1.1 Biofilter

Biofiltration is a process of biodegradation of water-soluble contaminants. In the biofilter, the biodegradable contaminants are solubilised from the gas and vapour phases forming an aqueous phase on the surface of an organic medium. The compounds are then degraded by the bacteriological population on this medium. Biofilters are effective at removing sulphur-based odour compounds such as hydrogen sulphide, organic sulphides and mercaptans. Their effectiveness on the removal of nitrogen compounds, such as ammonia, is limited, thus justifying the use of the acid scrubbers as a pre-treatment.

The air discharged from the acid scrubber/humidifier will be forced through the biofilter to reduce odour concentrations before it is discharged to the atmosphere. The biofilter will consist of a concrete basin, protected by a liner of HDPE. The biofilter floor will be formed by slabs elevated by specific supports soa s to form a plenum which will allow the air to flow evenly under the complete biofilter field. The air discharged from the scrubber/humidifier will be blown into this air plenum before being forced through the biofilter material. As required by the Client, the biofilter medium will consist of 2 layers (with a wood root base and a top layer of Kokosmix (a proprietary biofilter media)). The biofilter material selected will have a high odour-removal efficiency and long life, while providing low pressure losses combined with a good moisture holding capacity. The organic pollutants in the odourous air will be retained by the biofilter material and metabolised by the resident microorganisms. The resulting metabolites are environmentally friendly and include carbon dioxide, water and heat.

The biological process requires a humid environment. Thus, the target range for the humidity level of the biofilter material is between 50% and 70%. The biofilter material will be automatically sprinkled with water (on the top surface) and watered at an intermediate level so as to achieve adequate humidity levels. These will be permanently monitored by humidity sensors installed inside the biofilter media.

The water supplied to the system will be of human-consumption quality, with a maximum content of 0.6 mg/l of chlorine. The use of water from a different source will be subject to prior analytical characterization and, in consequence, might need a specific pre-treatment.

The fresh water admitted to the biofilter will receive a controlled dosing of a nutrient solution because it is expected that the C:N:P ratio will be unballanced in the aqueous phase of the biofilter. It will also have received a controlled dose of sodium hydroxide, to correct the acidic pH of the income stream to the optimal interval for biological processes.

The leachates and the condensates from the biofilter will be collected in the base of the unit and transfered by gravity to a underground tank, accompanied by a monitoring system for pH, electric conductivity (EC) and ORP. From that tank, a motor pump will recycle this water to the watering

system of the biofilter. When the pH or the EC are considered to be inappropriate for the hydration process, the contents of this tank will be discharged into the wastewater tank previously described in Section 4.4 and, then, into the wastewater treatment plant.

Desulphurization

In the bio-chemical reaction in the anaerobic digestion reactors sulphate reduction forms hydrogen sulphide (H2S).

$SO_4^{2-} + 4H_2 \rightarrow H_2S + 2H_2O + 2OH^-O_4^{2-} + CH_3COOH \rightarrow H2S + 2HCO3^-$

S^{2-} is soluble but depending on the pH value it is in equilibrium with HS^- and H_2S. H_2S is an acid gas with toxic properties. H_2S can release the liquid phase and penetrate the biogas system, where in high concentration it can effect corrosion in the CHP. There are chemical and biological options to reduce the H_2S content in the biogas.

The proposed technology to reduce the H_2S content in the biogas it is Biological Desulphurization. This process for the biogas shall be included to reduce the consumption of iron chloride and to prevent an unnecessary increase of salinity in the waste suspension.

The biological oxidation process occurs in inoculated with selected micro-organisms which are immobilized on the filling material within. Micro-organisms of the Thiobacillus (*e.g. Thiooxidans*) type are used. These bacteria are chemolithotrophs and use carbon dioxide as their carbon source.

Their metabolism degradation can be represented generally by the following equations:

$H_2S + 2\ O_2 \rightarrow H_2SO_4$

$2\ H_2S + O_2 \rightarrow 2\ S + 2\ H_2O$

$S + H_2O + 1{,}5\ O_2 \rightarrow H_2SO_4$

A nutrient solution is sprayed continuously over the filling material, whereas the biogas coming from the digesters will be mixed with a certain amount of air and flows upstream through the reactor. The air dosing will be controlled. The oxidation products sulphur and sulphite will be discharged with the nutrient solution. Therefore the solution which is recycled over the reactor has to be partly displaced. The quantity of waste solution depends on the H2S concentration in the biogas and on several reaction conditions like pH.

Cummins Inc.	Basic Engine Model:	Curve Number:	*G-DRIVE*
Columbus, Indiana 47202-3005	**6BTA5.9-G5**	**FR-92241**	**B5.9**
Engine Data Sheet	Engine Critical Parts List: **CPL: 2387**	Date: **30Mar09**	**1**

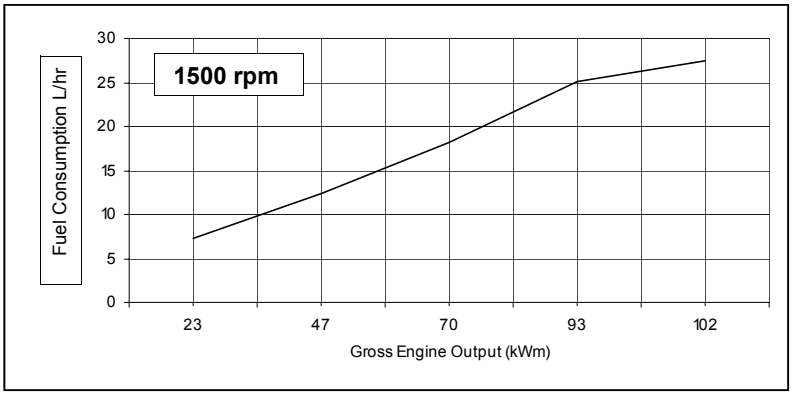
Displacement : **5.9** litre (**360** in^3)	Bore : **102**mm (**4.02** in.) Stroke : **120** mm (**4.72** in.)
No. of Cylinders : **6**	Aspiration : **Turbocharged and Aftercooled**

Engine Speed	Standby Power		Prime Power		Continuous Power	
rpm	kWm	hp	kWm	hp	kWm	hp
1500	102	137	93	125	82	110

Engine Performance Data @ 1500 rpm

OUTPUT POWER			FUEL CONSUMPTION			
%	kWm	hp	kg/ kWm·h	lb/ hp·h	litre/ hour	US gal/ hour
STANDBY POWER						
100	102	137	0.228	0.376	27	7.2
PRIME POWER						
100	93	125	0.228	0.375	25	6.6
75	70	94	0.221	0.364	18	4.8
50	47	63	0.227	0.373	12	3.3
25	23	31	0.265	0.435	7	1.9
CONTINUOUS POWER						
100	82	110	0.221	0.364	21	5.6

litre/hour



CONVERSIONS:(litres = US Gal x 3.785) (US Gal = litres x 0.2642)

Data Subject to Change Without Notice

These guidelines have been formulated to ensure proper application of generator drive engines in A.C. generator set installations. **STANDBY POWER RATING:** Applicable for supplying emergency power for the duration of the utility power outage. No overload capability is available for this rating. Under no condition is an engine allowed to operate in parallel with the public utility at the Standby Power rating. This rating should be applied where reliable utility power is available. A Standby rated engine should be sized for a maximum of an 80% average load factor and 200 hours of operation per year. This includes less than 25 hours per year at the Standby Power rating. Standby ratings should never be applied except in true emergency power outages. Negotiated power outages contracted with a utility company are not considered an emergency. **PRIME POWER RATING:** Applicable for supplying electric power in lieu of commercially purchased power. Prime Power applications must be in the form of one of the following two categories:**UNLIMITED TIME RUNNING PRIME POWER:** Prime Power is available for an unlimited number of hours per year in a variable load application. Variable load should not exceed a 70% average of the Prime Power rating during any operating period of 250 hours. The total operating time at 100% Prime Power shall not exceed 500 hours per year. A 10% overload capability is available for a period of 1 hour within a 12-hour period of operation. Total operating time at the 10% overload power shall not exceed 25 hours per year. **LIMITED TIME RUNNING PRIME POWER:** Limited Time Prime Power is available for a limited number of hours in a non-variable load application. It is intended for use in situations where power outages are contracted, such as in utility power curtailment. Engines may be operated in parallel to the public utility up to 750 hours per year at power levels never to exceed the Prime Power rating. The customer should be aware, however, that the life of any engine will be reduced by this constant high load operation. Any operation exceeding 750 hours per year at the Prime Power rating should use the Continuous Power rating.**CONTINUOUS POWER RATING**: Applicable for supplying utility power at a constant 100% load for an unlimited number of hours per year. No overload capability is available for this rating.

Reference AEB 10.47 for determining Electrical Output.

Data shown above represent gross engine performance capabilities obtained and corrected in accordance with ISO-3046 conditions of 100 kPa (29.53 in Hg) barometric pressure [110 m (361 ft) altitude], 25 °C (77 °F) air inlet temperature, and relative humidity of 30% with No. 2 diesel or a fuel corresponding to ASTM D2.
Derates shown are based on 15 in H_20 air intake restriction and 2 in Hg exhaust back pressure.

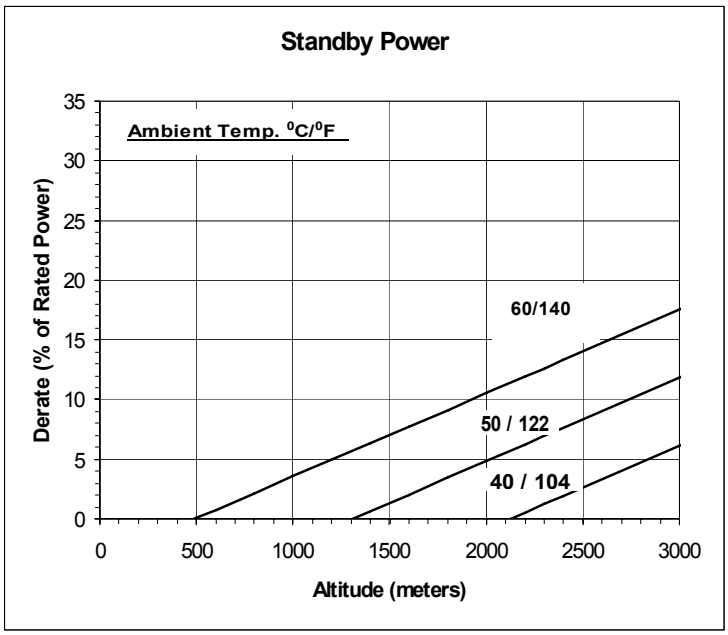
The fuel consumption data is based on No. 2 diesel fuel weight at 0.85 kg/litre (7.1 lbs/US gal). Power output curves are based on the engine operating with fuel system, water pump and lubricating oil pump; not included are battery charging alternator, fan, optional equipment and driven components.

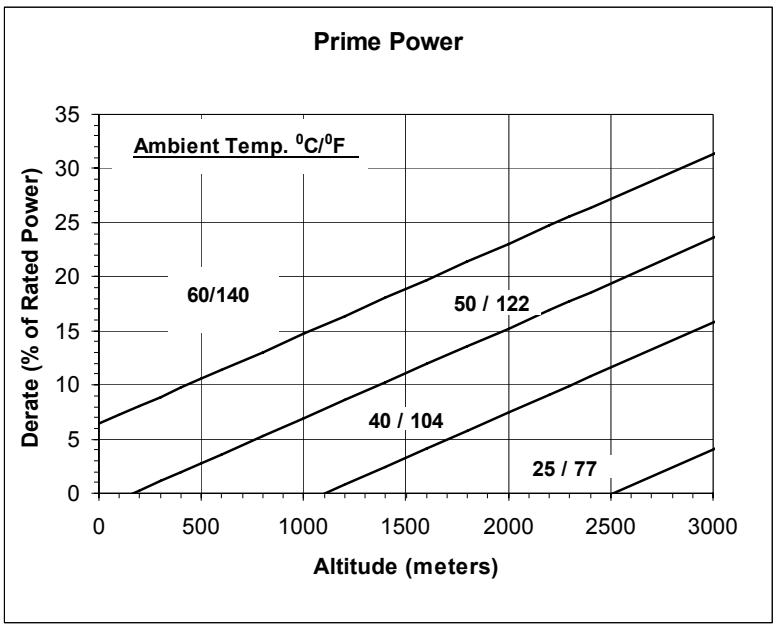
Data Status: Limited Production

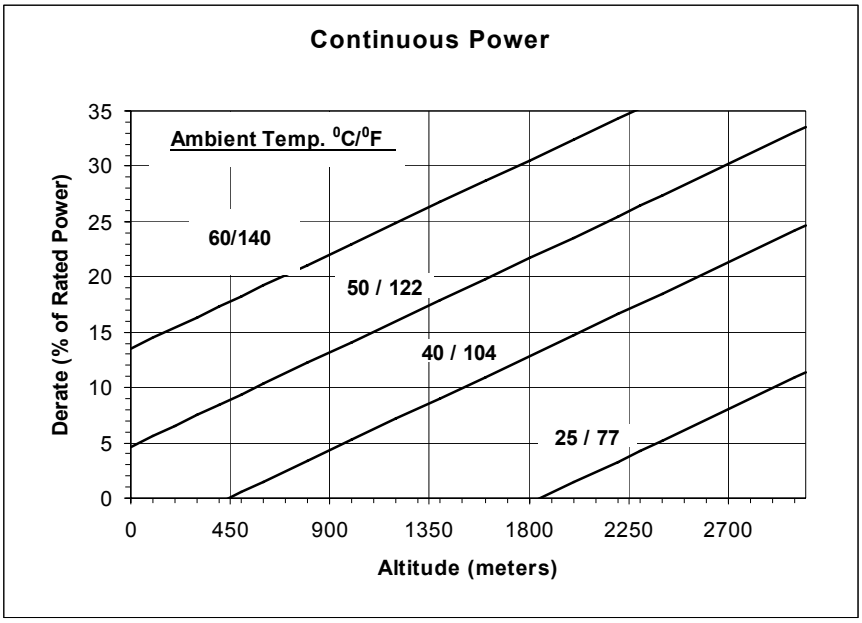
Data Tolerance: ± 5%

Chief Engineer:

1500 RPM Power Derate Curves







Operation At Elevated Temperature And Altitude:

For **Standby Operation** above these conditions, derate by an additional 2.1% per 300 m (1000 ft), and 5.7% per 10 °C (18 °F).

For **Prime Operation** above these conditions, derate by an additional 2.5% per 300 m (1000 ft), and 7.8% per 10 °C (18 °F).

For **Continuous Operation** above these conditions, derate by an additional 2.8% per 300 m (1000 ft), and 8.9% per 10 °C (18 °F).

Cummins Inc.
Engine Data Sheet

ENGINE MODEL : 6BTA5.9-G5

DATA SHEET : DS-92241
CONFIGURATION NUMBER : D403091GX02 **DATE :**30Mar09
PERFORMANCE CURVE : FR-92241

INSTALLATION DIAGRAM
• Fan to Flywheel: __

CPL NUMBER
• Engine Critical Parts List: 2387

GENERAL ENGINE DATA

Type	Inline 6-Cylinder Diesel	
Aspiration	Turbocharged and Charge Air Cooled	
Bore x Stroke — in x in (mm x mm)	4.02 x 4.72 (102 X 120)	
Displacement — in^3 (litre)	360 (5.9)	
Compression Ratio	17.6 :1	
Dry Weight (Approximate),		
Fan to Flywheel Engine — lb (kg)	886	(402)
Wet Weight (Approximate),		
Fan to Flywheel Engine — lb (kg)	939	(426)
Moment of Inertia of Rotating Components		
• with FW 9017 Flywheel — $lb_m \cdot ft^2$ ($kg \cdot m^2$)	5	(0.6)
• with FW 9134 Flywheel — $lb_m \cdot ft^2$ ($kg \cdot m^2$)	11	(1.2)
Center of Gravity from Rear Face of Block — in (mm)	21.4	(544)
Center of Gravity Above Crankshaft Centerline — in (mm)	6.1	(155)
Maximum Static Loading at Rear Main Bearing — lb (kg)	TBD	TBD

ENGINE MOUNTING

Maximum Bending Moment at Rear Face of Block — lb • ft (N • m)	996	(1350)

EXHAUST SYSTEM

Maximum Back Pressure — in Hg (kPa)	3	(10.25)

AIR INDUCTION SYSTEM

Maximum Intake Air Restriction:		
• with Dirty Filter Element — in H_2O (kPa)	25	(6)
• with Clean Filter Element — in H_2O (kPa)	15	(4)

COOLING SYSTEM

Jacket Water Circuit Requirements

Coolant Capacity — Engine Only — US gal (litre)	2.4	(9.1)
Maximum Static Head of Coolant Above Engine Crank Centerline — ft (m)	46	(14)
Standard Thermostat (Modulating) Range — °F (°C)	183-203	(84-95)
Minimum Pressure Cap — psi (kPa)	7	(48)
Maximum Top Tank Temperature for Standby / Prime Power — °F (°C)	212	(100)
Maximum Coolant Friction Head External to Engine — psi (kPa)	4	(28)

Charge Air Cooler Requirements

Maximum Temp. Rise Between Engine Air Intake and Aftercooler Air Outlet- 1500/1800 rpm — °F (°C)	N/A	(N/A)
Maximum Air Pressure Drop from Turbo Air outlet to Intake Manifold - 1500/1800 rpm . — in Hg (kPa)	N/A	(N/A)
Maximum Intake Manifold Temperature @ 77 °F (25 °C) ambient - 1500/1800 rpm — °F (°C)	192	(89)
Maximum Compressor Outlet Temperature — °F (°C)	265	(130)
Maximum Intake Manifold Temperature for engine protection (Shut Down Threshold) — °F (°C)	207	(97)

LUBRICATION SYSTEM

Oil Pressure @ Idle Speed (miniumum) — psi (kPa)	10	(69)
@ Governed Speed — psi (kPa)	30-50	(207-345)
Maximum Oil Temperature — °F (°C)	250	(121)
Oil Capacity with OP 9006 Oil Pan : Low - High — US gal (litre)	3-3.8	(11.5 -14.3)
Total System Capacity (With Combo Filters) — US gal (litre)	4.3	(16.4)

FUEL SYSTEM

Type Injection System		Bosch Mechanical
Maximum Restriction at Lift Pump(clean/dirty filter)	— in Hg (kPa)	4/8 (13.5/27)
Maximum Allowable Head on Injector Return Line (Consisting of Friction Head and Static Head)	— in Hg (kPa)	2.5 (8.4)
Maximum Fuel Flow to Injector Pump	— US gph (litre/hr)	11.9 (45)
Maximum Return Fuel Flow	— US gph (litre/hr)	TBD (TBD)
Maximum Fuel Inlet Temperature	— °F (°C)	160 (71)

ELECTRICAL SYSTEM

Cranking Motor (Heavy Duty, Positive Engagement)	— volt	12
Battery Charging System, Negative Ground	— ampere	55
Maximum Allowable Resistance of Cranking Circuit	— ohm	0.002
Minimum Recommended Battery Capacity		
• Cold Soak @ -18 °C to 0 °C (0 °F to 32 °F)	— 0°F CCA	950

COLD START CAPABILITY

Minimum Ambient Temperature for Cold Start with 1500 watt Coolant Heater to Rated Speed	— °F (°C)	5	(-15)
Minimum Ambient Temperature for Unaided Cold Start to Idle Speed	— °F (°C)	23	(-5)
Minimum Ambient Temperature for NFPA 110 Cold Start (90° F Minimum Coolant Temperature)	— °F (°C)	TBD	TBD

PERFORMANCE DATA

All data is based on:
- Engine operating with fuel system, water pump, lubricating oil pump, air cleaner and exhaust silencer; not included are battery charging alternator, fan, and optional driven components.
- Engine operating with fuel corresponding to grade No. 2-D per ASTM D975.
- ISO 3046, Part 1, Standard Reference Conditions of:

Barometric Pressure	: 100 kPa (29.53 in Hg)	Air Temperature	: 25 °C (77 °F)
Altitude	: 110 m (361 ft)	Relative Humidity	: 30%
Air Intake Restriction	: 381 mm H_2O (15 in H_2O)	Exhaust Restriction	: 6.7 kPa (2 in Hg)

Steady State Stability Band at any Constant Load	— %	+/- 0.86
Estimated Free Field Sound Pressure Level of a Typical Generator Set;		
Excludes Exhaust Noise; at Rated Load and 7.5 m (24.6 ft); @1800 rpm	— dBA	TBD
Exhaust Noise at 1 m Horizontally from Centerline of Exhaust Pipe Outlet Upwards at 45°	— dBA	TBD

	STANDBY POWER		PRIME POWER	
	60 hz	*50 hz*	*60 hz*	*50 hz*
Governed Engine Speed — rpm		1500		1500
Engine Idle Speed — rpm		700-1507		700-1507
Gross Engine Power Output — hp (kW)		137 (102		125 (93)
Brake Mean Effective Pressure — psi (kPa)		201 (1386)		183 (1265)
Piston Speed — ft/min (m/s)		1181 (6)		1181 (6)
Friction Horsepower — hp (kW)		N.A.		N.A.
Engine Water Flow at Stated Friction Head External to Engine:				
• 2.5 psi Friction Head — US gpm (litre/min)		7.5 (28.6)		7.5 (28.6)
• Maximum Friction Head — US gpm (litre/min)		N.A.		N.A.
Engine Data				
Intake Air Flow — cfm (litre/s)		276 (131)		253 (120)
Exhaust Gas Temperature — °F (°C)		1038 (533)		1004 (540)
Exhaust Gas Flow — cfm (litre/s)		755 (357)		687 (325)
Air to Fuel Ratio — air : fuel		23.4 : 1		23.7 : 1
Radiated Heat to Ambient — BTU/min (kW)		628 (12)		572 (11)
Heat Rejection to Jacket Coolant — BTU/min (kW)		4426 (78)		4018 (71)
Heat Rejection to Exhaust — BTU/min (kW)		4833 (85)		4401 (78)
Heat Rejected to Fuel — BTU/min (kW)		N.A.		N.A.
Aftercooler Heat Rejection — BTU/min (kW)		N.A.		N.A.
Turbocharger Compressor Outlet Pressure — psi (kPa)		17 (117)		15 (103)
Turbocharger Compressor Outlet Temperature — °F (°C)		265 (130)		238 (115)

N.A. - Not Available
N/A - Not Applicable to this Engine
TBD - To Be Determined

*This is the maximum heat rejection to fuel, which is at low load.

ENGINE MODEL : **6BTA5.9-G5**
DATA SHEET : DS-92241
DATE : 30Mar 09
CURVE NO. : FR-92241

6CTAA8.3-G2 Advantage Data Sheet

Cummins Engine Company, Inc. Columbus, Indiana 47201

Curve Number: **FR-90767**	Engine Critical Parts List: **CPL 2894**	Date: **30Oct03**
Displacement: **8.3** litre (**505** in^3)	Bore: **114** mm (**4.49** in.)	Stroke: **135** mm (**5.32** in.)
No. of Cylinders: **6**	Aspiration: **Turbocharged and Charge Air Cooled**	

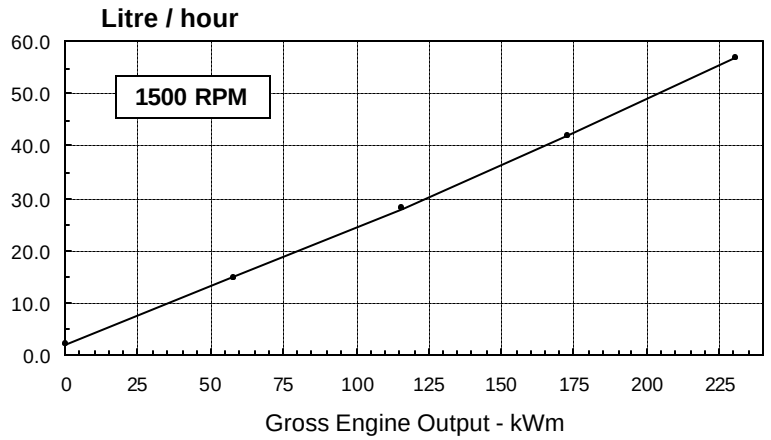
•• PRELIMINARY ••

Emergency Standby Ratings for application in Corporate Generator Sets Only

Engine Speed	Standby Power	
RPM	kWm	BHP
1500	231	310
1800	263	352

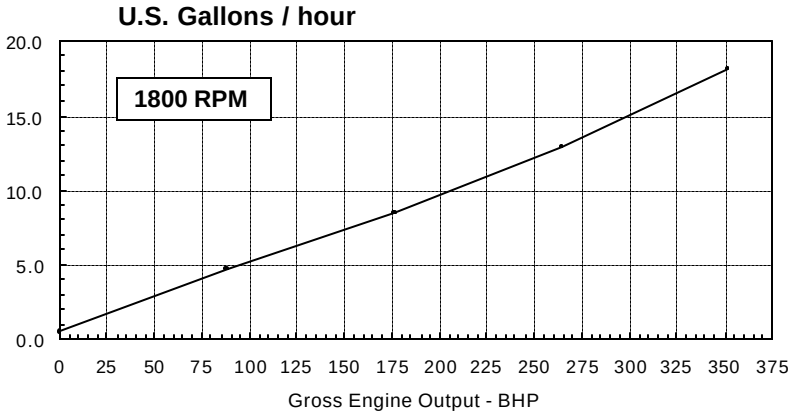
Engine Performance Data @ 1500 RPM

OUTPUT POWER			FUEL CONSUMPTION			
%	kWm	BHP	kg/ kWm·h	lb/ BHP·h	litre/ hour	U.S. Gal/ hour
STANDBY POWER						
100	231	310	0.204	0.335	57	15
75	173	233	0.197	0.325	42	11
50	116	155	0.199	0.325	28	7.3
25	58	78	0.213	0.355	15	4



Engine Performance Data @ 1800 RPM

OUTPUT POWER			FUEL CONSUMPTION			
%	kWm	BHP	kg/ kWm·h	lb/ BHP·h	litre/ hour	U.S. Gal/ hour
STANDBY POWER						
100	263	352	0.215	0.354	68	18.1
75	197	264	0.204	0.336	49	12.9
50	132	176	0.203	0.334	32	8.5
25	66	88	0.225	0.370	17	4.7



CONVERSIONS: (litres = U.S. Gal x 3.785) (kWm = BHP x 0.746) (U.S. Gal = litres x 0.2642) (BHP = kWm x 1.34)

Data shown above represent gross engine performance capabilities obtained and corrected in accordance with ISO-3046 conditions of 100 kPa (29.53 in Hg) barometric pressure [110 m (361 ft) altitude], 25 °C (77 °F) air inlet temperature, and relative humidity of 30% with No. 2 diesel or a fuel corresponding to ASTM D2.

See reverse side for application rating guidelines.

The fuel consumption data is based on No. 2 diesel fuel weight at 0.85 kg/litre (7.1 lbs/U.S. gal).

Power output curves are based on the engine operating with fuel system, water pump and lubricating oil pump; not included are battery charging alternator, fan, optional equipment and driven components.

TECHNICAL DATA DEPT. **CERTIFIED WITHIN 5%** **CHIEF ENGINEER**

6CTAA8.3-G2 Advantage Data Sheet

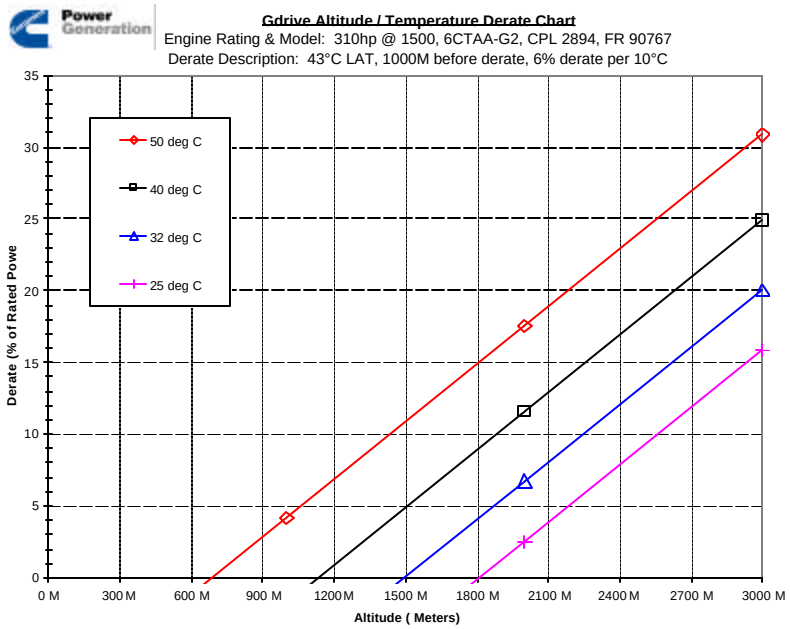
Cummins Engine Company, Inc. Columbus, Indiana 47201

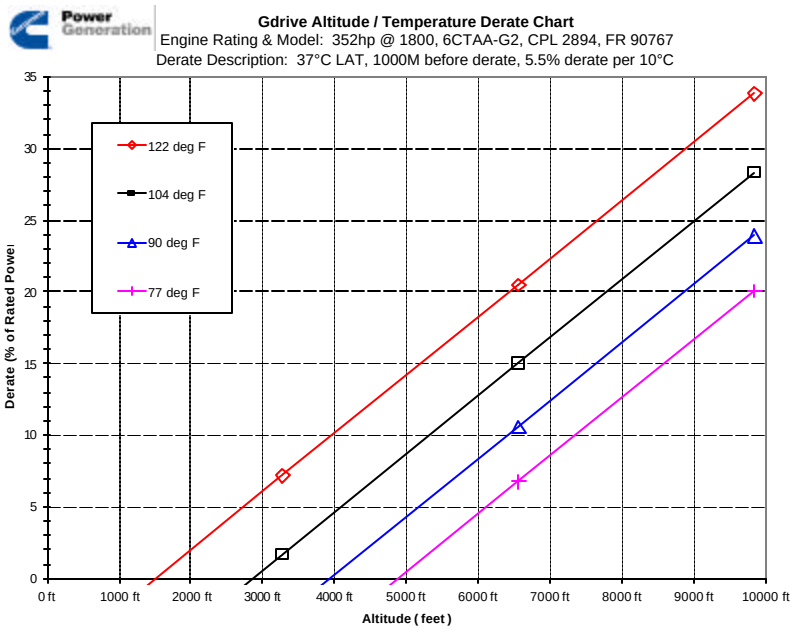
••PRELIMINARY••

POWER RATING APPLICATION GUIDELINES FOR EMERGENCY STANDBY ENGINES FOR APPLICATION IN CORPORATE GENERATOR SETS ONLY

These guidelines have been formulated to ensure proper application of generator drive engines in Cummins corporate generator set installations. Generator drive engines are not designed for and shall not be used in variable speed D.C. generator set applications.

Applicable for supplying emergency power for the duration of the utility power outage. No overload capability is available for this standby rating. Under no condition is an engine allowed to operate in parallel with the public utility at the Emergency Standby Power rating. This rating should be applied where reliable utility power is available. An emergency standby rated engine should be sized for a maximum of an **70%** typical load factor and **200 hours** of operation per year. This includes a maximum of **1 hour** in a **12 hour** period at the Emergency Standby Power rating. Emergency Standby rating should never be applied except in true emergency power outages. Negotiated power outages contracted with a utility company are not considered an emergency.





6CTAA8.3-G2 Advantage Data Sheet

Cummins Engine Company, Inc. Columbus, Indiana 47201

GENERAL ENGINE DATA

Type	4-Cycle; In-line; 6-Cylinder Diesel	
Aspiration	Turbocharged and Charge Air Cooled	
Bore x Stroke — in x in (mm x mm)	4.49 x 5.32 (114 x 135)	
Displacement — in^3 (liter)	505 (8.3)	
Compression Ratio	16.7 : 1	
Dry Weight		
Fan to Flywheel Engine — lb (kg)	1505	(684)
Wet Weight		
Fan to Flywheel Engine — lb (kg)	1572	(715)
Moment of Inertia of Rotating Components		
• with FW 9232 Flywheel — $lb_m \cdot ft^2$ ($kg \cdot m^2$)	36.5	(1.54)
Center of Gravity from Rear Face of Flywheel Housing — in (mm)	21.3	(541)
Center of Gravity Above Crankshaft Centerline — in (mm)	6.4	(163)
Maximum Static Loading at Rear Main Bearing — lb (kg)		N.A.

ENGINE MOUNTING

Maximum Bending Moment at Rear Face of Block — lb • ft (N • m)	1000	(1356)

EXHAUST SYSTEM

Maximum Back Pressure — in Hg (mm Hg)	3	(76)

AIR INDUCTION SYSTEM

Maximum Intake Air Restriction		
• with Dirty Filter Element — in H_2O (mm H_2O)	25	(635)
• with Normal Duty Air Cleaner and Clean Filter Element — in H_2O (mm H_2O)	10	(254)
• with Heavy Duty Air Cleaner and Clean Filter Element — in H_2O (mm H_2O)	15	(381)

COOLING SYSTEM

Coolant Capacity — Engine Only — US gal (liter)	3.25	(12.3)
Maximum Coolant Friction Head External to Engine — 1800 rpm — psi (kPa)	5	(35)
— 1500 rpm — psi (kPa)	4	(28)
Maximum Static Head of Coolant Above Engine Crank Centerline — ft (m)	60	(18.3)
Standard Thermostat (Modulating) Range — °F (°C)	180 - 203	(82 - 95)
Minimum Pressure Cap — psi (kPa)	10	(69)
Maximum Top Tank Temperature — °F (°C)	220	(104)

LUBRICATION SYSTEM

Oil Pressure @ Idle Speed — psi (kPa)	15	(103)
@ Governed Speed — psi (kPa)	40 - 60	(276 - 414)
Maximum Oil Temperature — °F (°C)	250	(121)
Oil Capacity with OP 9006 Oil Pan : High - Low — US gal (liter)	5 - 4	(18.9 - 15.1)
Total System Capacity (Including Full Flow Filter) — US gal (liter)	6.3	(23.8)
Angularity of OP 9006 Oil Pan — Front Down	45°	
— Front Up	45°	
— Side to Side	45°	

6CTAA8.3-G2 Advantage Data Sheet

Cummins Engine Company, Inc. Columbus, Indiana 47201

FUEL SYSTEM

.... Type Injection System..... .....Bosch P7100 Direct Injection

ELECTRICAL SYSTEM

Cranking Motor (Heavy Duty, Positive Engagement)	— volt	12	24
Battery Charging System, Negative Ground	— ampere	64	40
Maximum Allowable Resistance of Cranking Circuit	— ohm	0.00075	0.002
Minimum Recommended Battery Capacity (Cold Soak @ 10° F (-12° C) and Above	— 0° F CCA	950	475

COLD START CAPABILITY

Minimum Ambient Temperature for Aided (with Coolant Heater) Cold Start within 10 seconds	— °F (°C)	TBD	(TBD)
Minimum Ambient Temperature for Unaided Cold Start	— °F (°C)	TBD	(TBD)

PERFORMANCE DATA

All data is based on:

- Engine operating with fuel system, water pump, lubricating oil pump, air cleaner and exhaust silencer; not included are battery charging alternator, fan, and optional driven components.
- Engine operating with fuel corresponding to grade No. 2-D per ASTM D975.
- ISO 3046, Part 1, Standard Reference Conditions of:

Barometric Pressure : 100 kPa (29.53 in Hg)		Air Temperature : 25 °C (77 °F)	
Altitude : 110 m (361 ft)		Relative Humidity : 30%	

Steady State Stability Band at any Constant Load	— %	+/- 0.50	
Maximum Temperature Rise Between Engine Air Inlet and Intake Manifold	— °F (°C)	45	(25)
Maximum Air Pressure Drop from Turbo Air Outlet to Intake Manifold - @ 1500 RPM	— in Hg (mm Hg)	2.5	(63.5)
Maximum Air Pressure Drop from Turbo Air Outlet to Intake Manifold - @ 1800 RPM	— in Hg (mm Hg)	4	(102)

		STANDBY POWER			
Governed Engine Speed	— rpm	1800		1500	
Engine Idle Speed	— rpm	950 - 1150		950 - 1150	
Gross Engine Power Output	— BHP (kW_m)	220	(164)	195	(145)
Brake Mean Effective Pressure	— psi (kPa)	307	(2119)	323	(2230)
Piston Speed	— ft / min (m / s)	1416	(7.2)	1180	(6.0)
Friction Horsepower	— HP (kW_m)	22	(16.4)	17	(12.7)
Engine Water Flow at Stated Friction Head External to Engine:					
• 1 psi Friction Head	— US gpm (liter / s)	38	(2.4)	32	(2.0)
• Maximum Friction Head	— US gpm (liter / s)	30	(1.9)	24	(1.5)
Engine Data with Dry Type Exhaust Manifold					
Intake Air Flow	— cfm (liter / s)	664	(313)	540	(255)
Exhaust Gas Temperature	— °F (°C)	1103	(595)	1050	(565)
Exhaust Gas Flow	— cfm (liter / s)	1846	(871)	1443	(681)
Air to Fuel Ratio	— air : fuel	22.7 : 1		22.2 : 1	
Radiated Heat to Ambient	— BTU / min (kW_m)	1365	(24)	1378	(24)
Heat Rejection to Coolant	— BTU / min (kW_m)	5311	(93)	4549	(80)
Heat Rejection to Exhaust	— BTU / min (kW_m)	13139	(231)	10223	(180)
Heat Rejection to Aftercooler	— BTU / min (kW_m)	2771	(49)	2173	(38)
Charge Air Flow	— cfm (liter / s)	47	(21)	38	(17)
Turbocharger Compressor Outlet Pressure	— psi (kPa)	62	(1575)	58.1	(1475)
Turbocharger Compressor Outlet Temperature	— °F (°C)	360	(182)	347	(175)

ENGINE MODEL : **6CTAA8.3-G2**
DATA SHEET : DS-90767
DATE : 30Oct03
CURVE NO. : FR-90767

Typical Exhaust Emissions @ 1500 RPM

	Standby Power		
Component	**g/BHP·h**	**mg/m^3**	**PPM**
HC (Total Unburned Hydrocarbons)	0.13	60	N.A.
NOx (Oxides of Nitrogen as NO_2)	6.0	2820	N.A.
CO (Carbon Monoxide)	0.6	260	N.A.
PM (Particulate Matter)	0.3	120	N.A.

Typical Exhaust Emissions @ 1800 RPM

	Standby Power		
Component	**g/BHP·h**	**mg/m^3**	**PPM**
HC (Total Unburned Hydrocarbons)	0.15	60	N.A.
NOx (Oxides of Nitrogen as NO_2)	4.5	2020	N.A.
CO (Carbon Monoxide)	0.6	270	N.A.
PM (Particulate Matter)	0.2	100	N.A.

NOTE mg/m^3 and PPM numbers are corrected to 5% O_2 content.

Data was recorded during steady state rated engine speed (± 25 RPM) with full load (± 2%). Pressures, temperatures, and emission rates were stabilized.

Fuel Specification: ASTM D975 No. 2-D diesel fuel with 0.2% sulfur content (by weight) and 42-50 cetane number.
Fuel Temperature: 99° F ± 9° (at fuel pump inlet)
Intake Air Temperature: 77° F ± 9°
Barometric Pressure: 29.6 in. Hg ± 1 in. Hg
Humidity: NOx measurement corrected to 75 grains H_2O/lb dry air

The HC, NOx, and CO emissions data tabulated here were taken from a single engine under the test conditions shown above. Data for the other components are estimates. This data is subject to instrumentation, measurement, and engine-to-engine variability. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may result in elevated emission levels. Specifications May Change Without Notice.

Technical data sheet of offer

Biogas combustion unit

Type: HTV 4,8

High temperature combustion for high efficient combustion

Flow rate at flow pressure: min. 100 Nm³/h
max. 750 Nm³/h

The flare shall work at a min of 80mbar and a max of 150mbar (the nominal value its 110mbar).
After receive the external signal to start (PLC), the amount of gas burned on the flare may be modulated linearly (100 to 750Nm3) by the means of an analogue signal (4-20mA).

Heating value: min. 3,0 kWh/m³ max. 6,0 kWh/m³
Firing capacity: min. 300 kW max. 4500 kW

Combustion conditions: ≥1000°C exhaust gas temperature, concealed combustion inside a thermal insulated combustion chamber with 0.3 sec. retention time and a destruction quality >>99,9%
Exhaust gas: CO<50mg/m³, NOx<150mg/m³ at 6 Vol.% O2 reference content

Burner type: Coanda-Injection burner with several, back fire protected nozzles

Safety engineering: in dependence of EN, DIN, TR, ATEX, UVV, TA Luft and DVGW regulations

Dimension:

Number of burner circles:	1	
Gas connection to gas fitting line:	DN 200	
Total height ex foundation:	~ 8000	mm
Combustion chamber height:	~ 5000	mm
Combustion chamber diameter outside:	~ 1500	mm

The H2S concentration must be < 300ppm
The humidity must be < 35%

Materials:

Chamber:	☐ 1.4571	☐ 1.4301	☒ St. galv. **RAL 6010**
Console:	☐ 1.4571	☐ 1.4301	☒ St. galv.
Burner:	☒ 1.4571	☐ 1.4301	☐ 1.4828
Piping:	☒ 1.4571	☐ 1.4301	☐ St. galv.
Gas fittings:	EN, DVGW, IBEXU legislated		

Scope of supply:

1 Flare unit consisting of: Burner, heat insulated combustion pipe and console

1 Thermocouple for regulation of combustion air with 4 – 20mA output signal for external registration

1 Ignition unit consisting of:

- o EN-legislated burner control unit (BCU)
- o Ignition transformer (7,5kV, 100% duty ratio) and ignition electrode
- o UV-sensor for flame monitoring and with its own gas fitting line
- o Temperature sensor

1 Gas fitting line incl. internal piping, consisting of:

- o Modulate butterfly valve
- o Pressure switch, manometer and Quick shut valve
- o Deflagration flame arrestor with German ATEX certification
- o Explosion proof design of gas fittings (Cat3)

1 Control cabinet , consisting of:

- o Switch board, in ☐ painted Steel ☒ Plastic ☐ stainless steel
- o Start/Stop via remote signal
- o Status and fault display, UV-signal strength and operation status on BCU
- o Operation and failure signal via potential free contacts, Reset-Button

1 Set heavy loads anchors

2 Sets Documentation in English consisting of:

- o Operating and maintenance instructions and wiring diagram, certificates, EC conformity statement

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WASTE TREATMENT PLANT AT THE NORTH OF MALTA

MWM
Energy. Efficiency. Environment.

Technical data
1200 kWel; 400 V, 50 Hz; Bio gas

Design conditions

Comb. air temperature / rel. Humidity:	[°C] / [%]	25 / 60
Altitude:	[m]	100
Exhaust temp. after heat exchanger:	[°C]	180
NO_x Emission (tolerance - 8%):	[mg/Nm^3 @5%O_2]	500

Genset:

Engine:	**TCG2020V12**	
Speed:	[1/min]	1500
Configuration / number of cylinders:	[-]	V / 12
Bore / Stroke / Displacement:	[mm]/[mm]/[dm^3]	170 / 195 / 53
Compression ratio:	[-]	13,5
Mean piston speed:	[m/s]	9,8
Mean lube oil consumption at full load:	[g/kWh]	0,2
Engine-management-system:	[-]	TEM EVO
Generator:	**Marelli MJB 450 LB4**	
Voltage / voltage range / cos Phi:	[V] / [%] / [-]	400 / ±5 / 1
Speed / frequency:	[1/min] / [Hz]	1500 / 50

Fuel gas data: 2)

Methane number:	[-]	141
Lower calorific value:	[kWh/Nm^3]	5,56
Gas density:	[kg/Nm^3]	1,25
Standard gas:	Bio gas	
Analysis: CO_2	[Vol%]	40,00
N_2	[Vol%]	4,70
O_2	[Vol%]	0,30
H_2	[Vol%]	0,00
CO	[Vol%]	0,00
CH_4	[Vol%]	55,00
C_2H_4	[Vol%]	0,00
C_2H_6	[Vol%]	0,00
C_3H_6	[Vol%]	0,00
C_3H_8	[Vol%]	0,00
C_4H_8	[Vol%]	0,00
C_4H_{10}	[Vol%]	0,00
C_5H_{12}	[Vol%]	0,00
C_xH_y	[Vol%]	0,00
H_2S	[Vol%]	0,00

Energy balance

Load:	[%]	**100**	**75**	**50**
Electrical power COP acc. ISO 8528-1:	[kW]	**1200**	**900**	**600**
Engine jacket water heat:	[kW ±8%]	631	470	335
Intercooler LT heat:	[kW ±8%]	94	68	44
Lube oil heat:	[kW ±8%]			
Exhaust heat with temp. after heat exchanger:	[kW ±8%]	582	476	355
Exhaust temperature:	[°C]	470	493	518
Exhaust mass flow, wet:	[kg/h]	6461	4871	3362
Combustion mass air flow:	[kg/h]	5808	4371	3011
Radiation heat engine / generator:	[kW ±8%]	41 / 32	39 / 25	38 / 20
Fuel consumption:	[kW+5%]	2870	2197	1544
Electrical / thermal efficiency:	[%]	41,8 / 42,2	41,0 / 43,0	38,9 / 44,7
Total efficiency:	[%]	84,0	84,0	83,6

System parameters 1)

Ventilation air flow (comb. air incl.) with ΔT = 15K	[kg/h]	30000
Combustion air temperature minimum / design:	[°C]	20 / 25
Exhaust back pressure from / to:	[mbar]	30 / 50
Maximum pressure loss in front of air cleaner:	[mbar]	5
Zero-pressure gas control unit selectable from / to: 2)	[mbar]	20 / 200
Pre-pressure gas control unit selectable from / to: 2)	[bar]	0,5 / 10
Starter battery 24V, capacity required:	[Ah]	430
Starter motor:	[kWel.] / [VDC]	15 / 24
Lube oil content engine / base frame:	[dm^3]	205 / 510
Dry weight engine / genset:	[kg]	5080 / 10700

Cooling system

Glycol content engine jacket water / intercooler:	[% Vol.]	35 / 35
Water volume engine jacket / intercooler:	[dm^3]	111 / 20
KVS / Cv value engine jacket water / intercooler:	[m^3/h]	42 / 30
Jacket water coolant temperature in / out:	[°C]	80 / 93
Intercooler coolant temperature in / out:	[°C]	50 / 53
Engine jacket water flow rate from / to:	[m^3/h]	36 / 56
Water flow rate engine jacket water / intercooler:	[m^3/h]	45 / 35
Water pressure loss engine jacket water / intercooler:	[bar]	1,1 / 1,4

3332456BA

1) See also "Layout of power plants": 2) See also Techn. Circular 0199-99-3017 9515

Frequency band f [Hz]	25	31,5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	12.5k	16k	L_{WA} [dB(A)]	S [m^2]
Air-borne noise 3) $L_{W,Terz}$ [dB(lin)]	94	95	98	100	106	109	108	109	106	115	115	115	109	110	109	109	109	108	108	108	107	109	103	102	114	107	101	104	98	121	114
Exhaust noise 4) $L_{W,Octave}$ [dB(lin)]				128			135			134			131			123			122			120			119					132	15,5

3) DIN EN ISO 3746 4) DIN 45635-11 Appendix A (±3 dB) L_W: Sound power level S: Area of measurement surface (S_0=1m^2)

WASTE TREATMENT PLANT AT THE NORTH OF MALTA

Technical data
600 kWel; 400 V, 50 Hz; Bio gas

Design conditions

Comb. air temperature / rel. Humidity:	[°C] / [%]	25 / 60
Altitude:	[m]	100
Exhaust temp. after heat exchanger:	[°C]	180
NO_x Emission (tolerance - 8%):	[mg/Nm^3 @5%O_2]	500

Genset:

Engine:	**TCG 2016 V12 C**	
Speed:	[1/min]	1500
Configuration / number of cylinders:	[-]	V / 12
Bore / Stroke / Displacement:	[mm]/[mm]/[dm^3]	132 / 160 / 26
Compression ratio:	[-]	15,0
Mean piston speed:	[m/s]	8
Mean lube oil consumption at full load:	[g/kWh]	0,2
Engine-management-system:	[-]	TEM EVO
Generator:	**Marelli MJB 400 LA4**	
Voltage / voltage range / cos Phi:	[V] / [%] / [-]	400 / ±5 / 1
Speed / frequency:	[1/min] / [Hz]	1500 / 50

Fuel gas data: 2)

Methane number:	[-]	141
Lower calorific value:	[kWh/Nm^3]	5,56
Gas density:	[kg/Nm^3]	1,25
Standard gas:	Bio gas	
Analysis: CO_2	[Vol%]	40,00
N_2	[Vol%]	4,70
O_2	[Vol%]	0,30
H_2	[Vol%]	0,00
CO	[Vol%]	0,00
CH_4	[Vol%]	55,00
C_2H_4	[Vol%]	0,00
C_2H_6	[Vol%]	0,00
C_3H_6	[Vol%]	0,00
C_3H_8	[Vol%]	0,00
C_4H_8	[Vol%]	0,00
C_4H_{10}	[Vol%]	0,00
C_5H_{12}	[Vol%]	0,00
C_xH_y	[Vol%]	0,00
H_2S	[Vol%]	0,00

Energy balance

Load:	[%]	**100**	**75**	**50**
Electrical power COP acc. ISO 8528-1:	[kW]	**600**	**450**	**300**
Engine jacket water heat:	[kW ±8%]	304	242	186
Intercooler LT heat:	[kW ±8%]	50	31	14
Lube oil heat:	[kW ±8%]			
Exhaust heat with temp. after heat exchanger:	[kW ±8%]	272	224	170
Exhaust temperature:	[°C]	454	477	504
Exhaust mass flow, wet:	[kg/h]	3207	2434	1685
Combustion mass air flow:	[kg/h]	2886	2185	1509
Radiation heat engine / generator:	[kW ±8%]	22 / 20	17 / 16	13 / 13
Fuel consumption:	[kW+5%]	1413	1091	773
Electrical / thermal efficiency:	[%]	42,5 / 40,7	41,3 / 42,7	38,8 / 46,1
Total efficiency:	[%]	83,2	84,0	84,9

System parameters 1)

Ventilation air flow (comb. air incl.) with ΔT = 15K	[kg/h]	16200
Combustion air temperature minimum / design:	[°C]	20 / 25
Exhaust back pressure from / to:	[mbar]	30 / 50
Maximum pressure loss in front of air cleaner:	[mbar]	5
Zero-pressure gas control unit selectable from / to: 2)	[mbar]	20 / 200
Pre-pressure gas control unit selectable from / to: 2)	[bar]	0,5 / 10
Starter battery 24V, capacity required:	[Ah]	143
Starter motor:	[kWel.] / [VDC]	5,4 / 24
Lube oil volume engine / external oil tank:	[dm^3]	100 / -
Dry weight engine / genset:	[kg]	2650 / 6180

Cooling system

Glycol content engine jacket water / intercooler:	[% Vol.]	35 / 35
Water volume engine jacket / intercooler:	[dm^3]	43 / 5
KVS / Cv value engine jacket water / intercooler:	[m^3/h]	37 / 10
Jacket water coolant temperature in / out:	[°C]	78 / 88
Intercooler coolant temperature in / out:	[°C]	40 / 45
Engine jacket water flow rate from / to:	[m^3/h]	22 / 37
Water flow rate engine jacket water / intercooler:	[m^3/h]	28 / 10
Water pressure loss engine jacket water / intercooler:	[bar]	0,6 / 1,0

3332259BA

1) See also "Layout of power plants": 2) See also Techn. Circular 0199-99-3017

Frequency band f [Hz]	25	31,5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	12.5k	16k	L_{WA} [dB(A)]	S [m^2]
Air-borne noise 3) $L_{W,Terz}$ [dB(lin)]	86	86	91	91	95	109	107	111	104	108	103	109	101	103	103	100	102	102	101	102	101	107	103	102	108	102	102	96	95	115	81
Exhaust noise 4) $L_{W,Octave}$ [dB(lin)]				118			129			134			129			128			128			123			117					134	15,2

3) DIN EN ISO 3746 4) DIN 45635-11 Appendix A (±3 dB) L_W: Sound power level S: Area of measurement surface (S_0=1m^2)