

Monitoring Report

Voluntary Carbon Standard 2007

Aydin Salavatli Dora-1 Geothermal Power Plant

Monitoring Period: 01/08/2010 – 31/08/2011
Date: 15/12/2011
Voluntary Carbon Units (VCUs): 29,995 tCO₂e
No.: 15/12/2011, version 03

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1. Project Background

By means of this Monitoring Report greenhouse gas emission reductions achieved by the project activity “Aydin Salavatli Dora-I Geothermal Power Plant” are being verified and certified as per requirements of the Voluntary Carbon Standard, Version 2007. The project has been implemented and is being operated by Menderes Geothermal Elektrik Uretim A.S. (MEGE) and the carbon credits are being realized with support from South Pole Carbon Asset Management Ltd. (SPC)

Further background information on the project activity can be found in the Project Document (VCS PD) and associated documents, which had already been submitted for validation as per requirements of the Voluntary Carbon Standard 2007 and had a positive validation opinion. The VCS PD and associated documents are available upon request.

The project is the first private investment employing the specific “Organic Rankine Cycle & Binary Technology in Turkey. The list of equipments is given in table below and the system processing schema is given in Annex.1:

Project Technical Characteristics

No.	Name	Quantity
1	Organic Turbine	2
2	Generator	1
3	12” control valve	3
4	Actuator	7
5	Positioner	9
6	16” control valve	4
7	6” control valve	4
8	4” control valve	2
9	8” control valve	3
10	10” control valve	1
11	Actuator	1
12	Positioner	6
13	12” control valve	4
14	Actuator	1
15	Positioner	1
16	Pentan Pump 1	1
17	Motor	1
18	Pentan Pump 2	1
19	Motor	1
20	O.E.C. Internal Use Transformator	1

2. Monitoring Background

Section 2, 3, and 4 of the VCS PD (Application of the baseline and monitoring methodology) provides all details in regard to calculation of emission reductions and the monitoring plan to be followed by the project activity. Both the emission reduction calculations and the monitoring plan are based on the approved UNFCCC Methodology AMS-I.D, Version 13.

Monitoring data is collected in accordance with the agreement (dated 20/09/2005) done between the project owner and Turkish Electricity Distribution Company (TEDAS) which provides the infrastructure for the connection to the national grid. The metering system is defined in the agreement as two groups: main counter and back up counter. The design of the metering system is checked and approved by TEDAS before commissioning of the plant. The technical specifications of the power meters should be in line with Measure and Metering Devices Regulation² by Ministry of Industry and Trade. In addition, the Communiqué for Power Meters announced by Energy Market Regulations Authority (EMRA)³ requires all meters to be in line with either Turkish Standards Institution⁴ or International Electro-technical Commissions Standards. The meters are placed at the point the electricity is fed to the grid and sealed on behalf of the both parties.

For the sale of the electricity generated, as per the previous prevalent practice, TEDAS officers accompanied by a representative of the project owner noted the readings of two power meters at the end of each month. If no dispute is in question, the project owner issued an invoice for the sale of net electricity exported to the grid as the same amount printed in the official report. The measurement of the electricity export was done by energy meters of Actaris make, that had been calibrated before installation.

Now a new system of monitoring the electricity export has been introduced all across Turkey. Under the new procedures, the energy meters measuring electricity export are connected to the TEDAS system and online meter reading are taken by TEDAS/ AYDEM officials. Copies of the periodic break-up of electricity data are also provided to the project owner in a soft copy format and the electricity export data is also available in the online portal as PMUM records, based on which an invoice is raised by the company. For this online measurement system, the energy meters mentioned above have been replaced with energy meters of Elster make to facilitate the online meter reading from remote locations on 18th April 2011. These meters have been calibrated before installation. There have been no performance issues with the same meters since installation and hence the same have not been replaced or repaired or calibrated again for the duration of the monitoring period.

This method of online meter reading is comparatively more efficient, reliable, consistent and accurate, as it eliminates the degree of human error and ensures consistency of monitoring practices as well as effective management of time and resources.

The project activity has also made positive contributions to the local populace on a socio-economic level by means of several activities including employment of personnel from the region, provision of infrastructure and amenities to a local school, as well as augmentation of the technical knowledge of the people by provision of various trainings to the plant personnel, as evident from the records of the training programs.

² <http://www.mevzuat.adalet.gov.tr/html/21179.html>

³ <http://www.epdk.gov.tr/mevzuat/teblig/elektriksayac.htm>

⁴ <http://www.tse.org.tr/english/tsedefault1.asp>

Monitoring Responsibilities:

Responsibilities of various officials in the Monitoring Plan have been briefly indicated below:

- Shift Operator (MEGE): measures the operating data for each shift
- Chief Engineer (MEGE): reviews the measured data
- General Manager (MEGE): checks the online portals for electricity export and import and verifies it with the plant records with support from the Chief Engineer
- Carbon Manager (SPC): works closely with the General Manager and Chief Engineer of MEGE to collect the data, calculate and report the GHG ERs, as well as facilitate the project verification by a DOE

3. Monitoring Results

3.1. Monitoring period

This is the third monitoring report of this project activity. It covers the period 01/08/2010 to 31/08/2011.

3.2. Presentation of monitoring results

All monitoring data is available in an Excel spreadsheet. The spreadsheet includes:

- 1) Monthly electricity export and input data from the PMUM online portal records
- 2) Operating hours of the back-up engine

3.3. Monitoring data used

The net electricity exported to the grid and imported from the grid has been monitored by TEDAS (Turkish Electricity Distribution Company)/ AYDEM by monthly online energy meter readings and has been reflected in the PMUM records on the online portal. As the energy meters are placed in the connection point to the grid, the electricity export data shall already include the deduction of the auxiliary consumption and transmission losses from the electricity generation.

The electricity exported by the project activity as per the official PMUM records from the online portal have been taken as the basis to the emission calculations. In order to be conservative, the electricity imported is subtracted from the electricity exported before emission reduction calculations.

Data / Parameter:	EGy
Data unit:	MWh
Description:	Net electricity exported to the grid in the year y
Source of data to be used:	Monthly official electricity export and import figures are sourced from the PMUM records available on an online portal. The calculation of emission reductions in the monitoring protocols shall be based on the net electricity fed to the grid which is calculated by subtracting the net import from net export.
Description of measurement methods and procedures to be applied:	Measured continuously by a power meter and recorded monthly by monitoring employees of TEDAS/ AYDEM by means of online meter readings. Only the net electricity export to the grid shall be taken into account. This means that the monitoring measurement method shall exclude electricity imported from the grid by the project activity and possible transmission losses.
QA/QC procedures to be applied:	- Exported electricity to the grid is measured by a kilowatt meter which is controlled by the electricity distribution company (TEDAS/ AYDEM). - Trained and qualified staff is responsible for recording electricity export data from the kilowatt meter. - A spare meter is used for crosschecking the accuracy and both meters are calibrated if required. - Meters have been maintained/ replaced periodically according to national regulations. - As mentioned earlier in section 2, TEDAS/ AYDEM officials have commenced a comparatively more reliable and accurate procedure of online electricity meter readings on a monthly basis and provide a soft copy of the break-up to the project owner and indicate the same in an online portal (PMUM records). These values are used for GHG ER calculations.
Any comment:	

Data / Parameter:	PE_{Dcons}
Data unit:	Tons
Description:	Diesel consumed from running the diesel generator
Source of data to be used:	Plant Records
Value of data	Value of data would be used to calculate project emissions only if emissions contribute to more than 1%.
Description of measurement methods and procedures to be applied:	Diesel Consumption has been calculated on the basis of monitored operating hours on the diesel generator engine and its default consumption.
QA/QC procedures to be applied:	Data has been collected by qualified plant staff monthly and reported on an annual basis.
Any comment:	Consumption from the engine is expected to be negligible (below 1% of the total emission reductions)

3.4. Metering equipment accuracy

The calibration and maintenance of the two power meters in the Aydin Salavatli Dora-1 Geothermal Power Plant are done by Turkish Electricity Distribution Company (TEDAS). Both meters are jointly inspected and sealed on behalf of the officers and the plant operator. They are not interfered with by either party except in the presence of the other party. The energy meters (both main and spare) measuring the have replaced by TEDAS/ AYDEM on 18th April 2011 to facilitate the online meter reading.

The model and the technical characteristics of the power meters are summarized in the table below.

Specification	Explanation
Brand Name	ELSTER
Type	A1500
Serial Number	424848 (main meter)/ 424849 (spare meter)
Connection Type	3 phases-4 wires
Accuracy Class	Active CI 0.5S; Reactive CI 2.0
Voltage (Volt)	3 x 58/100V
Current (Amper)	1 A

Third chapter of the Communiqué for power meters defines the standard and accuracy classes of the power meters in accordance with the transmission line capacity.

Capacity of the transmission line	Greater than 100 MVA	100 MVA -10 MVA	Lower than 10 MVA
Active power meters	IEC-EN 60687 0.2S class	IEC-EN 60687 0.5S class	IEC-EN 60687 0.5 class
Reactive power meters	IEC-EN 61268 2 class	IEC-EN 61268 2 class	IEC-EN 61268 2 class

The capacity of the transmission line connected is 34.5 kVA, therefore the power meters should have the accuracy class 0.5S for active meters and 2 for reactive meters. The

power meters used in the plant are in line with the requirements as presented in the table above.

During the present monitoring period, the energy meters of Actaris make have been replaced with energy meters of Elster make to facilitate the online meter reading from remote locations on 18th April 2011. These meters have been calibrated before installation. There have been no performance issues with the same meters since installation and hence the same have not been replaced or repaired or calibrated again for the duration of the monitoring period.

The periodical maintenance is under the responsibility of TEDAS and has been fixed as once in 10 years in accordance with Article.9 of Measure and Metering Devices Regulation⁵.

3.5.Calculation methodology

The emission reductions of the Project have been calculated in accordance with the approved small scale CDM-methodology AMS-I.D.: "Grid connected renewable electricity generation", version 13. For baseline calculations the AMS-I.D refers to the "Tool to calculate the emission factor for an electricity system", which offers two options of which the Combined Margin (CM) approach has been chosen. The CM consists of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the above-mentioned tool.

Emission Reductions = Baseline Emissions – Project Emissions

Baseline Emissions:

$$BE_y = (EG_y - EG_{baseline}) * EF_{grid,CM,y}$$

Where,

Parameter	SI Unit	Description
BE_y	tCO ₂ e	Baseline Emission in year y
$EF_{grid,CM,y}$	tCO ₂ e/MWh	Combined margin CO ₂ emission factor for grid connected power generation in year y
EG_y	MWh	Electricity supplied by the project activity to the grid
$EG_{baseline}$	MWh	Baseline electricity supplied to the grid in the case of modified or retrofit facilities

$EF_{grid,CM}$ has been calculated as 0.591 tCO₂/MWh for the crediting period. The detailed calculations could be found on the validated VCS PD.

Project Emissions:

The project emissions comprise the emissions from diesel generator and are accountable only if they contribute to more than 1% of baseline emissions.

The technical specifications of the generator could be found in Annex.2. The generator has an installed power of 250 kW and consumes 200 g fuel per kWh in full load.

The diesel consumption is calculated by the formula below:

$$PE_{Dcons} = Cap_{DE} * T * CF$$

⁵ <http://www.mevzuat.adalet.gov.tr/html/21179.html>

Where,

Parameter	SI Unit	Description
PE_{Dcons}	T	<i>Diesel consumed from running the diesel generator</i>
Cap_{DE}	kW	<i>Installed capacity of the diesel engine</i>
T	H	<i>Operating time of the engine</i>
CF	t/kWh	<i>Consumption factor for fuel.</i>

Project emission is calculated by multiplying the fuel consumption by the emission factor which is calculated in accordance with the values for gas/diesel oil printed in IPCC guidelines⁶.

$$EF_{diesel} = NCV * COEF_{diesel}$$

Where,

Parameter	SI Unit	Description
EF_{diesel}	tCO_2e/t	<i>Tonne of CO_2 produced per tonne of fuel consumed.</i>
NCV	TJ/kg	<i>Net calorific value for diesel</i>
$COEF_{diesel}$	kg/TJ	<i>Tonne of CO_2 produced per energy produced.</i>

3.6.Emission reductions

Emission Reductions = Baseline Emissions – Project Emissions

The calculated emission reductions achieved by the project activity within the present monitoring period amount to 29,995 tCO₂e.

Emission Reduction Estimates Vintage Break-up:

2010: 11,476

2011: 18,519

Total: 29,995

⁶ Table 1.2. Default NCVs and Table 1.4 .Default CO₂ Factors for Combustion in the Energy Industries, Vol.2. Energy, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf)

4. Summary of Monitoring Data and Results

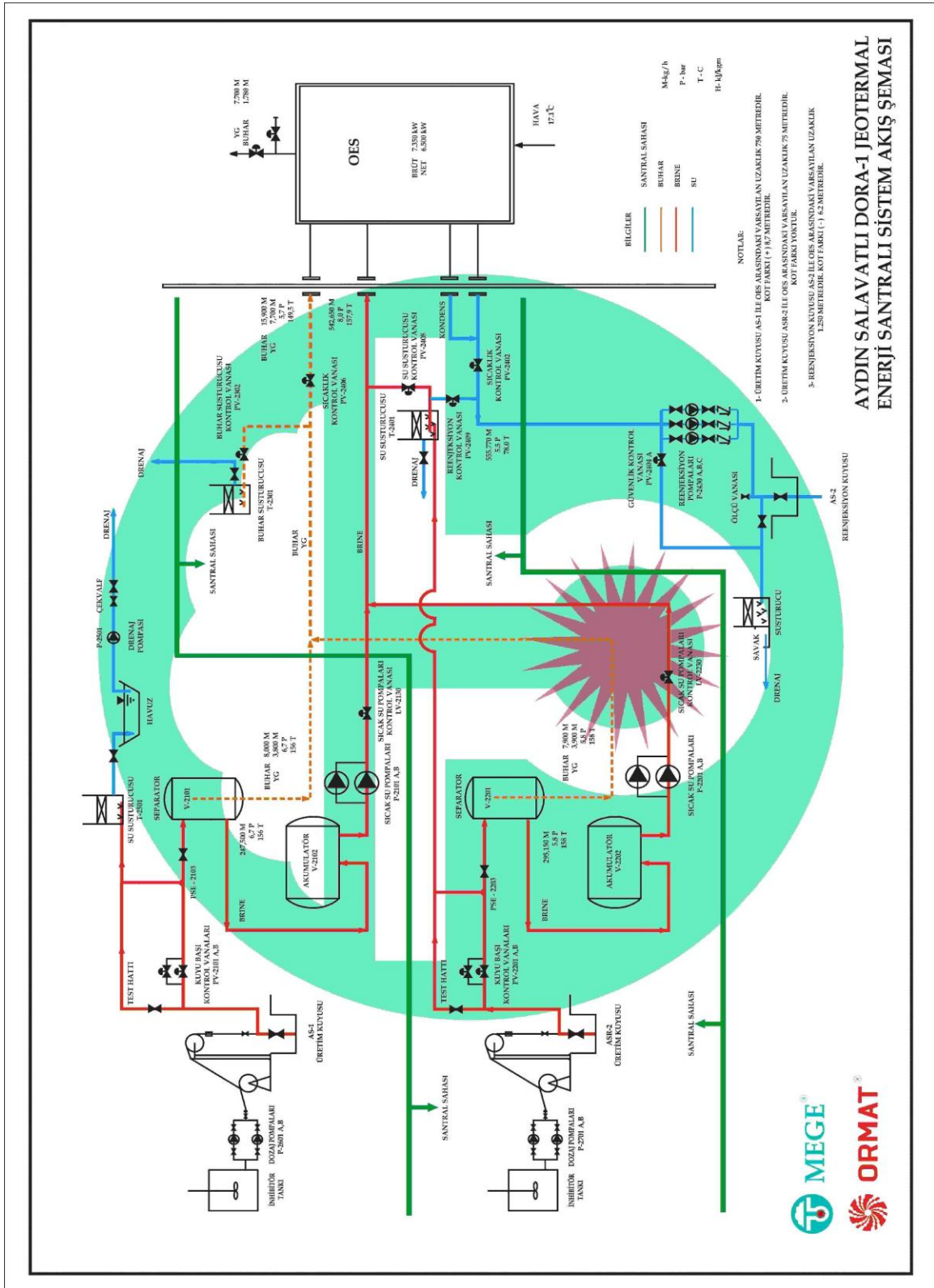
A summary of monitoring data and emission reductions based on aggregated data on a monthly basis are provided in the table below:

			Official Records (PMUM)		Calculations		
Sl. No.	Year	Month	Net Electricity exported (kWh)	Net electricity imported (kWh)	Balance of Net electricity Exported to the Grid (kWh)	GHG Emission Factor (tCO2/MWh)	Emission Reductions (tCO2e)
1	2010	August	3,210,795	656	3,210,139	0.591	1,897
2		September	3,516,206	488	3,515,718	0.591	2,078
3		October	4,209,937	1,980	4,207,957	0.591	2,487
4		November	4,068,691	3,200	4,065,491	0.591	2,403
5		December	4,425,070	5,810	4,419,260	0.591	2,612
Sub-Total-2010			19,430,699	12,134	19,418,565		11,476
6	2011	January	4,818,744	1,109	4,817,635	0.591	2,847
7		February	4,185,720	1,940	4,183,780	0.591	2,473
8		March	4,619,651	1,096	4,618,555	0.591	2,730
9		April	4,290,754	302	4,290,451	0.591	2,536
10		May	3,965,825	1,751	3,964,073	0.591	2,343
11		June	3,423,420	895	3,422,525	0.591	2,023
12		July	3,095,228	1,613	3,093,615	0.591	1,828
13		August	2,947,392	2,444	2,944,948	0.591	1,740
Sub-Total-2011			31,346,734	11,151	31,335,583		18,519
Total			50,777,433	23,285	50,754,148		29,995

Parameter	Unit	Value	Comments
Initial Operating hours	hrs	306.23	Plant Records
Final Operating hours	hrs	364.44	Plant Records
Operating hours	hrs	58.21	Calculated
Capacity of Engine	kW	250	Technical Data
Consumption Factor	tonnes/ kWh	0.0002	Technical Data
Diesel Consumption	tonnes	2.9105	Calculated
NCV of Diesel	TJ/Gg	43	IPCC
Carbon Emission factor of Diesel	kg/TJ	74100	IPCC
Emission Factor for Diesel	tCO ₂ / ton	3.186	Calculated
GHG Emissions from Diesel	tCO ₂	9	Calculated
As a% of total Emission Reductions	%	0.03	Calculated

As the GHG emissions from diesel consumption in the DG set is less than 1% of the GHG emissions from the project activity for the same period, the same may be neglected.

Annex.1 Process Flow Chart



Annex.2. Technical Specifications of the Generator

TAD740GE

Technical Data

General

Engine designation	TAD740GE
No. of cylinders and configuration	In-line 6
Method of operation	4-stroke
Bore, mm (in.)	107 (4.21)
Stroke, mm (in.)	135 (5.31)
Displacement, l (in ³)	7.28 (445)
Compression ratio	17.2:1
Dry weight, kg (lb)	901 (1987)
With Gen Pac, kg (lb)	1128 (2487)
Wet weight, kg (lb)	964 (2126)
With Gen Pac, kg (lb)	1196 (2637)

Performance

with fan, kW (hp)	1500 rpm	1800 rpm
Prime Power	220 (299)	226 (310)
Max Standby Power	242 (329)	251 (341)

Lubrication system

Oil consumption, liter/h (US gal/h)	1500 rpm	1800 rpm
Prime Power	0.04 (0.011)	0.05 (0.013)
Max Standby Power	0.05 (0.013)	0.06 (0.016)
Oil system capacity incl filters, liter (US gal)	29 (7.7)	
Oil change intervals at specification		
VDS-2, h	600	
VDS, ACEA E3, h	400	
ACEA E1, E2, API CD, CF, CF-4, CG-4, h	200	

Fuel system

Spec. fuel consumption at		
Prime Power, g/kWh (lb/hph)	1500 rpm	1800 rpm
25 %	227 (0.368)	230 (0.373)
50 %	200 (0.324)	205 (0.330)
75 %	198 (0.321)	199 (0.323)
100 %	200 (0.324)	200 (0.324)
Max Standby Power, g/kWh (lb/hph)		
25 %	219 (0.355)	230 (0.373)
50 %	200 (0.324)	203 (0.329)
75 %	198 (0.321)	199 (0.323)
100 %	201 (0.326)	202 (0.328)

Intake and exhaust system

Air consumption at 27°C, m ³ /min (cfm)	1500 rpm	1800 rpm
Prime Power	14.7 (519)	17.6 (622)
Max Standby Power	15.6 (551)	18.6 (657)
Max allowable air intake restriction, kPa (In wc)	5 (20.1)	
Heat rejection to exhaust, kW (BTU/min)	1500 rpm	1800 rpm
Prime Power	160 (9099)	164 (9327)
Max Standby Power	180 (10237)	184 (10464)
Exhaust gas temperature after turbine, °C (°F)	1500 rpm	1800 rpm
Prime Power	525 (977)	470 (878)
Max Standby Power	540 (1004)	485 (905)
Max allowable back-pressure in exhaust line, kPa (In wc)	10 (40.2)	
Exhaust gas flow, m ³ /min (cfm)	1500 rpm	1800 rpm
Prime power	39.2 (1384)	43.0 (1519)
Max Standby Power	41.8 (1476)	46.3 (1635)

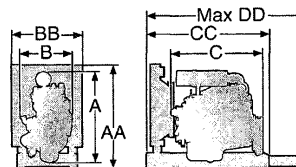
Cooling system

Heat rejection radiation from engine, kW (BTU/min)	1500 rpm	1800 rpm
Prime Power	13 (737)	13 (737)
Max Standby Power	15 (850)	15 (850)
Heat rejection to coolant, kW (BTU/min)		
Prime Power	99 (5630)	99 (5630)
Max Standby Power	106 (6028)	110 (6256)
Fan power consumption, kW (hp)	5 (7)	8 (11)

Standard equipment

Engine	Gen Pac
Automatic belt tensioner	*
Lift eyelets	*
Flywheel	*
Flywheel housing with conn. acc. to SAE 2	*
Flywheel for 11.5" flex. plate and flexible coupling	*
Vibration damper	*
Engine suspension	*
Fixed front suspension	*
Lubrication system	*
Oil dipstick	*
Full-flow oil filter of spin-on type	*
By-pass oil filter of spin-on type	*
Oil cooler, side mounted	*
Fuel system	*
Twin fuel filters of disposable type	*
Flexible fuel lines	*
Fuel injection pump, Bosch, with electronic actuator	*
Intake and exhaust system	*
Air filter with replaceable paper insert	*
Air restriction indicator	*
Air cooled exhaust manifold	*
Connecting flange for exhaust line	*
Turbo charger	*
Heat guard for exhaust pipe and turbo	*
Crankcase ventilation	*
Cooling system	*
Tropical radiator including intercooler	*1)
Radiator guard	*
Gear driven coolant pump	*
Fan hub	*
Thrust fan	*
Fan guard	*
Belt guard	*
Alternator	*
Alternator 60A / 24V low, right side	*
Starting system	*
Starter motor, Bosch 5.4kW / 24V	*
Electrical wiring	*
Cable iron	*
Instruments and senders	*
Temp. and oil pressure for automatic stop/alarm 103°C	*
Other equipment	*
Expandable base frame	*
Engine Packing	*
Plastic wrapping	*

1) must be ordered, see order specification - optional equipment
 - optional equipment or not applicable
 * included in standard specification



A* = 1375 mm / 54.0 in
 B* = 945 mm / 37.2 in
 C* = 1697 mm / 66.8 in
 *Incl. radiator & intercooler

AA = 1490.5 mm / 58.7 in
 BB = 945 mm / 37.2 in
 CC = 1732 mm / 68.2 in
 DD = 2722 mm / 107.2 in

Note! The engine illustrated may not be entirely identical to production standard engines.

Power Standards

The engine performance corresponds to ISO 3046, BS 5514 and DIN 6271. The technical data applies to an engine without cooling fan and operating on a fuel with calorific value of 42.7 MJ/kg (10360 BTU/lb) and a density of 0.84 kg/liter (7.01 lb/US gal), also where this involves a deviation from the standards. Power output guaranteed within 0 to +2% at rated ambient conditions at delivery. Ratings are based on ISO 8528. Engine speed governing in accordance with ISO 3046/IV, class A1 and ISO 8528-5 class G3

Exhaust emissions

The engine complies with EPA / CARB - Tier 1 and TA-luft exhaust emission regulations.

Rating Guidelines

PRIME POWER rating corresponds to ISO Standard Power for continuous operation. It is applicable for supplying electrical power at variable load for an unlimited number of hours instead of commercially purchased power. A10 % overload capability for governing purpose is available for this rating. MAXIMUM STANDBY POWER rating corresponds to ISO Standard Fuel Stop Power. It is applicable for supplying standby electrical power at variable load in areas with well established electrical networks in the event of normal utility power failure. No overload capability is available for this rating. 1 hp = 1 kW x 1.36

Information

For more technical data and information, please look in the Generating Set Engines Sales Guide.

VOLVO PENTA

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