

Technical Data

4000 Series

Gas Engine Cogeneration Unit

4006-23TRS1 4006-23TRS2

Basic technical data

Number of cylinders	6
Cylinder arrangement	Vertical, In line
Cycle	4 stroke, spark ignition
Induction system	Turbocharged
Compression ratio	12:1 nominal
Bore	160 mm
Stroke	190 mm
Cubic capacity	22,921 litres
Direction of rotation	Anti-clockwise viewed on flywheel
Firing order	1, 5, 3, 6, 2, 4
Cylinder 1	furthest from flywheel
Total weight of Electrounit (engine only)	
-dry	2420 kg
-wet	2652 kg
Overall dimensions	
-height	1964 mm
-length	3027 mm
-width	1706 mm
Moment of inertia	
Engine	4.12 kgm ²
Flywheel	5.92 kgm ²
Cyclic irregularity for engine/flywheel (prime power):	
1500 rev/min, 322 kW - 4006-23TRS1	1:97
1500 rev/min, 393 kW - 4006-23TRS2	1:110

Ratings

This is defined in ISO3046 / 1 (BS5514 / 1 - 1982)
Electrical ratings are based on stated alternator efficiency and are for guidance only. For Load Acceptance Figures, please refer to Stafford Applications Engineering Department.

Operating point

Engine speed	1500 rev/min
Injection timing	28° BTDC
Mixture cooler water temperature	45 °C
Cooling water exit temperature	< 96 °C
Exhaust emission	according to TA-Luft (NOx)

Fuel data

Lower calorific value	34,710 kJ/Sm ³ (45,671 kJ/kg)
Density	0.76 kg/Sm ³
Stoich. air requirement	16 kJ/kg
Minimum methane number	75

Performance

Steady state speed stability at constant load ... ± 0.25%

Note: All data based on operation to ISO 3046/1, BS 5514 and DIN 6271 standard reference conditions.

Test Conditions

Air temperature	25 °C
Barometric pressure	100 kPa
Relative humidity	30%

General installation 4006-23TRS1 / 4006-23TRS2

Designation	Units	Continuous Baseload rating	
		1500	
		TRS1	TRS2
Gross engine power	kWm	322	393
BMEP gross	Bar	11,24	13,7
Combustion air flow	m ³ /min	25	29,9
Exhaust gas temperature max. after turbo	°C	495	485
Exhaust gas flow (max.)	m ³ /min	65,2	76,9
Boost pressure ratio	-	2,2	2,49
Overall electrical efficiency	%	37,44	38,35
Piston speed	m/s	9.5	9.5
Charge coolant flow	l/s	6.7	6.7
Norminal excess air factor (Lambda)	λ	1,69	1,69
Typical Gen Set 25 °C (100 kPa) Electrical Output (unity 1.0pf)	kWe	307	375
Assumed alternator efficiency	%	95,40	95,40

Continuous Baseload rating: Power available for continuous full load operation. No overload available.

Energy balance

4006-23TRS1 / 4006-23TRS2

Designation	Units	1500 rev/min TRS1		1500 rev/min TRS2	
		Continuous Baseload rating	%	Continuous Baseload rating	%
Energy in fuel	kW	820	100	978	100
Energy in power output (Net)	kW	322	39,25	393	40,2
Energy in exhaust	kW	276	33,7	323	33,1
Energy to Coolant and oil	kW	157	19,1	172	17,6
Energy to charge cooler	kW	38	4,6	57	5,8
Sum of useable heat	kW	433	52,8	461	47,1
Sum of useable energy	kW	754	92,05	854	87,3
Energy to radiation	kW	27	3,3	33	3,3

Note: Not to be used for CHP design purposes. (Indicative figures only). Consult Perkins Engines Co. Ltd. Assumes complete combustion.

Cooling system

Recommended coolant: 50% inhibited ethylene glycol or 50% inhibited propylene glycol and 50% clean fresh water. For combined heat and power systems and where there is no likelihood of ambient temperature below 10 °C, then clean 'soft' water may be used, treated with 1% by volume of Perkins inhibitor in the cooling system. The inhibitor is available in 1 litre bottles from Perkins.

Total coolant capacity (engine only)..... 36 litres
Maximum jacket water pressure in crankcase..... 1 bar (plus static pressure head)

Jacket cooling water data	Units	1500 rev/min
Coolant flow	m ³ /h	29
Coolant exit temperature (max)	°C	96
Coolant entry temperature (max)	°C	88

Charge cooling water data	Units	1500 rev/min
Coolant flow	m ³ /h	24
Coolant entry temperature (max)	°C	45

Charge cooler Fin and tube on engine
Coolant pump Customer supply
Shutdown switch setting coolant 96 °C rising
Coolant immersion heater capacity..... 2 kW 1 off

Lubrication system

Recommended lubricating oil: Lubricating oil requirements vary with fuel used. Full specifications including oil sampling and recommendations and condemnation limits appear on the Fuel, Coolant and Lubricating Oil Recommendation Sheet for the 4000 Series Gas Engines.

Lubricating oil capacity

Total system..... 122,7 litres
Sump maximum 113,4 litres
Sump minimum 90,7 litres

Lubricating oil temperature

Maximum to bearings 105 °C
Lubricating oil pressure at 85° C temperature to bearings . 0,34 MPa

Designation		1500	1500
Oil consumption (continuous rating)			
After RUNNING-IN ††	g/kwhr	0,14	0,14
Oil flow rate from oil pump	l/s	1,75	1,75

†† typical 250 hours

Sump drain plug tapping size GA1
Oil pump Gear driven
Shutdown switch setting oil 1,93 bar falling
Normal operating angles:
-front and rear 5°
-side tilt 22.5°

Fuel system

Recommended fuel: Natural Gas LHV at 34 MJ/m³ (930 Btu/cu.ft).
Other fuels may be used e.g.

-landfill

-digester gas

Ratings will vary from those shown.

Where fuels other than Natural Gas are being considered it is imperative that a full gas analysis (including details of any solid or liquid components) be obtained. Reference should then be made to Perkins Engine Company Ltd. to determine its suitability.

Gas supplies must be filtered to the same standard as the engine intake air, i.e. Maximum particle size not to exceed 50 micron.

Gas supply pressure: 1,5 kPa to 5 kPa at full rated flow
Carburettor type Deltec with zero pressure regulator

Installation of gas supply and shut off valves to be in accordance with local regulations.

Fuel consumption gross	kJ / kW _s	kJ / kW _s
Designation	TRS1	TRS2
rev/min	1500	1500
At CONTINUOUS Baseload rating	2,55	2.49
At 75% of Prime Power rating	2,63	2.57
At 50% of Prime Power rating	3,84	2.73
At 25% of Prime Power rating	3,88	3.35

Fuel: Natural Gas - LHV = 34,71 MJ/m³
Tolerance on Fuel consumption +5%

Designation		TRS1	TRS2
Mass flow data	Units	1500	1500
Fuel	kg/h	64,4	76,8
Volume flow data (100kPa)			
Fuel (15 °C)	Sm ³ /hr.	84,7	101

Induction system

Maximum air intake restriction of engine:

Clean filter 127 mm H₂O
Dirty filter 380 mm H₂O
Air filter type 1 off dry type

Exhaust emissions data

Ambient temperature of 25 °C.

Emissions at continuous baseload rating.

If the engine is to operate in ambient conditions other than test conditions then suitable adjustments may be necessary for any change in inlet air temperature or barometric pressure.

Designation		TRS1	TRS2
rev/min		1500	1500
Oxygen (O ₂)	%	8,93	9,00
*Oxides of Nitrogen (NOx)	mg/Nm ³	477	493
*Hydrocarbons (HC)	kg/h	3	3
*Carbon Monoxide (CO)	mg/Nm ³	735	750

Mass flow data			
Combustion air (25 °C)	kg/h	1742	2087
Volume flow data (100 kPa)			
Combustion air (25 °C)	m ³ /h	1501	1793

Exhaust system

Designation		TSR1	TSR2
Maximum back pressure for total system	Units	1500	1500
	mm H ₂ O	400	400

Exhaust Outlet flange size 1 x 152 mm

For recommended pipe sizes see the installation manual.

Designation		TSR1	TSR2
Volume flow data (100 kPa)	Units	1500	1500
Exhaust gas (at turbo exit temperature)	m ³ /h	3912	4615

Designation		TSR1	TSR2
Exhaust data	Units	1500	1500
Exhaust temperature	°C	498	485
Oxygen content in exhaust gas	%	8,93	9,00
Lambda	λ	1,69	1,69

Starting requirements

Temperature range		
Down to 0 °C (32 °F)	Oil:	Refer to Perkins Engine Co. Ltd.
	Starter:	1 x 24 volts
	Battery:	2 x 12V Total Ah 232
	Inrush current to starter:	1000 amps
	Cranking current:	600 amps
	Starter cable size:	70 mm ²
	Maximum length:	6 m

Notes:

- The battery capacity is defined by the 20 hour rate.
- The starting ability of an engine with immersion heater will be improved by about 10 °C and the start aid specification can be modified accordingly. The oil specification should be for the minimum ambient temperature as the oil will not be warmed by the immersion heater.
- Breakaway current is dependent on battery capacity available. Cables should be capable of handling the transient current which may be up to double the steady cranking current.

Electrical system

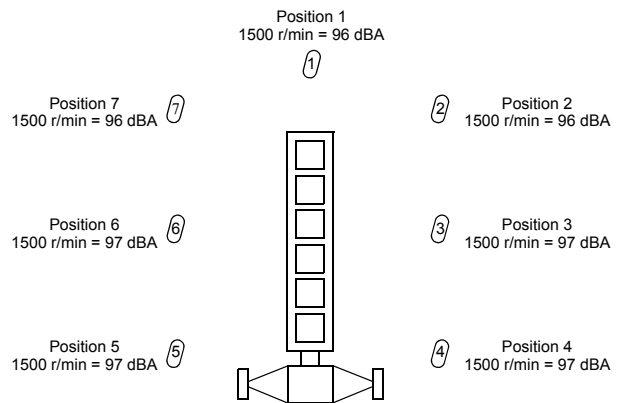
Type Insulated return
 Starter motor 24 volts
 Starter motor power 7,5 kW
 Number of teeth on flywheel 190
 Number of teeth on starter motor 12
 Minimum cranking speed 120 rev/min
 Pull in current of starter motor solenoid 26,8 amps at 24 volts
 Hold in current of starter motor solenoid 9 amps at 24 volts

Ignition System

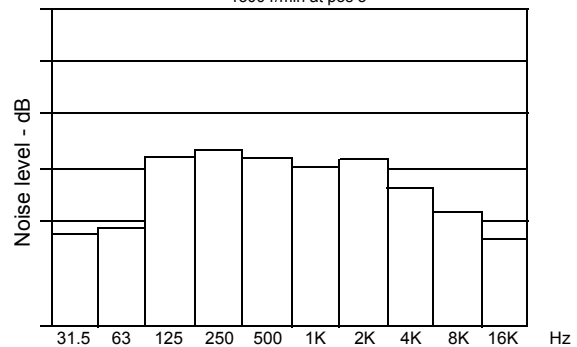
Primary system Altronic Disn 800
 Primary voltage 24 volts
 Polarity Negative earth
 Spark plug gap 0,25 mm
 Ignition timing 28° BTDC

Noise levels

The figures for total noise levels are typical for an engine running at the continuous baseload power rating in a semi-reverberant environment and measured at a distance of one metre from the periphery of the engine. (sound pressure level re: -20 x 10⁻⁶ pa)
 Speed 1500 rev/min
 Ambient noise level 70 dBA



The following histograms show an octave analysis at the position of maximum noise level
 1500 r/min at pos 5

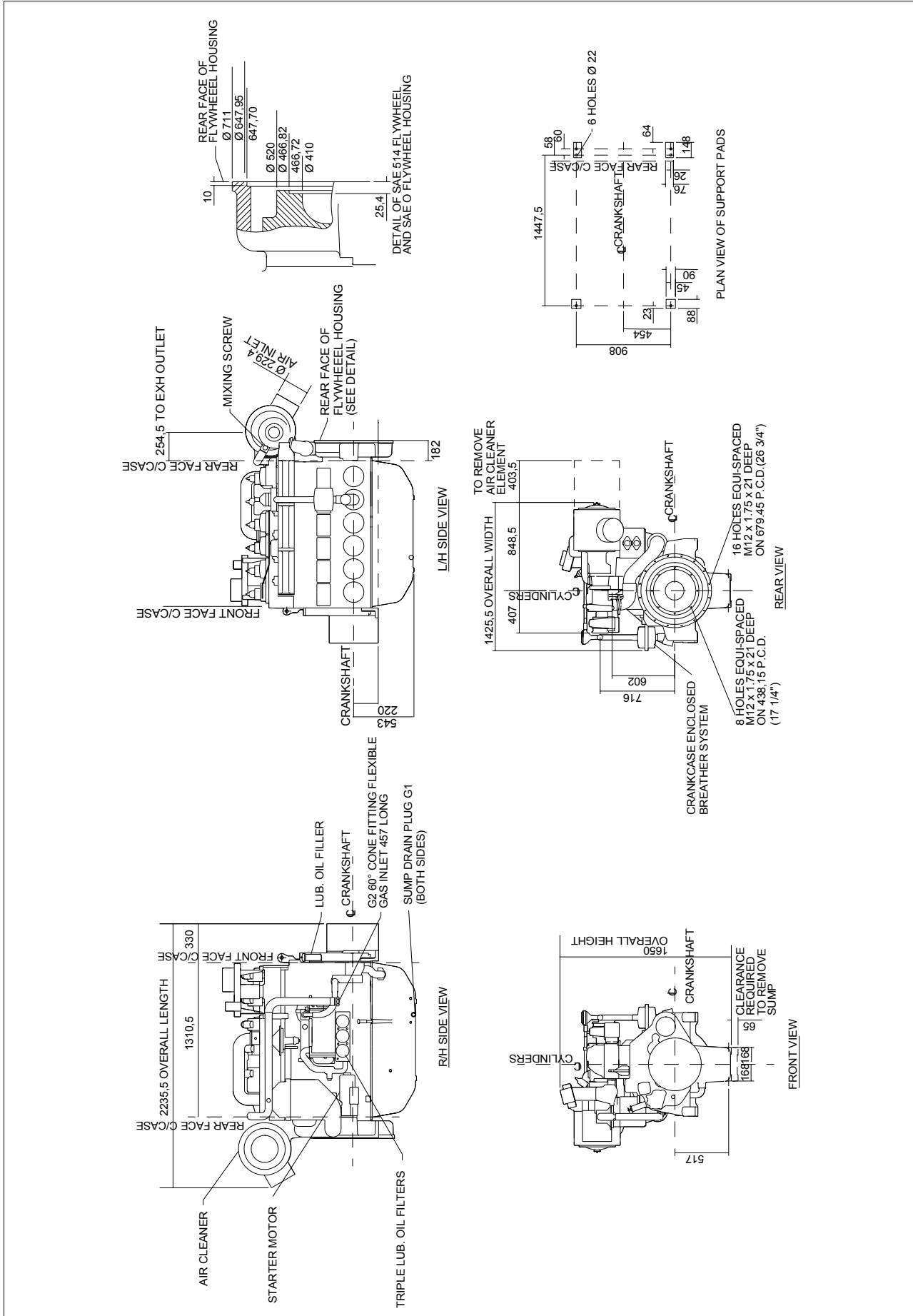


Engine mounting

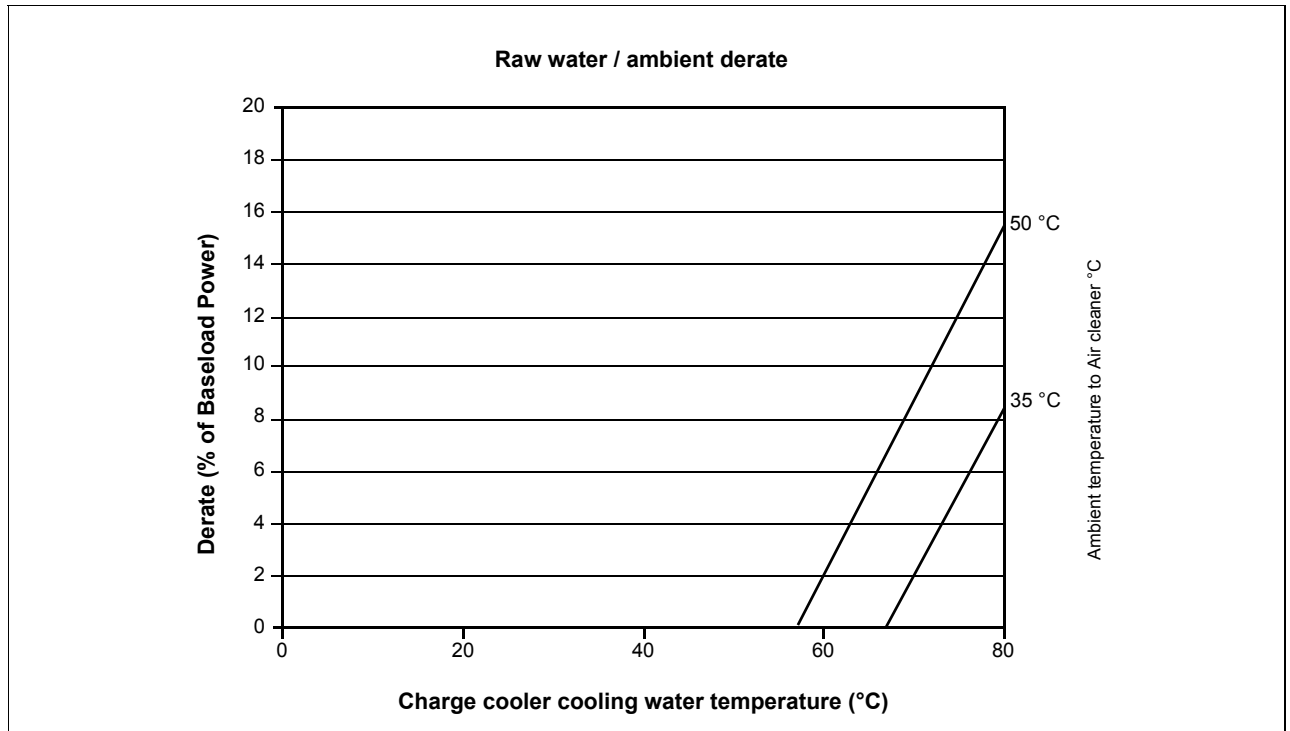
Maximum additional load applied to flywheel due to all rotating components 650 kg

The information given in this document is for guidance only.

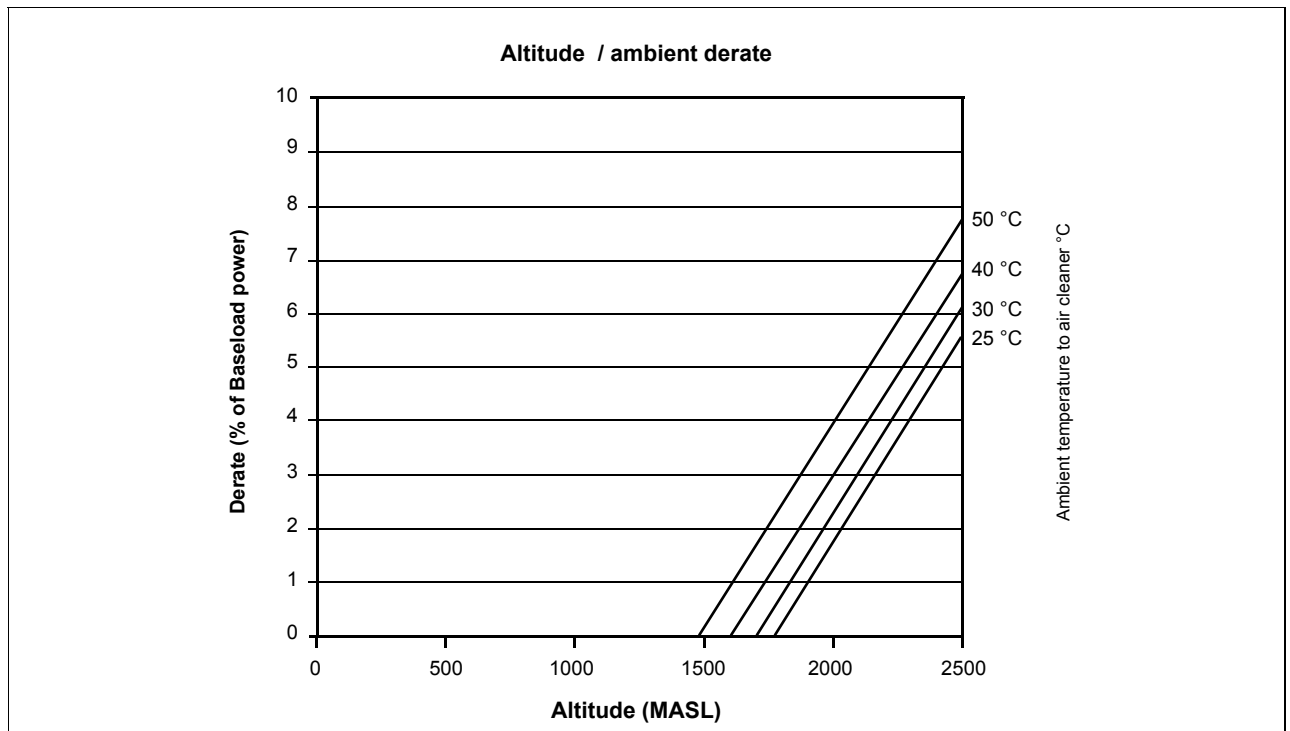
General Arrangement Drawing 4006-23TRS1 / 4006-23TRS2



4006-23TRS1 Derate chart



4006-23TRS1 Derate chart

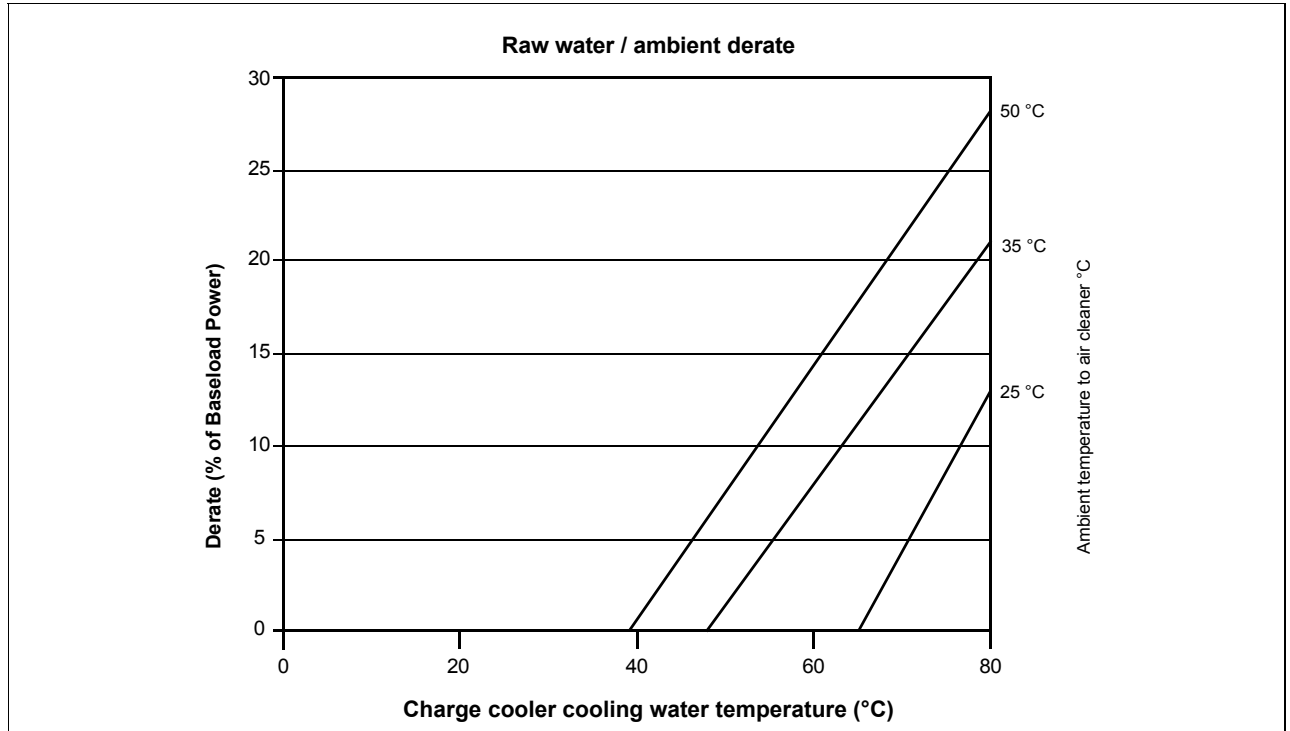


Derating from ISO 3046 standard conditions. The maximum power is the continuous Baseload rating when assessing derate parameters.

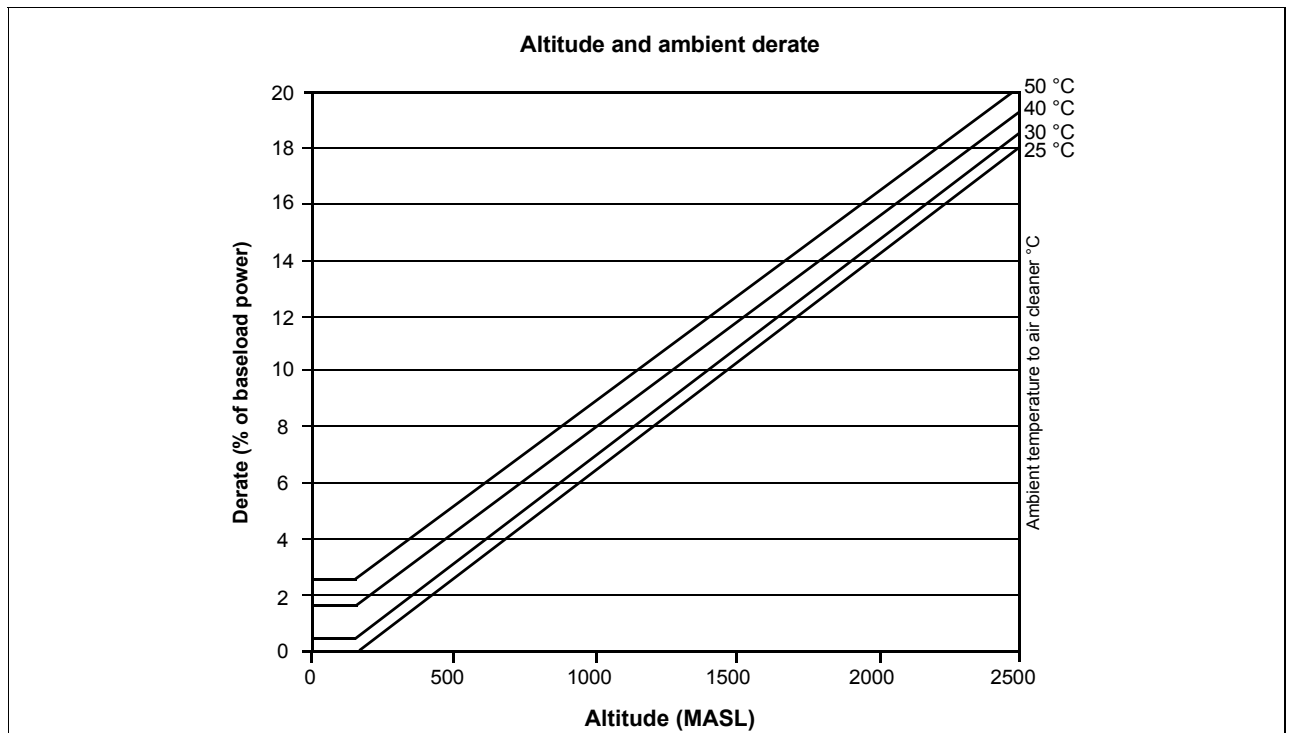
Notes:

- Derating for high charge cooler cooling water temperature and ambient must be added to that for altitude.
- It may be necessary to derate for inferior fuel quality. Refer to Perkins Engines Company Ltd.
- For altitudes above 2500m refer to Perkins Engines Company Ltd.

4006-23TRS2 Derate chart



4006-23TRS2 Derate chart



Derating from ISO 3046 standard conditions. The maximum power is the continuous Baseload rating when assessing derate parameters.

Notes:

- Derating for high charge cooler cooling water temperature and ambient must be added to that for altitude.
- It may be necessary to derate for inferior fuel quality. Refer to Perkins Engines Company Ltd.
- For altitudes above 2500m refer to Perkins Engines Company Ltd.

@ Perkins

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