

<b>VOLVO PENTA</b>	Document No	Issue Index
	<b>TAD1650GE</b>	<b>21587771</b>

## General

In-line four stroke diesel engine with direct injection. Rotation direction, anti-clockwise viewed towards flywheel.  
Turbocharged

Number of cylinders			6
Displacement, total		litre in <sup>3</sup>	16,12 983,9
Firing order			1-5-3-6-2-4
Bore		mm in	144 5,67
Stroke		mm in	165 6,50
Compression ratio			16.5:1
Wet weight	Engine only	kg	1550
		lb	3417
	Engine incl. cooling system and air filtration system	kg lb	1751 3860
	Engine incl. cooling system, air filtration system, and frame	kg lb	2020 4453

## Performance

			rpm	1500	1800
Standby Power	without fan	kW		442	498
		hp		601	677
	with fan	kW			
See diagram for fan power consumption					
Prime Power	without fan	kW		402	454
		hp		547	617
	with fan	kW			
See diagram for fan power consumption					
Torque at:	Standby Power	Nm		2814	2642
		lbft		2075	1948
	Prime Power	Nm		2559	2409
		lbft		1887	1776
Mean piston speed		m/s		8,3	9,9
		ft/sec		27,1	32,6
Effective mean pressure at:	Standby Power	MPa		2,2	2,1
		psi		318	299
Effective mean pressure at:	Prime Power	MPa		2,0	1,9
		psi		289	272
Max combustion pressure at:	Standby Power	MPa		16,6	17,6
		psi		2408	2553
Max combustion pressure at:	Prime Power	MPa		14,9	16,1
		psi		2161	2335
Total mass moment of inertia, J (mR <sup>2</sup> )		kgm <sup>2</sup>		4,20	
		lbft <sup>2</sup>		99,7	
Friction Power		kW		40	56
		hp		54,4	76,16
<b>Derating see Technical Diagrams</b>					

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**Engine noise emission**

Test Standards: ISO 3744-1981 (E) sound power

Tolerance  $\pm 0.75$  dB(A)

		rpm	1500	1800
Measured sound power Lw	No load	dB(A)	112,2	115,1
	Standby Power	dB(A)	114,1	116,8
	Prime Power	dB(A)	113,7	116,7
Calculated sound pressure Lp at 1 m	No load	dB(A)	101,2	104,1
	Standby Power	dB(A)	103,1	105,8
	Prime Power	dB(A)	102,7	105,7

**Unsilenced exhaust noise****Fan ratio 1:1,13**

Data calculated as sound pressure Lp.

	rpm	1500	1800
Standby Power	dB(A)	115	117
Prime Power	dB(A)	115	117

**Test conditions for load acceptance data**

Warm engine.	Generator	Model	Type of AVR
	Stamford	HCI 534 D1	MX341
AVR Settings	UFRO : Std-setting 47Hz / 57Hz / 400 V.		

Load acceptance performance can vary due to actual alternator inertia, voltage regulator, type of load and local ambient conditions. Please note that load step 0-100% is based on calculation.

**Single step load performance at 1500 rpm**

Load (%)	Speed diff (%)		Recovery time (s)		Remaining load (%)	Speed diff (%)		Recovery time (s)	
	Prime	Standby	Prime	Standby		Prime	Standby	Prime	Standby
0-20	1,3	1,4	0,7	0,7	20-100	15,7	19,0	3,1	5,0
0-40	2,4	2,8	1,0	1,1	40-100	5,5	6,2	1,5	4,2
0-60	4,9	7,0	1,3	2,1	60-100	3,0	5,5	1,0	2,9
0-66	7,0		2,1		66-100	3,4		0,7	
0-72		10,0		2,6	72-100		4,1		2,4
0-79	9,8		2,6		79-100	1,8		0,6	
0-80	10,0	13,5	3,2	2,6	80-100	1,7	2,1	0,6	1,6
0-100	16,5	22,3	5,0	5,0					
100-0	5,5	6,2	0,8	1,2					

**Single step load performance at 1800 rpm**

Load (%)	Speed diff %		Recovery time (s)		Remaining load (%)	Speed diff (%)		Recovery time (s)	
	Prime	Standby	Prime	Standby		Prime	Standby	Prime	Standby
0-20	1,0	1,0	0,4	0,5	20-100	6,3	8,1	1,6	3,1
0-40	2,0	1,7	0,6	0,8	40-100	3,3	3,8	1,6	3,0
0-60	3,0	3,4	1,0	1,1	60-100	2,1	2,5	1,3	1,7
0-75		6,1		1,5	75-100		1,5		2,2
0-80	6,0	7,0	1,5	1,1	80-100	1,0	1,2	0,3	1,2
0-88	7,0		1,6		88-100	0,7		0,3	
0-90		9,1		1,6	90-100		0,6		0,3
0-99	8,8		1,6		99-100	0,0		0,0	
0-100	9,0	11,4	1,6	1,6					
100-0	4,0	4,1	0,8	0,7					

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**Cold start performance**

	°C	rpm	1500	1800
Time from start to stay within 0.5% of no load speed at ambient temperature:	20	s	4,5	4,8
	5	s	5,2	5,0
	-15*	s	5,1	5,8
	-30**	s	7,4	6,5

\* With manifold heater 4 kW engaged, lubrication oil 15W/40 and block heater.

\*\* With manifold heater 4 kW engaged, lubrication oil 5W/30 and block heater, Fuel MK-1.

Block heater type	Make	Power kW	Engaged hours	Cooling water temp engine block
	Volvo	2	12	10°C 50°F

**Lubrication system**

		rpm	1500	1800
Lubricating oil consumption	Standby Power	litre/h	0,10	0,10
		US gal/h	0,026	0,026
	Prime Power	litre/h	0,10	0,11
		US gal/h	0,026	0,029
Oil system capacity including filters		litre	48	
		US gal	12,7	
Oil sump capacity:	max	litre	42	
		US gal	11,1	
	min	litre	32	
		US gal	8,5	
Oil change intervals/specifications:	VDS 3	h	600	
	VDS 2	h	400	
		h		
Engine angularity limits:	front up	°	30	
	front down	°	30	
	side tilt	°	30	
Oil pressure at rated speed		kPa	300 - 650	
		psi	44 - 94	
Lubrication oil temperature in oil sump:	max	°C	130	
		°F	266	
Oil filter micron size		μ	40,000	

\* See also general section in the sales guide

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Fuel system		rpm	1500	1800
<b>Standby Power</b> Specific fuel consumption at:	25%	g/kWh lb/hph	235 0,381	245 0,397
	50%	g/kWh lb/hph	213 0,345	216 0,350
	75%	g/kWh lb/hph	206 0,334	208 0,337
	100%	g/kWh lb/hph	202 0,327	208 0,337
<b>Prime Power</b> Specific fuel consumption at:	25%	g/kWh lb/hph	237 0,384	249 0,404
	50%	g/kWh lb/hph	212 0,344	218 0,353
	75%	g/kWh lb/hph	204 0,331	207 0,336
	100%	g/kWh lb/hph	202 0,327	206 0,334

Fuel system		rpm	1500	1800
Fuel to conform to	ASTM-D975-No1 and 2D JIS KK 2204, EN 590			
System supply flow at:	litre/h		132,0	149,0
	US gal/h		34,9	39,4
Fuel supply line max restriction (Measured at fuel inlet connection)	kPa		30,0	30,0
	psi		4,4	4,4
Fuel supply line max pressure, engine stopped	kPa		16,5	16,5
	psi		2,4	2,4
System return flow	litre/h		25,0	25,0
	US gal/h		6,6	6,6
Fuel return line max restriction (Measured at fuel return connection)	kPa		20,0	20,0
	psi		2,9	2,9
Maximum allowable inlet fuel temp (Measured at fuel inlet connection)	°C		60	60
	°F		140	140
Prefilter / Water separator micron size	μ		10,000	
Fuel filter micron size	μ		5,000	
Governor type/make, standard	Volvo / EMS 2.2			
Injection pump type/make	Delphi E3.18			

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<b>Intake and exhaust system</b>		<b>rpm</b>	<b>1500</b>	<b>1800</b>
Air consumption at: (+25°C and 100kPa)	Standby Power	m <sup>3</sup> /min cfm	30 1059	36 1271
	Prime Power	m <sup>3</sup> /min cfm	29 1024	35 1236
Max allowable air intake restriction including piping		kPa psi	5 0,7	5 0,7
Air filter restriction clean Volvo Penta filter		kPa psi		
Heat rejection to exhaust at:	Standby Power	kW BTU/min	329 18710	382 21724
	Prime Power	kW BTU/min	300 17061	345 19620
Exhaust gas temperature after turbine at:	Standby Power	°C °F	511 952	508 946
	Prime Power	°C °F	495 923	468 874
Max allowable back pressure in exhaust line	Standby Power	kPa psi	10 1,5	10 1,5
	Prime Power	kPa psi	8 1,2	8 1,2
Exhaust gas flow at: (temp and pressure after turbine at the corresponding power setting)	Standby Power	m <sup>3</sup> /min cfm	78,0 2755	91,0 3214
	Prime Power	m <sup>3</sup> /min cfm	73,0 2578	84,0 2966

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<b>Cooling system</b>		<b>rpm</b>	<b>1500</b>	<b>1800</b>
Heat rejection radiation from engine at:	Standby Power	kW	19	21
		BTU/min	1081	1194
	Prime Power	kW	21	23
		BTU/min	1194	1308
Heat rejection to coolant at:	Standby Power	kW	191	220
		BTU/min	10862	12511
	Prime Power	kW	180	206
		BTU/min	10236	11715
Radiator cooling system type		Closed circuit		
Standard radiator core area		m <sup>2</sup>	1,42	
		foot <sup>2</sup>	15,28	
Fan diameter		mm	890	
		in	35,04	
Fan power consumption see diagram for actual fan ratio		kW		
		hp		
Coolant capacity,	Engine	litre	24	
		US gal	6,34	
	Engine with std radiator and hoses	litre	61	
		US gal	16,11	
	Engine with HD radiator and hoses	litre	56	
		US gal	14,79	
Coolant pump		drive/ratio	Belt / 1.85:1	
Coolant flow with standard system		l/s	6,4	7,7
		US gal/s	1,69	2,03
Minimum coolant flow		l/s	5,1	6,1
		US gal/s	1,35	1,61
Maximum outer circuit restriction, including piping		kPa	40	60
		psi	5,8	8,7
Thermostat	start to open	°C	82	
		°F	180	
	fully open	°C	92	
		°F	198	
Maximum static pressure head (expansion tank height + pressure cap setting)		kPa	100	
		psi	14,5	
Minimum static pressure head (expansion tank height + pressure cap setting)		kPa	70	
		psi	10,2	
Standard pressure cap setting		kPa	75	
		psi	10,9	
Maximum top tank temperature		°C	107	
		°F	225	
Draw down capacity. The difference between min coolant level in the expansion tank and the lowest level where the engine's coolant system still is functioning		litre	1,8	
		US gal	0,48	

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<b>Charge air cooler system</b>		<b>rpm</b>	<b>1500</b>	<b>1800</b>
Heat rejection to charge air cooler	Standby Power	kW	97	125
		BTU/min	5516	7109
	Prime Power	kW	87	114
		BTU/min	4948	6483
Charge air mass flow	Standby Power	kg/s	0,58	0,68
	Prime Power	kg/s	0,55	0,67
Charge air inlet temp. (Charge air temp after turbo compressor)	Standby Power	°C	209	226
		°F	408	439
	Prime Power	°C	197	209
		°F	387	408
Charge air outlet temp. (Charge air temp after intercooler)	Standby Power	°C	45	45
		°F	113	113
	Prime Power	°C	43	43
		°F	109	109
Maximum pressure drop over charge air cooler incl. piping		kPa	8	
		psi	1,16	
Charge air pressure (After charge air cooler)		kPa	320	
		psi	46,41	
Standard charge air cooler core area		m <sup>2</sup>	0,765	
		foot <sup>2</sup>	8,23	

**Cooling performance, STD cooling package with 890mm fan**

Cooling air flow and external restriction at different radiator air temperatures based on 107°C TTT and 40% coolant. Valid at 1 atm. (radiator and cooling fan, see optional equipment)

**Fan drive ratio 1:1,13**

Engine speed rpm	External restriction Pa	PRIME POWER		STANDBY POWER	
		Air mass flow m <sup>3</sup> /s	Air on temp °C	Air mass flow m <sup>3</sup> /s	Air on temp. °C
1500	0	9,1	69	9,1	66
	150	8,7	68	8,7	65
	300	8,2	67	8,2	64
	450	7,6	66	7,6	63
1800	0	10,9	68	10,9	65
	150	10,5	67	10,5	64
	300	10,0	66	10,0	63
	450	9,9	65	9,9	62

**Fan drive ratio 1:1,04**

Engine speed rpm	External restriction Pa	PRIME POWER		STANDBY POWER	
		Air mass flow m <sup>3</sup> /s	Air on temp °C	Air mass flow m <sup>3</sup> /s	Air on temp. °C
1500	0	8,6	66	8,6	63
	150	7,9	66	7,9	63
	300	7,4	64	7,4	61
	450	6,8	63	6,8	60
1800	0	10,3	66	10,3	63
	150	9,9	65	9,9	62
	300	9,3	64	9,3	60
	450	9,0	63	9,0	59

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**Fan drive ratio 1:0,97**

Engine speed rpm	External restriction Pa	PRIME POWER		STANDBY POWER	
		Air mass flow m <sup>3</sup> /s	Air on temp °C	Air mass flow m <sup>3</sup> /s	Air on temp. °C
1500	0	7,5	66	7,5	61
	150	7,3	66	7,3	61
	300	6,8	64	6,8	59
	450	6,4	63	6,4	57
1800	0	9,3	64	9,3	61
	150	8,9	63	8,9	60
	300	8,4	62	8,4	58
	450	8,0	61	8,0	57

**Fan drive ratio 1:0,88 visco**

Engine speed rpm	External restriction Pa	PRIME POWER		STANDBY POWER	
		Air mass flow m <sup>3</sup> /s	Air on temp °C	Air mass flow m <sup>3</sup> /s	Air on temp. °C
1500	0	6,6	57	6,6	54
	150	6,5	57	6,5	54
	300	6,2	55	6,2	52
	450	5,7	53	5,7	49
1800	0	8,0	60	8,0	57
	150	7,8	59	7,8	56
	300	7,4	58	7,4	54
	450	7,0	57	7,0	53

**Cooling performance, HD cooling package with 890mm fan and fan drive ratio 1:0,97**

Cooling air flow and external restriction at different radiator air temperatures based on 107°C TTT and 40% antifreeze (radiator and cooling fan, see optional equipment)

Engine speed rpm	External restriction Pa	PRIME POWER		STANDBY POWER	
		Air mass flow kg/s	Air on temp C°	Air mass flow kg/s	Air on temp C°
1500	0		72		70
	100		69		67
	200		67		64
	300		63		61
	400		61		57
1800	0		73		70
	100		70		68
	200		69		66
	300		68		65
	400		66		63

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**Engine management system**

Functionality	Alternatives	Default setting
Governor mode	Isochronus / Droop	Isochronus
Governor droop	0-8 %	4,0
Governor response	Adjustable PID-constants (VODIA)	Standard
Dual speed	1500 / 1800 rpm	According to customer
Idle speed	600-1200 rpm	900 rpm
Fine speed adjustment	± 120 rpm	0,0
Stop function	Energized to Run / Stop	Energized to Stop
Preheating function	On / Off	On
Lamp test	On / Off	On

**Engine sensor and switch settings**

Parameter	Unit	Alarm level		Engine protection	
		Setting range	Default setting	Level	Action. Default/Alternative
Oil temp	°C	120 - 130	125	Setting +5	Shut down.
Oil pressure	Low idle	kPa	-	150,0	Shut down
	1500 rpm	kPa	-	250,0	Shut down
	1800 rpm	kPa	-	300,0	Shut down
Oil level		-	Min level	-	-
Piston cooling pressure >1000 rpm	kPa	-	150	150,0	Shut down
Coolant temp	°C	95 - 103	102	Setting +5	Shut down.
Coolant level		-	On	Low level	Shut down.
Fuel feed pressure	Low idle	kPa	-	150	-
	>1400 rpm		-	300	-
Water in fuel		-	High level	-	-
Crank case pressure	kPa	-	Increased Pressure	Increased Pressure	Shut down
Air filter pressure droop	kPa	-	5	-	-
	0,0		Alarm level		Engine protection
Altitude, above sea	m	-	-	-	Automatic derating, see section derating
Charge air temp	°C	-	80	85,0	
Charge air pressure	kPa	-	310	320,0	
Engine speed	rpm	100 - 120% of rated speed	120%	Alarm level	Shut down.

**Engine protection can be disabled. For consequences please see VP International Limited Warranty Policy**

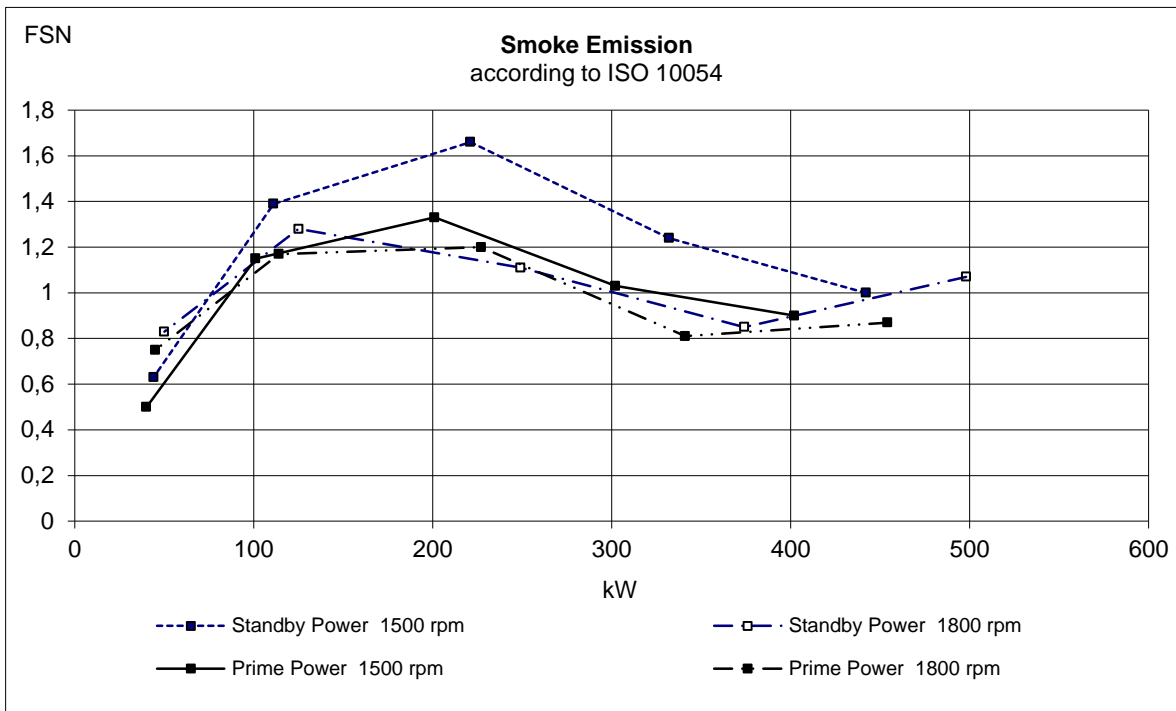
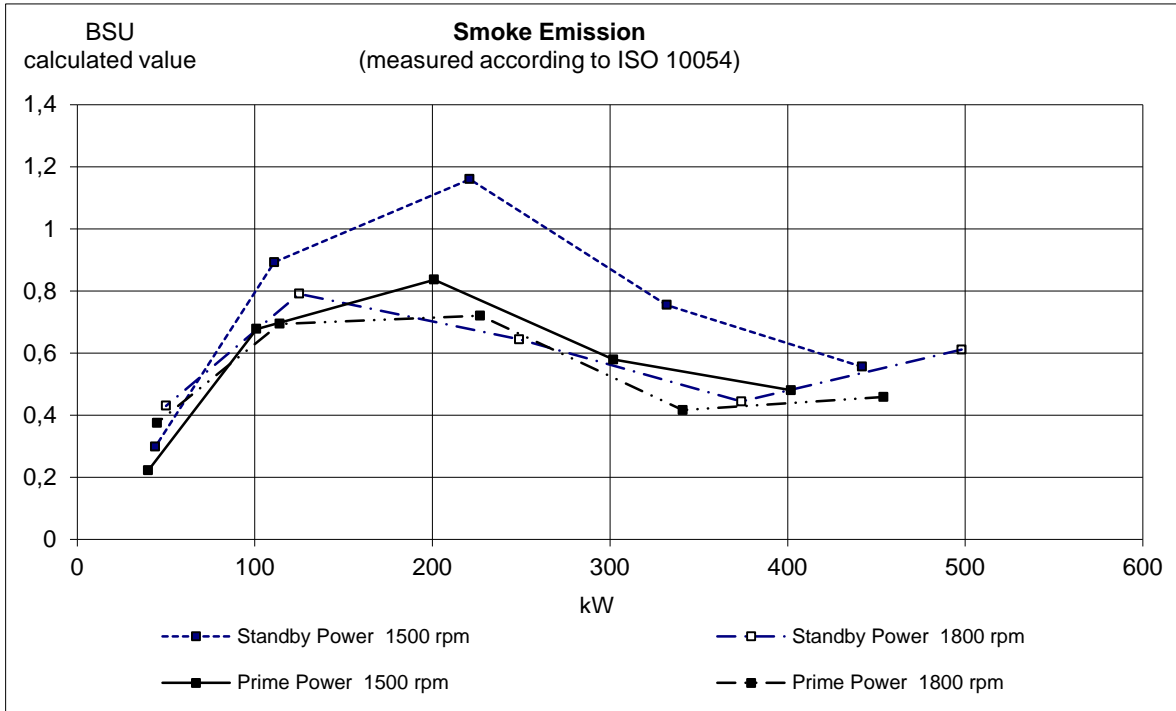
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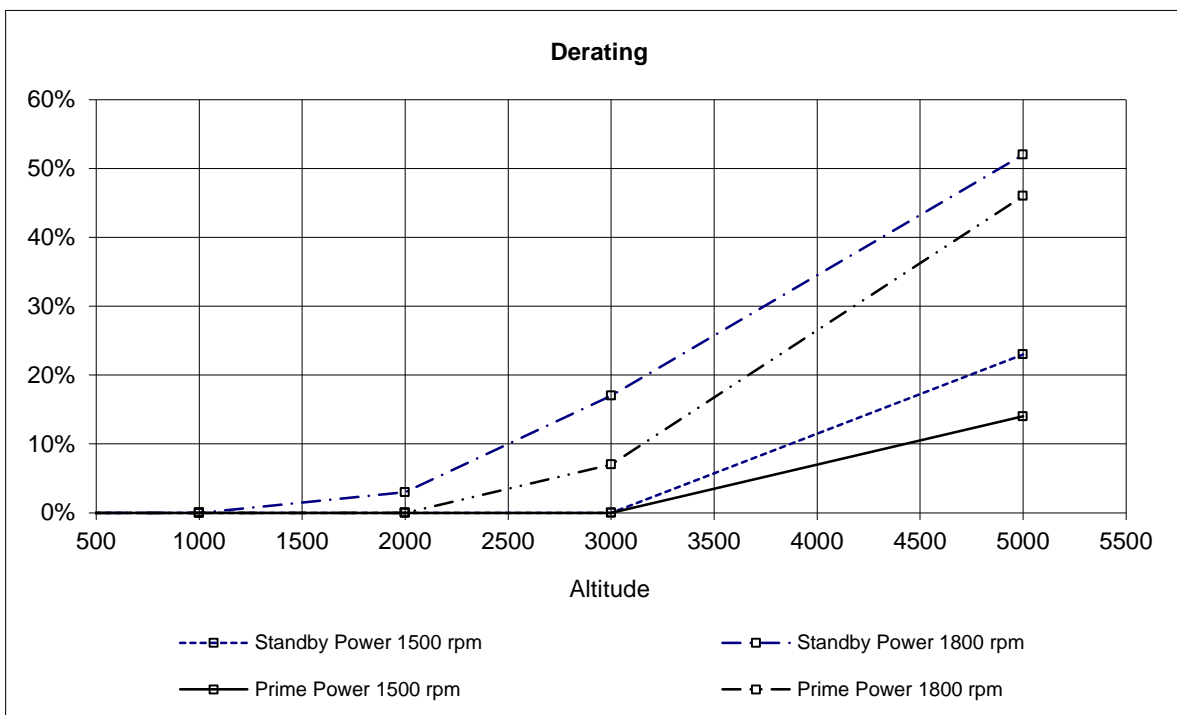
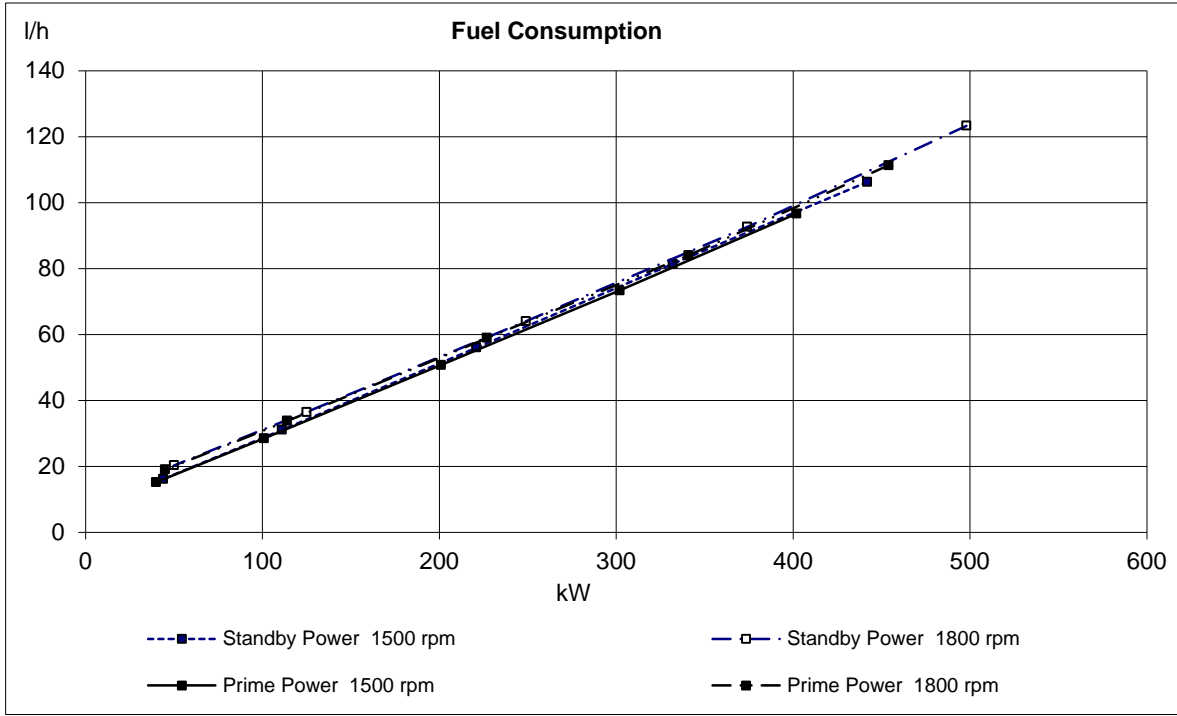
**Electrical system**

Voltage and type		24 V / insulated from earth	
Alternator:	make/output	A	Bosch / 80
	tacho output	Hz/alt. Rev	6
	drive ratio		3.9 : 1
Starter motor	make	Melco	
	type	105 P70	
	kW	7,0	
Number of teeth on:	flywheel	153	
	starter motor	12	
Max wiring resistance main circuit		mΩ	2
Cranking current at +20°C		A	280
Crank engine speed at 20°C		rpm	150
Starter motor battery capacity:	max	Ah/A	2x225
	min at +5°C	Ah/A	-
Inlet manifold heater (at 20 V)		kW	4,0
Power relay for the manifold heater		A	1

**Power take off**

		rpm	1500	1800
Front end in line with crank shaft max:		Nm lbft	-	
Front end belt pulley load. Direction of load viewed from flywheel side:	max left	kW hp	-	-
	max down	kW hp	-	-
	max right	kW hp	-	-
Timing gear at compressor PTO max:		Nm lbft	600 443	
Speed ratio direction of rotation viewed from flywheel side		1,31:1/clockwise		
Timing gear at servo pump PTO max:		Nm lbft	100 74	
Speed ratio direction of rotation viewed from flywheel side		1,58:1/clockwise		
Timing gear at hydraulic pump PTO max:		Nm lbft	-	
Speed ratio direction of rotation viewed from flywheel side				
Max allowed bending moment in flywheel housing		Nm lbft	15000 11063	
Max. rear main bearing load		N lbf	5000 1124,0	





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