

Interpretation of Engine Emissions Data

By

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What are Diesel Emissions?

1. Gaseous

- A. Carbon Monoxide “CO” 50ppm TLV
- B. Nitric Oxide “NO” 25ppm TLV
- C. Nitrogen Dioxide “NO₂” 5ppm TLV

2. Solids “DPM”

- A. Elemental Carbon “EC”
- B. Organic Carbon “OC”
- C. Total Carbon “EC + OC = TC”
- D. Whole Diesel Particulate Mater

3. Other bad and good stuff

Where to Start?

“In God We Trust”

“Everyone else bring creditable data”

1. We need to look at engines using the same standard.
 - a. Approval Data (ISO 8178).
 - b. In mine stall test.
2. Understand the data.

ISO 8178

Mode Number	1	2	3	4	5	6	7	8
Torque %	100	75	50	10	100	75	50	0
Engine Speed	Rated	Rated	Rated	Rated	Peak Torque	Peak Torque	Peak Torque	Idle
Weighting Factor	0.15	0.15	0.15	0.1	0.1	0.1	0.1	0.15

ISO 8178 DATA

Modes	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
<i>RPM</i>	2900.0	2900.0	2900.0	2899.9	1740.0	1740.0	1740.0	749.3
<i>TORQUE lbft</i>	399.5	299.9	200.0	40.0	410.8	299.9	200.0	0.3
<i>HORSEPOWER</i>	220.6	165.6	110.5	22.1	136.1	99.4	66.3	0.0
<i>FUEL Consumption lbs/hr</i>	99.76	85.19	58.74	22.73	49.45	37.04	24.17	1.27

ISO 8178

g/hr

Modes	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
NO GR/HR	302.61	239.75	323.09	94.17	269.09	207.20	192.25	14.03
NO2 GR/HR	28.93	39.21	44.09	20.47	39.74	38.09	36.66	2.99
CO2 GR/HR	136710.40	114908.83	78398.80	31540.13	67664.38	49968.11	34084.57	2438.93
CO GR/HR	782.85	555.19	122.37	106.95	197.92	134.03	84.58	9.22

ISO 8178

PPM

Modes	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
<i>CO PPM DRY</i>	668.4	488.9	113.8	140.4	352.5	286.8	217.9	74.7
<i>NOX PPM DRY</i>	257.1	219.8	308.1	133.6	491.3	464.8	522.1	123.7
<i>NO PPM DRY</i>	242.0	198.6	282.9	117.0	448.1	415.0	464.3	108.6
<i>NO2 PPM DRY</i>	15.1	21.2	25.2	16.6	43.2	49.8	57.8	15.1

ISO 8178 Vent Rate

Dodge Ram 325 hp @ 2900 RPM

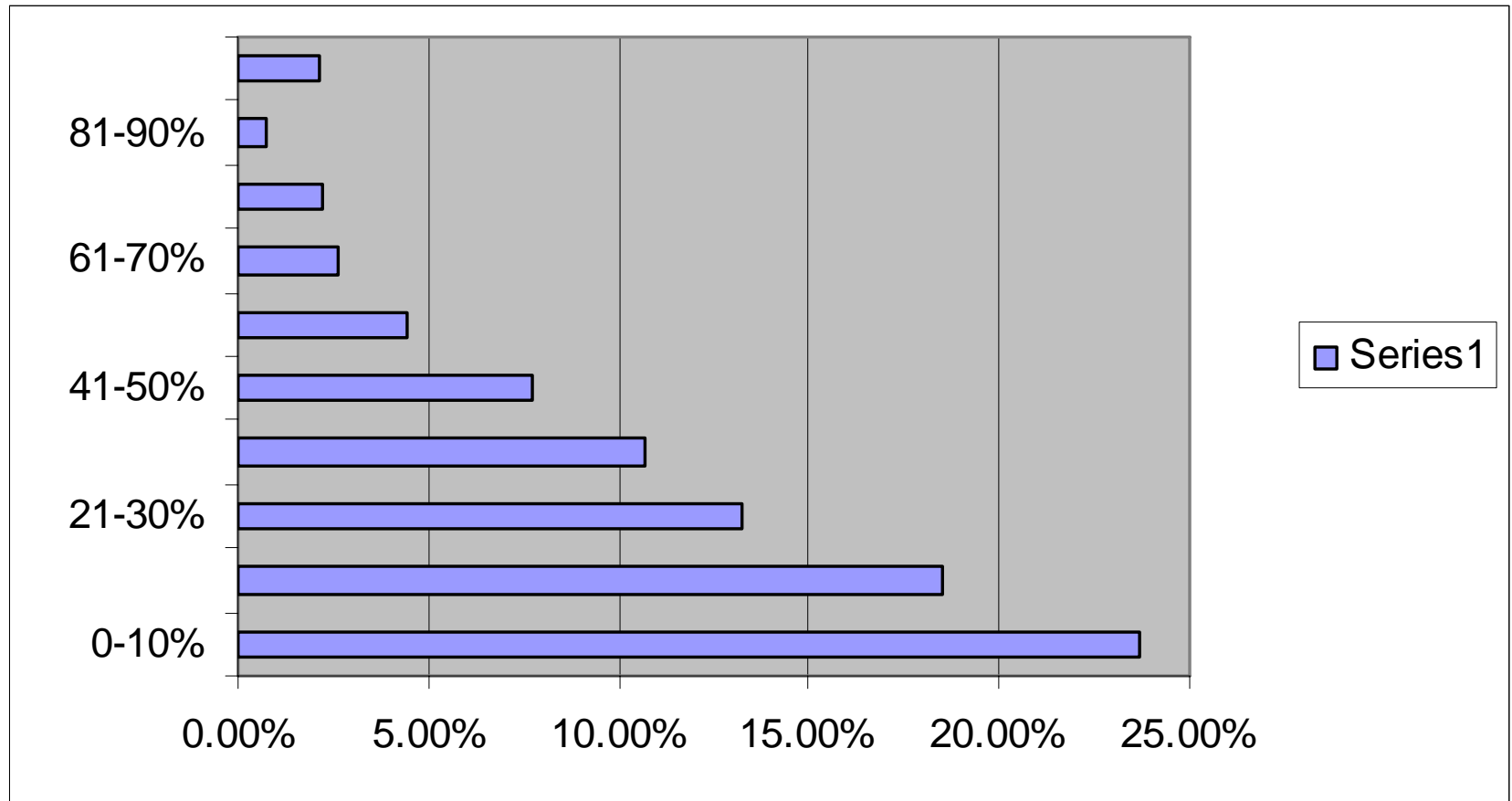
Vent Rate in CFM	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Total G/HR DPM
NO	12643	6133	3591	2108	8044	5904	4519	421	
NO2	786	2079	157	316	1517	869	331	27	
CO2	12914	10886	8310	3010	7111	5330	3464	303	
CO	1941	3136	2475	1163	330	206	88	120	
Weighted DPM	9.46	5.81	2.01	1.67	0.89	0.59	0.78	0.29	21.315

ISO 8178

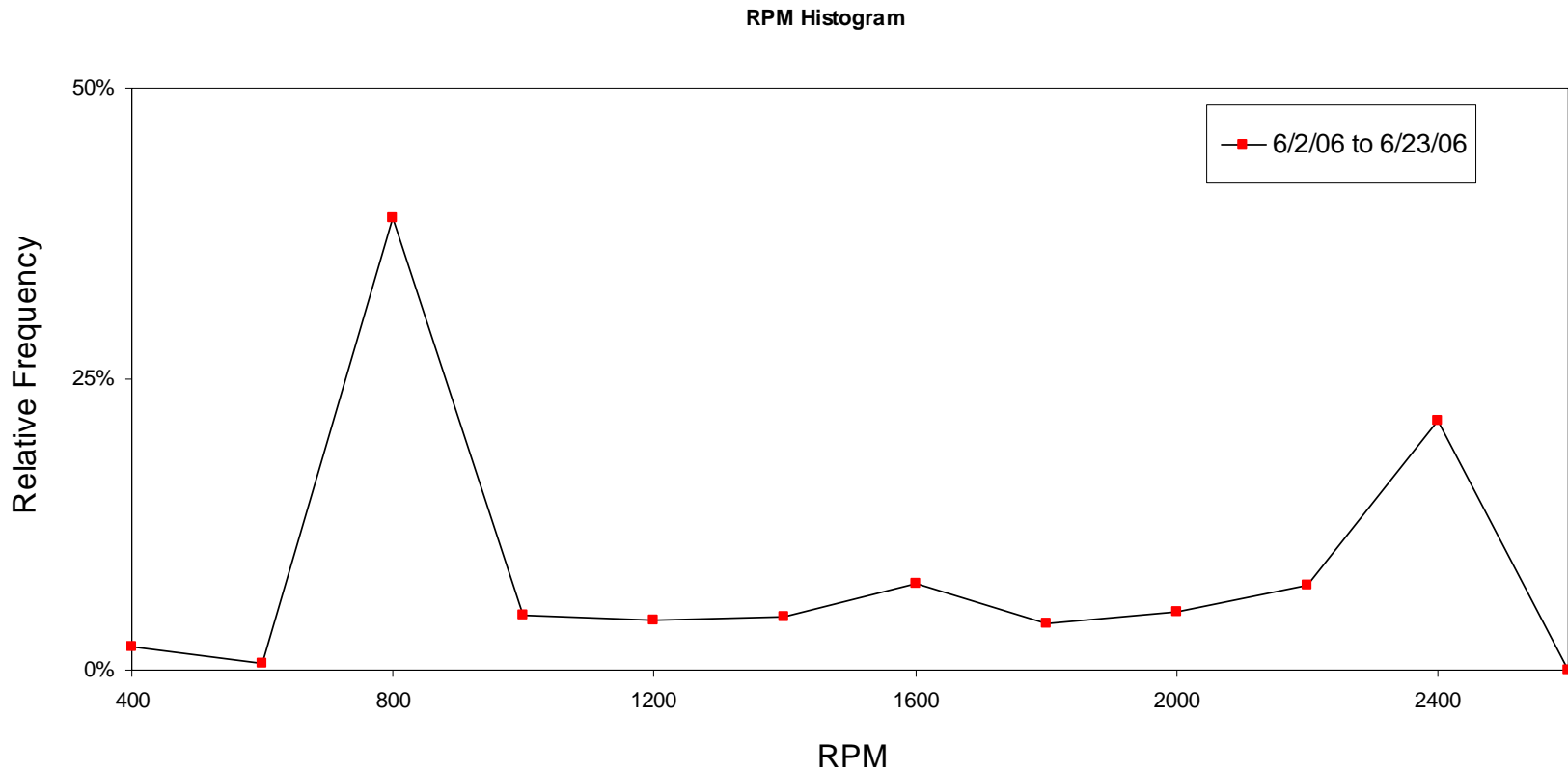
DPM

Modes	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
Modal Particulate emission (gr/hr)	38.232	14.904	22.584	16.044	9.792	9.456	5.112	1.082084
	0.15	0.15	0.15	0.1	0.1	0.1	0.1	0.15
Weighted Particulate (gr/hr)	5.7348	2.2356	3.3876	1.6044	0.9792	0.9456	0.5112	0.162313
Weighted HP	33.08559	24.83699	16.5681	2.209355	13.61022	9.935478	6.626491	0.00587
Weighted Average HP	106.9	HP						
Weighted Average PARTICULATE	15.6	GR/HR						
	0.1	(GR/HP-HR)						
PARTICULATE INDEX (PI) CFM	9157.5							

Putting it all together. Additional information.



Putting it all together. Additional information.



Baseline. In Use Stall Test.

UNIT	BASELINE	% CHANGE	15-Oct-06	8-Oct-06	1-Oct-06	24-Sep-06	17-Sep-06	10-Sep-06
LD001	247.2	23.5%	323	328		200	234	251
LD002	206.5	-19.4%	173	198	219	213	251	185
LD003	247.8	-14.2%	217	210	174	315	322	242
LD005	299.5	0.5%	301	261	319	303	324	289
LD006	341.3	-36.0%	251	375	356	351	256	459
UV026	132.8	21.4%	169	185	101	121	117	104

Understanding the Results.

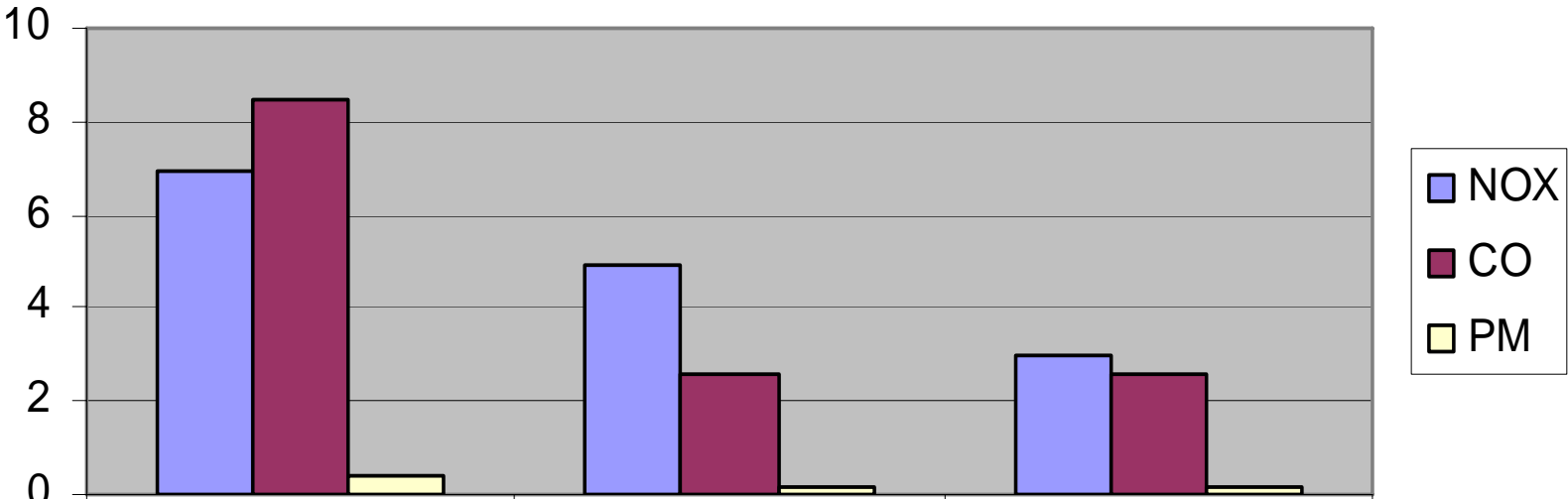
TORQUE CURVE TEST ALL TESTS AT FULL THROTTLE		
MSHA # :	7E-B004-0	
Engine:	Caterpillar 3304 PCNA	
Engine Rating:	100 HP @ 2200 RPM	
Engine Speed, RPM	CO, ppm	CO2, %
2200	392	10.8
2100	394	10.9
2000	352	10.8
1900	348	10.7
1800	330	10.6
1700	332	10.5
1600	315	10.4
1500	313	10.3
1400	314	10.2

TORQUE CURVE TEST - ALL TESTS AT FULL THROTTLE		
MSHA # :	7E-B083	
Engine:	Diamler Chrysler OM 906	
Engine Rating:	201 HP @ 2200 RPM	
Engine Speed, RPM	CO, ppm	CO2, %
2200	71	7.09
2000	130	7.48
1800	134	7.85
1600	145	8.59
1400	446	9.76
1200	1575	10.98

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UNIT	BASELINE	% CHANGE	15-Oct-06	8-Oct-06	1-Oct-06	24-Sep-06	17-Sep-06	10-Sep-06
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EPA Tiers g/bhp-hr



NOX	6.9	4.9	3
CO	8.5	2.6	2.6
PM	0.4	0.15	0.15

Tier 2 vs. Tier 3

Is Newer Really Cleaner???

HP @ RPM	Vent Rate	PI	DPM grams/hr	DPM grams/hp-hr
101 @ 2200	3500	7000	11.79	0.22
121 @ 2200	4000	7000	11.17	0.18
148 @ 2200	5500	6000	9.64	0.12
275 @ 2200	11000	10000	16.52	0.11
255 @ 2200	9500	10000	16.75	0.12
240 @ 2500	9500	10000	16.76	0.12
100 @ 2200	4500	2500	4.14	0.08
121 @ 2200	5500	3000	4.39	0.07
147 @ 2200	6500	3000	4.85	0.06
275 @ 2200	11000	7000	11.89	0.08
255 @ 2200	11500	6000	9.59	0.07
240 @ 2500	13500	5500	9.35	0.07

The Best Advice I Have.

1. Use only MSHA approved engines.
 - a. Just because it is MSHA approved does not make it clean but you do have comparable data to use.
2. If for some reason you can not use MSHA approved engines, require the ISO 8178 test results before you purchase an engine.

Questions?