Technical File
for 3600 Marine Engine
@ 900 & 1000 RPM

(Engine Family 3600A900&1000)

Engine Model	**3616**
Engine Serial No.	**1PD00596**
Performance Spec.	**0K-9295**
GL Family Approval No.	**64411-06 HH**

Do Not Discard
This Document is to be kept on board.

GL EMISSION CERTIFICATION
H.-J. Rein C. Kurok
Hamburg 2010-01-15 Approval No.: 92302-09 HH

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3600 Engine Part Number Table (continued)*

Performance Specification		0K3618	0K3618	0K3690	0K3648	0K3648	0K3230	0K7374
Engine Rating (Advertised)	Application	GS	GS	GS	GS	GS	GS	GS
	Rpm	900	900	900	1000	1000	900	900
	BkW	1900	1900	1900	2710	2710	2530	1730
	(bhp)	(2548)	(2548)	(2548)	(3634)	(3634)	(3393)	(2320)
	Cycle	D2, E2	D2, E2	D2, E2	D2, E2	D2, E2	D2, E2	D2
Engine Model	Part Number	3606	3606	3606	3608	3608	3608	3606
Compression Ratio		13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1
Static Timing	Deg.	15.0	12.5	12.5	15.0	12.5	13.5	11.5
Piston	Part Number	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700
Cylinder Head	Part Number	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827
Camshaft	Part Number	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169
Aftercooler	Part Number	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625
Turbocharger Basic Group	Part Number	157-5514	157-5514	157-5514	200-8031 258-2288 284-8277	200-8031 258-2288 284-8277	175-6670 258-2292 284-8277 284-8281	4P-3102
Injector	Part Number	1842527 2249090	2249090	2249090	1842527 2249090	2249090	1842527 2249090	2249090

GS = Generator Set

*** Note; Replacement part may change**

The part numbers of the components listed above were valid in November 2007, but may change over time. They may not necessarily be the specific part numbers that this engine was shipped with. See also section "Record Changes to Emission Related Components".

3600 Engine Part Number Table (continued)*

Performance Specification		0K4739	0K3666	0K3589	0K7005	0K2442	0K7408	0K3252
Engine Rating (Advertised)	Application	GS	GS	GS	GS	GS	GS	GS
	Rpm	1000	1000	1000	1000	1000	1000	1000
	BkW	2030	2030	2030	1900	2030	1850	2020
	(bhp)	(2722)	(2722)	(2722)	(2548)	(2722)	(2481)	(2709)
	Cycle	D2, E2	D2, E2	D2, E2	D2, E2	D2, E2	D2, E2	D2
Engine Model	Part Number	3606	3606	3606	3606	3606	3606	3606
Compression Ratio		13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1
Static Timing	Deg.	12.0	12.0	12.0	12.0	12.5	12.0	14.5
Piston	Part Number	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700
Cylinder Head	Part Number	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827
Camshaft	Part Number	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169
Aftercooler	Part Number	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625
Turbocharger Basic Group	Part Number	1894427	1894427	1894427	1894427	1894427	1894427	1894427
Injector	Part Number	2249090	2249090	2249090	2249090	2249090	2249090	2249090

GS = Generator Set

*** Note; Replacement part may change**

The part numbers of the components listed above were valid in November 2007, but may change over time. They may not necessarily be the specific part numbers that this engine was shipped with. See also section "Record Changes to Emission Related Components".

3600 Engine Part Number Table (continued)*

Performance Specification		0K3230	0K3299	0K3299	0K3691	0K3548	0K7415
Engine Rating (Advertised)	Application	GS	GS	GS	GS	GS	GS
	Rpm	900	900	900	900	1000	1000
	BkW	2530	2530	2530	2530	2710	2710
	(bhp)	(3393)	(3393)	(3393)	(3393)	(3634)	(3634)
	Cycle	D2, E2	D2, E2	D2, E2	D2, E2	D2, E2	D2, E2
Engine Model	Part Number	3608	3608	3608	3608	3608	3608
Compression Ratio		13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1
Static Timing	Deg.	11.0	13.5	11.0	11.0	15.0	15.0
Piston	Part Number	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700
Cylinder Head	Part Number	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827
Camshaft	Part Number	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169
Aftercooler	Part Number	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625
Turbocharger Basic Group	Part Number	175-6670 258-2292 284-8277 284-8281	175-6670 258-2292 284-8277 284-8281	175-6670 258-2292 284-8277 284-8281	175-6670 258-2292 284-8277 284-8281	200-8031 258-2288 284-8277	200-8031 258-2288 284-8277
Injector	Part Number	2249090	1842527 2249090	2249090	2249090	2249090	2249090

GS = Generator Set

*** Note; Replacement part may change**

The part numbers of the components listed above were valid in November 2007, but may change over time. They may not necessarily be the specific part numbers that this engine was shipped with. See also section "Record Changes to Emission Related Components".

3600 Engine Part Number Table (continued)*

Performance Specification		0K5544	0K7429	0K3653	0K6313	0K2979	0K1948	0K8393
Engine Rating (Advertised)	Application	GS	GS	GS	GS	GS	GS	GS
	Rpm	900	1000	1000	1000	900	900	900
	BkW	2300	2460	2460	2710	2605	2312	2300
	(bhp)	(3048)	(3299)	(3299)	(3634)	(3493)	(3100)	(3048)
	Cycle	D2, E2	D2, E2	D2, E2	D2, E2	D2	D2, E2	D2, E2
Engine Model	Part Number	3608	3608	3608	3608	3608	3608	3608
Compression Ratio		13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1
Static Timing	Deg.	11.0	12.5	12.5	12.5	14.0	10.5	11.0
Piston	Part Number	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700
Cylinder Head	Part Number	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827
Camshaft	Part Number	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169
Aftercooler	Part Number	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625	175-2277 264-0167 299-5625
Turbocharger Basic Group	Part Number	175-6670 258-2292 284-8277 284-8281	2582288	1948722 2582287 2848276	200-8031 258-2288 284-8277	1763598	1794688	2848281
Injector	Part Number	2249090	2249090	2249090	2249090	2249090	2249090	2249090

GS = Generator Set

*** Note; Replacement part may change**

The part numbers of the components listed above were valid in November 2007, but may change over time. They may not necessarily be the specific part numbers that this engine was shipped with. See also section "Record Changes to Emission Related Components".

3600 Engine Part Number Table (continued)

Performance Specification		0K3233	0K3234	0K3243	0K3576	0K3577 0K8083	0K3597	0K6343	0K7433
Engine Ratings (Advertised)	rpm	1000	1000	900	900	900	900	1000	900
	BkW	3140	3140	3460	3460	3460	3800	3700	3112
	bhp	*4211*	*4211*	*4640*	*4640*	*4640*	*5096*	*4962*	*4173*
	Cycle	D2	D2	D2 E2	D2 E2	D2 E2	D2	D2 E2	D2 E2
Engine Ratings (Overload) NOTE: Applies to Marine Auxiliary Engines Only	rpm	1000	1000	900	900	900	900	1000	900
	BkW	3140	3140	3460	3460	3460	4180	4060	3425
	bhp	*4211*	*4211*	*4640*	*4640*	*4640*	*5605*	*5445*	*4593*
Engine Model	Part Number	3612	3612	3612	3612	3612	3612	3612	3612
Compression Ratio		13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1
Static Timing	Deg.	14.5	14.5	15	15	12.5	12.5	20	12.5
Piston	Part Number	1976700 2183589 1726772 3142700	1976700 2183589 1726772 3142700	1976700 2183589 1726772 3142700	1976700 2183589 1726772 3142700	1976700 2183589 1726772 3142700	1976700 2183589 1726772 3142700	1976700 2183589 1726772 3142700	1976700 2183589 1726772 3142700
Cylinder Head	Part Number	2421827 2525580 7E9001	2421827 2525580 7E9001	2421827 2525580 7E9001	2421827 2525580 7E9001	2421827 2525580 7E9001	2421827 2525580 7E9001	2421827 2525580 7E9001	7E9001 2421827 2525580
Camshaft	Part Number	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169
Aftercooler	Part Number	1725633 1855776	1725633 1855776	1725633 1855776	1725633 1855776	1725633 1855776	1725633 1855776	1725633 1855776	1725633 1855776
Turbocharger Basic Group	Part Number	2002571	2002571	1575514	1575514	1575514	1575514	1894427	1575514
Injector	Part Number	2249090	2249090	2249090	2249090	2249090	1374729 2249090	2249090	2249090
Personality Module	Part Number	NA	NA	NA	NA	NA	NA	NA	NA

3600 Engine Part Number Table (continued)*

Performance Specification		0K4757	0K7387	0K4787	0K-3112	0K3689	0K7434	0K7419	0K3699	0K9178
Engine Rating (Advertised)	Application	GS	GS	GS	GS	GS	GS	GS	GS	GS
	Rpm	900	900	900	900	900	900	900	1000	1000
	BkW	3800	3800	3460	3460	5060	5060	5060	5420	5417
	(bhp)	(5096)	(5096)	(4640)	(4640)	(6786)	(6786)	(6786)	(7268)	(7264)
	Cycle	D2	D2	D2, E2	D2, E2	D2, E2	D2, E2	D2, E2	D2, E2	D2
Engine Model	Part Number	3612	3612	3612	3612	3616	3616	3616	3616	3616
Compression Ratio		13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1
Static Timing	Deg.	10.0	10.0	10.5	15.0	15.0	12.5	12.5	15.0	11.0
Piston	Part Number	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	172-6772 1976700 218-3589 314-2700	1726772 2183589 3142700
Cylinder Head	Part Number	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827	7E9001 2421827
Camshaft	Part Number	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169	7E7169
Aftercooler	Part Number	185-5776 172-5633	185-5776 172-5633	185-5776 172-5633	185-5776 172-5633	172-5633	172-5633	172-5633	172-5633	1305632
Turbocharger Basic Group	Part Number	1575514	1575514	1575514	1575514	1948722 2582287 2848276	1948722 2582287 2848276	1948722 2582287 2848276	200-8031 258-2288 284-8277	2848277
Injector	Part Number	2249090	2249090	2249090	184-2527	2249090	2249090	2249090	2249090	2249090

GS = Generator Set

*** Note; Replacement part may change**

The part numbers of the components listed above were valid in November 2007, but may change over time. They may not necessarily be the specific part numbers that this engine was shipped with. See also section "Record Changes to Emission Related Components".

3600 Engine Part Number Table (continued)*

Performance Specification		0K9295	0K9180	0K5520	0K9252
Engine Rating (Advertised)	Application	GS	GS	GS	GS
	Rpm	900	900	1000	900
	BkW	4600	2530	2860	5060
	(bhp)	(6169)	(3393)	(3835)	(6786)
	Cycle	D2	D2	D2	D2 E2
Engine Model	Part Number	3616	3608	3608	3616
Compression Ratio		13.0:1	13.0:1	13.0:1	13.0:1
Static Timing	Deg.	12.0	11.0	12.5	12.0
Piston	Part Number	3142700	3142700	3142700	3142700
Cylinder Head	Part Number	2421827	2421827	2421827	2421827
Camshaft	Part Number	7E7169	7E7169	7E7169	7E7169
Aftercooler	Part Number	1725633	1752277 2640167 2995625	1752277 2640167 2995625	1725633
Turbocharger Basic Group	Part Number	2848281	2848281	1948722	2848281
Injector	Part Number	2249090	2249090	2249090	2249090

Installation Requirements

The following installation requirements must be met at rated load and speed with 25 °C ambient seawater temperature to enable the engine to comply with the nitrogen oxides (NOx) emission limits of Regulation 13 of Annex VI of MARPOL 73/78:

Max. Jacket Water Outlet Temperature	92 °C (198 °F)
Max. Aftercooler Water Temperature (With 25 °C seawater temperature)	38 °C (100 °F)
Maximum Air Inlet Restriction	3.7 kPa (15" Water Column)
Maximum Exhaust Backpressure	2.50 kPa (10" Water Column)

Engine Performance

The rated speed and rated power of the engine is included on the engine information nameplate. This nameplate is located on the right rear corner of the engine (as viewed from the flywheel end).

Engine Emissions

Emissions data measurement is consistent with the procedures described in Resolution 2 of the 1997 MARPOL Conference "Technical Code on Control of Emissions of Nitrogen Oxides from Marine Diesel Engines". This engine's exhaust emissions are in compliance with the International Maritime Organization's Regulation 13 of Annex VI to the MARPOL 73/78 Convention. The NOx limit for the engines in this family is 11.3 g/kw-hr.

Engine Parameter Check Method

Introduction:

The engine parameter check method that follows shall be used by the surveyor to verify that the engine, as installed on board the ship, complies with the nitrogen oxides (NOx) emission limits of Regulation 13 Annex VI of MARPOL 73/78. This method is to be used for the initial certification survey, periodic and intermediate surveys, and initial engine's certification survey. This Technical File shall for part of the Engine Air Pollution Presentation certificate (EAPP) issued under the provisions of MARPOL Annex VI, as Statement of Compliance (SOC), which is valid until entry into force of Annex VI. After entry into force date the SOC shall be transferred into the official "Engine International Air Pollution Prevention certificate" (EIAPP) to be issued by the vessel's flag state administration or a recognized organization acting on their behalf.

Procedures:
The procedures listed below are detailed on the following pages. They can be used to demonstrate compliance with the NOx emissions limits.

Steps of Engine Parameter Check Method:

1. Check Engine Parameter
2. Identify Emission-Related Engine Components
3. Record Changes to Emissions Related Components
4. Identify Adjustable Features
5. Record Changes to Adjustable Features

1. Check Engine Parameters:

The adjustable engine parameter of this engine is:

- Low Idle Engine Speed

Note:
Refer to engine Troubleshooting Manual for instructions on how to determine the value of this parameter. Minimum low idle engine speed is 300 rpm. Maximum low idle engine speed is 63 per cent of rated speed.

Record this item in the table below:

Documentation Inspection of Engine Parameters

Date	Actual Value	Allowable Range	Item	Approved By:
			Low Idle Engine Speed	

2. Identify Emission-Related Engine Components:

The table below lists the components that influence the engine's NOx emissions for this engine model. The list under section Engine Part Numbers Table of this document shows the part numbers of those components as shipped from Caterpillar Inc. factories.

Note to surveyor:
The part numbers on the front of this Technical File indicate how the engine was shipped from the factory.

Note to Caterpillar dealers:
Part numbers for the components influencing the NOx can also be found in the Technical Marketing Information (TMI) system by viewing the engine test specification number corresponding to the engine serial number. The engine test specification number is also included on the engine information nameplate of each engine.

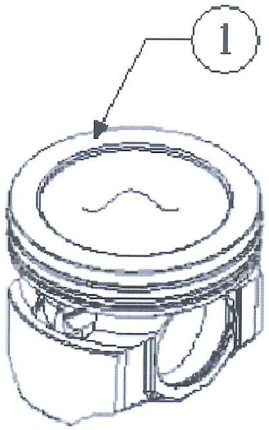
Compare the observed part number with the part number from the tables on pages 3 through 15 to insure that the part numbers are correct for these emissions related components.

Emission Related Component List:

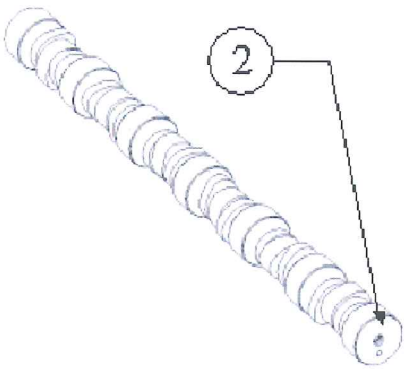
Item	Component Description	Location on Engine Component Part No. Also See Diagrams Below
1	Piston (See Note 1)	On the top of the piston crown assembly
2	Camshaft (See Note 1)	Stamped on the end of the camshaft
3	Injector	Etched on top of the Injector.
4	Aftercooler (See Note 1)	Stamped on the aftercooler core body or mounting flange
5	Turbocharger	On nameplate of turbocharger on center section
6	Personality module software	Not Applicable on mechanically controlled engines
7	Cylinder head	Cast into top surface of head. Visible from above.

Note 1:
Part number not accessible without significant engine disassembly. Therefore it is not necessary to be checked by the surveyor

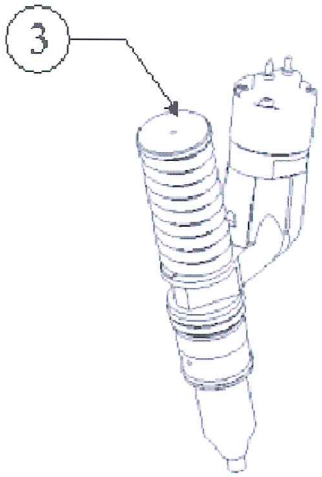
Part Number Locations:



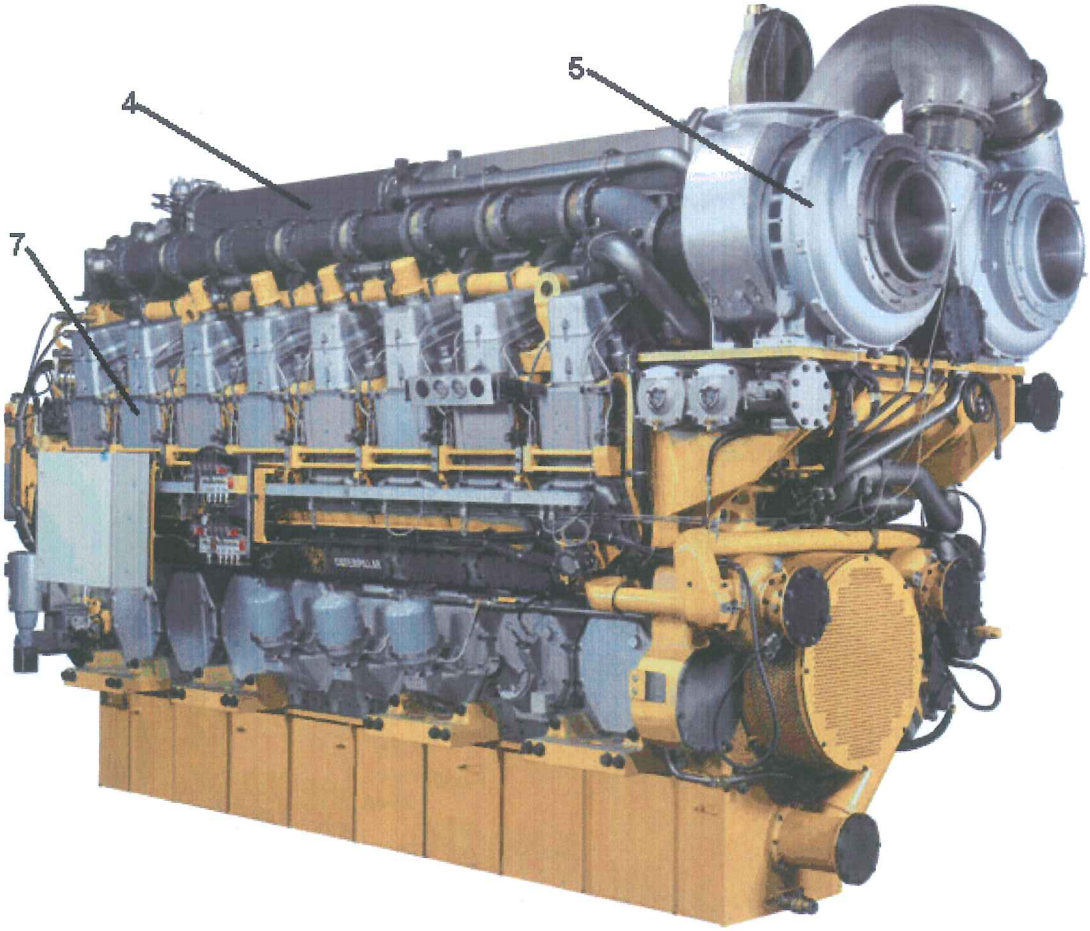
1. Piston



2. Camshaft



3. Injector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5
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3. Record Changes to Emissions-Related Components:

A record must be kept of the changes to the emissions related components listed on the previous table. Use the table below to record these changes in chronological order as they occur.

Note:
Emission related components may only be replaced as listed in this Technical File or otherwise approved by the administration or recognized organization, which has approved the technical file.

Caterpillar recommends emission related components and all other components be replaced with parts approved by your Caterpillar Dealer.

Record Of Changes to Emissions Related Components:

Date of Change	Old Part No.	New Part No.	Component	Manufacturer of Component	Approved By:

4. Identify Adjustable Features:

The table below identifies the full range of adjustable features related to the NOx emissions for this engine.

Note:
The fuel injection timing of this engine is included on the information plate. This plate is located on the right rear corner of the engine (as viewed from the flywheel end).

List of Possible Adjustable Features

Date	Allowable Range	Adjustable Feature
	See Information Plate	Fuel Injection Timing

Remark:
Ensure the feature is adjusted correctly by using the appropriate procedure or have your local Caterpillar dealer make the necessary checks or adjustments.

5. Record Changes to Adjustable Features:

The table below identifies the full range of adjustable features related to the NOx emissions foe this engine.

Note:
The fuel injection timing of this engine is included on the information plate. This plate is located on the right rear corner of the engine (as viewed from the flywheel end).

List of Possible Adjustable Features

Date	Allowable Range	Adjustable Feature

Remark:
Ensure the feature is adjusted correctly by using the appropriate procedure or have your local Caterpillar dealer make the necessary checks or adjustments.

Appendix A: IMO Certification Test Report – D2

Parent Engine

*Engine Information**

Emissions Test Report No.:	**Sheet 1/5**
Engine	
Manufacturer	Caterpillar Inc., Peoria, Illinois, USA
Engine Type	3612
Family or Group identification	3600A900&1000
Serial number	9RC00395
Rated speed	900 rpm
Rated power	3460 kW
Intermediate speed	N/A rpm
Maximum torque at intermediate speed	N/A Nm
Static injection timing	12.5 deg CA BTDC
Electronic injection timing	no
Variable injection timing	no
Variable turbocharger geometry	no
Bore	280 mm
Stroke	300 mm
Nominal compression ratio	13.0:1
Mean effective pressure at rated power	2082 kPa
Maximum cylinder pressure at rated power	16,200 kPa
Cylinder number and configuration	Number: 12 cyl. , V:12
Auxiliaries	2 pumps
Specified ambient conditions:	
Maximum sea water temperature	32 °C
Maximum charge air temperature	45.9 °C
Cooing system spec. intermediate cooler	yes
Cooling system spec. charge air stages	1 stage
Low/high temperature cooling system set points	N/A °C
Maximum inlet depression	-3.7 kPa
Maximum exhaust back pressure	2.50 kPa
Fuel oil specification	IMO DM Fuel
Fuel oil temperature	38 °C
Lubricating Oil specification	Shell Rimula 30W (API CD Service Rating)
Application/Intended for:	
Customer	
Final application/installation, Ship	Ship
Final application/installation, Engine	Auxiliary (Generator Sets)
Emissions test result:	
Cycle	D2
NOx	9.10 g/kW-hr
Test identification	3612 ABS Certification Test
Date/time	20 June 2003. 9:03 AM
Test site/bench	Test Cell 522, Lafayette, Indiana, USA
Test number	
Surveyor	Richard T. McCombs – ABS
Date and Place of report	
Signature	

* If applicable

*Engine Family Information**

Emission Test Report No.:	**Sheet 2/5**
Engine Family Information (Common specifications)	
Combustion cycle	4 stroke cycle
Cooling medium	Water
Cylinder configuration	I6, I8, V12, V16
Method of aspiration	Pressure charged
Fuel type to be used on board	Distillate
Combustion chamber	Open chamber
Valve port configuration	Cylinder head
Valve port size and number	4 valves per cylinder Intake dia.: 90 mm Exhaust dia.: 90 mm
Fuel system type	Mechanical Unit Injector
Miscellaneous features:	
Exhaust gas recirculation	No
Water injection/emulsion	No
Air injection	No
Charge cooling system	Yes
Exhaust after-treatment	No
Exhaust after-treatment type	N/A
Dual fuel	No
Engine Family Information (Selection of parent engine for test bed test	
Family Identification	3600A900&1000
Method of pressure charging	Turbocharged
Charge air cooling system	Combined Circuit Aftercooled
Criteria of the Selection (specify)	Maximum D2 weighted NOx
Number of cylinder (parent)	12
Max. rated power per cylinder (parent)	288 kW
Rated speed	900 rpm
Injection timing (range)	13 to 22.5 °BTDC
Max. fuel parent engine	11324 g/min
Selected parent engine	Parent (3612)
Application	Auxiliary

* If applicable

*Test Cell Information**

Emissions Test Report No.:					**Sheet 3/5**
Exhaust Pipe					
Diameter				495	Mm
Length				35.5	M
Insulation				No	M
Probe Location			762 mm from turbo outlet		
Remark					

Measurement equipment					
	Manufacturer	Model	Measurement	Calibration	
			Ranges	Span gas conc.	Deviation
Analyzer					
NOx Analyzer	Pierburg	CLD-PM2000	0-1700 ppm	1602 ppm	± 1 %
CO Analyzer	Rosemount	BINOS 2000	0-1000 ppm	947 ppm	± 1 %
CO2 Analyzer	Rosemount	BINOS 2000	0-16 %	15.3%	± 1 %
O2 Analyzer	Seimens	OXYMAT 5E	0-25 %	23.87%	± 1 %
HC Analyzer	Pierburg	FID-PM2000	0-2500 ppm C1	799 ppm Propane (2397 ppm C1)	± 1 %
Speed	Schenck	Ex-act	Rpm		± 2 %
Torque	Schenck	Ex-act	Nm		± 0.5 %
Power, if applicable	Schenck	Ex-act	kW		N/A
Fuel flow	Max Machinery	215-310	CC/MIN		± 0.5 %
Air flow	Brandt	N/A	LPM		± 2 %
Exhaust flow	N/A	N/A	N/A		N/A
Temperatures					
Coolant	Omega	CPSS14U6	-200 TO +350%		± 2 %
Lubricant	Omega	CPSS14U6	-200 TO +350%		± 2 %
Exhaust gas	Omega	CPSS-14G-6	-200 TO +350%		± 6 %
Inlet air	Omega	CPSS14U6	-200 TO +350%		± 1 %
Intercooled air	Omega	CPSS14U6	-200 TO +350%		± 2 %
Fuel	Omega	CPSS14U6	-200 TO +350%		± 2 %
Pressures					
Exhaust gas	Viatran	245-AA-GB6-DH	kPa		± 0.5 %
Inlet manifold	Viatran	245-AK-A-BL	kPa		± 0.5 %
Atmospheric	Viatran	PX961-16A5V	kPa		± 0.5 %
Vapor pressure					
Intake air	Viatran	245-AA-GBL-DH	kPa		
Dew Point					
Intake air	Honeywell	4114-A-08-D1-111	Deg C		± 0.2 %

Fuel Characteristics

Fuel type					
Fuel properties:			**Fuel elemental analysis**		
Density (30C)	ISO 3675	0.8496 kg/l	Carbon	86.64	% mass
Viscosity (40 C)	ISO 3104	2.224 mm2/s	Hydrogen	12.81	% mass
			Nitrogen	<0.1	% mass
			Oxygen	0.6	% mass
			LHV/Hu	42.6251	MJ/kg

* If applicable

*Ambient and Gaseous Emissions Data**

Emissions Test Report No.:						**Sheet 4/5**
Mode		1	2	3	4	5
Power/Torque	%	100	75	50	25	10
Speed	%	100	100	100	100	100
Time at beginning of mode		9:03 AM	10:08 AM	10:27 AM	10:56 AM	11:12 AM

Ambient Data						
Atmospheric pressure	kPa	99.5	99.4	99.4	99.6	99.6
Intake air temperature	°C	26	26	26	27	26
Intake air humidity	g/kg	6.7	5.3	5.2	5.1	5.0
Atmospheric factor (fa)		1.009	1.010	1.009	1.013	1.008

Gaseous Emissions Data:						
NOx concentration dry	ppm	873.8	942.42	902.14	696.12	453.33
CO concentration dry	ppm	65.63	98.41	103.28	200.45	294.88
CO2 concentration dry	%	6.11	6.01	5.92	4.9	3.33
O2 concentration dry	%	12.59	12.69	12.76	14.07	16.27
HC concentration wet	ppm	212.82	242.92	263.89	299.28	464.42
NOx humidity correction factor		0.9500	0.9412	0.9404	0.9331	0.9322
Fuel specification factor (FFH)		1.738	1.739	1.739	1.746	1.757
Dry/wet correction factor		0.938	0.939	0.939	0.947	0.960
NOx mass flow	kg/hr	29.269	23.604	15.763	8.000	3.989
CO mass flow	kg/hr	1.409	1.594	1.168	1.503	1.694
CO2 mass flow	kg/hr	2061	1530	1052	577	301
O2 mass flow	kg/hr	NA	NA	NA	NA	NA
HC mass flow	kg/hr	2.584	2.226	1.688	1.269	1.509
SO2 mass flow	kg/hr	NA	NA	NA	NA	NA
NOx specific	g/kWhr	8.42	9.09	9.10	9.27	11.48

* If applicable

*Engine Test Data**

Emissions Test Report No.:						Sheet 5/5
Mode		1	2	3	4	5
Power/Torque	%	100	75	50	25	10
Speed	%	100	100	100	100	100
Time at beginning of mode		9:03 AM	10:08 AM	10:27 AM	10:56 AM	11:12 AM

Engine Data						
Speed rpm		900	900	900	900	900
Auxiliary power kW		0	0	0	0	0
Dynamometer setting Nm		36899	27562	18383	9164	3685
Power	kW	3461.4	2594.4	1733.9	865.4	348.2
Mean effective pressure bar		2092	1562	1042	519	209
Fuel rack mm		7.80	4.50	1.10	-2.30	-4.30
Uncorrected spec. fuel consumption g/kWhr		195.38	194.7	202.74	226	299.1
Fuel flow kg/hr		679	505	351	195	103
Air flow kg/hr		23075	17394	12141	8017	6106
Exhaust flow (gexhw) kg/hr		23755	17900	12493	8212	6210
Exhaust temperature °C		527	502	481	389	288
Exhaust back pressure mbar		10	7	4	3	2
Cylinder Coolant temperature out °C		91	90	88	83	71
Cylinder Coolant temperature in °C		86	86	85	80	69
Cylinder Coolant pressure	bar	361	358	355	351	353
Aftercooler Coolant temperature in °C		32	32	32	29	28
Temperature intercooled air °C		43	41	40	37	34
Lubricant temperature °C		81	81	80	80	79
Lubricant pressure	bar	445	451	460	472	482
Inlet depression mbar		-37	-21	-11	-5	-3

* If applicable

Appendix A: IMO Certification Test Report – E2

Parent Engine

*Engine Information**

Emissions Test Report No.:	**Sheet 1/5**
Engine	
Manufacturer	Caterpillar Inc., Peoria, Illinois, USA
Engine Type	3608
Family or Group identification	3600A900&1000
Serial number	6MC00727
Rated speed	1000 rpm
Rated power	2460 kW
Intermediate speed	N/A rpm
Maximum torque at intermediate speed	N/A Nm
Static injection timing	12.5 deg CA BTDC
Electronic injection timing	no
Variable injection timing	no
Variable turbocharger geometry	no
Bore	280 mm
Stroke	300 mm
Nominal compression ratio	13.0
Mean effective pressure at rated power	kPa
Maximum cylinder pressure at rated power	16,200 kPa
Cylinder number and configuration	Number: 8 cyl. , I8
Auxiliaries	2 pumps
Specified ambient conditions:	
Maximum sea water temperature	38 °C
Maximum charge air temperature	45.9 °C
Cooing system spec. intermediate cooler	yes
Cooling system spec. charge air stages	1 stage
Low/high temperature cooling system set points	N/A °C
Maximum inlet depression	-3.7 kPa
Maximum exhaust back pressure	2.50 kPa
Fuel oil specification	IMO DMA Fuel
Fuel oil temperature	38 °C
Lubricating Oil specification	Shell Rimula 30W (API CD Service Rating)
Application/Intended for:	
Customer	
Final application/installation, Ship	Ship
Final application/installation, Engine	Propulsion (Var. Pitch Prop or Electric)
Emissions test result:	
Cycle	E2
NOx	6.98 g/kW-hr
Test identification	3608 ABS Certification Test
Date/time	20 May 2005. 7:30 AM
Test site/bench	Test Cell 523, Lafayette, Indiana, USA
Test number	
Surveyor	Richard T. McCombs – ABS
Date and Place of report	
Signature	

* If applicable

*Engine Family Information**

Emission Test Report No.:	**Sheet 2/5**
Engine Family Information (Common specifications)	
Combustion cycle	4 stroke cycle
Cooling medium	Water
Cylinder configuration	I6, I8, V12, V16
Method of aspiration	Pressure charged
Fuel type to be used on board	Distillate
Combustion chamber	Open chamber
Valve port configuration	Cylinder head
Valve port size and number	4 valves per cylinder Intake dia.: 90 mm Exhaust dia.: 90 mm
Fuel system type	Mechanical Unit Injector
Miscellaneous features:	
Exhaust gas recirculation	No
Water injection/emulsion	No
Air injection	No
Charge cooling system	Yes
Exhaust after-treatment	No
Exhaust after-treatment type	N/A
Dual fuel	No
Engine Family Information (Selection of parent engine for test bed test)	
Family Identification	3600A900&1000
Method of pressure charging	Turbocharged
Charge air cooling system	Combined Circuit Aftercooled
Criteria of the Selection (specify)	Maximum E2 weighted NOx
Number of cylinder (parent)	8
Max. rated power per cylinder (parent)	308 kW
Rated speed	1000 rpm
Injection timing (range)	13 to 22.5 °BTDC
Max. fuel parent engine	8442g/min
Selected parent engine	Parent (3608, 0K3653)
Application	Electric Propulsion

* If applicable

*Test Cell Information**

Emissions Test Report No.:					**Sheet 3/5**
Exhaust Pipe					
Diameter				495	Mm
Length				35.5	M
Insulation				No	M
Probe Location			762 mm from turbo outlet		
Remark					

Measurement equipment					
	Manufacturer	Model	Measurement	Calibration	
			Ranges	Span gas conc.	Deviation
Analyzer					
NOx Analyzer	Pierburg	CLD-PM2000	0-1700 ppm	1602 ppm	± 1 %
CO Analyzer	Rosemount	BINOS 2000	0-1000 ppm	947 ppm	± 1 %
CO2 Analyzer	Rosemount	BINOS 2000	0-16 %	15.3%	± 1 %
O2 Analyzer	Seimens	OXYMAT 5E	0-25 %	23.87%	± 1 %
HC Analyzer	Pierburg	FID-PM2000	0-2500 ppm C1	799 ppm Propane (2397 ppm C1)	± 1 %
Speed	Schenck	Ex-act	Rpm		± 2 %
Torque	Schenck	Ex-act	Nm		± 0.5 %
Power, if applicable	Schenck	Ex-act	kW		N/A
Fuel flow	Max Machinery	215-310	CC/MIN		± 0.5 %
Air flow	Brandt	N/A	LPM		± 2 %
Exhaust flow	N/A	N/A	N/A		N/A
Temperatures					
Coolant	Omega	CPSS14U6	-200 TO +350%		± 2 %
Lubricant	Omega	CPSS14U6	-200 TO +350%		± 2 %
Exhaust gas	Omega	CPSS-14G-6	-200 TO +350%		± 6 %
Inlet air	Omega	CPSS14U6	-200 TO +350%		± 1 %
Intercooled air	Omega	CPSS14U6	-200 TO +350%		± 2 %
Fuel	Omega	CPSS14U6	-200 TO +350%		± 2 %
Pressures					
Exhaust gas	Viatran	245-AA-GB6-DH	kPa		± 0.5 %
Inlet manifold	Viatran	245-AK-A-BL	kPa		± 0.5 %
Atmospheric	Viatran	PX961-16A5V	kPa		± 0.5 %
Vapor pressure					
Intake air	Viatran	245-AA-GBL-DH	kPa		
Dew Point					
Intake air	Honeywell	4114-A-08-D1-111	Deg C		± 0.2 %

Fuel Characteristics

Fuel type (ISO 8216)	ISO-F-DMA				
Fuel properties:			**Fuel elemental analysis**		
Density (30C)	ISO 3675	0.8519	Carbon	86.79	% mass
Viscosity (40 C)	ISO 3104	2.668	Hydrogen	13.2	% mass
Water % volume	ISO 3733	<.05	Nitrogen	0.1	% mass
			Oxygen	.01	% mass
			LHV/Hu	42.59	MJ/kg

* If applicable

*Ambient and Gaseous Emissions Data**

Emissions Test Report No.:					**Sheet 4/5**
Mode		1	2	3	4
Power/Torque	%	100	75	50	25
Speed	%	100	100	100	100
Time at beginning of mode		14:22:01	15:33:32	15:49:41	16:03:53

Ambient Data					
Atmospheric pressure	kPa	98.9	98.9	98.9	98.9
Intake air temperature	°C	24	24	24	24
Intake air humidity	g/kg	7.57	7.57	7.57	7.57
Atmospheric factor (fa)		1.02	1.02	1.02	1.02

Gaseous Emissions Data:					
NOx concentration dry	ppm	628.43	644.82	651.31	550.74
CO concentration dry	ppm	76.12	105.55	199.1	307.2
CO2 concentration dry	%	5.93	5.61	5.61	5.09
O2 concentration dry	%	12.66	13.12	13.1	13.81
HC concentration wet	ppm	151.6	199.55	270.85	405.01
NOx humidity correction factor		.947	.956	.962	.966
Fuel specification factor (FFH)		1.823	1.825	1.825	1.829
Dry/wet correction factor		1.0106	1.008	1.0058	1.0046
NOx mass flow	kg/hr	18.03	14.25	9.97	5.23
CO mass flow	kg/hr	1.33	1.42	1.86	1.78
CO2 mass flow	kg/hr	1073.42	782.26	542.04	305.04
O2 mass flow	kg/hr	2291.66	1829.45	1265.72	827.63
HC mass flow	kg/hr	1.23	1.25	1.17	1.09
SO2 mass flow	kg/hr	NA	NA	NA	NA
NOx specific	g/kWhr	7.23	7.7	8.1	8.55

* If applicable

*Engine Test Data**

Emissions Test Report No.:					Sheet 5/5
Mode		1	2	3	4
Power/Torque	%	100	75	50	25
Speed	%	100	100	100	100
Time at beginning of mode		14:22:01	15:33:32	15:49:41	16:03:53

Engine Data					
Speed	rpm	1000	1000	1000	1000
Auxiliary power	kW	0	0	0	0
Dynamometer setting	Nm	23827	17638	11747	5841
Power	kW	2495.5	1848.1	1231	612
Mean effective pressure	bar	2034	1507	1004	499
Fuel rack	mm	6.6			
Uncorrected spec. fuel consumption	g/kWhr	203	203	211	241
Fuel flow	kg/hr	504	375	260	148
Air flow	kg/hr	17597.6	13569	9402	5845
Exhaust flow (gexhw)	kg/hr	18101.6	13944	9662	5993
Exhaust temperature	°C	374	361	377	352
Exhaust back pressure	mbar	24.7	19	11	9
Cylinder Coolant temperature out	°C	90	89	88	86
Cylinder Coolant temperature in	°C	87	86	86	84
Cylinder Coolant pressure	bar	4.17	4.17	4.15	4.15
Aftercooler Coolant temperature in	°C	32	33	32	32
Temperature intercooled air	°C	43	42	40	39
Lubricant temperature	°C	82	81	81	81
Lubricant pressure	bar	4.8	4.9	5	5.2
Inlet depression	mbar	-36.5	-21.7	-11	-4

* If applicable