Meeting follow up- FW: Emissions Profile data
Dave Newsad
to:
Doug Hardesty
03/05/2010 11:17 AM
Cc:
Brad.C.Thomas
Show Details

History: This message has been replied to.

Doug, per our discussion yesterday, attached are the raw data used to develop the engine profile curves presented in the pending COP Chukchi application. We marked exactly which data was used. Don't hesitate to call with any questions on this.

From: Aislin Muto
Sent: Friday, March 05, 2010 9:56 AM
To: Dave Newsad
Subject: Emissions Profile data

Aislin Muto,
Hoefler Consulting Group
425-222-7746 (office)
360-201-4504 (cell)

www.hoeflernet.com

N C POWER SYSTEMS CO.

INDUSTRIAL ENGINE PERFORMANCE DATA [PQ0089]

MAY 19, 2009

For Help Desk Phone Numbers Click here

Performance Number: DM7520

Change Level: 01

Sales Model: C15 DITA	**Combustion:** DI	**Aspr:** TA
Engine Power: 540 HP	**Speed:** 2,100 RPM	**After Cooler:** ATAAC
Manifold Type: DRY	**Governor Type:** ELEC	**After Cooler Temp(F):** 120
Turbo Quantity: 1	**Engine App:** IN	**Turbo Arrangement:**
Application Type: IND-DIESEL	**Engine Rating:** IN	**Strategy:**
Rating Type: IND-C (INT)	**Certification:** EPA TIER-3 2005 - ---- EU STAGE -IIIA 2006 - 2010	

General Performance Data 1

ENGINE SPEED RPM	ENGINE POWER BHP	ENGINE TORQUE LB.FT	ENGINE BMEP PSI	FUEL BSFC LB/BHP-HR	FUEL RATE GPH	INTAKE MFLD TEMP DEG F	INTAKE MFLD P IN-HG	INTAKE AIR FLOW CFM	EXH MFLD TEMP DEG F	EXH STACK TEMP DEG F	EXH GAS FLOW CFM
2,100	540	1,351.21	219.74	0.37	28.9	121.46	49.45	1,267.8	1,183.46	937.94	3,471.44
2,000	540	1,419.07	230.76	0.37	28.66	121.64	50.52	1,239.55	1,192.1	953.78	3,432.59
1,900	540	1,493.56	242.8	0.37	28.61	121.46	52.09	1,214.83	1,213.7	976.46	3,414.93
1,800	540	1,576.9	256.29	0.37	28.37	121.46	53.54	1,179.51	1,236.2	999.5	3,372.55
1,700	534	1,649.18	268.18	0.36	27.76	119.48	53.87	1,126.54	1,244.66	1,013.72	3,252.48
1,600	522	1,714.83	278.77	0.36	27.05	117.32	54.13	1,070.04	1,262.48	1,030.82	3,128.88
1,500	506	1,773.09	288.34	0.36	26.18	114.98	54.04	1,006.47	1,276.7	1,048.1	2,987.62
1,400	485	1,818.82	295.74	0.36	24.99	113.18	53.9	939.37	1,279.04	1,041.98	2,779.27
1,300	444	1,795.22	291.82	0.35	22.22	106.52	46.7	801.64	1,265	1,045.58	2,383.74
1,200	360	1,573.95	255.85	0.37	19.05	101.84	42.76	716.89	1,283.9	1,060.34	2,143.6
1,100	325	1,550.35	252.08	0.35	16.46	94.46	30.92	554.44	1,317.74	1,126.04	1,737.48

Engine Heat Rejection Data

ENGINE SPEED RPM	ENGINE POWER BHP	REJ TO JW BTU/MN	REJ TO ATMOS BTU/MN	REJ TO EXHAUST BTU/MN	EXH RCOV TO 350F BTU/MN	FROM OIL CLR BTU/MN	FROM AFT CLR BTU/MN	WORK ENERGY BTU/MN	LHV ENERGY BTU/MN	HHV ENERGY BTU/MN
2,100	540	8,303.0	4,686.1	23,999.1	13,819.4	3,230.2	4,640.6	22,918.6	60,623.3	64,547.3
2,000	540	8,075.5	4,760.0	23,942.2	13,933.1	3,213.1	4,509.8	22,918.6	60,282.1	64,263.0
1,900	540	7,961.8	4,583.7	24,056.0	14,160.6	3,201.8	4,481.4	22,918.6	60,111.5	64,035.5
1,800	540	7,904.9	4,526.8	24,056.0	14,331.2	3,190.4	4,418.8	22,918.6	59,940.9	63,864.9
1,700	534	7,791.2	4,509.8	23,430.4	13,990.0	3,127.8	4,214.1	22,634.2	58,746.6	62,556.9
1,600	522	7,677.4	4,583.7	22,747.9	13,705.6	3,059.6	4,020.7	22,122.4	57,438.6	61,192.0
1,500	506	7,506.8	4,634.9	21,951.8	13,307.5	2,968.6	3,821.7	21,496.8	55,732.5	59,372.2
1,400	485	7,279.3	4,612.1	20,473.2	12,283.9	2,826.4	3,645.4	20,530.0	53,116.5	56,585.5
1,300	444	6,540.0	4,407.4	17,743.4	10,634.7	2,525.0	2,928.8	18,823.9	47,372.6	50,443.6
1,200	360	5,800.7	5,340.1	16,037.3	9,667.9	2,246.4	2,542.1	15,241.1	42,197.4	44,984.1
1,100	325	5,175.2	4,691.8	13,478.2	8,303.0	1,939.3	1,603.7	13,762.5	36,396.7	38,728.4

EMISSIONS DATA

EPA TIER-3 2005 - ---- ********** G5
Gaseous emissions data measurement are consistent with those described in
in 40 CFR, EU 97/68/EC, ECE Regulation No. 96 and ISO 8178 for measuring
HC, CO, PM and NOx.

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance
with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kw-hr		
U. S. (incl Calif)	EPA/Tier 3	CO:3.5	NOx + HC:4.0	PM:0.2
Europe	EU/Stage-IIIA	CO:3.5	NOx + HC:4.0	PM:0.2

EU STAGE -IIIA 2006 - 2010 ********** G5
Gaseous emissions data measurement are consistent with those described in
in 40 CFR, EU 97/68/EC, ECE Regulation No. 96 and ISO 8178 for measuring
HC, CO, PM and NOx.

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance
with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kw-hr		
U. S. (incl Calif)	EPA/Tier 3	CO:3.5	NOx + HC:4.0	PM:0.2
Europe	EU/Stage-IIIA	CO:3.5	NOx + HC:4.0	PM:0.2

REFERENCE EXHAUST STACK DIAMETER	--
WET EXHAUST MASS	5,676.9 LB/HR
WET EXHAUST FLOW (971.60 F STACK TEMP)	3,476.03 CFM
WET EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	1,175.00 STD CFM
DRY EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	1,076.39 STD CFM
FUEL FLOW RATE	29 GAL/HR

Cement Engine

C 15 DITA

RATED SPEED "Not to exceed data"

ENGINE SPEED RPM	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR VOC	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT
2,100	100	540	4.0900	4.0300	.1000	.4100	3.1000
2,100	75	405	2.2300	1.4900	.1900	.1600	11.9000
2,100	50	270	1.2400	.7900	.2500	.1400	13.6000
2,100	25	135	1.4100	1.3500	.1500	.4200	14.9000
2,100	10	54	1.0200	1.0000	.1700	.2000	16.7000

RATED SPEED "Nominal Data"

ENGINE SPEED RPM	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR	TOTAL CO2 LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT
2,100	100	540	3.7900	2.1600	.0600	631.1	.2100	3.1000
2,100	75	405	2.0600	.8000	.1000	537	.0800	11.9000
2,100	50	270	1.1500	.4200	.1300	406.7	.0700	13.6000
2,100	25	135	1.3000	.7200	.0800	188.3	.2200	14.9000
2,100	10	54	.9400	.5300	.0900	113.8	.1000	16.7000

INDUSTRIAL ENGINE PERFORMANCE DATA [DM1160]

MAY 19, 2009

For Help Desk Phone Numbers Click here

Performance Number: DM1160

Change Level: 01

Sales Model: 3176BDITA
Engine Power: 342 HP
Manifold Type: DRY
Turbo Quantity: 1
Application Type: IND-DIESEL
Rating Type: IND-C (INT)

Combustion: DI
Speed: 1,800 RPM
Governor Type: ELECT
Engine App: IN
Engine Rating: IN
Certification: EPA TIER-1 1996 - 2000
EU STAGE-1 1999 - 2001

Aspr: TA
After Cooler: ATAAC
After Cooler Temp(F): 120
Turbo Arrangement:
Strategy:

General Performance Data 1

ENGINE SPEED RPM	ENGINE POWER BHP	ENGINE TORQUE LB.FT	ENGINE BMEP PSI	FUEL BSFC LB/BHP-HR	FUEL RATE GPH	INTAKE MFLD TEMP DEG F	INTAKE MFLD P IN-HG	INTAKE AIR FLOW CFM	EXH MFLD TEMP DEG F	EXH STACK TEMP DEG F	EXH GAS FLOW CFM
2,100	325	812.79	194.79	0.34	15.77	110.66	33.97	716.89	1,030.46	861.8	1,871.68
2,000	334	876.96	210.16	0.34	16.09	109.58	35.86	706.29	1,057.46	882.5	1,882.27
1,900	338	933.75	223.8	0.34	16.3	109.22	37.79	695.7	1,085	904.1	1,885.81

1,800	342	997.92	239.17	0.34	16.38	109.58	39.65	685.11	1,113.44	927.68	1,885.81
1,700	342	1,056.19	253.24	0.34	16.38	110.3	41.04	663.92	1,142.96	955.94	1,868.15
1,600	339	1,113.72	267.02	0.34	16.22	110.84	41.84	635.66	1,172.84	987.44	1,832.83
1,500	332	1,163.87	279.06	0.34	15.93	111.02	42.2	603.88	1,202.54	1,020.92	1,776.33
1,400	322	1,206.65	289.21	0.34	15.45	110.12	42.02	561.5	1,231.7	1,056.02	1,695.11
1,300	307	1,241.31	297.62	0.34	14.79	108.14	40.9	515.59	1,259.42	1,095.44	1,596.22
1,200	286	1,250.16	299.65	0.34	13.87	105.62	38.38	459.09	1,284.98	1,142.78	1,472.62
1,100	254	1,211.81	290.52	0.35	12.68	102.74	34.26	395.52	1,306.76	1,200.02	1,320.77

Engine Heat Rejection Data

ENGINE SPEED RPM	ENGINE POWER BHP	REJ TO JW BTU/MN	REJ TO ATMOS BTU/MN	REJ TO EXHAUST BTU/MN	EXH RCOV TO 350F BTU/MN	FROM OIL CLR BTU/MN	FROM AFT CLR BTU/MN	WORK ENERGY BTU/MN	LHV ENERGY BTU/MN	HHV ENERGY BTU/MN
2,100	325	5,800.7	2,155.4	12,511.4	6,767.5	1,819.8	2,121.2	13,762.5	34,121.9	36,339.9
2,000	334	5,857.6	2,297.5	12,682.0	6,938.1	1,854.0	2,126.9	14,103.7	34,804.4	37,079.2
1,900	338	5,857.6	2,320.3	12,909.5	7,165.6	1,876.7	2,138.3	14,331.2	35,259.3	37,591.0
1,800	342	5,800.7	2,314.6	13,080.1	7,336.2	1,893.8	2,144.0	14,501.8	35,486.8	37,818.5
1,700	342	5,800.7	2,320.3	13,136.9	7,506.8	1,893.8	2,132.6	14,501.8	35,543.7	37,875.3
1,600	339	5,800.7	2,331.7	13,136.9	7,620.6	1,882.4	2,070.1	14,388.1	35,373.1	37,647.9
1,500	332	5,743.9	2,348.7	12,909.5	7,620.6	1,854.0	1,962.0	14,103.7	34,804.4	37,079.2
1,400	322	5,630.1	2,388.5	12,625.1	7,563.7	1,802.8	1,825.5	13,648.8	33,894.4	36,112.4
1,300	307	5,459.5	2,451.1	12,113.3	7,336.2	1,734.5	1,654.9	13,023.2	32,586.4	34,690.6
1,200	286	5,288.9	2,519.3	11,430.8	7,051.9	1,637.8	1,444.5	12,056.4	30,709.7	32,700.2
1,100	254	5,061.4	2,593.3	10,464.1	6,596.9	1,501.4	1,171.5	10,748.4	28,207.5	30,084.2

EMISSIONS DATA

EPA TIER-1 1996 - 2000 ********** A4
Gaseous emissions data measurements are consistent with those described in EPA 40 CFR PART 89 SUBPART D and ISO 8178 for measuring HC, CO, PM, and NOx.

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kW-hr
U. S. (incl Calif)	EPA/Tier-1	CO:11.4 HC:1.3 NOx:9.2 PM:0.5

EU STAGE-1 1999 - 2001 ********** A4
Gaseous emissions data measurements are consistent with those described in EPA 40 CFR PART 89 SUBPART D and ISO 8178 for measuring HC, CO, PM, and NOx.

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kW-hr
U. S. (incl Calif)	EPA/Tier-1	CO:11.4 HC:1.3 NOx:9.2 PM:0.5

REFERENCE EXHAUST STACK DIAMETER	5 IN
WET EXHAUST MASS	--
WET EXHAUST FLOW (-- STACK TEMP)	--
WET EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	--
DRY EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	--
FUEL FLOW RATE	--

From: Carl F. Thiele [mailto:THIELE_CARL_F@cat.com]
Sent: Thursday, January 07, 2010 3:21 PM
To: Dave Newsad
Cc: Faisal Rashid
Subject: RE: Follow up help- RE: Caterpillar engine certification help

Dave,
I don't have an easy way to pull up the exact engine serial number based on the rig name, but can pull up a representative engine which gives you a good idea for a particular rating.

To get the actual emissions for the engines, we would need the right engines to do the comparison. Emissions are very much tied to the serial number when presenting the data, especially with the different ratings, configurations, and Tier levels. The C7 Dry Manifold 250 hp Tier 3 ratings are as follows, but I cannot find a 960 ekW genset and would need more to guess. I have included the EPA Tier 3 and IMO limits below.

Faisal Rashid (cc:'ed above) is the Petroleum Territory Manager for NC Machinery, which covers Seattle and the rest of the Northwest.

Please tell us if this is a good start for your calculations.

C7 250 hp/ Tier 3 Complaint Nonroad Engine (these are the limits)

EMISSIONS DATA

EPA TIER-3 2006 - ---- ********** G4

Gaseous emissions data measurement are consistent with those described in 40 CFR, EU 97/68/EC, ECE Regulation No. 96 and ISO 8178 for measuring HC, CO, PM and NOx.

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kw-hr		
U. S. (incl Calif)	EPA/Tier 3	CO:3.5	NOx + HC:4.0	PM:0.2
Europe	EU/Stage-IIIA	CO:3.5	NOx + HC:4.0	PM:0.2

EU STAGE -IIIA 2006 - 2010 ********** G4

Gaseous emissions data measurement are consistent with those described in 40 CFR, EU 97/68/EC, ECE Regulation No. 96 and ISO 8178 for measuring HC, CO, PM and NOx.

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kw-hr		
U. S. (incl Calif)	EPA/Tier 3	CO:3.5	NOx + HC:4.0	PM:0.2
Europe	EU/Stage-IIIA	CO:3.5	NOx + HC:4.0	PM:0.2

Logging winch
Cat C7

RATED SPEED "Nominal Data"

ENGINE SPEED RPM	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR VOC	TOTAL CO2 LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT
2,200	100	250	1.3200	.3900	.1500	305.8	.0800	11.1000
2,200	75	188	.8100	.2400	.1600	246.1	.0500	12.8000
2,200	50	125	.4800	.2400	.1800	176.1	.0500	14.5000
2,200	25	62	.3500	.3600	.1200	95.1	.0800	15.8000
2,200	10	25	.2200	.3800	.2200	57.9	.0300	17.2000

3508B 910 ekW IMO 1 engine:

$$1.3405\ hp = 1\ kW$$

$$\left(\frac{lb}{hr}\right)\left(\frac{454g}{lb}\right) \Big/ (kW) = \frac{g}{kW\text{-}h}$$

EMISSIONS DATA

IMO 2000 - ********** M1
Gaseous emissions data measurements are consistent with those described in REGULATION 13 of ANNEX VI of MARPOL 73/78 and ISO 8178 for measuring HC, CO, PM, and NOx.

This engine's exhaust emissions are in compliance with the INTERNATIONAL MARINE ORGANIZATION'S ÝIMO¨ regulations.

EPA TIER-I 2004 - 2007 ********** L1
Gaseous emissions data measurements are consistent with those described in EPA 40 CFR PART 94.103 and ISO 8178 for measuring HC, CO, PM, and NOx.

This engine conforms to US EPA marine compression-ignition emission regulations.

LOCALITY	AGENCY/LEVEL
U. S. (incl Calif)	EPA/TIER-1

Emergency back up Engine Cat 3508B

RATED SPEED "Nominal Data"

EKW	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR VOC	TOTAL CO2 LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
910	100	1285	23.7200	.5800	.7200	1,357.8	.2000	11.3000	1.7000	1.2800
682.5	75	959	13.0900	.5100	.4700	1,040.1	.1300	12.4000	1.7000	1.2800
455	50	640	7.6400	.7200	.3900	727.8	.1400	13.1000	2.4000	1.2800
227.5	25	326	3.7400	.7000	.3400	420.7	.1700	14.6000	3.4000	1.3400
91	10	132	1.9500	1.3200	.4300	234.7	.2900	16.5000	7.0000	1.9100

Best regards,
Carl

"Dave Newsad" <dnewsad@hoeflernet.com>

01/05/2010 06:02 PM

To "Carl F. Thiele" <THIELE_CARL_F@cat.com>
cc
Subject RE: Follow up help- RE: Caterpillar engine certification help

Caterpillar: Confidential Green Retain Until: 02/04/2010

I do not have those Serial #s? It's one of 3 rigs under review for the project.

FYI- it's not a 100% we will be using the Maersk Resolute. Given the air permitting timing needs, EPA said they would accept an application using a "representative rig" with the understanding if we changed rigs we may have to amend the permit later. Our client stated they want to use the Maersk Resolute as the representative rig.

From: Carl F. Thiele [mailto:THIELE_CARL_F@cat.com]
Sent: Tuesday, January 05, 2010 3:57 PM

From: Thomas, Brad C [mailto:Brad.C.Thomas@conocophillips.com]
Sent: Tuesday, December 08, 2009 2:40 PM
To: Dave Newsad
Subject: FW: Equipment location and Emissions data for Maersk's HE JU Rigs

Here's the Maersk stuff. Still tracking down ENSCO.

Wartsila 8L26A2
Drill Rig Main Engine

5 Measurement results

Tab. 7: Measurement results

Mode	-	1	2	3	4	5
Start Time	hh:mm	17:30	18:13	18:45	19:06	19:30
Power	%	100	75	50	25	10
Speed	%	100	100	100	100	100
Engine test data						
Power [3]	kW	2480	1862	1249	624	256
Speed [3]	rpm	900	900	900	900	900
Fuel consumption [3]	kg/h	510.3	378.1	270.5	141.8	91.5
Uncorr. specific fuel consumption	g/kWh	206	203	217	227	358
Charge air temperature [3]	°C	46	46	46	47	48
Charge air ref.temperature [2]	°C	50	50	50	50	50
Charge air pressure [3]	bar	3.32	2.73	1.70	0.75	0.37
Ambient and gaseous emission						
Exhaust gas temp. at samp. point	°C	337	272	283	295	263
Barometric pressure of intake air	mbar	1018	1018	1019	1019	1019
Temperature of intake air	°C	27.8	27.6	26.8	27.3	27.1
Humidity of intake air	%	17.4	18.1	19.3	18.8	19.2
Atmospheric factor (fa)	-	0.999	0.998	0.994	0.996	0.995
NOx (dry)	ppm	865	754	653	446	255
CO (dry)	ppm	70	37	50	134	234
HC (wet)	ppm	204	241	303	372	431
CO_2 (dry)	%	6.37	5.09	4.86	4.56	3.73
O_2 (dry)	%	11.99	13.76	14.09	14.52	15.66
Correction factors						
NO_x humidity corr. factor (K_{HDIES})	-	0.942	0.943	0.942	0.939	0.937
Fuel specific factor (F_{FH})	-	1.655	1.663	1.664	1.666	1.671
Dry to wet correction factor (K_{wet})	-	0.945	0.954	0.956	0.958	0.964
Calculated gas mass flow						
NO_x	kg/h	21.75	17.59	11.36	4.32	1.93
CO	kg/h	1.14	0.56	0.56	0.84	1.15
HC	kg/h	1.74	1.88	1.77	1.21	1.09
CO_2	kg/h	1627	1204	860	449	288
O_2	kg/h	2228	2368	1814	1041	879
Exhaust mass flow [1]	kg/h	17801	16309	12176	6765	5261
Calculated specific emission						
NO_x without K_{HDIES} correction	g/kWh	9.31	10.01	9.66	7.37	8.05
NO_x	g/kWh	8.77	9.44	9.10	6.92	7.54
CO	g/kWh	0.46	0.30	0.45	1.35	4.49
HC VOC	g/kWh	0.70	1.01	1.42	1.94	4.25
CO_2	g/kWh	658	647	689	720	1126
O_2	g/kWh	898	1272	1452	1669	3438

1) Calculation of the exhaust gas mass flow: Universal carbon balance, Method 2
2) Given by the manufacturer
3) Taken from manufactures test report