

Technical Report

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

By

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NOTICE

Technical Reports do not necessarily represent final EPA decisions or positions. They are intended to present technical analysis of issues using data which are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments which may form the basis for a final EPA decision, position or regulatory action.

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

This report supersedes "Heavy-Duty Engine Testing Report - Correlation Testing of Isuzu 5.79L/JAMA Engine", EPA-AA-SDSB-87-6.

## 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

<u>Lab</u>	<u>Idle rpm</u>	<u>Peak Torque</u>		<u>Peak Power</u>		<u>Ref. BHP-hr</u>
		<u>Peak torque ft-lb</u>	<u>Peak torque speed-rpm</u>	<u>HP</u>	<u>Peak power speed-rpm</u>	
EPA	590	345.8	2106	173	3027	11.068
Nissan	590	336.3	2102	169	3063	10.968
HINO	580	340.7	2061	172	2980	11.070
Mitsubishi	590	340.7	2110	172	3070	11.270
Isuzu	580	337.7	1994	164	3020	10.810

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.

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<sub>2</sub> is given because no BSFC results were provided by the JAMA participants. (Carbon dioxide, or CO<sub>2</sub>, 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:

<u>Emission</u>	<u>(s/x) (100), Max.</u>
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 <sub>2</sub>	Part
<b>EPA</b>					
3311***	.62	1.84	6.77	645.4	.52
3312	.61	1.84	7.18	638.4	.53
3317	.61	1.75	7.31	636.7	.55
3318	.60	1.73	6.98	634.8	.56
$\bar{X}$	.61	1.79	7.06	638.8	.54
COV**	1.3	3.3	3.3	0.7	3.4

NISSAN

$\bar{X}$	.63	1.87	6.51	636.4	.677
$\Delta\%*$	3.3	4.5	-7.8	-0.4	25.4

HINO

$\bar{X}$	.57	1.78	6.19	594.0	.551
$\Delta\%*$	-6.6	-.6	-12.3	-7.0	2.0

MITSUBISHI

$\bar{X}$	.68	1.70	5.88	609.7	.493
$\Delta\%*$	11.5	-5.0	-16.7	-4.6	-8.7

ISUZU

$\bar{X}$	.70	1.94	7.09+	667.3	.573
$\Delta\%*$	14.8	8.4	.4	4.5	6.1

\* Relative to EPA.

\*\* COV = Coefficient of Variation, in percent ( $s/\bar{X} \times 100$ ).

\*\*\* EPA test number.

+ bag results only

Table 3

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

Lab	Emissions, g/BHP-hr				
	HC	CO	NOx	CO <sub>2</sub>	Part
<u>EPA</u>					
3311***	.64	2.21	6.90	658.2	.60
3312	.68	2.18	7.38	655.2	.56
3317	.66	2.16	7.34	653.3	.57
3318	.65	2.18	7.11	655.1	.64
$\bar{X}$	.66	2.18	7.18	655.5	.59
COV**	2.6	0.9	3.1	0.3	6.1
<u>NISSAN</u>					
$\bar{X}$	.81	2.11	6.60	653.2	.761
$\Delta\%$	22.7	-3.3	-7.9	-.3	28.4
<u>HINO</u>					
$\bar{X}$	.67	2.04	6.33	609.1	.627
$\Delta\%*$	1.9	-6.5	-11.8	-7.1	5.8
<u>MITSUBISHI</u>					
$\bar{X}$	.78	1.81	5.97	625.8	.506
$\Delta\%*$	18.6	-17.1	-16.8	-4.5	-14.6
<u>ISUZU</u>					
$\bar{X}$	.89	2.39	7.49+	707.7	.682
$\Delta\%*$	35.4	9.5	4.3	8.0	15.1

\* Relative to EPA.

\*\* COV = Coefficient of variation, in percent ( $s/\bar{X} \times 100$ ).

\*\*\* EPA test number.

+ bag results only

Table 4

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

<u>Lab</u>	Emissions, g/BHP-hr				
	<u>HC</u>	<u>CO</u>	<u>NOx</u>	<u>CO<sub>2</sub></u>	<u>Part</u>
<u>EPA</u>					
3300***	.52	1.82	6.41	601.0	.48
3301	.56	1.71	6.40	606.0	.50
3302	.62	1.80	6.61	603.2	.50
3303	.57	1.81	6.30	594.4	.50
3306	.66	1.78	6.50	600.1	.52
3307	.64	1.74	6.40	596.4	.50
3308	.58	1.76	6.63	599.9	.51
3311	.61	1.78	6.75	643.2	.51
3312	.59	1.79	7.15	635.5	.52
3317	.60	1.68	7.30	633.9	.55
3318	.60	1.65	6.96	631.5	.54
3305	.64	1.80	6.44	596.3	.51
$\bar{X}$	.60	1.76	6.65	611.8	.51
COV**	6.5	3.1	4.9	3.0	3.7
<u>NISSAN</u>					
$\bar{X}$	.60	1.83	6.50	633.8	.664
$\Delta\%*$	0	4.0	-2.3	3.6	29.8
<u>HINO</u>					
$\bar{X}$	.55	1.73	6.17	591.5	.538
$\Delta\%*$	-8.3	-1.7	-7.2	-3.3	5.2
<u>MITSUBISHI</u>					
$\bar{X}$	.66	1.68	5.86	607.0	.491
$\Delta\%*$	10.0	-4.6	-11.9	-.8	-4.0
<u>ISUZU</u>					
$\bar{X}$	.67	1.87	7.03+	660.8	.555
$\Delta\%*$	11.7	6.3	5.7	8.0	8.8

\* Percent difference relative to EPA.

\*\* COV = Coefficient of variation, in percent ( $s/\bar{X} \times 100$ ).

\*\*\* EPA test number.

+ bag results only

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, NOx, and CO<sub>2</sub>, were quite comparable to those of EPA, although their cold start HC results were quite high. 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, and particulate. The Hino HC and NOx results tend to be low and CO<sub>2</sub> was markedly low (especially the cold start data).

The Mitsubishi data were quite high for HC and low for CO, NOx, CO<sub>2</sub> and particulate. The Isuzu data were significantly higher than EPA for all measured values except NOx, but the Isuzu NOx data were bag results (not continuous as were all other NOx data).

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.

<u>Lab</u>	<u>HC</u>	<u>CO</u>	<u>NOx</u>	<u>CO<sub>2</sub></u>	<u>Part.</u>
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	1049.	258.6	1536.	318.6	2025.	342.6	2514.	334.6	3082.	307.4
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	1089.	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	2593.	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
759.	209.8	1249.	296.6	1736.	337.0	2226.	343.4	2716.	322.2	3202.	273.0
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	3249.	258.2
815.	218.2	1304.	301.4	1792.	339.8	2282.	341.4	2769.	317.8	3255.	253.0
823.	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	2793.	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.	191.8
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.	309.2	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	2953.	304.6	3425.	41.3
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	1513.	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	

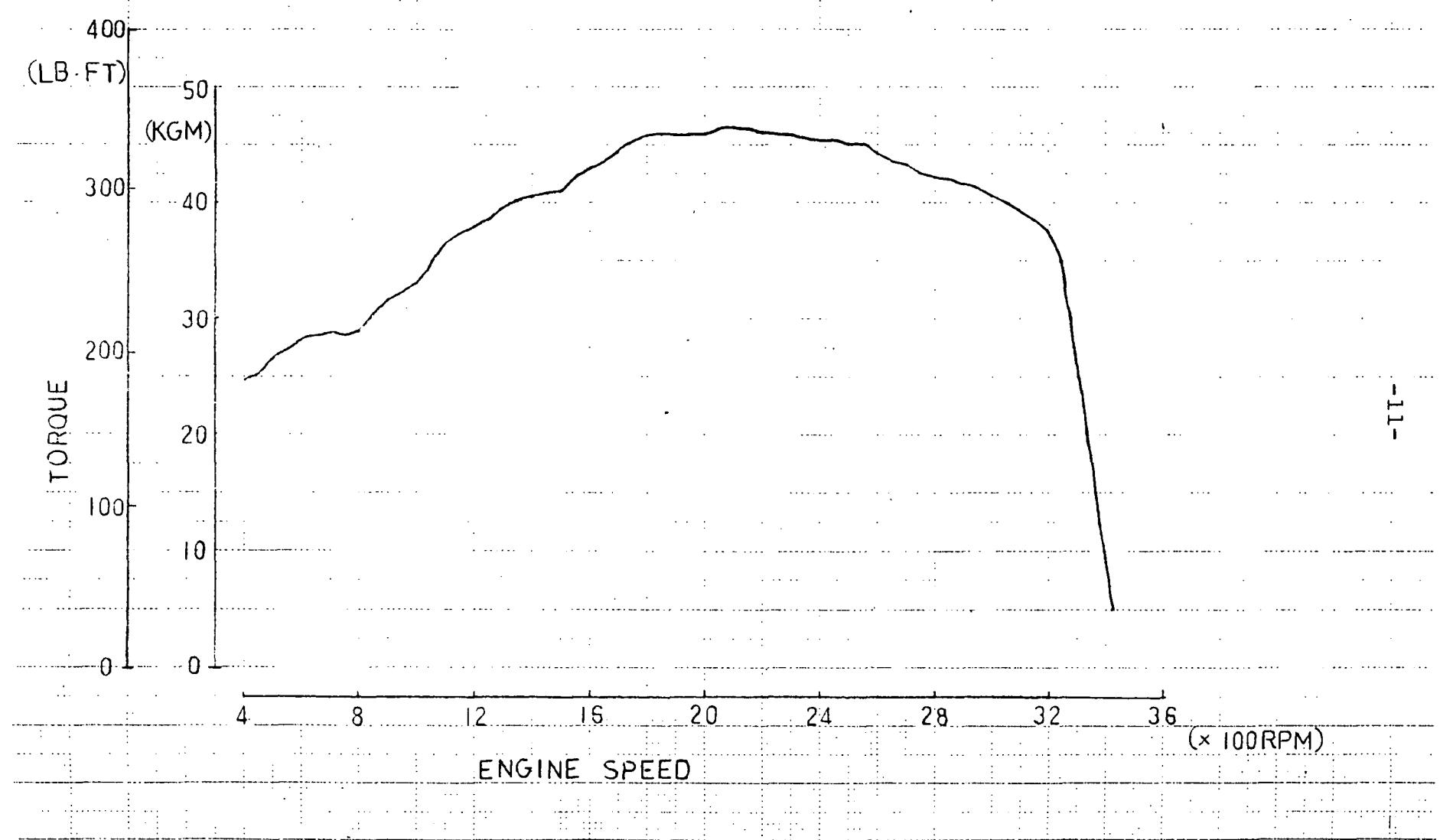
<COMMENT> MAX POWER: 172.8 HP @ 3027. RPM.

<COMMENT> RATED SPEED: 2998. RPM.

WANT A CALCOMP PLOT OF THE MAPPING CURVE? (Y/N), <DEFLT = N>: N

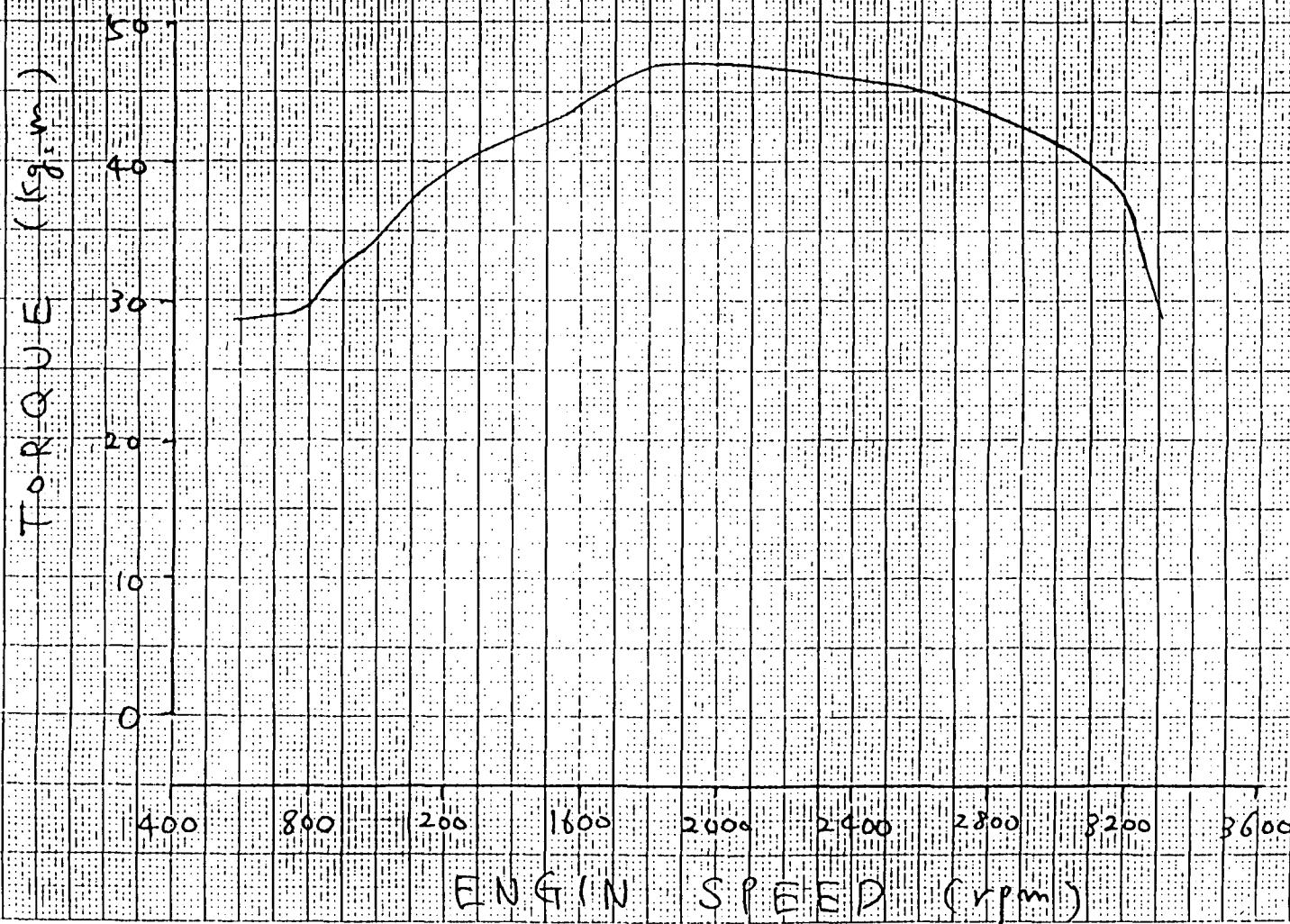
DO YOU WANT THE RPM TO & HP DATA LIST? (Y/N): Y

NISSAN DIESEL



MAPPING DATA

TEST AB, H NO 1



JIS A 1 1980 - 2901

6BDIT MAPPING

JUL 15, 1986

MITSUBISHI

lb-ft  
400

Kgm  
50

300

40

200

30

100

10

0

0

TORQUE

NO 714 ~ 11 11

400 800 1200 1600 2000 2400 2800 3200 3600

ENGINE SPEED RPM

FULL LOAD MAPPING RESULT

LUB. ISUZU KANASAKI

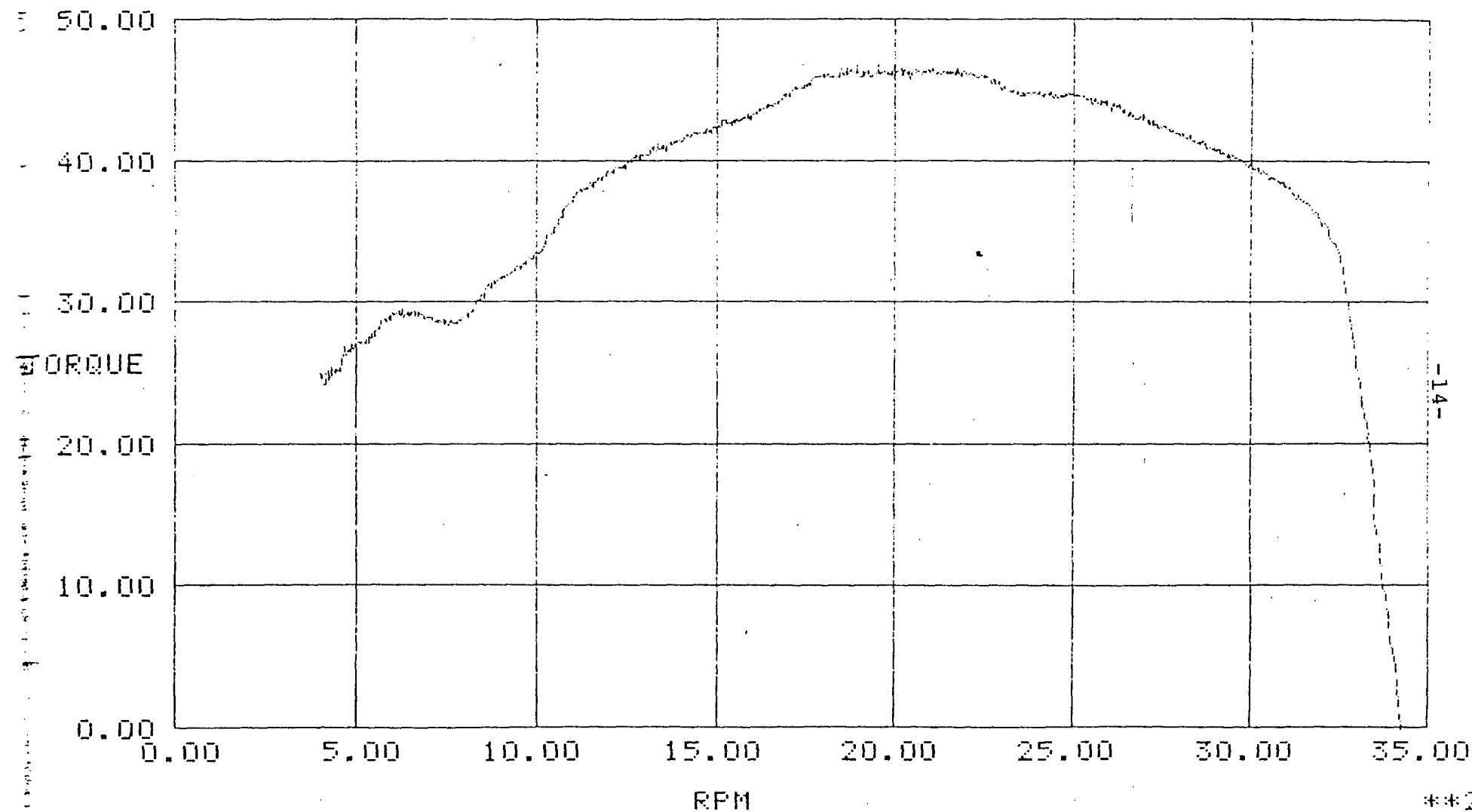
ENGINE NAME : 6BD1 409494

DATE : 86-7-22

TEST NO. = 5

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

761.2 mmHg.



HD-863300  
290 ISZ35384JAMACORR 0  
HS

## HEAVY DUTY DIESEL TRANSIENT ENGINE TEST

DATE: 09-29-86 TIME: 14:35:54 HD-863300

## DIESEL SUMMARY REPORT

TEST NUMBER: HD-863300  
TEST DATE/TIME: 9-26-86 8:37

MANUFACTURER: ISUZU  
ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG

DRY BULB TEMPERATURE: 73.60 F

ABSOLUTE HUMIDITY: 56.82 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST	CYCLE STATISTICS	CS	HS
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	0.00	4.39		NUMBER	0	1176
EXHAUST+BKG, GM	0.00	10.89		SLOPE	0.00000	0.99627
NET, GM/BHP-HR	0.000	0.656	0.656	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	0.000	11.871
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	0.00	19.48		STD ERROR	0.000	16.515
NET, GM/BHP-HR	0.00	1.82	1.82	(LIMIT: 100 RPM)		
				R-SQUARE	0.00000	0.99972
NOX (INTEGRATED)				(LIMIT: 0.97)		
BACKGROUND, PPM	0.00	0.50		TORQUE		
EXHAUST+BKG, GM	0.00	73.16		NUMBER	0	998
NET, GM/BHP-HR	0.000	6.407	6.407	SLOPE	0.00000	0.86431
CO2 (BAG)				(LIMIT: 0.77/0.83-1.03)		
BACKGROUND, PPM	0.000	0.039		Y-INTERCEPT	0.000	10.257
EXHAUST+BKG, GM	0.00	7492.40		(LIMIT: +-15 FT-LBS)		
NET, GM/BHP-HR	0.0	601.0	601.0	STD ERROR	0.000%	8.367%
				(LIMIT: 13% MAX ENG TQ)		
PARTICULATE				R-SQUARE	0.00000	0.91189
SECONDARY TARE, GM	0.000000	0.171400		(LIMIT: 0.85/0.88)		
SECONDARY PART, GM	0.000000	0.171500		POWER		
PRIMARY TARE, GM	0.000000	0.167700		NUMBER	0	997
PRIMARY PART, GM	0.000000	0.171450		SLOPE	0.00000	0.91092
TOTAL, GM/BHP-HR	0.00	0.48	0.48	(LIMIT: 0.87/0.89-1.03)		
FUEL CONSUMPTION				Y-INTERCEPT	0.000	1.100
LBS	0.00	4.48	4.48	(LIMIT: +-5 BHP)		
LBS/BHP-HR	0.000	0.419	0.419	STD ERROR	0.000%	7.704%
BRAKE HORSEPOWER-HOUR	0.000	10.686		(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%

HD-863301  
290 ISZ35384JAMACORR 0  
HS

## HEAVY DUTY DIESEL TRANSIENT ENGINE TEST

DATE: 09-29-86 TIME: 14:42:38 HD-863301

## DIESEL SUMMARY REPORT

TEST NUMBER: HD-863301  
TEST DATE/TIME: 9-26-86 9:42

MANUFACTURER: ISUZU  
ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG

DRY BULB TEMPERATURE: 77.10 F

ABSOLUTE HUMIDITY: 52.35 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST	CYCLE STATISTICS	CS	HS
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	0.00	3.57		NUMBER	0	1176
EXHAUST+BKG, GM	0.00	10.32		SLOPE	0.00000	0.99733
NET, GM/BHP-HR	0.000	0.679	0.679	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	0.000	9.999
BACKGROUND, PPM	0.00	0.24		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	0.00	18.51		STD ERROR	0.000	16.509
NET, GM/BHP-HR	0.00	1.71	1.71	(LIMIT: 100 RPM)		
				R-SQUARE	0.00000	0.99972
				(LIMIT: 0.97)		
NOX (INTEGRATED)				TORQUE		
BACKGROUND, PPM	0.00	0.50		NUMBER	0	998
EXHAUST+BKG, GM	0.00	73.03		SLOPE	0.00000	0.87162
NET, GM/BHP-HR	0.000	6.400	6.400	(LIMIT: 0.77/0.83-1.03)		
CO2 (BAG)				Y-INTERCEPT	0.000	7.659
BACKGROUND, PPM	0.000	0.038		STD ERROR	0.000%	8.451%
EXHAUST+BKG, GM	0.00	7447.07		(LIMIT: 13% MAX ENG TQ)		
NET, GM/BHP-HR	0.0	606.0	606.0	R-SQUARE	0.00000	0.91164
				(LIMIT: 0.85/0.88)		
PARTICULATE				POWER		
SECONDARY TARE, GM	0.000000	0.169900		NUMBER	0	997
SECONDARY PART, GM	0.000000	0.170100		SLOPE	0.00000	0.91190
PRIMARY TARE, GM	0.000000	0.166000		(LIMIT: 0.87/0.89-1.03)		
PRIMARY PART, GM	0.000000	0.169600		Y-INTERCEPT	0.000	0.560
TOTAL, GM/BHP-HR	0.00	0.50	0.50	(LIMIT: +-5 BHP)		
FUEL CONSUMPTION				STD ERROR	0.000%	7.773%
LBS	0.00	4.46	4.46	(LIMIT: 8%)		
LBS/BHP-HR	0.000	0.423	0.423	R-SQUARE	0.00000	0.92671
				(LIMIT: 0.91)		
BRAKE HORSEPOWER-HOUR	0.000	10.561		WORK		
				ACTUAL	0.000	10.561
				(LIMIT: -15%-5% REF BHP-HR)		
				REFERENCE	0.000	11.068
				% DIFFERENCE	0.00%	-4.58%

HD-863302  
290 ISZ35384JAMACORR 0  
HS

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST  
DIESEL SUMMARY REPORT

DATE: 09-29-86 TIME: 15:29:38 HD-863302

TEST NUMBER: HD-863302  
TEST DATE/TIME: 9-26-86 10:46

MANUFACTURER: ISUZU  
ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG  
DRY BULB TEMPERATURE: 78.00 F  
ABSOLUTE HUMIDITY: 65.85 GRAINS H2O / LB. DRY AIR

<u>EMISSION RESULTS</u>	<u>CS</u>	<u>HS</u>	<u>WTD TEST</u>	<u>CYCLE STATISTICS</u>	<u>CS</u>	<u>HS</u>
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	0.00	3.72		NUMBER	0	1176
EXHAUST+BKG, GM	0.00	11.71		SLOPE	0.000000	0.99690
NET, GM/BHP-HR	0.000	0.798	0.798	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	0.000	7.753
BACKGROUND, PPM	0.00	0.48		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	0.00	19.88		STD ERROR	0.000	16.635
NET, GM/BHP-HR	0.00	1.80	1.80	(LIMIT: 100 RPM)		
R-SQUARE				R-SQUARE	0.000000	0.99972
NOX (INTEGRATED)				(LIMIT: 0.97)		
BACKGROUND, PPM	0.00	0.50		TORQUE		
EXHAUST+BKG, GM	0.00	72.91		NUMBER	0	997
NET, GM/BHP-HR	0.000	6.611	6.611	SLOPE	0.000000	0.85055
CO2 (BAG)				(LIMIT: 0.77/0.83-1.03)		
BACKGROUND, PPM	0.000	0.038		Y-INTERCEPT	0.000	10.800
EXHAUST+BKG, GM	0.00	7417.39		(LIMIT: +-15 FT-LBS)		
NET, GM/BHP-HR	0.0	603.2	603.2	STD ERROR	0.000%	8.584%
PARTICULATE				(LIMIT: 13% MAX ENG TQ)		
SECONDARY TARE, GM	0.000000	0.168300		R-SQUARE	0.000000	0.90480
SECONDARY PART, GM	0.000000	0.168400		(LIMIT: 0.85/0.88)		
PRIMARY TARE, GM	0.000000	0.168700		POWER		
PRIMARY PART, GM	0.000000	0.172550		NUMBER	0	996
TOTAL, GM/BHP-HR	0.00	0.50	0.50	SLOPE	0.000000	0.90415
FUEL CONSUMPTION				(LIMIT: 0.87/0.89-1.03)		
LBS	0.00	4.44	4.44	Y-INTERCEPT	0.000	0.933
LBS/BHP-HR	0.000	0.421	0.421	(LIMIT: +-5 BHP)		
BRAKE HORSEPOWER-HOUR	0.000	10.558		STD ERROR	0.000%	7.717%
				(LIMIT: 8%)		
				R-SQUARE	0.000000	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%

HD-863303  
290 ISZ35384JAMACORR 0  
HS

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST  
DIESEL SUMMARY REPORT

DATE: 09-29-86 TIME: 15:28:37 HD-863303

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

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG  
DRY BULB TEMPERATURE: 76.70 F  
ABSOLUTE HUMIDITY: 48.10 GRAINS H2O / LB. DRY AIR

<u>EMISSION RESULTS</u>	<u>CS</u>	<u>HS</u>	<u>WTD TEST</u>	<u>CYCLE STATISTICS</u>	<u>CS</u>	<u>HS</u>
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	0.00	0.00		NUMBER	0	1176
EXHAUST+BKG, GM	0.00	10.97		SLOPE	0.00000	0.99725
NET, GM/BHP-HR	0.000	0.723	0.723	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	0.000	6.807
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	0.00	19.10		STD ERROR	0.000	16.420
NET, GM/BHP-HR	0.00	1.81	1.81	(LIMIT: 100 RPM)		
				R-SQUARE	0.00000	0.99972
NOX (INTEGRATED)				(LIMIT: 0.97)		
BACKGROUND, PPM	0.00	0.00		TORQUE		
EXHAUST+BKG, GM	0.00	72.50		NUMBER	0	998
NET, GM/BHP-HR	0.000	6.301	6.301	SLOPE	0.00000	0.85291
CO2 (BAG)				(LIMIT: 0.77/0.83-1.03)		
BACKGROUND, PPM	0.000	0.000		Y-INTERCEPT	0.000	10.066
EXHAUST+BKG, GM	0.00	7416.88		(LIMIT: +-15 FT-LBS)		
NET, GM/BHP-HR	0.0	594.4	594.4	STD ERROR	0.000%	8.603%
				(LIMIT: 13% MAX ENG TQ)		
PARTICULATE				R-SQUARE	0.00000	0.90506
SECONDARY TARE, GM	0.000000	0.168800		(LIMIT: 0.85/0.88)		
SECONDARY PART, GM	0.000000	0.168950		POWER		
PRIMARY TARE, GM	0.000000	0.168100		NUMBER	0	997
PRIMARY PART, GM	0.000000	0.171950		SLOPE	0.00000	0.90427
TOTAL, GM/BHP-HR	0.00	0.50	0.50	(LIMIT: 0.87/0.89-1.03)		
FUEL CONSUMPTION				Y-INTERCEPT	0.000	0.801
LBS	0.00	4.37	4.37	(LIMIT: +-5 BHP)		
LBS/BHP-HR	0.000	0.415	0.415	STD ERROR	0.000%	7.743%
BRAKE HORSEPOWER-HOUR	0.000	10.536		(LIMIT: 8%)		
				R-SQUARE	0.00000	0.92609
				(LIMIT: 0.91)		
WORK				WORK		
				ACTUAL	0.000	10.536
				(LIMIT: -15%-5% REF BHP-HR)		
				REFERENCE	0.000	11.068
				% DIFFERENCE	0.00%	-4.81%

HD-863305  
290 ISZ35384JAMACORR 0  
HS

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST  
DIESEL SUMMARY REPORT

DATE: 09-29-86 TIME: 15:29:09 HD-863305

TEST NUMBER: HD-863305  
TEST DATE/TIME: 9-26-86 13:41

MANUFACTURER: ISUZU  
ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG

DRY BULB TEMPERATURE: 75.90 F

ABSOLUTE HUMIDITY: 63.14 GRAINS H<sub>2</sub>O / LB. DRY AIR

<u>EMISSION RESULTS</u>	<u>CS</u>	<u>HS</u>	<u>WTD TEST</u>	<u>CYCLE STATISTICS</u>	<u>CS</u>	<u>HS</u>
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	0.00	3.35		NUMBER	0	1176
EXHAUST+BKG, GM	0.00	10.54		SLOPE	0.00000	0.99332
NET, GM/BHP-HR	0.000	0.725	0.725	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	0.000	4.836
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	0.00	18.79		STD ERROR	0.000	16.197
NET, GM/BHP-HR	0.00	1.80	1.80	(LIMIT: 100 RPM)		
R-SQUARE				R-SQUARE	0.00000	0.99973
(LIMIT: 0.97)				(LIMIT: 0.97)		
NOX (INTEGRATED)				TORQUE		
BACKGROUND, PPM	0.00	0.50		NUMBER	0	998
EXHAUST+BKG, GM	0.00	70.89		SLOPE	0.00000	0.84132
NET, GM/BHP-HR	0.000	6.438	6.438	(LIMIT: 0.77/0.83-1.03)		
CO2 (BAG)				Y-INTERCEPT	0.000	11.678
BACKGROUND, PPM	0.000	0.034		(LIMIT: +-15 FT-LBS)		
EXHAUST+BKG, GM	0.00	7166.99		STD ERROR	0.000%	8.630%
NET, GM/BHP-HR	0.0	596.3	596.3	(LIMIT: 13% MAX ENG TQ)		
R-SQUARE				R-SQUARE	0.00000	0.90214
(LIMIT: 0.85/0.88)				(LIMIT: 0.85/0.88)		
PARTICULATE				POWER		
SECONDARY TARE, GM	0.000000	0.169700		NUMBER	0	997
SECONDARY PART, GM	0.000000	0.169900		SLOPE	0.00000	0.89543
PRIMARY TARE, GM	0.000000	0.165100		(LIMIT: 0.87/0.89-1.03)		
PRIMARY PART, GM	0.000000	0.168750		Y-INTERCEPT	0.000	0.890
TOTAL, GM/BHP-HR	0.00	0.51	0.51	(LIMIT: +-5 BHP)		
FUEL CONSUMPTION				STD ERROR	0.0000%	7.659%
LBS	0.00	4.35	4.35	(LIMIT: 8%)		
LBS/BHP-HR	0.000	0.416	0.416	R-SQUARE	0.00000	0.92625
(LIMIT: 0.91)				(LIMIT: 0.91)		
BRAKE HORSEPOWER-HOUR	0.000	10.460		WORK		
				ACTUAL	0.000	10.460
				(LIMIT: -15%-5% REF BHP-HR)		
				REFERENCE	0.000	11.068
				% DIFFERENCE	0.00%	-5.49%

HD-863306  
290 ISZ35384JAMACORR 0  
HS

## HEAVY DUTY DIESEL TRANSIENT ENGINE TEST

DATE: 09-29-86 TIME: 14:03:50 HD-863306

## DIESEL SUMMARY REPORT

TEST NUMBER: HD-863306  
TEST DATE/TIME: 9-26-86 14:13

MANUFACTURER: ISUZU  
ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG  
DRY BULB TEMPERATURE: 71.50 F  
ABSOLUTE HUMIDITY: 59.42 GRAINS H2O / LB. DRY AIR

<u>EMISSION RESULTS</u>	<u>CS</u>	<u>HS</u>	<u>WTD TEST</u>	<u>CYCLE STATISTICS</u>	<u>CS</u>	<u>HS</u>
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	0.00	0.00		NUMBER	0	1176
EXHAUST+BKG, GM	0.00	11.31		SLOPE	0.00000	0.99264
NET, GM/BHP-HR	0.000	0.784	0.784	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	0.000	6.497
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	0.00	18.71		STD ERROR	0.000	16.441
NET, GM/BHP-HR	0.00	1.78	1.78	(LIMIT: 100 RPM)		
				R-SQUARE	0.00000	0.99972
NOX (INTEGRATED)				(LIMIT: 0.97)		
BACKGROUND, PPM	0.00	0.00		TORQUE		
EXHAUST+BKG, GM	0.00	72.35		NUMBER	0	998
NET, GM/BHP-HR	0.000	6.497	6.497	SLOPE	0.00000	0.84885
CO2 (BAG)				(LIMIT: 0.77/0.83-1.03)		
BACKGROUND, PPM	0.000	0.000		Y-INTERCEPT	0.000	10.804
EXHAUST+BKG, GM	0.00	7301.84		(LIMIT: +-15 FT-LBS)		
NET, GM/BHP-HR	0.0	600.1	600.1	STD ERROR	0.000%	8.623%
				(LIMIT: 13% MAX ENG TQ)		
PARTICULATE				R-SQUARE	0.00000	0.90384
SECONDARY TARE, GM	0.000000	0.159400		(LIMIT: 0.85/0.88)		
SECONDARY PART, GM	0.000000	0.159600		POWER		
PRIMARY TARE, GM	0.000000	0.170900		NUMBER	0	997
PRIMARY PART, GM	0.000000	0.174650		SLOPE	0.00000	0.89911
TOTAL, GM/BHP-HR	0.00	0.52	0.52	(LIMIT: 0.87/0.89-1.03)		
FUEL CONSUMPTION				Y-INTERCEPT	0.000	0.857
LBS	0.00	4.39	4.39	(LIMIT: +-5 BHP)		
LBS/BHP-HR	0.000	0.419	0.419	STD ERROR	0.000%	7.671%
BRAKE HORSEPOWER-HOUR	0.000	10.486		(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%

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HD-863307  
290 ISZ35384JAMACORR 0  
HS

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST  
DIESEL SUMMARY REPORT

DATE: 09-29-86 TIME: 14:03:31 HD-863307

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

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG  
DRY BULB TEMPERATURE: 76.50 F  
ABSOLUTE HUMIDITY: 50.65 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST	CYCLE STATISTICS	CS	HS
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	0.00	4.61		NUMBER	0	1176
EXHAUST+BKG, GM	0.00	11.47		SLOPE	0.00000	0.99316
NET, GM/BHP-HR	0.000	0.704	0.704	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	0.000	5.281
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	0.00	18.25		STD ERROR	0.000	16.180
NET, GM/BHP-HR	0.00	1.74	1.74	(LIMIT: 100 RPM)		
				R-SQUARE	0.00000	0.99973
NOX (INTEGRATED)				(LIMIT: 0.97)		
BACKGROUND, PPM	0.00	0.50		TORQUE		
EXHAUST+BKG, GM	0.00	73.03		NUMBER	0	998
NET, GM/BHP-HR	0.000	6.401	6.401	SLOPE	0.00000	0.84623
CO2 (BAG)				(LIMIT: 0.77/0.83-1.03)		
BACKGROUND, PPM	0.000	0.036		Y-INTERCEPT	0.000	11.563
EXHAUST+BKG, GM	0.00	7283.72		STD ERROR	0.000%	8.590%
NET, GM/BHP-HR	0.0	596.4	596.4	(LIMIT: 13% MAX ENG TQ)	0.00000	0.90397
				R-SQUARE	(LIMIT: 0.85/0.88)	
PARTICULATE				POWER		
SECONDARY TARE, GM	0.000000	0.165250		NUMBER	0	997
SECONDARY PART, GM	0.000000	0.165400		SLOPE	0.00000	0.89853
PRIMARY TARE, GM	0.000000	0.163700		(LIMIT: 0.87/0.89-1.03)		
PRIMARY PART, GM	0.000000	0.167500		Y-INTERCEPT	0.000	0.973
TOTAL, GM/BHP-HR	0.00	0.50	0.50	(LIMIT: +-5 BHP)		
FUEL CONSUMPTION				STD ERROR	0.000%	7.666%
LBS	0.00	4.38	4.38	(LIMIT: 8%)		
LBS/BHP-HR	0.000	0.416	0.416	R-SQUARE	0.00000	0.92658
				(LIMIT: 0.91)		
BRAKE HORSEPOWER-HOUR	0.000	10.516		WORK		
				ACTUAL	0.000	10.516
				(LIMIT: -15%-5% REF BHP-HR)		
				REFERENCE	0.000	11.068
				% DIFFERENCE	0.00%	-4.99%

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HD-863308  
290 ISZ35384JAMACORR 0  
HS

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST  
DIESEL SUMMARY REPORT

DATE: 09-30-86 TIME: 12:10:42 HD-863308

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

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG  
DRY BULB TEMPERATURE: 73.50 F  
ABSOLUTE HUMIDITY: 62.47 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST	CYCLE STATISTICS	CS	HS
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	0.00	0.00		NUMBER	0	1176
EXHAUST+BKG, GM	0.00	10.92		SLOPE	0.00000	0.99283
NET, GM/BHP-HR	0.000	0.693	0 693	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	0.000	6.189
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	0.00	18.40		STD ERROR	0.000	16.458
NET, GM/BHP-HR	0.00	1.76	1.76	(LIMIT: 100 RPM)		
				R-SQUARE	0.00000	0.99972
				(LIMIT: 0.97)		
NOX (INTEGRATED)				TORQUE		
BACKGROUND, PPM	0.00	0.00		NUMBER	0	998
EXHAUST+BKG, GM	0.00	72.33		SLOPE	0.00000	0.84045
NET, GM/BHP-HR	0.000	6.633	6.633	(LIMIT: 0.77/0.83-1.03)		
CO2 (BAG)				Y-INTERCEPT	0.000	11.688
BACKGROUND, PPM	0.000	0.000		(LIMIT: +-15 FT-LBS)		
EXHAUST+BKG, GM	0.00	7280.28		STD ERROR	0.000%	8.704%
NET, GM/BHP-HR	0.0	599.9	599.9	(LIMIT: 13% MAX ENG TQ)	0.00000	0.90043
				R-SQUARE		
				(LIMIT: 0.85/0.88)		
PARTICULATE				POWER		
SECONDARY TARE, GM	0.000000	0.145550		NUMBER	0	997
SECONDARY PART, GM	0.000000	0.145600		SLOPE	0.00000	0.89436
PRIMARY TARE, GM	0.000000	0.141850		(LIMIT: 0.87/0.89-1.03)		
PRIMARY PART, GM	0.000000	0.145800		Y-INTERCEPT	0.000	0.886
TOTAL, GM/BHP-HR	0.00	0.51	0.51	(LIMIT: +-5 BHP)		
FUEL CONSUMPTION				STD ERROR	0.000%	7.745%
LBS	0.00	4.38	4.38	(LIMIT: 8%)		
LBS/BHP-HR	0.000	0.419	0.419	R-SQUARE	0.00000	0.92454
BRAKE HORSEPOWER-HOUR	0.000	10.454		(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%

122

HD-863311  
290 ISZ35384JAMACORR 0  
8B

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST  
DIESEL SUMMARY REPORT

DATE: 09-30-86 TIME: 13:45:36 HD-863311

TEST NUMBER: HD-863311  
TEST DATE/TIME: 9-30-86 8:14

MANUFACTURER: ISUZU  
ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.00 "HG

DRY BULB TEMPERATURE: 77.80 F

ABSOLUTE HUMIDITY: 44.08 GRAINS H<sub>2</sub>O / LB. DRY AIR

<u>EMISSION RESULTS</u>	<u>CS</u>	<u>HS</u>	<u>WTD TEST</u>	<u>CYCLE STATISTICS</u>	<u>CS</u>	<u>HS</u>
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	4.61	3.79		NUMBER	1176	1176
EXHAUST+BKG, GM	15.48	10.39		SLOPE	0.99686	0.99909
NET, GM/BHP-HR	1.096	0.682	0.742	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	-11.650	-7.363
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	23.00	18.42		STD ERROR	16.664	16.552
NET, GM/BHP-HR	2.21	1.78	1.84	(LIMIT: 100 RPM)		
				R-SQUARE	0.99971	0.99972
NOX (INTEGRATED)				(LIMIT: 0.97)		
BACKGROUND, PPM	0.00	0.25		TORQUE		
EXHAUST+BKG, GM	77.53	76.09		NUMBER	997	998
NET, GM/BHP-HR	6.895	6.751	6.772	SLOPE	0.83291	0.85514
CO <sub>2</sub> (BAG)				(LIMIT: 0.77/0.83-1.03)		
BACKGROUND, PPM	0.034	0.034		Y-INTERCEPT	12.761	7.596
EXHAUST+BKG, GM	7794.91	7589.84		(LIMIT: +-15 FT-LBS)		
NET, GM/BHP-HR	658.2	643.2	645.4	STD ERROR	8.889%	8.673%
				(LIMIT: 13% MAX ENG TQ)		
PARTICULATE				R-SQUARE	0.89474	0.90412
SECONDARY TARE, GM	0.168900	0.172400		(LIMIT: 0.85/0.88)		
SECONDARY PART, GM	0.169200	0.172600		POWER		
PRIMARY TARE, GM	0.143000	0.171600		NUMBER	996	998
PRIMARY PART, GM	0.147300	0.175250		SLOPE	0.89100	0.89513
TOTAL, GM/BHP-HR	0.60	0.51	0.52	(LIMIT: 0.87/0.89-1.03)		
FUEL CONSUMPTION				Y-INTERCEPT	0.925	0.432
LBS	4.79	4.63	4.66	(LIMIT: +5 BHP)		
LBS/BHP-HR	0.460	0.448	0.450	STD ERROR	7.695%	7.733%
BRAKE HORSEPOWER-HOUR	10.408	10.332		(LIMIT: 8%)		
				R-SQUARE	0.92457	0.92485
				(LIMIT: 0.91)		
WORK				WORK		
				ACTUAL	10.408	10.332
				(LIMIT: -15%-5% REF BHP-HR)		
				REFERENCE	11.068	11.068
				% DIFFERENCE	-5.96%	-6.65%

1231

HD-863312  
290 ISZ35384JAMACORR 0  
8B

## HEAVY DUTY DIESEL TRANSIENT ENGINE TEST

DATE: 10-01-86 TIME: 09:41:45 HD-863312

## DIESEL SUMMARY REPORT

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

AMBIENT DATA

BAROMETER (DRY): 28.90 "HG

DRY BULB TEMPERATURE: 73.20 F

ABSOLUTE HUMIDITY: 68.91 GRAINS H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST	CYCLE STATISTICS	CS	HS
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	3.35	3.20		NUMBER	1176	1176
EXHAUST+BKG, GM	11.32	10.63		SLOPE	0.99867	0.99948
NET, GM/BHP-HR	0.810	0.762	0.769	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	-11.556	-5.900
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	22.60	18.32		STD ERROR	16.577	16.439
NET, GM/BHP-HR	2.18	1.79	1.84	(LIMIT: 100 RPM)		
				R-SQUARE	0.99972	0.99972
NOX (INTEGRATED)				(LIMIT: 0.97)		
BACKGROUND, PPM	0.00	0.00		TORQUE		
EXHAUST+BKG, GM	77.59	74.45		NUMBER	998	998
NET, GM/BHP-HR	7.375	7.146	7.179	SLOPE	0.83595	0.85691
CO2 (BAG)				(LIMIT: 0.77/0.83-1.03)		
BACKGROUND, PPM	0.034	0.034		Y-INTERCEPT	11.240	5.997
EXHAUST+BKG, GM	7730.51	7473.74		(LIMIT: +-15 FT-LBS)		
NET, GM/BHP-HR	655.2	635.5	638.4	STD ERROR	8.835%	8.687%
				(LIMIT: 13% MAX ENG TQ)		
PARTICULATE				R-SQUARE	0.89672	0.90420
SECONDARY TARE, GM	0.167700	0.167100		(LIMIT: 0.85/0.88)		
SECONDARY PART, GM	0.167900	0.167100		POWER		
PRIMARY TARE, GM	0.172200	0.168300		NUMBER	997	998
PRIMARY PART, GM	0.176500	0.172300		SLOPE	0.88879	0.89477
TOTAL, GM/BHP-HR	0.56	0.52	0.53	(LIMIT: 0.87/0.89-1.03)		
				Y-INTERCEPT	0.790	0.141
FUEL CONSUMPTION				(LIMIT: +-5 BHP)		
LBS	4.74	4.55	4.57	STD ERROR	7.749%	7.787%
LBS/BHP-HR	0.457	0.443	0.445	(LIMIT: 8%)		
BRAKE HORSEPOWER-HOUR	10.357	10.256		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%

HD-863317  
290 ISZ35384JAMACORR 0  
8B

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST  
DIESEL SUMMARY REPORT

DATE: 10-02-86 TIME: 14:11:50 HD-863317

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 H2O / LB. DRY AIR

EMISSION RESULTS	CS	HS	WTD TEST	CYCLE STATISTICS	CS	HS
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	3.65	3.42		NUMBER	1176	1176
EXHAUST+BKG, GM	13.42	11.22		SLOPE	1.000020	1.000009
NET, GM/BHP-HR	0.956	0.770	0.797	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	-4.364	-5.459
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	23.04	17.92		STD ERROR	16.341	16.311
NET, GM/BHP-HR	2.16	1.68	1.75	(LIMIT: 100 RPM)		
NOX (INTEGRATED)				R-SQUARE	0.99972	0.99972
BACKGROUND, PPM	0.25	0.50		(LIMIT: 0.97)		
EXHAUST+BKG, GM	80.56	80.72		TORQUE		
NET, GM/BHP-HR	7.337	7.300	7.306	NUMBER	995	997
CO2 (BAG)				SLOPE	0.92345	0.93674
BACKGROUND, PPM	0.034	0.034		(LIMIT: 0.77/0.83-1.03)		
EXHAUST+BKG, GM	7930.83	7703.78		Y-INTERCEPT	0.853	-2.084
NET, GM/BHP-HR	653.3	633.9	636.7	(LIMIT: +-15 FT-LBS)		
PARTICULATE				STD ERROR	8.229%	8.327%
SECONDARY TARE, GM	0.165200	0.165000		(LIMIT: 13% MAX ENG TQ)		
SECONDARY PART, GM	0.165350	0.165100		R-SQUARE	0.92352	0.92458
PRIMARY TARE, GM	0.162700	0.164700		(LIMIT: 0.85/0.88)		
PRIMARY PART, GM	0.167200	0.169000		POWER		
TOTAL, GM/BHP-HR	0.57	0.55	0.55	NUMBER	994	997
FUEL CONSUMPTION				SLOPE	0.93049	0.93641
LBS	4.87	4.71	4.73	(LIMIT: 0.87/0.89-1.03)		
LBS/BHP-HR	0.456	0.442	0.444	Y-INTERCEPT	0.114	-0.360
BRAKE HORSEPOWER-HOUR	10.674	10.648		(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%

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HD-863318  
290 ISZ35384JAMACORR 0  
8B

HEAVY DUTY DIESEL TRANSIENT ENGINE TEST  
DIESEL SUMMARY REPORT

DATE: 10-03-86 TIME: 09:29:33 HD-863318

TEST NUMBER: HD-863318  
TEST DATE/TIME: 10-2-86 13:33

MANUFACTURER: ISUZU  
ENGINE ID: 290 ISZ35384JAMACORR 0

AMBIENT DATA

BAROMETER (DRY): 29.10 "HG

DRY BULB TEMPERATURE: 73.60 F

ABSOLUTE HUMIDITY: 53.42 GRAINS H2O / LB. DRY AIR

<u>EMISSION RESULTS</u>	<u>CS</u>	<u>HS</u>	<u>WTD TEST</u>	<u>CYCLE STATISTICS</u>	<u>CS</u>	<u>HS</u>
HC (INTEGRATED)				SPEED		
BACKGROUND, PPM	3.87	3.12		NUMBER	1176	1176
EXHAUST+BKG, GM	13.02	10.27		SLOPE	1.00239	0.99950
NET, GM/BHP-HR	0.901	0.700	0.729	(LIMIT: 0.97-1.03)		
CO (BAG)				Y-INTERCEPT	-6.699	-2.552
BACKGROUND, PPM	0.00	0.00		(LIMIT: +-50 RPM)		
EXHAUST+BKG, GM	23.25	17.71		STD ERROR	16.301	16.249
NET, GM/BHP-HR	2.18	1.65	1.73	(LIMIT: 100 RPM)		
NOX (INTEGRATED)				R-SQUARE	0.99972	0.99972
BACKGROUND, PPM	0.50	0.50		(LIMIT: 0.97)		
EXHAUST+BKG, GM	81.49	80.33		TORQUE		
NET, GM/BHP-HR	7.107	6.962	6.982	NUMBER	995	998
CO2 (BAG)				SLOPE	0.92107	0.93933
BACKGROUND, PPM	0.034	0.034		(LIMIT: 0.77/0.83-1.03)		
EXHAUST+BKG, GM	7935.64	7696.87		Y-INTERCEPT	0.837	-1.881
NET, GM/BHP-HR	655.1	631.5	634.8	(LIMIT: +-15 FT-LBS)		
PARTICULATE				STD ERROR	8.224%	8.394%
SECONDARY TARE, GM	0.162000	0.167500		(LIMIT: 13% MAX ENG TQ)		
SECONDARY PART, GM	0.162000	0.167600		R-SQUARE	0.92325	0.92398
PRIMARY TARE, GM	0.165100	0.166700		(LIMIT: 0.85/0.88)		
PRIMARY PART, GM	0.170150	0.171000		POWER		
TOTAL, GM/BHP-HR	0.64	0.54	0.55	NUMBER	994	998
FUEL CONSUMPTION				SLOPE	0.93028	0.93946
LBS	4.88	4.72	4.74	(LIMIT: 0.87/0.89-1.03)		
LBS/BHP-HR	0.458	0.440	0.443	Y-INTERCEPT	0.099	-0.237
BRAKE HORSEPOWER-HOUR	10.662	10.728		(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%

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

13-MODE WEIGHTED RESULTS

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

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

-27-

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\*

TEST NO.: HD-863319      ENGINE: 290 ISZ35384JAMACORR 0      TEST D/T: 10- 2-86 14:55      REPORT D/T: 10-03-86 09:26      P040684

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 H<sub>2</sub>O/LB AIR)

MODE-TO-MODE RESULTS

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

13-MODE WEIGHTED RESULTS

HC (GM/BPHR) : 0.31  
CO (GM/BPHR) : 0.95      \*\*\* NOTE: Number of modes for this test do not equal 13  
NOX (GM/BPHR) : 7.61  
BSFC (LB/BPHR) : 0.372  
CO2 (GM/BPHR) : 555.57

COMMENTS

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

\$COPY -PERR \*PRINT\*  
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\$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-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
	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	
	X	1. 87	1. 86	1. 78	1. 73	1. 70	1. 67	1. 94	
CO <sub>2</sub> (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	
	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	
	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
	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
	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	
	X	2.11	2.13	2.04	2.01	1.81	1.81	2.39	
CO <sub>2</sub> (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	
	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	
	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
	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
	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
	X		1.056		1.022		0.996		1.050

TRANSIENT EMISSION  
\*\*\* HOT-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
	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	
	X	1.83	1.81	1.73	1.68	1.68	1.65	1.87	
CO <sub>2</sub> (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	
	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	
	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
	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	
	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	
	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	mitsubishi	ISUZU
1	ENG.SPEED	3000RPM				
	TORQUE	LB-FT	298 LB-FT	298 LB-FT	301 LB-FT	302 LB-FT
	IIC (G/BHP-HR)	75	0. 19	0. 13	0. 29	0. 24
	CO (G/BHP-HR)	1. 1	1. 17	1. 06	0. 81	0. 87
	CO <sub>2</sub> (G/BHP-HR)	560. 6	549. 9	580. 4	553. 2	
	NOX (G/BHP-HR)	7. 25	6. 75	7. 08	7. 88	
	PART. (G/BHP-HR)	55	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
	IIC (G/BHP-HR)	75	0. 16	0. 16	0. 22	0. 19
	CO (G/BHP-HR)	56	0. 62	0. 56	0. 56	0. 58
	CO <sub>2</sub> (G/BHP-HR)	511. 4	481. 4	474. 4	506. 1	
	NOX (G/BHP-HR)	7. 38	6. 64	6. 70	7. 95	
	PART. (G/BHP-HR)	31	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
	I-C (G/BHP-HR)	6.35	0.49	0.60	0.77	0.58
	CO (G/BHP-HR)	1.4%	1.40	1.44	1.45	1.36
	CO <sub>2</sub> (G/BHP-HR)	54.35	536.6	525.2	495.8	548.3
	NOX (G/BHP-HR)	4.43%	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
	I-C (G/HR)	14.94%	10.88	16.81	17.29	19.64
	CO (G/HR)	27.4%	21.90	25.54	23.17	25.75
	CO <sub>2</sub> (G/HR)	38	1923.0	1738.7	1264.0	1113.7
	NOX (G/HR)	28.75%	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 def on range VT NC



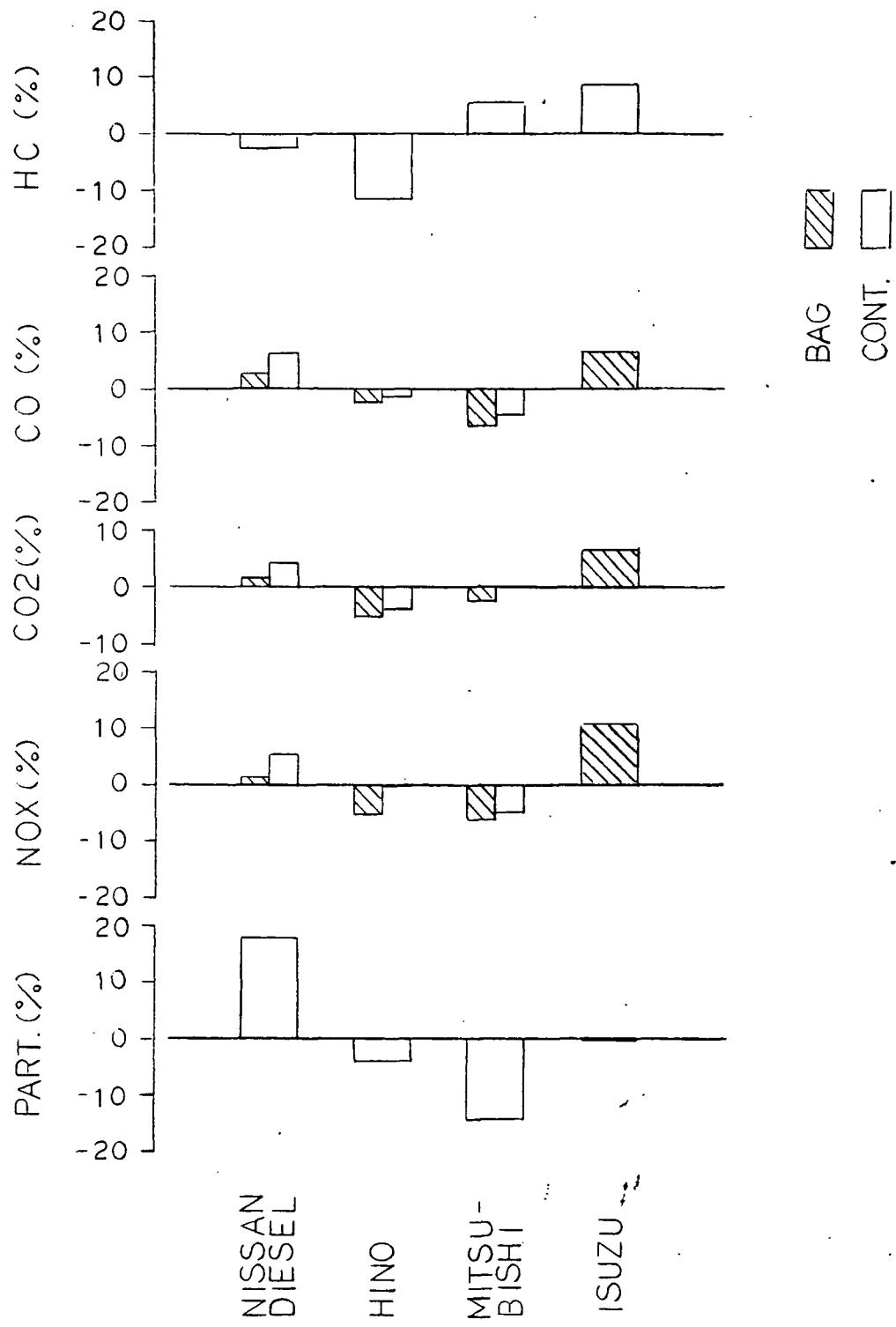
→ Smq was E deflection

b/c was 3-E - wise

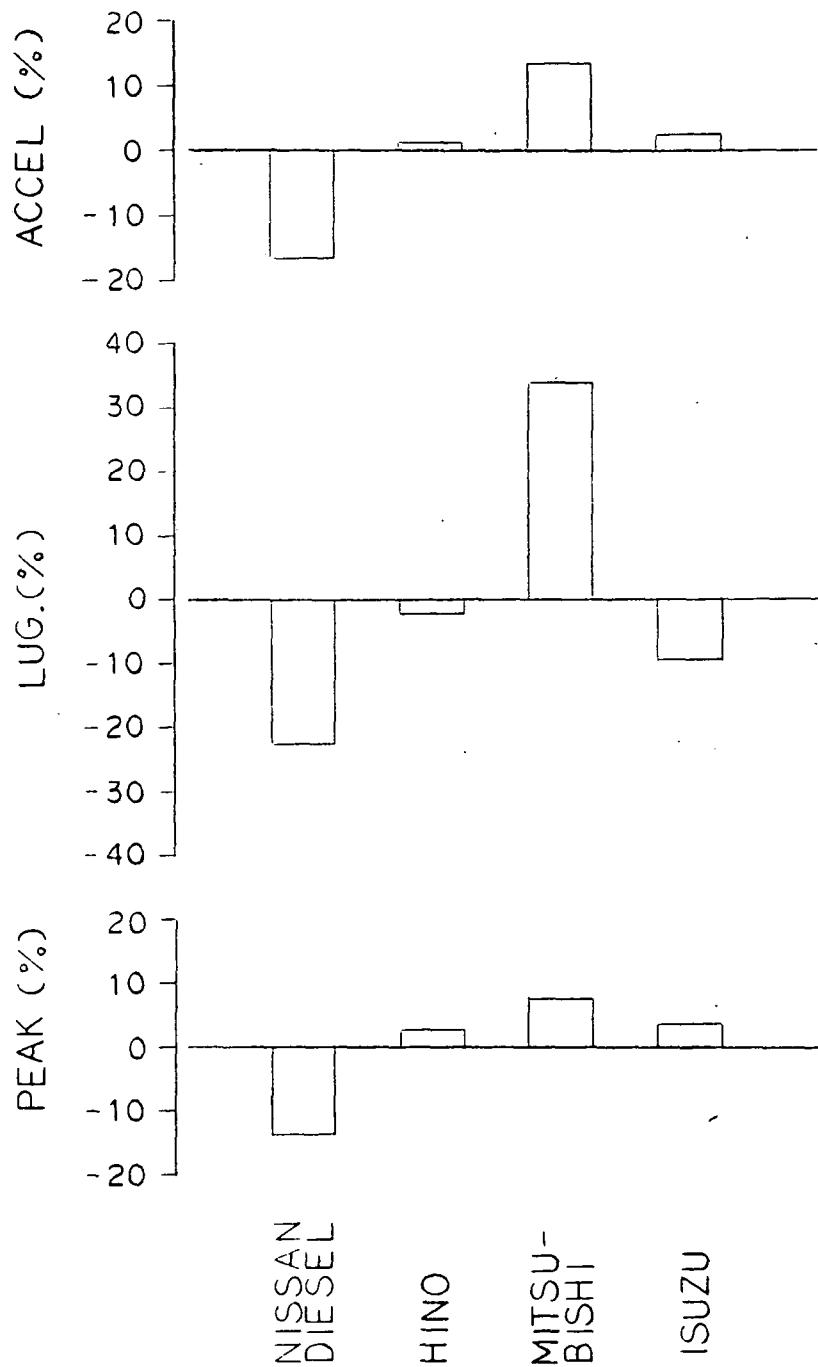
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Def data

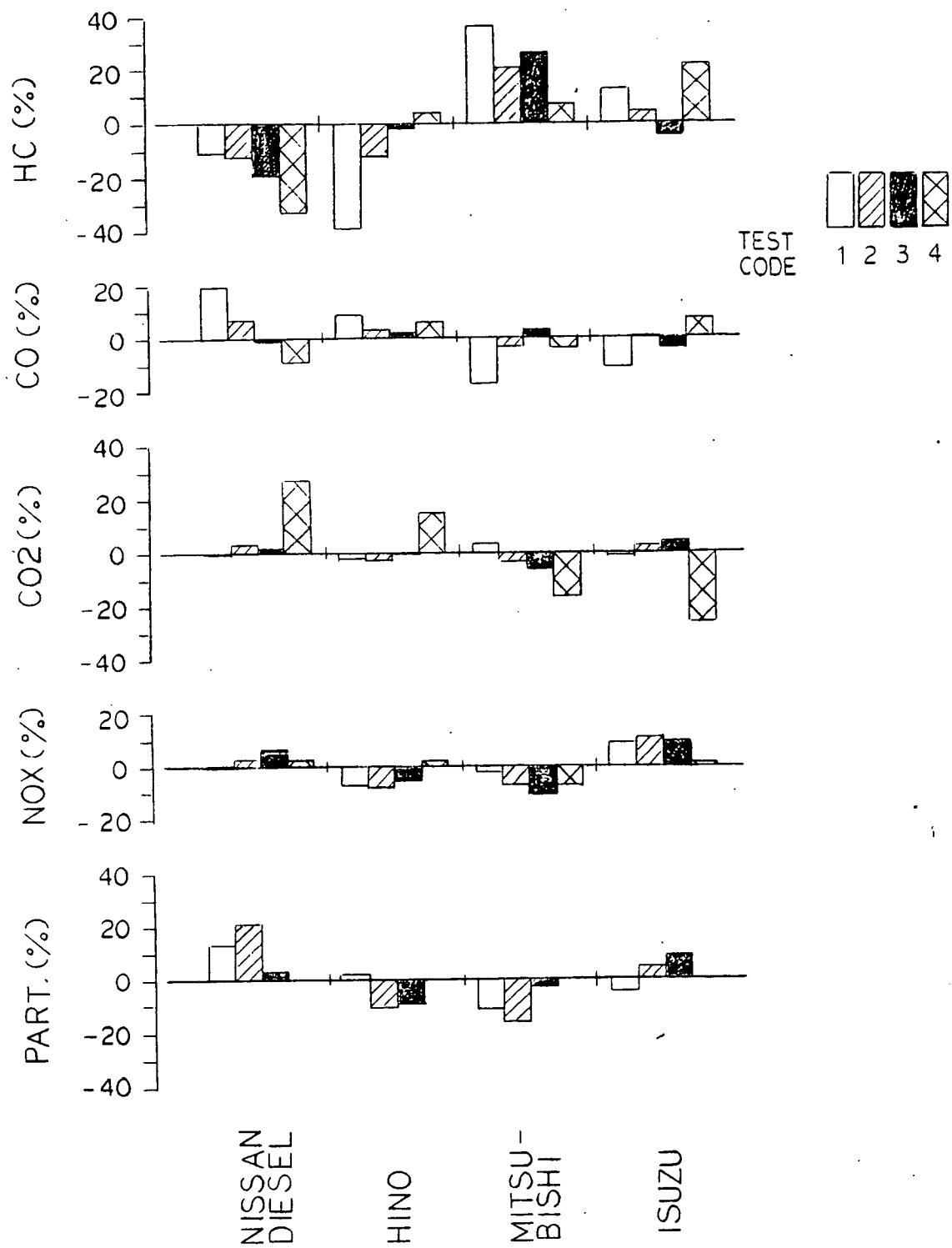
PERCENT DIFFERENCE OF TRANSIENT (COMP) DATA  
( EACH LAB. - MEAN ) / MEAN  $\times 100$  (%)



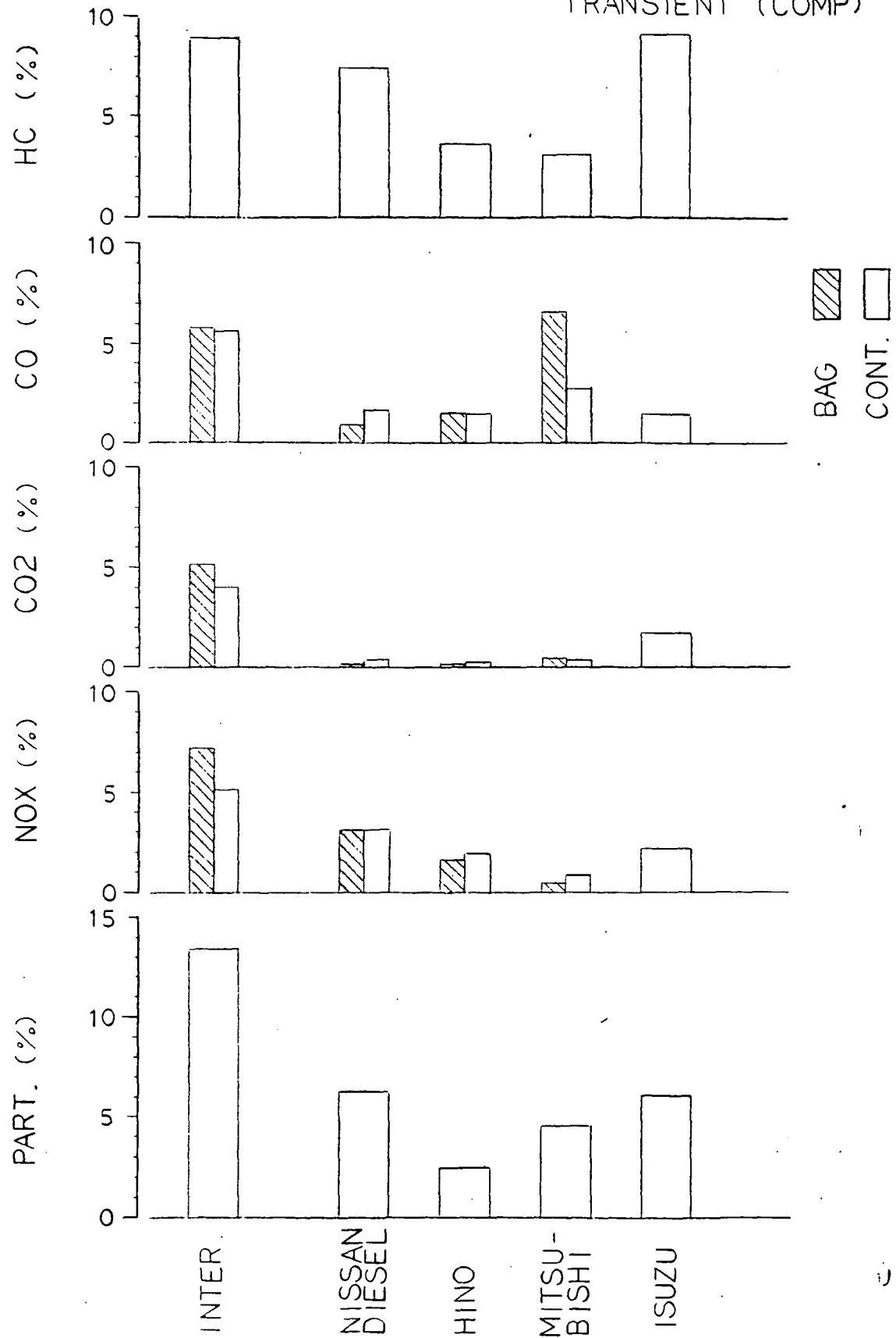
PERCENT DIFFERENCE OF SMOKE DATA  
( EACH LAB. - MEAN ) / MEAN  $\times$  100 (%)



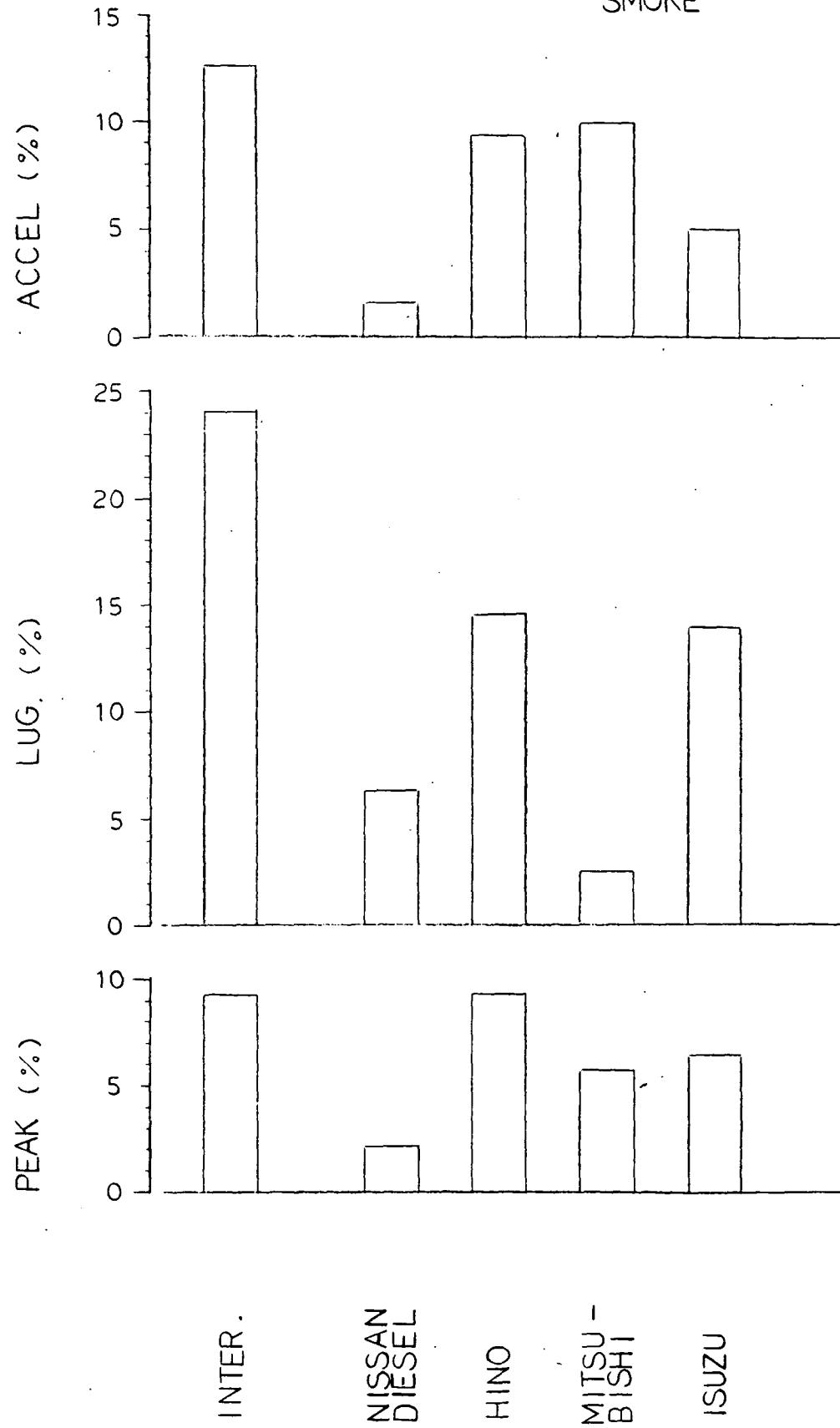
PERCENT DIFFERENCE OF STEADY STATE DATA  
( EACH LAB. - MEAN ) / MEAN  $\times$  100 (%)



COEFFICIENT OF VARIANCE  
INTER LAB. AND WITHIN LAB.  
TRANSIENT (COMP) *1/4*



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 <sub>3</sub> H <sub>8</sub> in Air <del>(ppm)</del> PPM	JJ 4484	30.0	29.79	150
	JJ 4483	15.0	14.79	120
	JJ 4482	3.0	2.984	130
CO in N <sub>2</sub> (ppm)	JJ 5722	270	275.36	110
	JJ 5721	40	40.81	150
NO in N <sub>2</sub> (ppm)	JJ 5581	90	91.52	140
	JJ 5575	45	44.17	150
	JJ 5540	15	14.92	150
CO <sub>2</sub> in N <sub>2</sub> (%)	JJ 4468	1.3	1.289 %	140
	JJ 4467	0.5	.5090 %	120

Analyzer		
THC	Model	400
	Range	0-100 & 050
	Fuel	H <sub>2</sub> -HE
CO(H)	Model	868
	Range	NOT USED
CO(L)	Model	8501
	Range	0-100 & 0-250
N O	Model	951-A
	Range	0-100 & 0-50
	Converter Efficiency	96 %
CO <sub>2</sub>	Model	868
	Range	2.5 % & 1 %

1986 EPA-JAMA DIESEL CROSS CHECK REFERENCE GAS

GAS	C <sub>3</sub> H <sub>8</sub> (ppmc)			CO(ppm)		NO(ppm)			CO <sub>2</sub> (%)	
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 <sub>3</sub> H <sub>8</sub> (ppmc)			CO(ppm)		NO(ppm)			CO <sub>2</sub> (%)	
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 <sub>2</sub>	
	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



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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 *(Signature)*

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

THRU: Chester J. France, Chief  
Standards Development and Support Branch *(Signature)*

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. *1984* Isuzu 6BD1-T. The remaining engine information will be supplied by the manufacturer before testing.

Work Description.

Set restrictions

*1984*

Check power @ WOT, rated & peak torque ~~1000~~ 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

	<u>SPR23</u>	<u>Torque, ft. lb.</u>
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

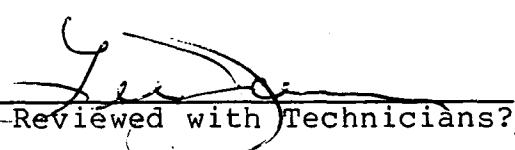
Test data taken: All usual emissions and performance.

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:

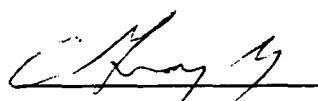
Lee Jones

  
Reviewed with Technicians? \_\_\_\_\_

Date 9-10-86

Approval:

Charles L. Gray, Jr.

  
Priority High

Date 9-13

ATTACHMENT II

DIESEL MANUFACTURERS' DATA SHEET

Manufacturer ISUZU Contact \_\_\_\_\_ Phone \_\_\_\_\_

EPA Program ID No. 290 ISZ 35384 JAMA CORR & Q

ENGINE INFORMATION

- |  |                               |
|--|-------------------------------|
| 1. Family and/or model   | <u>ESZ0353EAB7/6BD1T</u>      |
| 2. Serial Number   | <u>409494</u>                 |
| 3. Model Year  | <u>'84 MODEL YEAR</u>         |
| 4. Displacement  | <u>353 CUBIC INCH(5.785l)</u> |
| 5. Fuel type (diesel #1 or #2)   | <u>D-2</u>                    |
| 6. List of Emission Controls   |                               |
| 7. Certified injection timing  | <u>16° BTDC</u>               |
| 8. Accumulated hours or mileage  | <u>ABOUT 80 HOURS</u>         |
| 9. Vehicle application/ type of service  | <u>CORR.</u>                  |
| 10. Certified Curb idle speed (rpm)  | <u>580</u>                    |
| 11. Rated HP <u>165 @ 3000</u> rpm (fuel rate <u>67.5 mm<sup>3</sup>/stroke; 66.8 lbs/hr</u> )         |                               |
| 12. Max torque <u>335 ft-lb @ 1900</u> rpm (fuel rate <u>67.5 mm<sup>3</sup>/stroke; 42.3 lbs/hr</u> ) |                               |

SPECIAL INSTRUCTIONS

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

Shutdown 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<sub>2</sub>O Transient" 15.7 in 400 mm "H<sub>2</sub>O" / 3000 RPM, Full LOAD  
IS-MODE BETWEEN AIR CLEANER & IN.DUCT where measured
- ✓ 10. Exhaust backpressure "Hg Transient" 3.9 in 100 mm "Hg" / 3000 RPM, FULL LOAD  
12-MODE 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. *Please supply required amount, please*
- 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.

Mr. T. Baines  
September 12, 1986  
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- 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,



Toshiji Obara  
Japan Automobile Manufacturers Association

/jj

D-2 Diesel Control Fuel  
Lot G-463

<u>Property</u>	<u>Results</u>	<u>Specification</u>	<u>Test Method</u>
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.