ANNEX I

ECE Regulation 24.03 and Annex 10

Engine power and smoke (compression ignition)

Job/Report No: ESF 070782

Engine: DongFeng Cummins C220 20 Declared fuel rate: 112 mm³/stroke
Cubic capacity: 8.268 Litres at: 2200 rpm
Number of cylinders: 6 Density: 0.8369 kg/l@15^{0}C
2 or 4 stroke: 4

Engine Speed	rpm		2275	2200	2150	1960	1720	1650	1600	1480	1300	1240	1000
Indicated torque	Nm	1.	588.6	699.2	713.6	760.2	807.8	810.8	815.5	824.9	830.5	829.3	781.4
		2.											
Indicated Power	kW		140.23	161.08	160.67	156.03	145.50	140.10	136.64	127.85	113.06	107.69	81.83
Fuel consumption	kg/hr	1.	33.45	38.18	37.39	34.53	30.5	29.1	28.21	26.34	23.5	22.51	18.1
		2.											
Temperature at injection pump	°C		38.9	39.1	39.2	39.2	39.1	39.0	38.9	38.9	38.8	38.8	38.7
Temperature at fuel measurement	°C												
Temperature of Coolant	°C		82.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Oil temperature @Gallery	°C		90.0	95.0	96.0	96.0	95.0	94.0	94.0	94.0	93.0	92.0	92.0
Air Intake temperature	°C	1.	22.7	23.0	23.3	23.3	23.3	23.3	23.3	23.4	23.4	23.3	23.4
	°C	2.											
Intake depression	kPa (X)		1.5	1.4	1.3	0.8	0.3	0.1	-0.1	-0.3	-0.6	-0.7	-0.9
Temperature after turbo-charger	°C		140.3	173.5	171.9	165.4	158.7	156.8	157.7	149.6	132.5	129.1	82.5
Pressure after turbo-charger	bar												
	kPa (Y)*		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperature at intercooler outlet	°C		46.3	45.1	45.2	45.8	50.9	52.5	55.2	51.9	53.6	54.6	54.0
Pressure at intercooler outlet	bar												
	kPa (Y)**		168.8	173.2	172.7	173.0	173.8	170.9	168.3	152.1	121.4	113.4	43.4
Exhaust temperature	°C		475	478	479	477	494	488	490	507	583	607	612
Exhaust pressure	mbar												
	kPa		4.2	4.9	4.7	4.0	3.7	2.9	3.0	2.1	4.6	3.6	0.2
Barometric pressure(H:72/306)	mbar												
	kPa		101.60	101.50	101.50	101.50	101.60	101.60	101.60	101.60	101.60	101.60	101.60
Humidity	%		56.7	36.2	32.8	33.2	31	47.3	31.8	38.2	36.4	40.6	45.6
Vapour pressure	kPa		1.56	1.02	0.94	0.95	0.89	1.35	0.91	1.10	1.05	1.16	1.31
Dry atmospheric (ps)	kPa		100.04	100.48	100.56	100.55	100.71	100.25	100.69	100.50	100.55	100.44	100.29
Smoke unit	m^{-1}		0.130	0.080	0.072	0.055	0.055	0.052	0.041	0.035	0.126	0.251	1.286

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Diesel Power and Smoke, TURBOCHARGED

INTERCOOLED

Job/Report No: ESF 070782

Engine Speed		2275	2200	2150	1960	1720	1650	1600	1480	1300	1240	1000
A (99/ps)^0.7	dry atmos	100.04	100.48	100.56	100.55	100.71	100.25	100.69	100.50	100.55	100.44	100.29
		0.9927	0.9896	0.9891	0.9892	0.9881	0.9913	0.9882	0.9895	0.9892	0.9899	0.9910
B (T/298)^1.5	A.I.T (K)	295.7	296.0	296.3	296.3	296.3	296.3	296.3	296.4	296.4	296.3	296.4
		0.9884	0.9899	0.9915	0.9915	0.9915	0.9915	0.9915	0.9920	0.9920	0.9915	0.9920
fa = A x B		0.9813	0.9797	0.9806	0.9807	0.9796	0.9828	0.9798	0.9816	0.9812	0.9815	0.9830
F (Valid 72/306 requires 0.98-1.02)		0.9856	0.9867	0.9872	0.9872	0.9866	0.9866	0.9866	0.9868	0.9868	0.9866	0.9868
C mg/min		557500	636333	623167	575500	508333	485000	470167	439000	391667	375167	301667
D Cycles/min		1137.5	1100	1075	980	860	825	800	740	650	620	500
E Swept Volume Litres		8.268	8.268	8.268	8.268	8.268	8.268	8.268	8.268	8.268	8.268	8.268
F q = C/DE		59.28	69.97	70.11	71.03	71.49	71.10	71.08	71.75	72.88	73.19	72.97
G Absolute Inlet Pressure, mb/kPa,	(Baro -X)	100.1	100.1	100.2	100.7	101.3	101.5	101.7	101.9	102.2	102.3	102.5
H Absolute Outlet Pressure, mb/kPa,	(Baro + Y)	270.4	274.7	274.2	274.5	275.4	272.5	269.9	253.7	223.0	215.0	145.0
I r = H/G (When naturally-aspirated, set 1)		2.70	2.74	2.74	2.73	2.72	2.68	2.65	2.49	2.18	2.10	1.41
J qc = q/r = F/I		21.94	25.50	25.62	26.06	26.30	26.48	26.78	28.82	33.40	34.82	51.58
fm = 0.036 qc - 1.14		0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.72
α d = fa^fm		0.9943	0.9939	0.9942	0.9942	0.9938	0.9948	0.9939	0.9944	0.9943	0.9944	0.9878

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Measurement											
Engine speed, rpm	2275	2200	2150	1960	1720	1650	1600	1480	1300	1240	1000
Specific fuel consumption (indicated) g/kWh	238.54	237.02	232.72	221.30	209.62	207.71	206.46	206.03	207.85	209.03	221.20
Corrected Power, kW	139.43	160.10	159.73	155.12	144.60	139.37	135.80	127.14	112.42	107.08	80.83
Corrected Torque, Nm	585.3	694.9	709.4	755.8	802.8	806.6	810.5	820.3	825.8	824.7	771.9
Power to be subtracted for 1.											
other auxiliares, kW 2.											
3.											
Power absorbed by fan, kW To be subtracted if fan not fitted	1.80	1.76	1.73	1.63	1.50	1.46	1.43	1.37	1.27	1.24	1.11
Net Power, kW	137.6	158.3	158.0	153.5	143.1	137.9	134.4	125.8	111.1	105.8	79.7
Net Torque, Nm	577.7	687.3	701.7	747.8	794.5	798.1	802.0	811.5	816.5	815.1	761.3
Corrected Specific Fuel Consumption (net) g/kWh	243.0	241.1	236.7	225.0	213.1	211.0	209.9	209.4	211.4	212.7	227.0

ANNEX II

ECE Regulation 24.03 and Annex 10

Diesel Power and Smoke,

Report/Job No: ESF 070782

Operation No
Paragraph (R24)

Steady State Smoke Test Result

DongFeng Cummins C220 20

	Test No	1	2	3	4	5	6	7
Ann4,2.2	Engine Speed, rpm	2200	1960	1720	1480	1240	1000	
	Indicated Power, kW	161.08	156.03	145.50	127.85	107.69	81.83	
	Exhaust Pipe back pressure, kPa	4.9	4.0	3.7	2.1	3.6	0.2	
†	Smoke Valve pressure, mm H2O < 75	✓	✓	✓	✓	✓	✓	✓
†	Smoke tube temp limit °C >70	✓	✓	✓	✓	✓	✓	✓
†	Smoke Valve temp	✓	✓	✓	✓	✓	✓	✓
	Fuel Consumption	115.2 mm³/stroke @ 2200rpm			Limit 112 ±7 mm³/stroke @ 2200rpm			
	Air intake temp, °C	23.0	23.3	23.3	23.4	23.3	23.4	-
	Inlet depression, kPa	1.40	0.80	0.30	-0.30	-0.70	-0.90	-
Ann4,4.1	Nominal gas flow, L/s	151.58	135.04	118.51	101.97	85.44	68.90	-
Ann7	Limit, m^{-1}	1.219	1.300	1.377	1.483	1.616	1.789	-
Ann4,4.2	Opacity, %	0.08	0.06	0.06	0.04	0.25	1.29	-
	m^{-1}	0.08	0.06	0.06	0.04	0.25	1.29	-
	difference	1.139	1.245	1.322	1.448	1.365	0.503	-
Ann5, 3.1	Result nearest limit (SM)	------	------	------	------	------	1.286	------
	Corresponding limit (SL)	------	------	------	------	------	1.789	------
	Hartridge units with cold start engaged	------	------	------	------	------	------	------

† Tick to show compliance

ANNEX III

ECE Regulation 24.03 and Annex 10

Diesel Power and Smoke, DongFeng Cummins C220 20

Report/Job No: ESF 070782

Operation No

Paragraph (R24)

Free Acceleration Smoke Test

Ann5, 1.1.1 Water temperature: 65 °C Oil temperature: 66 °C

Ann10, 5.3.2 Intake air temperature: 23.2 °C RH: 40.1 %

Ann4, 3.3 Barometric pressure (H): 762.06 mm Hg Pg = 0.236

Barometric pressure: 101.60 kPa Vp: 0.095 kPa ps: 101.5 kPa

Factor F = 0.9897 x 0.9970 = 0.9867

Ann4, 3.3.1.2 Factor fa = 0.9827 x 0.9910 = 0.9738

Ann5, 2.3

Test No	Inertia (1) =2 kgm^2		Inertia (2) = kgm^2		Inertia (3) = kgm^2		Inertia (4) = kgm^2	
	Opacity m^{-1}	XM m^{-1}	Opacity	XM m^{-1}	Opacity	XM m^{-1}	Opacity	XM m^{-1}
Ann5, 2.5,2.6 1	0.486							
2	0.5							
3	0.555							
4	0.496	0.51						
5								
6								
7								
8								
9								
10								

			Inertia (1)	Inertia (2)	Inertia (3)	Inertia (4)
Ann5, 2.6	FAS test result:	(XM)	0.51			
Ann 5, 3	Result nearest to limit in steady speed tes	(SM)	1.29			
	Corresponding limit:	(SL)	1.789			
	Corrected result:	(XL)				
	SL/SM = 1.391		1.391			
	X1L = SL/SM x XM =		0.71			
	X2L = XM + 0.5 =		1.01			
	Absorbed coefficient to be marked on Vehicle		0.71			

Highest absorption coefficient, steady speed test 1.29 m^{-1}

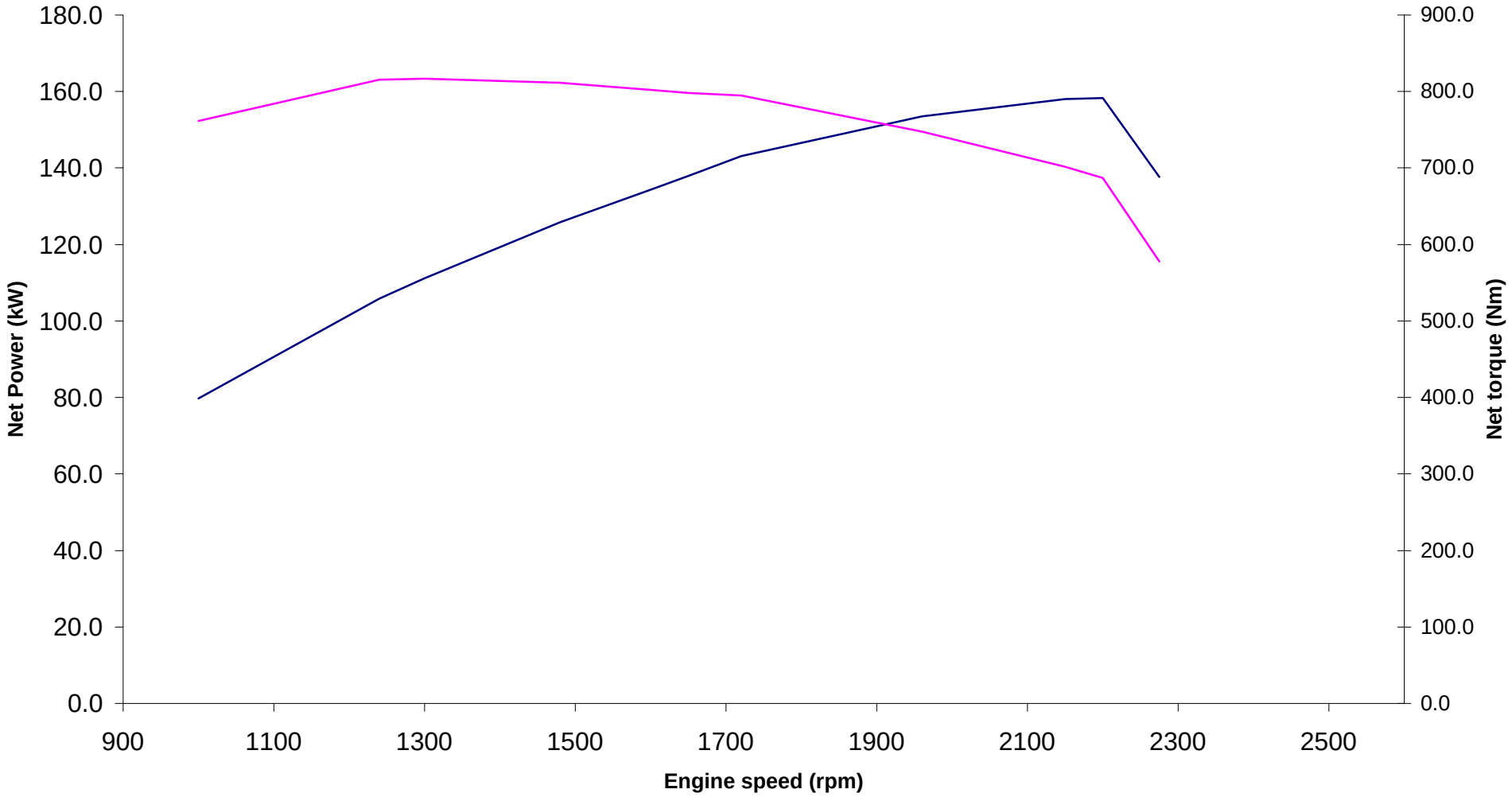
Corresponding limit + 0.5 (A) 2.29 m^{-1}

FAS test result (XM) I(1)= 0.51 m^{-1}, I(2)= m^{-1}

I(3)= m^{-1}, I(4)= m^{-1}

(For turbocharged engines XM must be less than A)

Engine net power and torque



Annex 10 - Appendix

Statement of the results of tests for measuring net engine power

This information is to be supplied by the manufacturer simultaneously with the identification sheet constituting Annex 1 to the Regulation. If the test under this Regulation is a bench test of the engine, this form shall be completed by the laboratory performing the test.

1 TEST CONDITIONS DongFeng Cummins C220 20

1.1 Pressures measured at maximum power:

1.1.1 Total barometric pressure: 101500 Pa

1.1.2 Water vapour pressure: 1015 Pa

1.1.3 Exhaust pressure: 4920 Pa

1.2 Temperatures measured at maximum power:

1.2.1 of the intake air: 296.0 K

1.2.2 at the outlet of the engine intercooler: 318.3 K

1.2.3 of the cooling fluid:

1.2.3.1 at the engine cooling fluid outlet: 358.2 K (1)

1.2.3.2 at the reference point in the case of air cooling: Not applicable

1.2.4 of the lubricating oil 368.2 K measured at Gallery

1.2.5 of the fuel:

1.2.5.1 at the fuel pump inlet: 312.3 K

1.2.5.2 in the fuel-consumption measuring device: Not applicable

1.3 Characteristics of the dynamometer:

1.3.1 Make: AVL

Model: APA404/E/2801

1.3.2 Type: Eddy Current

2 FUEL

2.1 For positive-ignition engines operating on liquid fuel: Not applicable

2.1.1 Make:

2.1.2 Specification:

2.1.3 Anti-knock additive (lead, etc):

2.1.3.1 Type:

2.1.3.2 Content: mg/1

2.1.4 Octane number RON: (ASTM D 26 99-70)

2.1.4.1 Specific density: g/cm3 at 288 K

2.1.4.2 Lower calorific value: kJ/kg

2.2 For positive-ignition engines operating on gaseous fuel: Not applicable

2.2.1 Make:

2.2.2 Specification:

2.2.3 Storage pressure: bar

2.2.4 Utilisation pressure: bar

2.2.5 Lower calorific value: kJ/kg

2.3 For compression ignition engines operating on gaseous fuels: Not applicable

2.3.1 Feed system: g Gas:

2.3.2 Specification of gas used:

2.3.3 Fuel oil/gas proportion:

2.3.4 Lower calorific value: kJ/kg

2.4 For compression-ignition engines operating on liquid fuel:

2.4.1 Make:	Fangyuan	
2.4.2 Specification of fuel used:	Compression Ignition Standard Fuel	
2.4.3 Cetane index (ASTM D 976-71):	-	
2.4.4 Specific density:	0.8369	g/cm3 at 288 K
2.4.5 Lower calorific value:	-	kJ/kg

3 LUBRICANT

3.1 Make:	Lanzhizun
3.2 Specification:	CF4/SG
3.3 SAE viscosity:	15W40

4.2	Maximum net power	158.3	kW at	2200	min-1
4.3	Maximum net torque	802.0	Nm at	1600	min-1

5 Engine submitted for testing on: 23-Nov-05

6 Technical service conducting tests: Vehicle Certification Agency

4.DETAILED RESULTS OF MEASUREMENTS

4.1 Statements of results of net power measurement test (*)

Engine speed, min^{-1}		2275	2200	2150	1960	1720	1650	1600	1480	1300
Measured torque, Nm		588.60	699.20	713.60	760.20	807.80	810.80	815.50	824.90	830.50
Measured power, kW		140.23	161.08	160.67	156.03	145.50	140.10	136.64	127.85	113.06
Measured fuel flow, g/kWh		238.54	237.02	232.72	221.30	209.62	207.71	206.46	206.03	207.85
Measured smoke index, m^{-1} (1)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barometric pressure, kPa		101.6	101.5	101.5	101.5	101.6	101.6	101.6	101.6	101.6
Water vapour pressure, kPa		1.56	1.02	0.94	0.95	0.89	1.35	0.91	1.10	1.05
Inlet air temperature, K		295.85	296.15	296.45	296.45	296.45	296.45	296.45	296.55	296.55
Power to be added	No 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
for auxilliaries in	No 2									
excess of table 1, kW	No 3									
Power correction factor		0.9943	0.9939	0.9942	0.9942	0.9938	0.9948	0.9939	0.9944	0.9943
Corrected brake power, kW (~~with~~/without(2) fan)		139.43	160.10	159.73	155.12	144.60	139.37	135.80	127.14	112.42
Power of fan,kW (to be subtracted if fan not fitted)		1.8009091	1.76	1.7327273	1.6290909	1.4981818	1.46	1.4327273	1.3672727	1.2690909
Net power, kW		137.63	158.34	157.99	153.49	143.10	137.91	134.37	125.77	111.15
Net torque, Nm		577.71	687.27	701.73	747.83	794.50	798.14	801.96	811.48	816.46
Corrected specific fuel consumption, g/kWh (net)(3)		243.04	241.13	236.66	224.96	213.13	211.01	209.94	209.43	211.43
Cooling liquid temperature at outlet, K		355.2	358.2	358.2	358.2	358.2	358.2	358.2	358.2	358.2
Lubricating oil temperature at measuring point, K		363.2	368.2	369.2	369.2	368.2	367.2	367.2	367.2	366.2
Air temperature after supercharger, K(4)		413.5	446.7	445.1	438.6	431.9	430.0	430.9	422.8	405.7
Fuel temperature at injection pump inlet, K		312.1	312.3	312.4	312.4	312.3	312.2	312.1	312.1	312.0
Air temperature after charge air cooler, K(4)		319.5	318.3	318.4	319.0	324.1	325.7	328.4	325.1	326.8
Pressure after supercharger, kPa(4)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pressure after charge air cooler, kPa		168.8	173.2	172.7	173.0	173.8	170.9	168.3	152.1	121.4

NOTES FOR TABLE AT PARAGRAPH 4:

(1) Only for diesel engines

(2) Delete as inapplicable

(3) Calculated with the net power for compression-ignition and positive-ignition engines, in the latter case multiplied by the power correction factor.

(4) If applicable

(*) The characteristic curves of the net power and the net torque shall be drawn as a function of the engine speed.

4.DETAILED RESULTS OF MEASUREMENTS

4.1 Statements of results of net power measurement test (*) DongFeng Cummins C220 20

Engine speed, min^{-1}		1240	1000
Measured torque, Nm		829.30	781.40
Measured power, kW		107.69	81.83
Measured fuel flow, g/kWh		209.03	221.20
Measured smoke index, m^{-1} (1)		0.01	0.03
Barometric pressure, kPa		101.6	101.6
Water vapour pressure, kPa		1.16	1.31
Inlet air temperature, K		296.45	296.55
Power to be added	No 1	0.00	0.00
for auxilliaries in	No 2		
excess of table 1, kW	No 3		
Power correction factor		0.9944	0.9878
Corrected brake power, kW (~~with~~/without(2) fan)		107.08	80.83
Power of fan,kW (to be subtracted if fan not fitted)		1.2363636	1.1054545
Net power, kW		105.85	79.72
Net torque, Nm		815.14	761.30
Corrected specific fuel consumption, g/kWh (net)(3)		212.66	227.03
Cooling liquid temperature at outlet, K		358.2	358.2
Lubricating oil temperature at measuring point, K		365.2	365.2
Air temperature after supercharger, K(4)		402.3	355.7
Fuel temperature at injection pump inlet, K		312.0	311.9
Air temperature after charge air cooler, K(4)		327.8	327.2
Pressure after supercharger, kPa(4)		0.0	0.0
Pressure after charge air cooler, kPa		113.4	43.4

2.1 Engine performance

Engine speed, min-1		2275	2200	2150	1960	1720	1650	1600	1480
Engine test results	Specific fuel consumption, g/kWh	238.5	237.0	232.7	221.3	209.6	207.7	206.5	206.0
	Torque, Nm	588.6	699.2	713.6	760.2	807.8	810.8	815.5	824.9
	Power, kW	140.2	161.1	160.7	156.0	145.5	140.1	136.6	127.8
Correction factor		0.9943	0.9939	0.9942	0.9942	0.9938	0.9948	0.9939	0.9944
Corrected brake power, kW		139.43	160.10	159.73	155.12	144.60	139.37	135.80	127.14
Corrected specific fuel consumption**		243.04	241.13	236.66	224.96	213.13	211.01	209.94	209.43
Corrected torque Nm		585.3	694.9	709.4	755.8	802.8	806.6	810.5	820.3
Power to be added for auxiliary equipment fitted on engine in excess of Table 1 in Annex I (see item 1 in the Addendum to Appendix 1 of Annex 1). Power to be subtracted when fan not fitted (see Table 1, note 5)	No 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	No 2								
	No 3								
		-1.80	-1.76	-1.73	-1.63	-1.50	-1.46	-1.43	-1.37
Net power, kW		137.6	158.3	158.0	153.5	143.1	137.9	134.4	125.8
Net torque, Nm		577.7	687.3	701.7	747.8	794.5	798.1	802.0	811.5

** Applicable to compression ignition engines only

2.1 Engine performance

Engine speed, min^{-1}		1300	1240	1000
Engine test results	Specific fuel consumption, g/kWh	207.9	209.0	221.2
	Torque, Nm	830.5	829.3	781.4
	Power, kW	113.1	107.7	81.8
Correction factor		0.9943	0.9944	0.9878
Corrected brake power, kW		112.42	107.08	80.83
Corrected specific fuel consumption**		211.43	212.66	227.03
Corrected torque Nm		825.8	824.7	771.9
Power to be added for auxiliary equipment fitted on engine in excess of Table 1 in Annex I (see item 1 in the Addendum to Appendix 1 of Annex 1). Power to be subtracted when fan not fitted (see Table 1, note 5)	No 1	0.00	0.00	0.00
	No 2			
	No 3			
		-1.27	-1.24	-1.11
Net power, kW		111.1	105.8	79.7
Net torque, Nm		816.5	815.1	761.3

** Applicable to compression ignition engines only