


<b>VOLVO PENTA</b>	Document No	Issue Index
	<b>23110278</b>	<b>04</b>
<b>TWD1645GE</b>		

**Important**

This Technical Data Sheet and the corresponding Installation Instructions provide important information to ensure the installed engine will operate according to the design specification in the Volvo Penta application for certification.

Requirements marked with  are considered as critical for exhaust emissions compliance according to the design specification in the Volvo Penta application for certification.

Failing to follow and meet these instructions and requirements when installing a certified engine in a piece of nonroad equipment for use in the United States violates U.S. federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act.

**General**

In-line four stroke diesel engine with direct injection. Rotation direction, anti-clockwise viewed towards flywheel. 2 - stage turbocharged with intercooling and aftercooling.

Number of cylinders			6
Displacement, total		litre	16,12
		in <sup>3</sup>	983,9
Firing order			1-5-3-6-2-4
Bore		mm	144
		in	5,67
Stroke		mm	165
		in	6,50
Compression ratio			16,8
Wet weight (Not including after treatment system)	Engine only	kg	1810
		lb	3990
	Engine incl. cooling system and air filtration system	kg	2217
		lb	4888
	Engine incl. cooling system, air filtration system, and frame	kg	2767
		lb	6100

**Performance**

			<b>rpm</b>	<b>1500</b>	<b>1800</b>
Prime Power	without fan	kW		616	653
		hp		838	889
	with fan	kW		595	619
		hp		809	842
Standby Power	without fan	kW		675	715
		hp		919	973
	with fan	kW		654	681
		hp		890	927
Torque at:	Prime Power	Nm		3922	3467
		lbft		2892	2557
	Standby Power	Nm		4300	3795
		lbft		3171	2799
Mean piston speed		m/s		8,3	9,9
		ft/sec		27,1	32,6
Effective mean pressure at:	Prime Power	MPa		3,1	2,7
		psi		443	392
Effective mean pressure at:	Standby Power	MPa		3,4	3,0
		psi		486	429
Max combustion pressure at:	Prime Power	MPa		21,7	21,0
		psi		3152	3041
Max combustion pressure at:	Standby Power	MPa		22,9	22,2
		psi		3314	3220
Total mass moment of inertia, SAE 1 14" flywheel J (mR <sup>2</sup> )		kgm <sup>2</sup>		4,40	
		lbft <sup>2</sup>		104,3	
Total mass moment of inertia, SAE 0 18" flywheel J (mR <sup>2</sup> ) (an adapter is used to convert 14" flywheel to 18")		kgm <sup>2</sup>		6,10	
		lbft <sup>2</sup>		144,8	
Friction Power		kW		39	57
		hp		53,6	76,8
<b>Derating due to altitude - 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 (with fan)	No load	dB(A)	115,6	119,1
	Prime Power	dB(A)	118,2	120,7
	Standby Power	dB(A)	118,9	120,3
Calculated sound pressure Lp at 1 m (with fan)	No load	dB(A)	103,6	107,1
	Prime Power	dB(A)	106,2	108,7
	Standby Power	dB(A)	106,9	108,3

**Unsilenced exhaust noise**

Data calculated as sound pressure Lp.

Assumed microphone distance 1 m

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

**Test conditions for load acceptance data**

Warm engine.	Generator	Model	Type of AVR
	ABB	AMG 0355CC04 DBPM	Basler-Electric DECS-150
AVR Settings	UFRO (Hz):	3	DIP *: 1,4 DWELL*: 1,4
		Voltage (V):	400 Load factor: 1,0

Applies to Stamford nomenclature,

\* (V/Hz) :

Load acceptance performance can vary due to actual alternator inertia, voltage regulator, type of load and local ambient conditions.

Abbreviation:	Full name:	Descriptions
AVR	Automatic Voltage Regulator	Generator performance and safty control unit
UFRO	Under Frequency Roll Off	Overheating protection at under frequency
DIP		Controls the slope of voltage drop when the UFRO is active
DWELL		Controls the slope of voltage recovery when the UFRO is active.

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**Single step load performance at 1500 rpm - PRIME (Resistiv load)**

Load (%)	Speed diff (%)	Speed Recovery time (s)	Voltage diff (%)	Voltage Recovery time G3 +/- 8 V (s)	Voltage Recovery time G2 +/- 20 V (s)	Remaining load (%)	Speed diff (%)	Speed Recovery time (s)	Voltage diff (%)	Voltage Recovery time G3 +/- 8 V (s)	Voltage Recovery time G2 +/- 20 V (s)
0-20	2,1	0,4	-	-	-	20-100	18,9	2,1	-	-	-
0-40	4,4	1,1	-	-	-	40-100	9,7	1,1	-	-	-
0-50	-	-	-	-	-	50-100	-	-	-	-	-
0-60	12,9	1,5	-	-	-	60-100	5,1	0,8	-	-	-
0-42 (G3)	7,0	1,1	-	-	-	42-100	-	-	-	-	-
0-48 (G2)	10,0	1,4	-	-	-	48-100	-	-	-	-	-
0-80	21,0	2,2	-	-	-	80-100	1,9	0,0	-	-	-
0-100	28,0	2,7	-	-	-						
100-0	2,8	0,5	-	-	-						

**Single step load performance at 1500 rpm - STAND BY (Resistiv load)**

Load (%)	Speed diff (%)	Speed Recovery time (s)	Voltage diff (%)	Voltage Recovery time G3 +/- 8 V (s)	Voltage Recovery time G2 +/- 20 V (s)	Remaining load (%)	Speed diff (%)	Speed Recovery time (s)	Voltage diff (%)	Voltage Recovery time G3 +/- 8 V (s)	Voltage Recovery time G2 +/- 20 V (s)
0-20	2,1	1,0	-	-	-	20-100	21,1	3,9	-	-	-
0-40	7,2	1,2	-	-	-	40-100	12,8	2,6	-	-	-
0-50	-	-	-	-	-	50-100	-	-	-	-	-
0-60	17,3	1,8	-	-	-	60-100	8,7	2,2	-	-	-
0-38 (G3)	7,0	1,1	-	-	-	38-100	-	-	-	-	-
0-44 (G2)	10,0	1,4	-	-	-	44-100	-	-	-	-	-
0-80	26,9	2,6	-	-	-						
0-100	33,5	5,2	-	-	-						
100-0	5,7	0,6	-	-	-						

**Single step load performance at 1800 rpm - PRIME (Resistiv load)**

Load (%)	Speed diff (%)	Speed Recovery time (s)	Voltage diff (%)	Voltage Recovery time G3 +/- 8 V (s)	Voltage Recovery time G2 +/- 20 V (s)	Remaining load (%)	Speed diff (%)	Speed Recovery time (s)	Voltage diff (%)	Voltage Recovery time G3 +/- 8 V (s)	Voltage Recovery time G2 +/- 20 V (s)
0-20	1,6	0,0	-	-	-	20-100	12,4	1,8	-	-	-
0-40	4,6	0,8	-	-	-	40-100	9,0	1,4	-	-	-
0-50	-	-	-	-	-	50-100	-	-	-	-	-
0-60	9,8	1,2	-	-	-	60-100	5,7	1,0	-	-	-
0-48 (G3)	7,0	1,0	-	-	-	48-100	-	-	-	-	-
0-58 (G2)	10,0	1,2	-	-	-	58-100	-	-	-	-	-
0-80	15,8	1,7	-	-	-	80-100	2,1	0,4			
0-100	21,7	2,4	-	-	-						
100-0	4,0	0,4	-	-	-						

**Single step load performance at 1800 rpm - STAND BY (Resistiv load)**

Load (%)	Speed diff (%)	Speed Recovery time (s)	Voltage diff (%)	Voltage Recovery time G3 +/- 8 V (s)	Voltage Recovery time G2 +/- 20 V (s)	Remaining load (%)	Speed diff (%)	Speed Recovery time (s)	Voltage diff (%)	Voltage Recovery time G3 +/- 8 V (s)	Voltage Recovery time G2 +/- 20 V (s)
0-20	1,7	0,0	-	-	-	20-100	13,8	6,6	-	-	-
0-40	5,7	0,9	-	-	-	40-100	10,1	3,2	-	-	-
0-50	-	-	-	-	-	50-100	-	-	-	-	-
0-60	12,2	1,4	-	-	-	60-100	6,9	2,5	-	-	-
0-44 (G3)	7,0	1,0	-	-	-	46-100	-	-	-	-	-
0-53 (G2)	10,0	1,1	-	-	-	58-100	-	-	-	-	-
0-80	18,3	1,9	-	-	-	80-100	3,1	1,4			
0-100	23,6	4,0	-	-	-						
100-0	3,9	0,8	-	-	-						

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Cold start performance	Ambient temperature deg C	Cooling water temp engine block with heater deg C	1500	1800
			Time from start to stay within 0.5% of no load speed at ambient temperature:	°C
	20			5,5
	5			7
	-15 *			9
	-30 **	4,2		7,2
	Min start temp*	°C		

\* With air inlet pre-heater 4 kW engaged, lubrication oil 10W/30.

\*\* With air inlet pre-heater 4 kW engaged, lubrication oil 10W/30 and block heater 2 kW (230 V), Fuel SD10

Block heater type	Heater on / off (Deg C)	Power kW 230 V / 110 V	Engaged hours	Cooling water temp engine block
<b>Calix PH</b>	<b>30 / 50</b>	<b>2 / 1,5</b>	10 h 1,5 kW at - 30 C	-2°C

Lubrication system		rpm	1500	1800
Lubricating oil consumption	Prime Power	litre/h	0,10	0,10
		US gal/h	0,026	0,026
	Standby Power	litre/h	0,11	0,11
		US gal/h	0,029	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:	VDS3 / VDS4 / VDS4.5	h	500	
Engine angularity limits:	front up	°	30	
	front down	°	30	
	side tilt	°	30	
Oil pressure at rated speed	kPa	300 - 500		
	psi	44 - 73		
Main Oil filter; cleaning efficiency 99% at particle size		µm	38	
By-pass Oil filter; cleaning efficiency 99% at particle size		µm	11	

\* See also general section in the sales guide

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Fuel system		rpm	1500	1800
<b>Prime Power</b> Specific fuel consumption at:	25%	g/kWh	218	234
		lb/hph	0,353	0,379
	50%	g/kWh	206	208
		lb/hph	0,335	0,337
	75%	g/kWh	196	198
		lb/hph	0,317	0,321
	100%	g/kWh	191	194
		lb/hph	0,309	0,314
<b>Standby Power</b> Specific fuel consumption at:	25%	g/kWh	215	229
		lb/hph	0,348	0,372
	50%	g/kWh	207	206
		lb/hph	0,335	0,333
	75%	g/kWh	194	197
		lb/hph	0,314	0,319
	100%	g/kWh	193	194
		lb/hph	0,313	0,315

Fuel system		rpm	1500	1800
Fuel to conform to	ASTM-D975-NO 1 and 2-D JIS KK 2204, EN590			
System supply flow at:	litre/h		177	195
	US gal/h		46,8	51,5
Fuel supply line max restriction (Measured at fuel inlet connection at full engine load)	kPa		-20	-20
	psi		-2,9	-2,9
Fuel supply line max pressure when engine is stopped. To avoid lube oil dilution by fuel.	kPa		16,5	16,5
	psi		2,4	2,4
System return flow	litre/h		25	25
	US gal/h		6,6	6,6
Fuel return line max restriction (Measured at fuel return connection)	kPa		20	20
	psi		2,9	2,9
Maximum allowable inlet fuel temp (Measured at fuel inlet connection)	°C		60	60
	°F		140	140
Prefilter - Water separator efficiency ( minimum)	%		98	
Prefilter - cleaning efficiency with new filter 98% at particulate size	µm		30	
Fuel filter - cleaning efficiency with new filter 98% at particulate size	µm		5	
Governor type/make, standard	Volvo / EMS 2.3			
Injection pump type/make	Unit Injector Delphi E3			

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**Intake and exhaust system**

		rpm	1500	1800
Air consumption at: (+25°C and 100kPa)	Prime Power	m <sup>3</sup> /min cfm	41,2 1455	44,5 1571
	Standby Power	m <sup>3</sup> /min cfm	43,53 1537	47,63 1682
 See front page for important information				
<b>Max allowable air intake restriction including piping with a clean air filter</b>		kPa psi	-3,0 -0,4	-3,0 -0,4
<b>Measured pressure drop standard Penta air inlet installation &amp; clean filter</b>		kPa	-2,0	-2,4
<b>Measured at standard inlet depression sensor position. Stand-by rating</b>		psi	-0,3	-0,3
Heat rejection to exhaust at:	Prime Power	kW BTU/min	415 23578	463 26302
	Standby Power	kW BTU/min	473 26876	513 29174
Exhaust gas temperature after LP turbine at:	Prime Power	°C °F	470 878	483 901
	Standby Power	°C °F	501 934	497 927
 See front page for important information				
Max allowable back pressure in exhaust line	Prime Power	kPa psi	9 1,3	9 1,3
	Standby Power	kPa psi	10 1,5	10 1,5
Exhaust gas flow at: (temp and pressure after LP turbine at the corresponding power setting)	Prime Power	m <sup>3</sup> /min cfm	98 3447	107 3786
	Standby Power	m <sup>3</sup> /min cfm	106 3754	115 4075

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**Cooling system**

		rpm	1500	1800
Heat rejection radiation & convection from engine at:	Prime	kW	23	24
		BTU/min	1308	1336
	Stand-by	kW	26	27
		BTU/min	1479	1535
Heat rejection to coolant HT circuit engine radiator at:	Prime Power	kW	239	234
		BTU/min	13592	13307
	Standby Power	kW	259	247
		BTU/min	14729	14047
Heat rejection to coolant LT circuit CAC radiator at:	Prime Power	kW	131	136
		BTU/min	7450	7734
	Standby Power	kW	146	156
		BTU/min	8303	8872
Radiator cooling system type		Two circuits, HT & LT		
Coolant	Volvo Penta coolant "ready mix" or Volvo Penta coolant mixed with clean fresh water 40 / 60			
Engine radiator core area		m <sup>2</sup>	1,77	
		foot <sup>2</sup>	19,05	
CAC radiator core area		m <sup>2</sup>	1,77	
		foot <sup>2</sup>	19,05	
Fan diameter		mm	965	
		in	37,99	
Fan power consumption		kW	21	34
		hp	29	46
Fan drive ratio			1,04	
Coolant capacity,	Engine only	litre	25	
		US gal	6,60	
	Charge air coolers ( HP + LP CAC )	litre	10	
		US gal	2,64	
	Coolant radiators incl piping, Engine circuit, HT	litre	50	
		US gal	13,21	
	Coolant radiators incl piping, CAC circuit, LT	litre	50	
		US gal	13,21	
	Expansion tank, Engine circuit, water volume	litre	11,8	
US gal		3,12		
Expansion tank, Engine circuit, air volume	litre	6,5		
	US gal	1,72		
Expansion tank, CAC circuit water volume	litre	4,3		
	US gal	1,14		
Expansion tank, CAC circuit air volume	litre	2,4		
	US gal	0,63		
Coolant pump, HT		drive/ratio	Belt / 1,85	
Coolant pump, CAC circuit, LT		drive/ratio	Belt / 2,29	
Thermostat	start to open	°C	82	
		°F	180	
	fully open	°C	92	
		°F	198	
Maximum static pressure head, at water pump inlet (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	
Charge air pressure / Boost pressure (measured in inlet manifold, absolute pressure)	Prime power	kPa (a)	419	390
		psi (abs)	60,7	56,5
Charge air pressure / Boost pressure (measured in inlet manifold, absolute pressure )	Stand-by power	kPa (a)	442	417
		psi (abs)	64,1	60,5
				
<b>See front page for important information</b>				
Charge air temp. Measured in inlet manifold, at 25 deg ambient temp	Prime Power	°C	52	52
		°F	125	125
	Standby Power	°C	52	53
		°F	126	127

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**OEM cooling system design:****- move of standard radiators**

		rpm	1500	1800
Maximum additional coolant with standard expansion tank	litre		15	
	US gal		3,96	
Maximum additional coolant, CAC with standard expansion tank	litre		5	
	US gal		1,32	
Maximum distance in vertical direction with standard pressure cap (75 kPa)	m		2,5	
	ft		8,20	
Maximum additional pressure drop due to move	KPa		10	
	psi		1,5	
Heat rejection to coolant HT circuit <b>engine radiator at:</b>	Prime Power	kW	239	234
		BTU/min	13592	13307
	Standby Power	kW	259	247
		BTU/min	14729	14047
Heat rejection to coolant LT circuit <b>CAC radiator at:</b>	Prime Power	kW	131	136
		BTU/min	7450	7734
	Standby Power	kW	146	156
		BTU/min	8303	8872
Minimum coolant flow <b>engine radiator</b> (at fully open thermostat)	litre/s		4,8	6
	US gal/s		1,27	1,59
Minimum coolant flow <b>CAC radiator</b> (at fully open thermostat)	litre/s		1,7	2,1
	US gal/s		0,44	0,55
Maximum coolant pressure drop over <b>engine- radiator incl. Piping</b> (at coolant flow above)	kPa		45	65
	psi		6,5	9,4
Maximum coolant pressure drop over <b>CAC - radiator incl. piping</b> (at coolant flow above)	kPa		40	70
	psi		5,8	10,2
Maximum coolant pressure drop over <b>complete engine cooling system</b> (at coolant flow above)	kPa		110	160
	psi		16,0	23,2
Maximum coolant pressure drop over <b>complete CAC cooling circuit</b> (at coolant flow above)	kPa		87	135
	psi		12,6	19,6
Nominal coolant pressure before CAC circuit coolant pump	kPa		50	50
	psi		7,3	7,3
Nominal coolant pressure before engine circuit coolant pump	kPa		50	50
	psi		7,3	7,3



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**Cooling performance**

Standard fan: 965 mm    Fan ratio: 1,04    Fan type: FIX    Top Tank temperatur TTT 107°C

Antifreeze content: 40%, Temperature inlet air at filter; 40°C

Engine speed rpm	Air on temp °C	PRIME POWER		STANDBY POWER		
		Air flow m <sup>3</sup> /s	External restriction Pa	Air flow m <sup>3</sup> /s	External restriction Pa	
1500	67,2	11,4	0	11,4	0	
	61,1					
	58,4					150
	56					300
	53,2					450
1800	64,8	13,4	0	13,4	0	
	62,6					
	61,9					150
	59,7					300
	57,9					450

Note! External restrictions are calculated for values &gt;0 Pa

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**Engine management system**

Functionality	Alternatives			Default setting
Governor mode	Droop	Isochronous		Isochronous
Governor droop	4%	0		N/A
Governor response	Adjustable PID-constants (VODIA)			
Dual speed	1500 rpm, 50 Hz / 1800 rpm, 60 Hz			1500 rpm, 50 Hz / 1800 rpm, 60 Hz
Idle speed	600 - 1200			900
Fine speed adjustment	+/- 90 rpm			0
Preheating function	Ignition	Request	Request+temp	If preheat available, preheat will be active at ignition on if temp low or demanded.
Ignition off stop engine	Yes		No	No

**Engine sensor and switch settings**

Parameter		Unit	Engine protection action			
			Warning level (Yellow)	Alarm level (Red)	Default	Optional
Oil temp		°C	125	127,5	Shut down after 10s	N/A
Oil pressure	900 rpm	kPa	170	145	Shut down	N/A
	1500 rpm		300	275	Shut down	N/A
	1800 rpm		300	275	Shut down	N/A
Oil level		Low level	N/A	Fault code only	N/A	
Coolant temp		°C	103	107	Shut down after 10s	N/A
Coolant level			N/A	Low level	Shut down after 10s	N/A
Fuel feed pressure	900 rpm	kPa	100	N/A	Fault code only	N/A
	1500 rpm		225	N/A	Fault code only	N/A
	1800 rpm		300	N/A	Fault code only	N/A
Water in fuel		Alarm when closed	N/A	Fault code only	N/A	
Crank case pressure		kPa	N/A	Alarm at high peaks	Shut down	N/A
Air filter pressure droop		kPa	5	N/A	Fault code only	N/A
Altitude, above sea		m	N/A	N/A	Automatic derating, see section derating	N/A
Charge air temp		°C	80	82,5	Shut down after 10s	N/A
Charge air pressure		kPa	30 above demand	40 above demand	Shut down after 1s	N/A
Engine overspeed		rpm	1900	N/A	Fault code only	N/A

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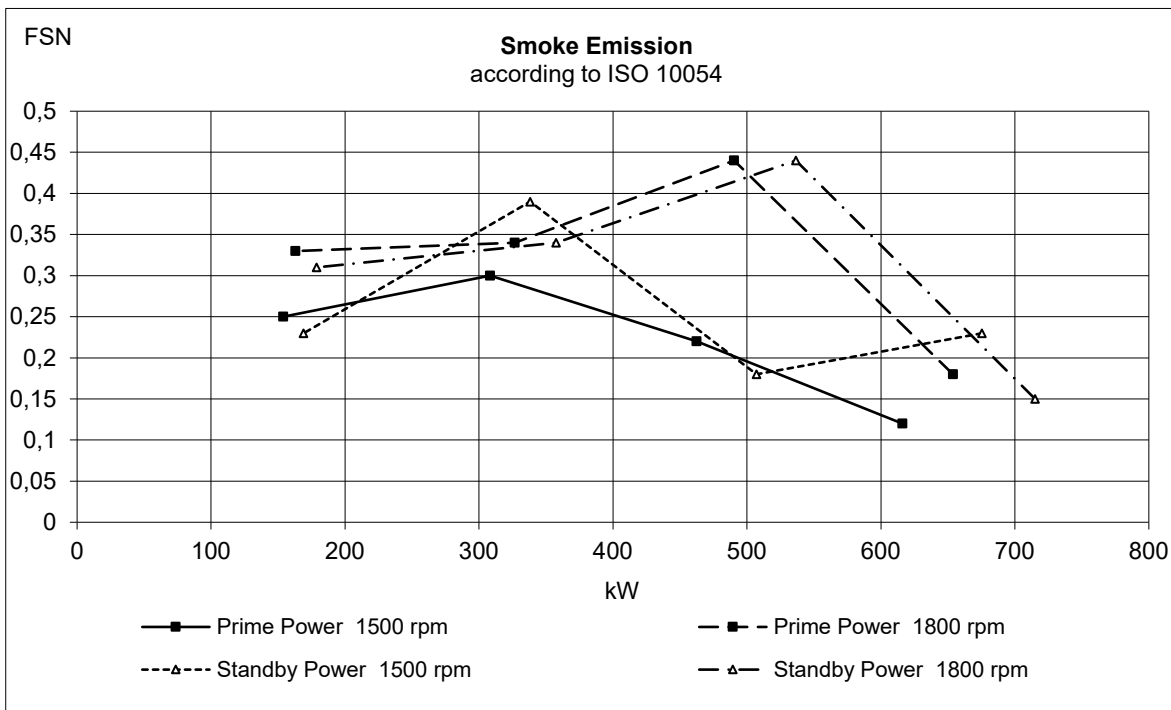
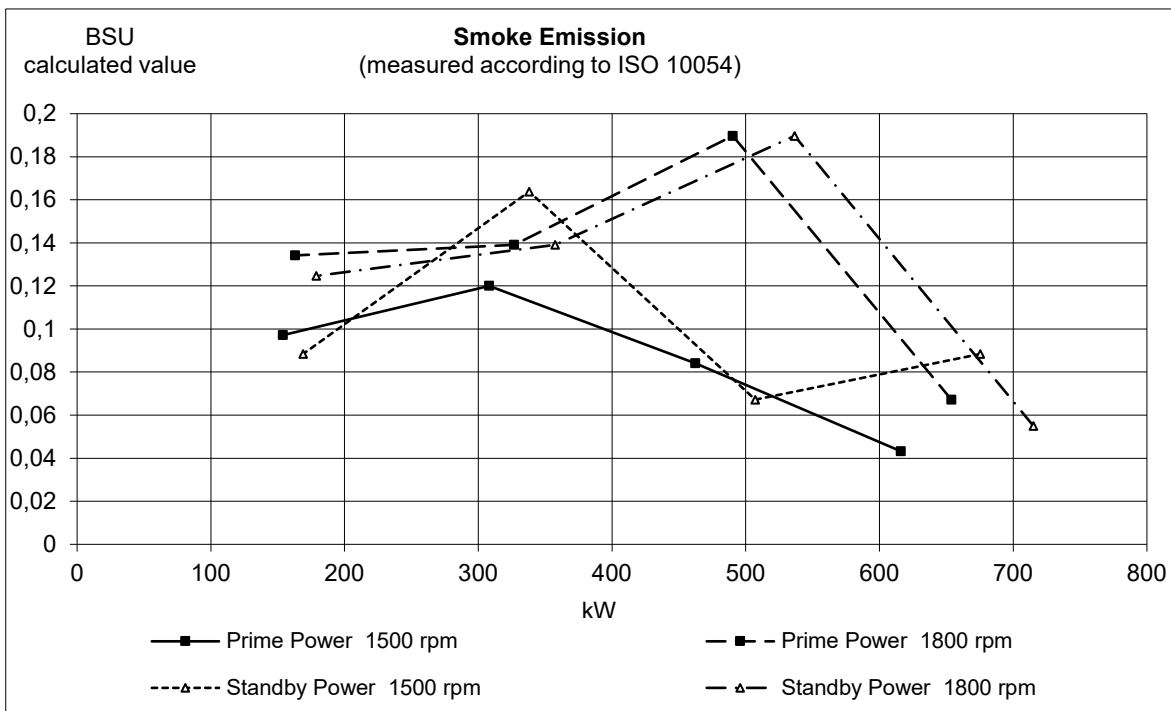
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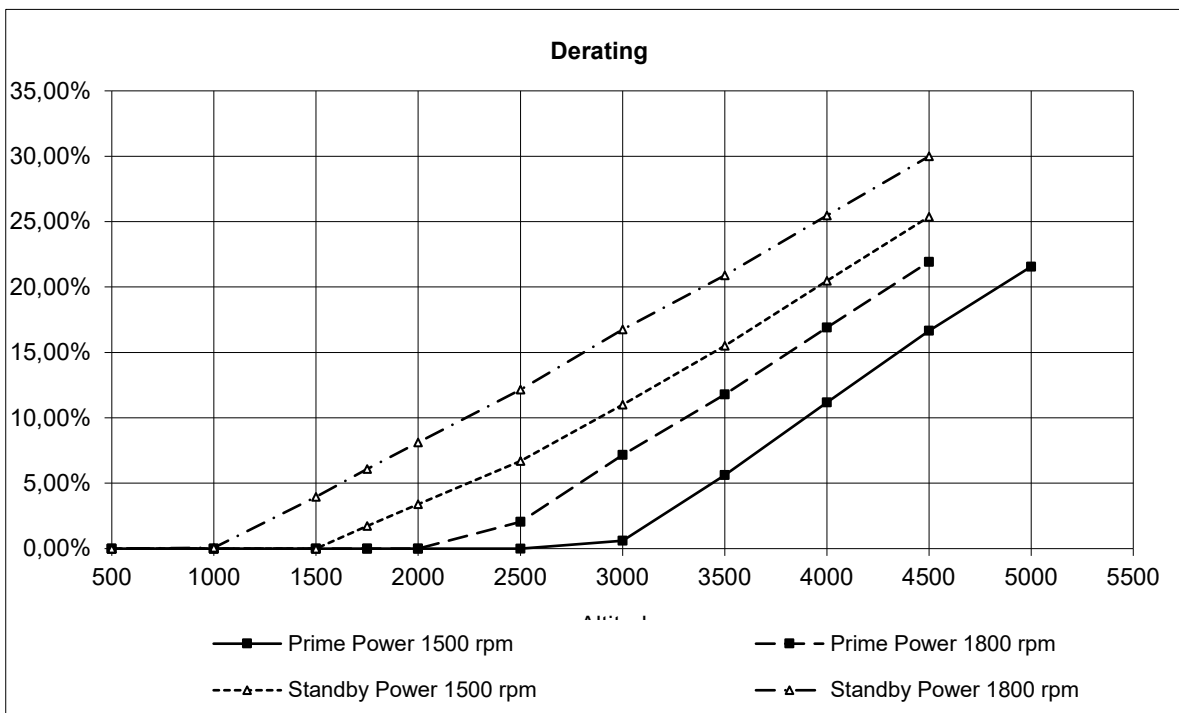
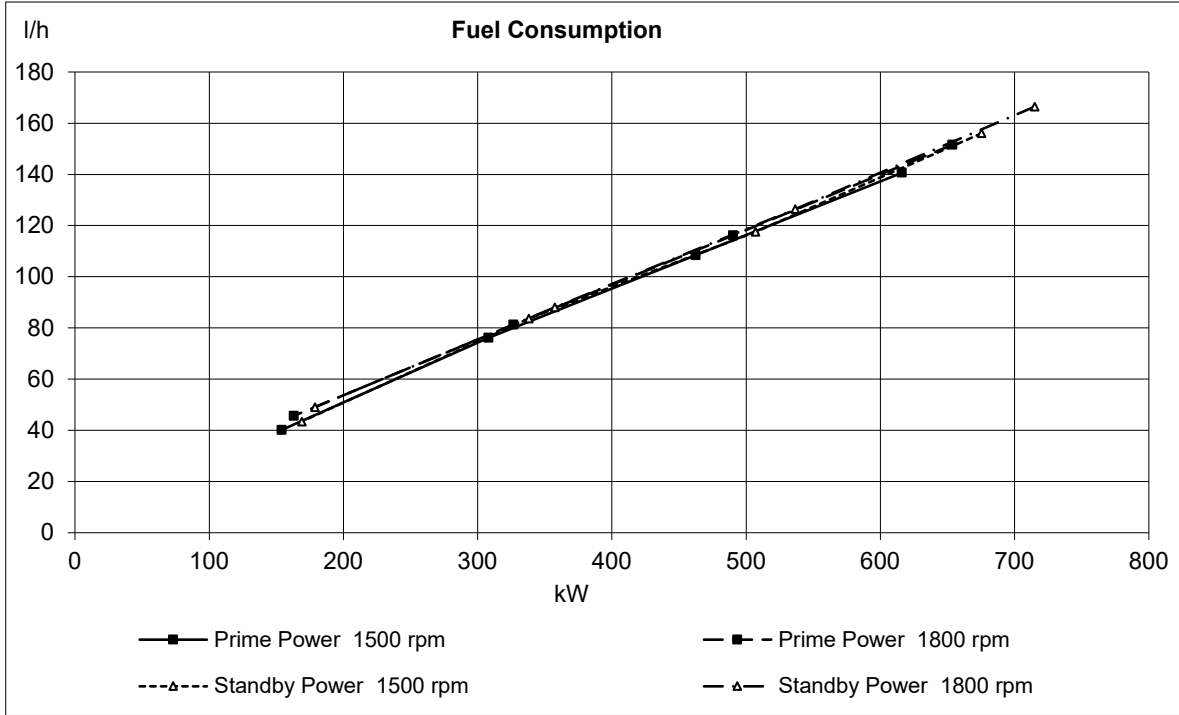
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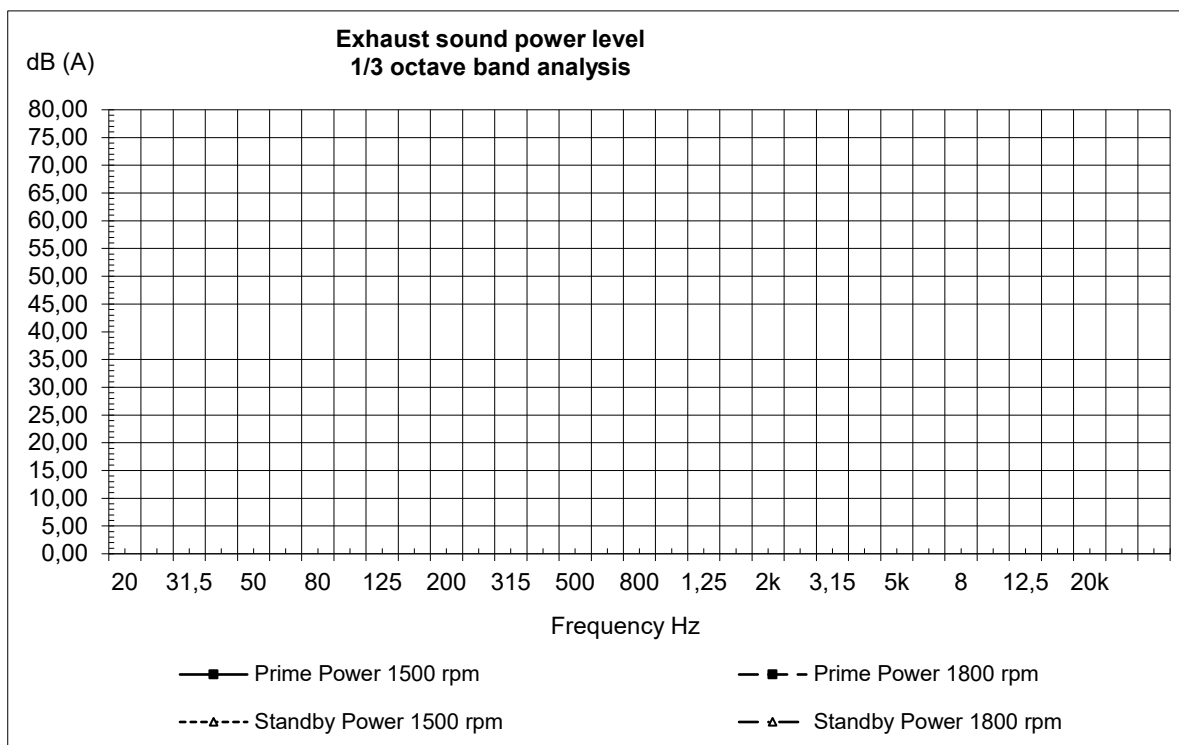
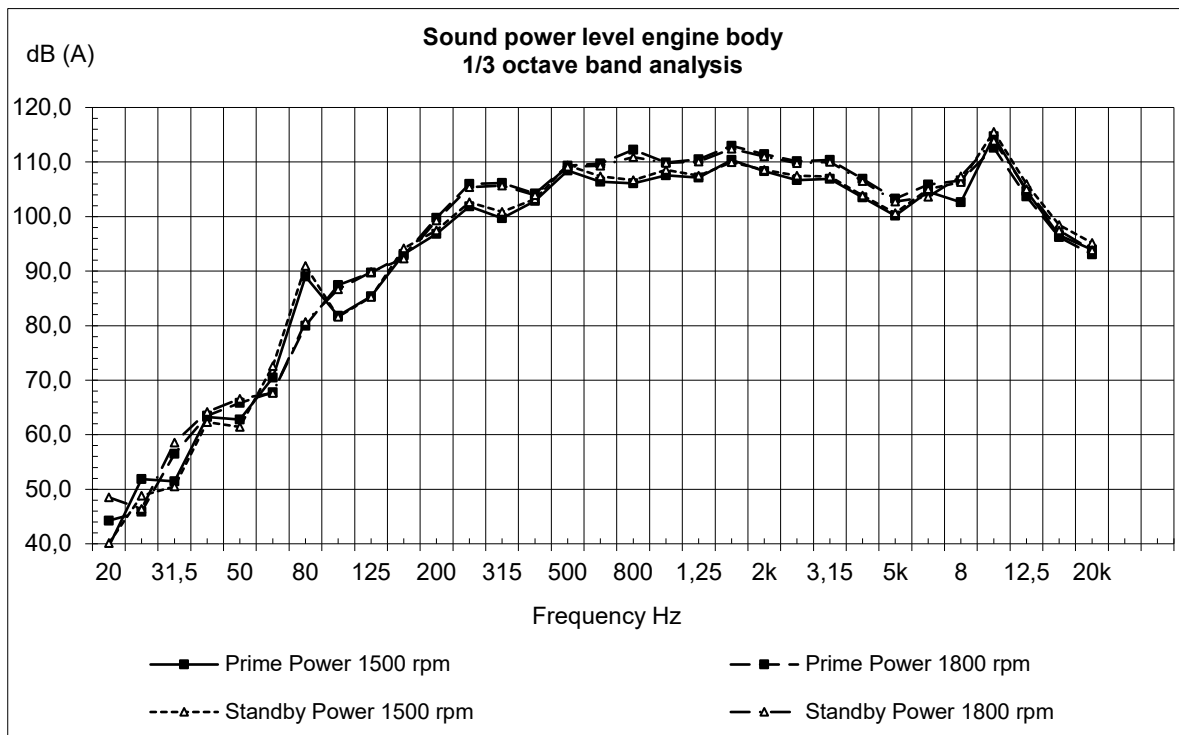
Voltage and type		24 V / insulated from earth	
Alternator:	make/output	A	Bosch / 80
	tacho output	Hz/alt. Rev	6
	drive ratio		3,94 : 1
Starter motor	make	Mitsubishi Electric	
	type	24V 7 kW 12/3. 17F	
	kW	7,0	
Number of teeth on:	flywheel	153	
	starter motor	12	
Max wiring resistance starter circuit ( harness, main switch, connectors, etc), at 20°C		mΩ	3,0
Cranking current at +20°C		A	300
Crank engine speed at 20°C		rpm	<b>155</b>
Starter motor battery capacity:	min	Ah	2 x 145
	CCA at -18°C	A	900
Inlet manifold heater (at 20 V)		kW	<b>4,0</b>
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	300 221	
Speed ratio / direction of rotation viewed from flywheel side			1,31:1 / ccw	
Timing gear at servo pump PTO max:		Nm lbft	100 74	
Speed ratio / direction of rotation viewed from flywheel side			1,75:1 / ccw	
		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		







**VOLVO PENTA**

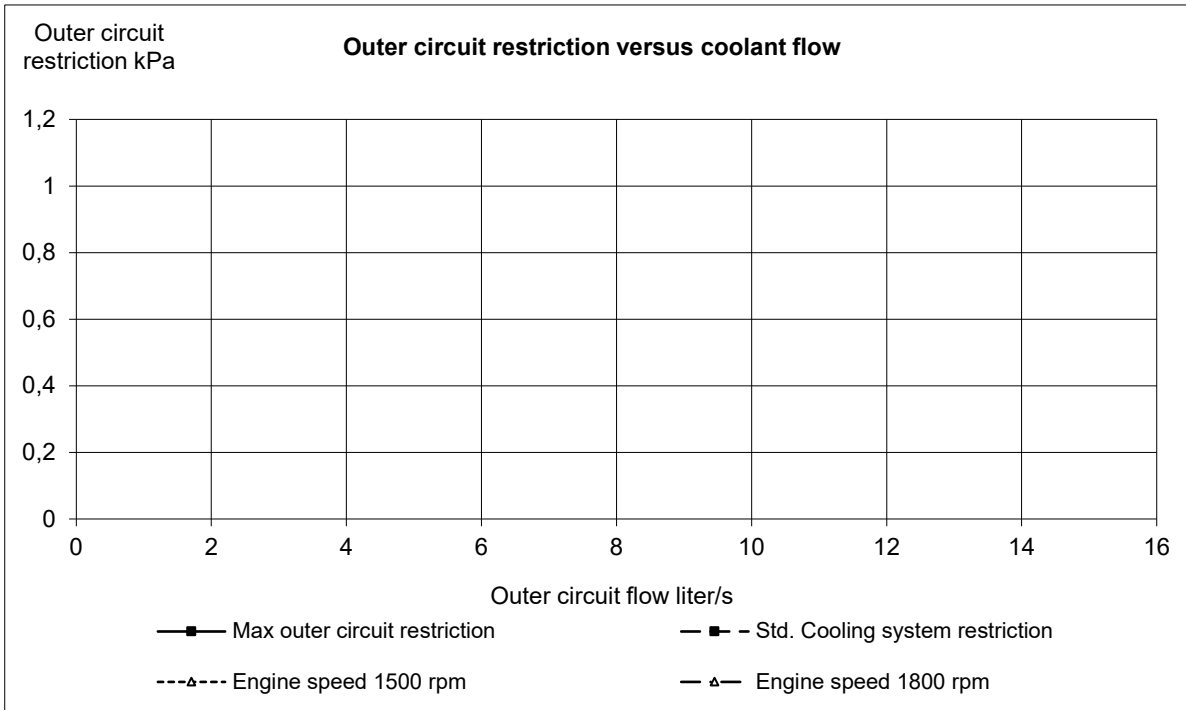
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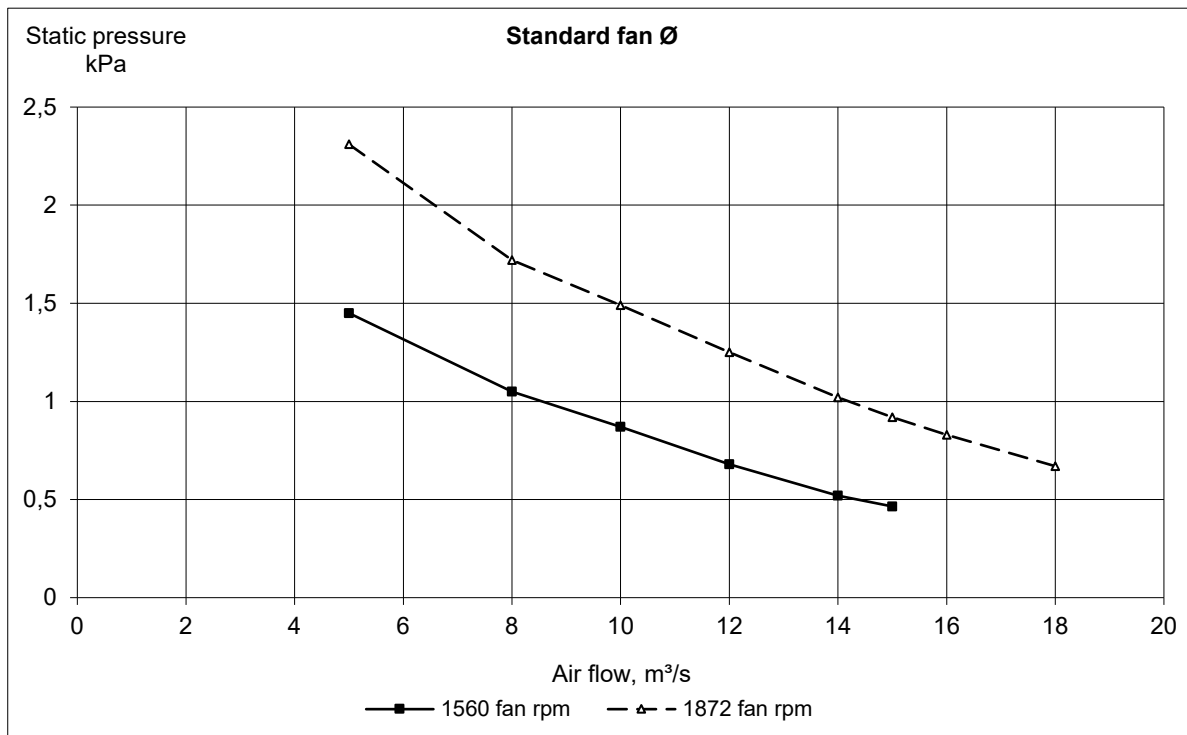
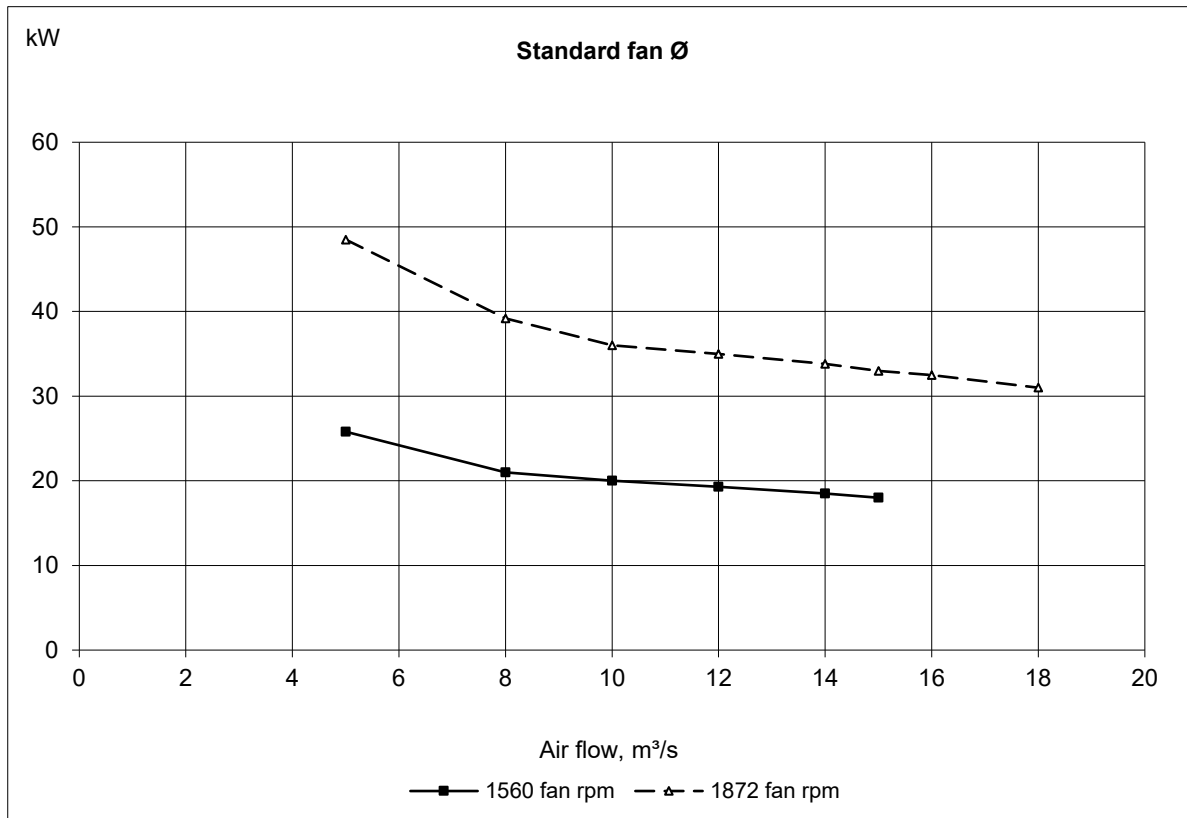
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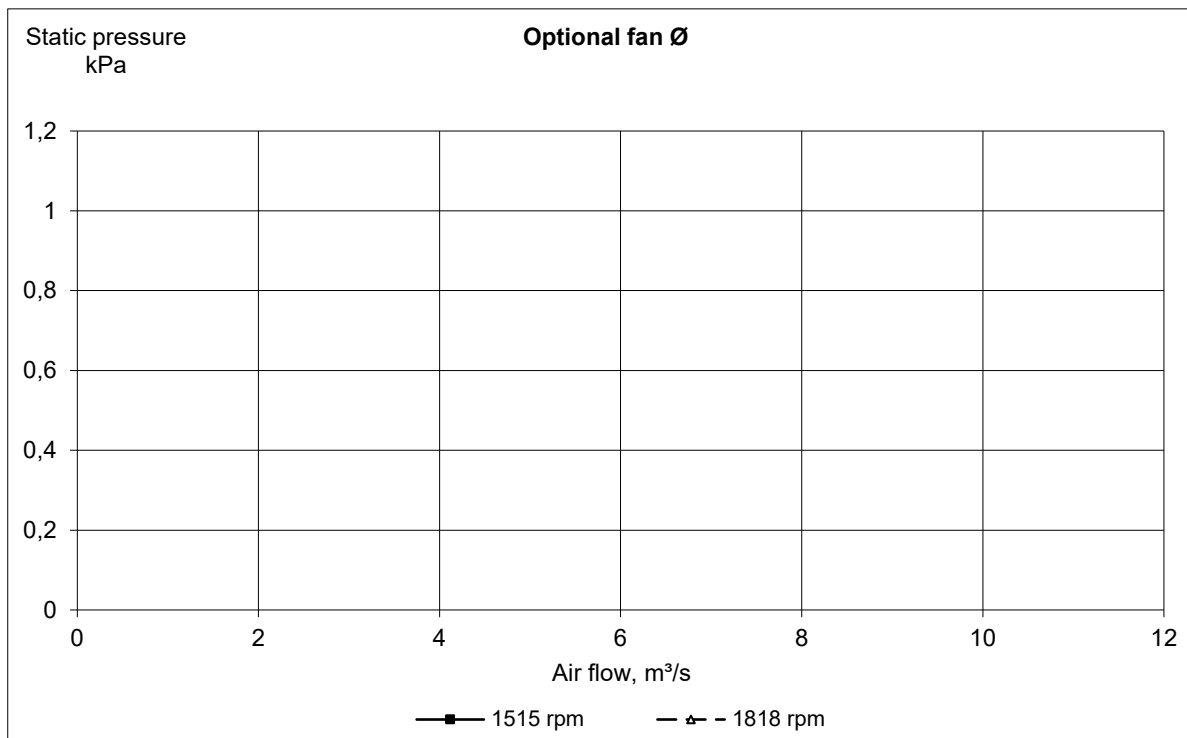
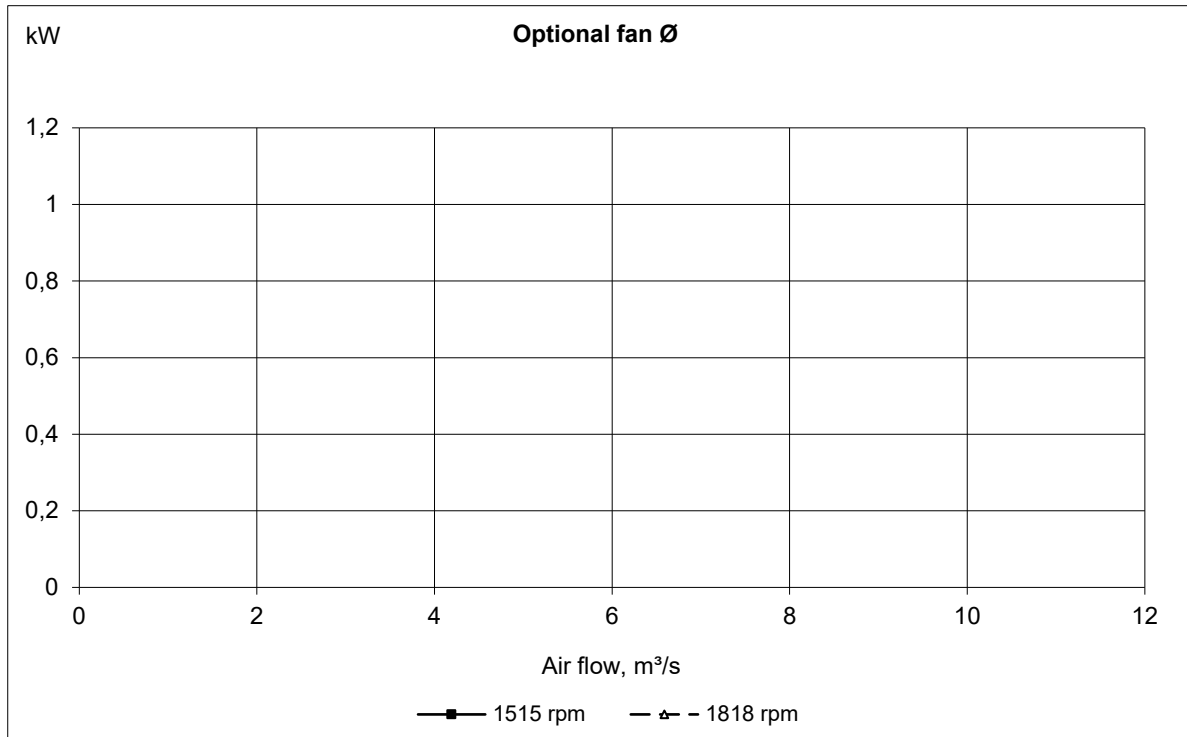
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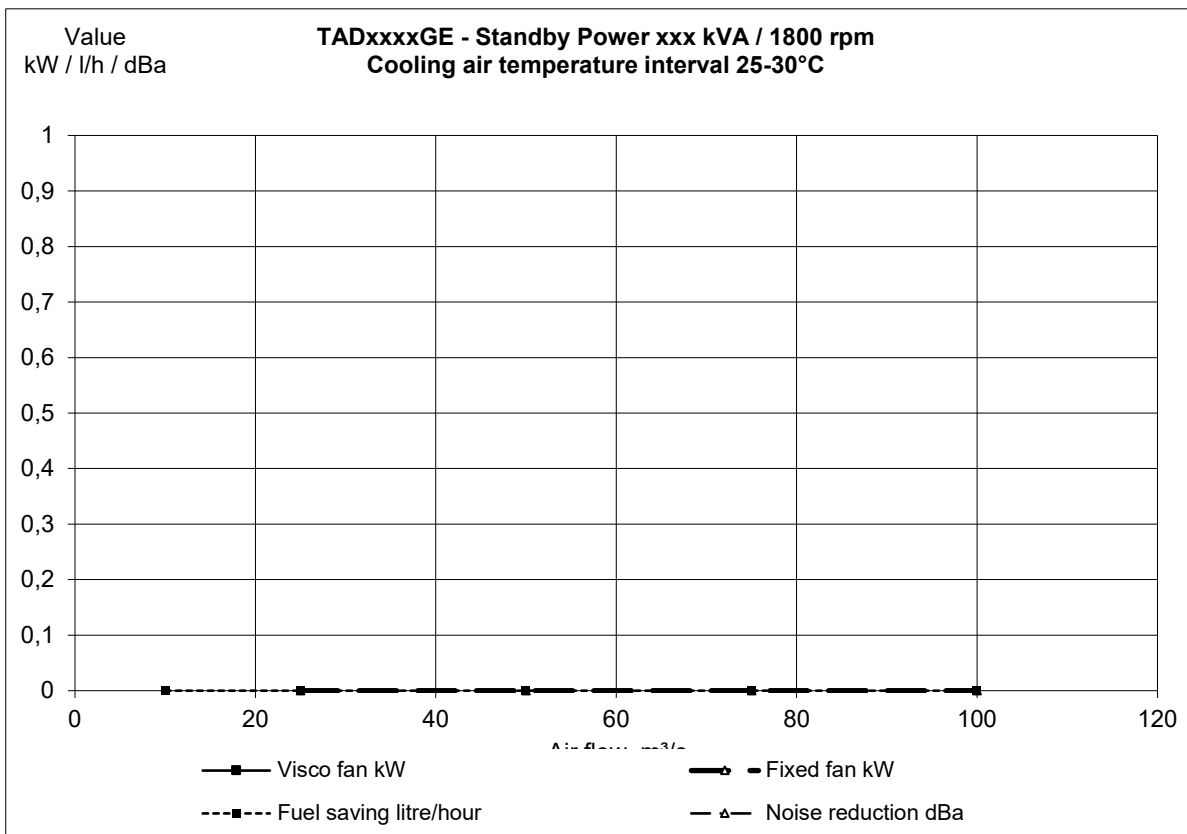
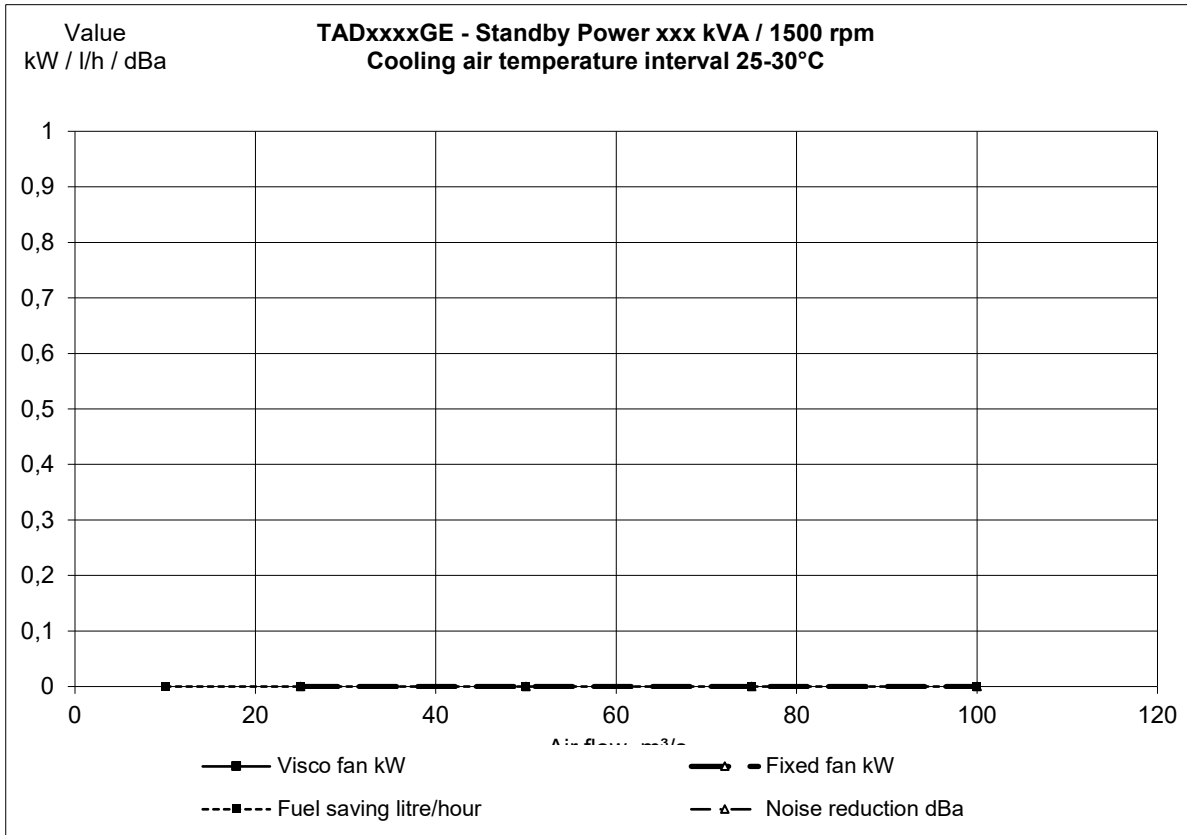
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