacturers Association

/jj

D-2 Diesel Control Fuel
Lot G-463

Property	Results	Specification	Test Method
Cetane Number	44.8	43-47	D 613
Cetane Index	46.7	43-47	D 976
Distillation Range			D 86
IBP, °F	374	345-375	
10%, °F	429	400-440	
50%, °F	506	495-525	
90%, °F	591	580-610	
EP, °F	634	630-660	
Sulfur, wt. %	0.31	0.2-0.4	D 2622
Aromatics, minimum	32.3	29	D 1319
Flashpoint, °F minimum	155	130	D 93
Viscosity, centistokes @ 40°C	2.43	2.2-3.2	D 445
Gravity, °API, 60°F	35.1	33-36	D 1298
Copper Strip Corrosion, maximum	No. 1	No. 3	D 130
Oxidation Stability, mg/100 ml, max.	0.4	1.5	D 2274
Cloud Point, Maximum, °F	8	15	D 2500
Particulate matter, maximum, mg/l	1.7	15	D 2276
Carbon Density, grams carbon/gal.	2782	2750-2806(a)	
Net Heat of Combustion, BTU/lb.	19435	Report	D 240

(a) The formula for this calculation is:

$$\text{Carbon Density} = \frac{141.5}{131.5 + \text{API gravity}} \times (\text{Weight Fraction Carbon}) \times 3778$$

Where: Weight fraction carbon is the percent carbon by weight found in the fuel by mass spectroscopy (ASTM D 2789), products of combustion analysis (Pregle analysis ASTM E 191), or equivalent means. 3778 is the weight of 1 gallon of water in grams at 60°F in dry air.