IMO NOx
TECHNICAL FILE

Hull No.	JHY4800-01
Engine Type	8H25/33P
Engine No.	B A 2 9 7 5

HYUNDAI
HEAVY INDUSTRIES CO., LTD.

Cert No. : HDONX-0514-10

ENGINE INTERNATIONAL AIR POLLUTION PREVENTION CERTIFICATE

Issued under the provisions of the Protocol of 1997 to the International Convention for the Prevention of Pollution from Ships, 1973, as modified of the Protocol of 1978 related thereto(hereinafter referred to as "the Convention") under the authority of the Government of
THE HONG KONG SPECIAL ADMINISTRATIVE REGION OF THE PEOPLE'S REPUBLIC OF CHINA
by the Korean Register of Shipping.

Engine Manufacturer	Model Number	Serial Number	Test Cycle(s)	Rated Power(kW) and Speed(RPM)	Engine Approval Number
HYUNDAI HEAVY INDUSTRIES CO., LTD.	8H25/33	BA2975	E2	2,320.00 kW 900.00 RPM	HDONX-0514-10

THIS IS TO CERTIFY :

1. that the above-mentioned marine diesel engine has been surveyed for pre-certification in accordance with the requirements of the Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines made mandatory by Annex VI of the Convention; and

2. that the pre-certification survey shows that the engine, its components, adjustable features, and Technical File, prior to the engine's installation and/or service on board a ship, fully comply with the applicable regulation 13 of Annex VI of the Convention.

This Certificate is valid for the life of the engine, subject to surveys in accordance with regulation 5 of Annex VI of the Convention, installed in ship under the authority of this Government.

Issued at DAEJEON, KOREA

Date of issue APRIL 26, 2010

KOREAN REGISTER OF SHIPPING

General Manager

Cert No. : HDONX-0514-10

SUPPLEMENT TO ENGINE INTERNATIONAL AIR POLLUTION PREVENTION CERTIFICATE(EIAPP CERTIFICATE)

RECORD OF CONSTRUCTION, TECHNICAL FILE AND MEANS OF VERIFICATION

In respect of the provisions of Annex VI of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto(hereinafter referred to as "the Convention") and of the Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines(hereinafter referred to as the "NOx Technical Code.")

Notes :

1. This Record and its attachments shall be permanently attached to the EIAPP Certificate. The EIAPP Certificate shall accompany the engine throughout its life and shall be available on board the ship at all times.
2. If the language of the original Record is neither English nor French, the text shall include a translation into one of these languages.
3. Unless otherwise stated, regulations mentioned in this Record refer to regulations of Annex VI of the Convention and the requirements for an engine's Technical File and Means of Verification refer to mandatory requirements from the NOx Technical Code.

1. PARTICULARS OF THE ENGINE

1.1 Name and address of manufacturer : HYUNDAI HEAVY INDUSTRIES CO., LTD.
NO.1, JEONHA-DONG, DONG-GU, ULSAN, KOREA

1.2 Place of engine build : As above

1.3 Date of engine build : MARCH , 2010

1.4 Place of pre-certification survey : ULSAN, KOREA

1.5 Date of pre-certification survey : MARCH 19, 2010

1.6 Engine type and model number : 4-Stroke Diesel Engine, 8H25/33

1.7 Engine serial number : BA2975

1.8 If applicable, the engine is a parent engine [-] or a member engine [X] of the following engine family [-] or engine group [X] HYUNDAI-HiMSEN 8H25/33-2008-13

1.9 Test Cycle(s) (see chapter 3 of the NOx Technical Code) : E2

Cert No. : HDONX-0514-10

1.10 Rated Power(kW) and Speed(RPM) : 2,320.00 kW at 900.00 RPM

1.11 Engine approval number : HDONX-0514-10

1.12 Specification(s) of test fuel : ISO 8217, DMC Grade

1.13 NOx reducing device designated approval number(if installed) : N/A

1.14 Applicable NOx emission limit(g / kWh)(Reg. 13 of Annex VI) : 11.54

1.15 Engine's actual NOx emission value (g / kWh) : 10.04

2. PARTICULARS OF THE TECHNICAL FILE

2.1 Technical File identification / approval number : HYUNDAI-HiMSEN 8H25/33-2008-13-BA2975

2.2 Technical File approval date : APRIL 26, 2010

2.3 The Technical File, as required by Chapter 2 of the NOx Technical Code, is an essential part of the EIAPP Certificate and must always accompany an engine throughout its life and always be available on board a ship.

3. SPECIFICATIONS FOR THE ON-BOARD NOx VERIFICATION PROCEDURES FOR THE ENGINE PARAMETER SURVEY

3.1 On-board NOx verification procedures identification / approval number : HYUNDAI-HiMSEN 8H25/33-2008-13-BA2975

3.2 On-board NOx verification procedures approval date : APRIL 26, 2010

3.3 The specifications for the on-board NOx verification procedures, as required by Chapter 6 of the NOx Technical Code, are an essential part of the EIAPP Certificate and must always accompany an engine through its life and always be available on board a ship.

THIS IS TO CERTIFY that this Record is correct in all respects.

Issued at DAEJEON, KOREA

Date of issue APRIL 26, 2010

KOREAN REGISTER OF SHIPPING

General Manager

Technical File

Issued under the provisions of the Protocol of 1997 to the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78, Annex VI)

for Examined under the provisions of Annex VI to MARPOL 73/78 including Amendments.

HYUNDAI-HiMSEN 8H25/33

Certified as the 'Member' Engine

APPROVED
2010. 04. 26

Engine group name : **HYUNDAI-HiMSEN 8H25/33-2008-13**

Prepared by : **Hyundai Heavy Industries Co., Ltd., Engine & Machinery Division, Engine Development & Test Department**

Identification/ approval number : **HYUNDAI-HiMSEN 8H25/33-2008-13-BA2975**

Issued by : **Hyundai Heavy Industries Co., Ltd., Ulsan, Korea**

Surveyor : **KR**

Date	Designed	Checked	Approved	Description	R
					3
					2
					1

Engine Type	HYUNDAI-HiMSEN 8H25/33	Approved by	Kwang Hean Ahn
Engine Rating	290.0kW/cyl. @ 900 rpm		
Engine Number	BA2975	Checked by	Jae Woo Lee
De, Up-rated Power	-		
Parent Engine Type	HYUNDAI-HiMSEN 8H25/33	Designed by	Hyun Mi Kim
Parent Engine Number	BA2763		
Issued Date	April 07, 2010	Doc. No.	B94-048932-1.0

CONTENTS

A. General

The Technical File is issued under the provisions of Annex VI of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 relating thereto (hereinafter referred to as "the Convention") and of the Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines (hereinafter referred to as " the NOx Technical Code")

for

HYUNDAI-HiMSEN 8H25/33

1. Certified as the Member Engine of Engine Group

Engine Manufacturer	: Hyundai Heavy Industries Co., Ltd.
Engine Type	: HYUNDAI-HiMSEN 8H25/33
Engine Number	: BA2975
Number of Engine	: One (1) set as the Member Engine
Test Cycle	: E2 (according to Chapter 3 of the NOx Technical Code)
Rated Power	: 2320 kW
Rated Speed	: 900 rpm
M.E.P.	: 23.9 bar

2. Prepared and Issued by Hyundai Heavy Industries Co., Ltd., Engine & Machinery Division (hereinafter referred to as ' HHI-EMD')

This is to certify that this Technical File including procedures for demonstrating compliance with NOx emission limits on board a ship, Engine Parameter Check Method, for the above mentioned marine diesel engine, prior to the engine's installation and/or service on board a ship, fully comply with the requirements of the NOx Technical Code made mandatory by Annex VI of the Convention.

Identification/approval number : .....

....

Date of issue *Signature of duly authorized official issuing the certificate*

(Seal or Stamp of the authority, as appropriate)

B. Summary

IMO NOx compliance test on one (1) main propulsion engine for Yizheng Jianghaiyang Ship-building Co., Ltd. Hull No. 4800-05 was carried out. The conditions of the compliance test were set based on the possibilities of having the highest NOx emission values.

The finalized conditions for parent engine of engine group were as follows :

Parent engine group name	HYUNDAI-HiMSEN 8H25/33-2008-13
Parent engine number	BA2763
Max. cylinder pressure	195 bar
Charge air temperature	48.0 ℃ (Refer to the Chapter G)
Exh. gas back pressure	Normal condition (Refer to the Chapter L)
Charge air pressure	Normal condition (Refer to the Chapter L)
Rated power	2320 kW
Rated speed	900 rpm

Finally, the NOx value of Parent Engine at the above highest NOx conditions was 10.04 g/kWh

1. Calibrations of Zero & Span for gas analyzers were successfully carried out under the presence of surveyor(s).

2. Analyzers and calibration gases were confirmed in compliance with the NOx Technical Code by the surveyor(s).

3. Calculations of the emission value and exh. gas emission were done according to the NOx Technical Code as follows :

   (1) Humidity correction factors for NOx for diesel engines (K_{HDIES}) were calculated according to formula (14) of 5.12.3.6 on the NOx Technical Code.
   (2) Humidity of intake air (Ha) according to formula (10) of 5.12.2.1 on the NOx Technical Code.
   (3) Dry to wet correction factor ($K_{w,r}$) for the raw exhaust gas according to formula (11) of 5.12.2.2 on the NOx Technical Code.
   (4) The exh. gas mass flows were calculated according to Method 2, Universal, Carbon/Oxygen-balance, 3 of Appendix 6 on the NOx Technical Code.

C. Particulars of the Engine

Vertical, four-stroke, direct injection, single acting, trunk piston & in-line type with exhaust turbo-charger and charge air cooler.

1. Name and address of manufacturer : Hyundai Heavy Industries Co., Ltd.
   1, Cheonha-Dong, Dong-Gu, Ulsan, Korea
2. Place of engine build : Same as the above
3. Date of engine build : March 2010
4. Place of pre-certification survey : Hyundai Heavy Industries Co., Ltd.
   1, Cheonha-Dong, Dong-Gu, Ulsan, Korea
5. Date of pre-certification survey : March 19, 2010
6. Engine type : HYUNDAI-HiMSEN 8H25/33
7. Engine number : BA2975

Engine Group Name : HYUNDAI-HiMSEN 8H25/33-2008-13

8. Test cycle(s)(acc. to Chapter 3 of the NOx Technical Code) : E2
9. Rated Power & Speed : 2320 kW at 900 rpm
10. Mean effective pressure : 23.9 bar
11. Maximum cylinder pressure : 190 bar
12. Specification of test fuel : Bunker-A ISO 8217, DMC grade
    (and/or Certification number of fuel sample analysis) (Parent of engine group)
13. NOx reducing device designated approval number (if installed) : Not applicable
14. Applicable NOx Emission Limit (regulation 13 of Annex VI) : 11.54 g/kWh
15. Engine's actual NOx Emission Value : 10.04 g/kWh (BA2763)
    (Parent of engine group)

D. Engine Specification and General Information

1. Components, setting and operating values of the engine which may influence its NOx emission

- Cylinder liner
- Cylinder head
- Piston
- Connecting rod
- Sealing ring (between cylinder liner and cylinder cover)
- Fuel injection pump
- Fuel injection valve
- Nozzle of fuel valve
- Camshaft
- Turbocharger
- Compressor wheel
- Turbine rotor
- Nozzle ring
- Diffuser
- Charge air cooler
- Maximum cylinder pressure
- Compression ratio
- Charge air temperature

2. Range of allowable adjustment or alternatives for the components of the engine

Maximum cylinder pressure (Pmax) 190 ± 5 bar : no external adjustment possible, only inernal adjustment possible by replacement of washer or shim in the fuel injection pump and/or individual adjustment of 'Nominal size'(*) of each fuel injection pump.

The thickness of washer and/or shim in the fuel pump can be adjusted in order to keep maximum cylinder pressure.

Water temperature at charge air cooler inlet
Under tropical conditions up to 36℃ of fresh water on-board.(**)

(*) Refer to the chapter L (page 27-4, setting table)
(**) Refer to the cross reference as given in the chapter G.6

3. Engine's performance data and information

Engine specification	
Engine manufacturer	Hyundai Heavy Industries Co., Ltd.
Rated Power	2320 kW
Rated speed	900 rpm
Group Identification	HYUNDAI-HiMSEN 8H25/33-2008-13
Serial number	BA2975
Intermediate speed	Not Applicable
Max. torque at intermediate speed	Not Applicable
Static injection timing	-
Electronic injection control	No
Variable turbocharger geometry	No
Bore	250 mm
Stroke	330 mm
Nominal compression ratio	17:1
Mean effective pressure at rated power	23.9 bar
Max. cylinder pressure at rated power	190 ± 5 bar
Cylinder number	8
Cylinder configuration	In-line
Auxiliaries	Pumps
Inlet and exhaust valve timing	
Exhaust valve open	70 deg-CA bBDC
Exhaust valve closed	82 deg-CA aTDC
Intake valve open	68 deg-CA bTDC
Intake valve closed	18 deg-CA aBDC
Specified ambient conditions	
Maximum cooling water inlet temperature	36 ℃
Maximum charge air temperature (*)	55 ℃ (Under tropical condition)
Cooling system specification intermediate cooler	Yes
Cooling system specification charge air stage	One(1) stage
Low temperature cooling system set point	36 ℃
High temperature cooling system set point	73 ℃
Maximum exhaust gas back pressure	300 mmWC
Lubricating oil specification	SAE 40
Application / Intended for	
Customer	EIGHT SHIPS LIMITED
Final application / installation, ship	Yizheng Jianghaiyang Ship-building Co., Ltd.Hull No. 4800-01
Final application / installation, engine	Main propulsion engine

4. The results of shop test

See 'Engine Performance Data at Test Bed' on Chapter L.

(*) Refer to the Chapter G.6

5. On board NOx verification procedure for the engine parameter check method

Parameter check method

See 'On Board NOx Verification Procedure' on Chapter G.

Location of IMO-ID number

See 'On Board NOx Verification Procedure' on Chapter G.

6. Engine Group Information

Selection of parent engine

Group Identification	HYUNDAI-HiMSEN 8H25/33-2008-13
Selected parent engine number	BA2763
Application	Not Applicable
Method of pressure charging	Exhaust gas turbocharging
Charge air cooling system	With charge air cooler, one(1) stage
Number of cylinder	8
Max. rated power per cylinder	290.0 kW
Rated speed	900 rpm

Common specifications

Combustion cycle	4 stroke cycle
Cooling medium (air cooler)	Fresh water
Cylinder configuration	In-line
Method of aspiration	Pulse
Fuel type to be used on board	Heavy fuel or Distillate
Combustion chamber	Open chamber
Intake valve port number	2 per cylinder
Exhaust valve port number	2 per cylinder
Fuel system type	One fuel injection pump per cylinder

Miscellaneous features

Exhaust gas recirculation	No
Water injection / emulsion	No
Air injection	No
Charge air cooling system	Yes
Exhaust after - treatment	No
Exhaust after - treatment type	Not applicable
Dual fuel	No

Emission test results

Test cycle	E2
NOx	10.04 g/kWh
Date	September 17, 2008
Test site / shop	HHI - EMD
Surveyor	KR
Date of report	April 07, 2010
Place of report	HHI - EMD
Signature	Mr. J. W. Lee of HHI-EMD

E. Guideline for Replacement of Components

1. General

If any of the components of the engine which may influence its NOx emissions on Chapter D has to be changed during operation, the replacing component should be identical to the old one.

The guarantee to receive the correct component can only be achieved by ordering the new component through the engine manufacturer.

2. Proceeding for the replacement

1. Order the component indicating the identification numbers specified in this Technical File through the engine manufacturer.

2. Substitute the old component by the new one.

3. Record the replacement in the 'Record Book of Engine Components' which has to be kept on board of the ship.

F. Measurements for IMO Compliance Test at Test Bed

The table 1 shows a list of the measured 'standard' performance parameters at test bed.
And the allowable ranges for some of the parameters are given in Chapter D.

Table 1. Measured Performance Parameters at test bed

*	- Rated power (kW)
*	- Rated speed (rpm)
	- Mean effective pressure (bar)
	- Cylinder maximum pressure (bar)
	- Fuel injection timing (deg. CA bTDC)
*	- Fuel consumption (kg/h)
	- Turbocharger speed (rpm)
	- Exhaust gas temperature after turbocharger (℃)
* *	- Exhaust gas flow (kg/h)
* *	- Air consumption (kg/h)
*	- Exhaust gas emissions
*	- Exhaust gas back pressure (mmWC)
*	- Atmospheric pressure (kPa)
*	- Intake air humidity (%)
*	- Intake air temperature (℃)
*	- Charge air pressure (kg/cm^2)
*	- Charge air temperature (℃)
*	- Charge air cooling water inlet/outlet temperature (℃)
*	- Fuel oil inlet temperature (℃)

Remarks)

1. The measurements marked * shall be carried out with gauges and analyzers calibrated according to the Appendix 4 of the NOx Technical Code.
2. The measurements marked * * shall be carried out through the Method 2, Universal, Carbon/Oxygen- balance, 3 of Appendix 6 on the NOx Technical Code.
3. Concerning the engine dynamometer specified in the NOx Technical Code Chapter 5, in case that an engine is supplied with alternator attached, it is not practical to apply a dynamometer to measure the engine power measurements. Therefore, by using of alternator power meter with alternator efficiency, the calculation of the power output from the engine based on reading taken from the alternator output hall be applied.

G. On Board NOx Verification Procedure

1. General

The following described procedure shows an easy and reliable verification of the engine in order to confirm its compliance with Regulation 13 (NOx) of Annex VI to MARPOL 73/78.
The procedure should be applied to initial, periodical and intermediate surveys after installation of the engine in the ship.
Verification of all Identification numbers, settings and operating values are defined in this Chapter.

The surveyor shall have the option of checking one or all the identified components, settings or operating values to ensure that the engine with no, or minor, adjustment or modifications complies with the applicable emission limits and that only components of the current specification are being used.

2. The procedure for on board verification

The procedure of an engine for on board verification shall be carried out as follows. :

First

The Technical File, Record Book and Technical documentation shall be checked by surveyor.

Second

The engine components and settings shall be reviewed by surveyor.

3. Check for engine components and settings

The following summarize the easy and reliable verification of the engine in order to confirm its components compliance with Regulation 13 (NOx) of Annex VI to MARPOL 73/78 for on-board NOx verification.

Engine Specification

1. Rated power : Check the name plate on engine body.
2. Rated speed : Check the name plate on engine body.

Combustion chamber

1. Cylinder liner : Check the IMO identification number.
2. Cylinder head : Check the IMO identification number.
3. Piston : Check the IMO identification number.
4. Connecting rod : Check the IMO identification number.

Fuel injection equipment

1. Fuel injection pump : Check the IMO identification number.
2. Number of fuel valve(s) : Check the number of the fuel valve(s) per cylinder.
3. Fuel injection valve(s) : Check the IMO identification number.
4. Nozzle of fuel valve : Check the IMO identification number.
5. Camshaft : Check the IMO identification number.

Turbocharger

1. Maker : Check the name plate.
2. Number of T/C(s) : Check the number of the T/C(s).
3. Serial No./Model : Check the name plate.
4. Compressor wheel : Check the IMO identification number.
5. Diffuser : Check the IMO identification number.
6. Turbine rotor : Check the IMO identification number.
7. Nozzle ring : Check the IMO identification number.

Charge air cooling system

1. Maker : Check the name plate.
2. Number of air cooler(s) : Check the number of the air cooler(s).
3. Air cooler : Check the IMO identification number. (*)

Performance set-up

1. Maximum cylinder pressure : Check the max. Cylinder pressure at rated power. (* *)
2. Compression ratio : Check the thickness of sealing ring.

(*) Refer to the cross reference as given in chapter G. 6
(* *) Refer to the cross reference as given in the page A.1.1~A.1.4

4. Marking of identification numbers of NOx relevant components

1) Purpose

This controls

- that NOx relevant components are specified.
- that is ensured that only these components are installed and
- that they are marked with the provided identification number.

2) Checking

The ID numbers of NOx relevant components were checked during assembly or final inspection by duly authorized surveyor.

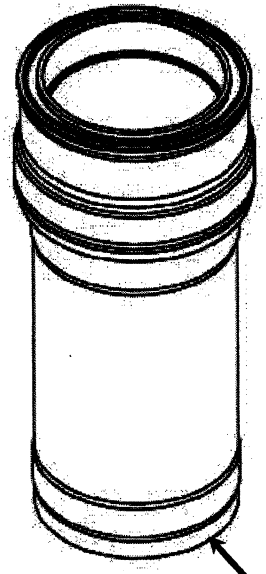
The identification numbers for NOx relevant components may be one (1) or two (2) kinds of numbers.

One of the mentioned IMO identification numbers can be available on this engine group as an alternative, if necessary.

Revision number of drawings of NOx relevant components for member engines may be different from parent engine but it is not effect on NOx emission valve.

It is only necessary for HHI to manage the drawing number(s) of NOx relevant components.

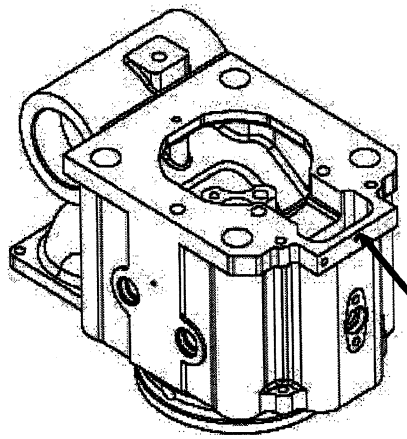
a. Cylinder liner



IMO identification number
H25CL1
Thickness of sealing ring
2.0 ± 0.1 mm
Drawing number
B91-004120-0
B93-004122-4

Location of IMO-ID number

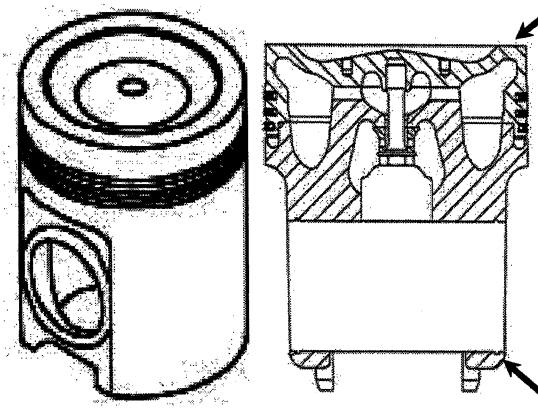
b. Cylinder head



IMO identification number
H25CH1
Drawing number
B90-010478-4

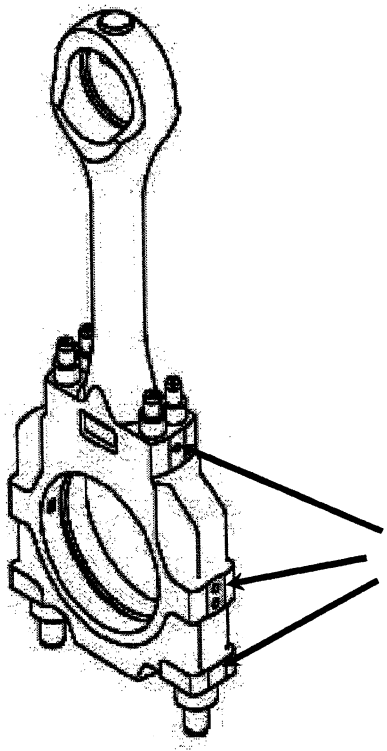
Location of IMO-ID number

c. Piston



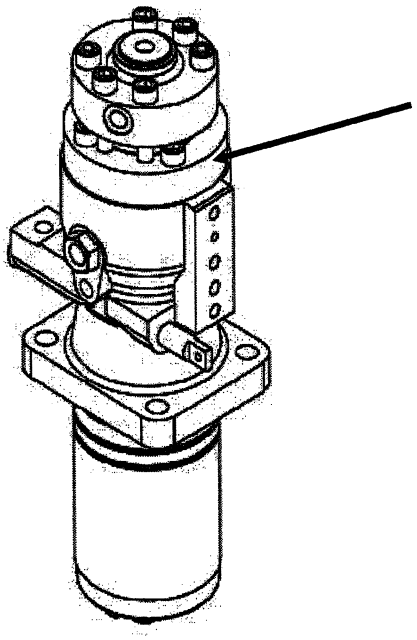
IMO identification number
H25PT1
Drawing number
B91-004879-6

d. Connecting rod



IMO identification number
H25CR1
Drawing number
B92-003071-1

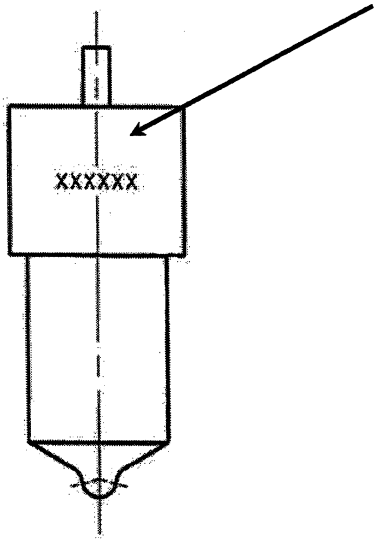
e. Fuel injection pump



Location of IMO-ID number

IMO identification number
H25FP1
Maker
NICO
Plunger Diameter
24
Drawing number
B91-013933-7

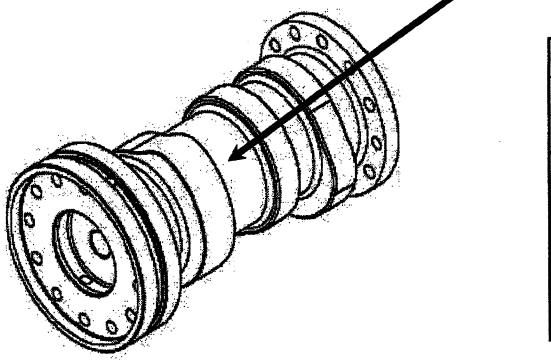
f. Atomizer



Location of IMO-ID number

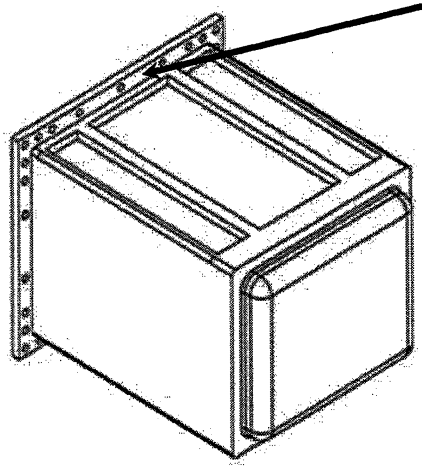
IMO identification number
H25FV1
Number of fuel valve(s) / cyl.
1
Drawing number
B93-021431-6

g. Camshaft



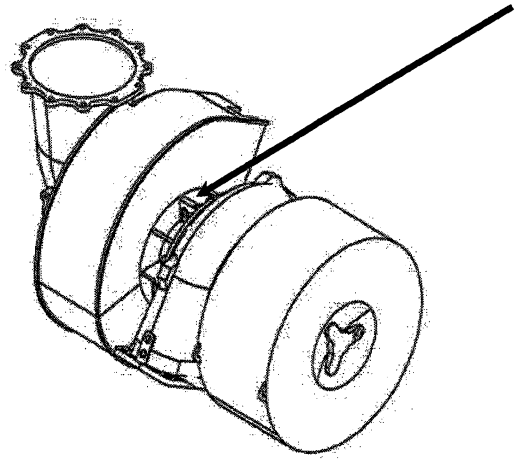
IMO identification number
H25FC2
Drawing number
B91-003358-7

h. Air cooler



IMO identification number
H25AC4
Maker
DongHwa Entec
Serial number
DHJ7F370-A
Number of air cooler
1
Drawing number
B94-008469-7

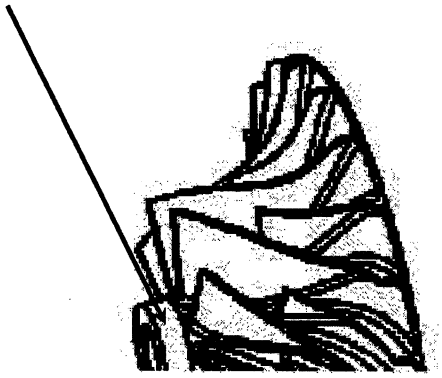
i. Turbocharger



Maker
KBB
Model
HPR6000
Serial number
817/08
Number of turbocharger
1

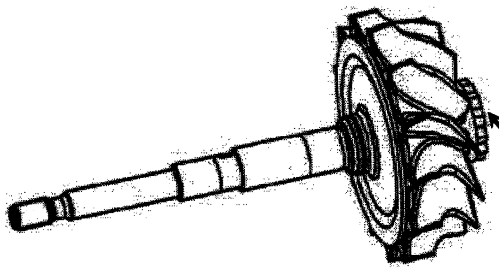
j. Compressor wheel

Location of IMO-ID number



IMO identification number
C209B

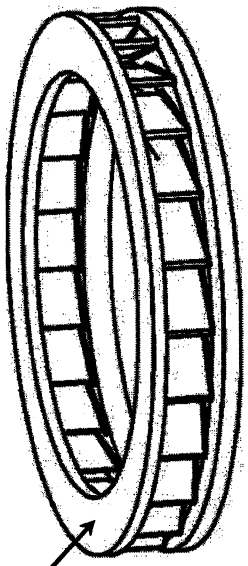
k. Turbine rotor



IMO identification number
T254

Location of IMO-ID number

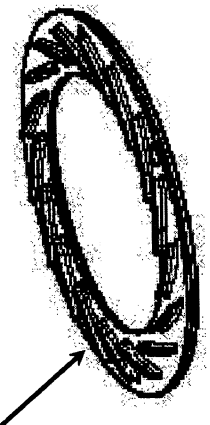
l. Nozzle ring



Location of IMO-ID number

IMO identification number
T42-119

m. Diffuser



Location of IMO-ID number

IMO identification number
C23-16.4B

5. Inspection of engine setting

1) Engine specification and performance set-up

Rated power	2320 kW
Rated speed	900 rpm
Mean effective pressure	23.9 bar at rated power
Maximum cylinder pressure	190 ± 5 bar at rated power
Compression ratio	17
Thickness of sealing ring	2.0 ± 0.1 mm
Diameter of plunger for Fuel Pump	24 mm

2) Nozzle of fuel valve (only for information)

Number of holes for fuel nozzle	10
Diameter of holes for fuel nozzle	0.38 mm
Angle of holes for fuel nozzle	155 deg.
Opening pressure of injection valve	450 bar
Closing pressure of injection valve	230 bar

6. Evaluation of the influence of charge air temperature on NOx emission

The method to check NOx compliance for varying maximum charge air temperature is shown in the following table.

As you can see Chapter B in this technical file, charge air temperature at NOx compliance test for parent engine was set to 48 ℃ at rated power.
Even though parent engine test was not undertaken with charge air temperature as given in the eighth column in the table, the effect of higher charge air temperatures can be calculated by the application of Formula (14), as given Chapter 5.12.3.5 in the NOx Technical Code,

You can see the estimated values of the NOx emission with maximum charge air temperature. NOx emission value at Tsc,max. is 10.38 g/kWh, as given in the tenth colume.

Therefore, charge air temperature of this group's engines can be available up to given eighth column in the table at each load under the tropical condition.

However, for engine's good behaviour charge air temperature of engines is to be run as low as possible.

	Based on Parent engine						Based on calculation [1]		
Load (%)	NOx, actual (g/kWh)	Ha (g/kg)	KHDIES(*)	Ta (℃)	Tsc, actual (℃)	Tsc,ref (℃)	Tsc, max. (℃)	KHDIES(**)	NOx, max. (g/kWh)
100	10.41	19.59	1.144	31.9	48.0	48.0	55.0	1.171	10.69
75	9.92	19.38	1.138	31.0	46.0	46.0	55.0	1.172	10.26
50	9.48	19.16	1.132	30.3	44.0	44.0	55.0	1.173	9.87
25	10.41	18.77	1.125	30.1	42.0	42.0	55.0	1.174	10.92
E2 (g/kWh)						**10.04**			**10.38**

KHDIES(*)	Based on Tsc,ref of parent engine
KHDIES(**)	Based on maximum allowable Tsc.
Ha	Humidity of the intake air of parent engine
Ta	Temperature of the air of parent engine
Tsc	Temperature of the intercooled air
Tsc, ref	Reference temperature of the intercooled air cooresponding to a sea water temperature of 25℃
Tsc, max.	Maximum allowable temperature of the intercooled air in accordance with only the NOx limits
1)	Based on tropical condition (Refer to the cross reference as given in Chapter D.2)

H. Test Cell Information (For Information)

Parent engine of engine group

Project	**JHY4800-05 main propulsion engine**
Engine Type	**HYUNDAI-HiMSEN 8H25/33**
Engine No.	**BA2763**

Measurement Equipments

		Manufacturer	Model or Serial No.	Measurement range	Calibration	
					Span gas conc.	Deviation
Analyzers (HORIBA MEXA-9100F)			**4076406001**			
NOx Analyser		HORIBA	CLA-155	2000 ppm	1867	-0.3 %
CO Analyser		HORIBA	AIA-120	300 ppm	282	-0.2 %
CO2 Analyser		HORIBA	AIA-120	10 %	9.12	-0.2 %
O2 Analyser		HORIBA	FMA-126D	25 %	23.3	0.2 %
HC Analylser		HORIBA	FMA-126D	500 ppmC	478	-0.1 %
Speed (power meter)		-	-	-	-	- %
Torque		-	-	- bhp	-	- %
Power (power meter)		CFW	CFSR-6.0	40000 bhp	-	0.16 %
Fuel flow		CAS	ET290	2000 kg	-	0.03 %
Air flow		Calculated-IMO universal, carbon/oxygen balance method				
Exhaust flow						
Temperatures						
Cooling water	in	WIKA	1H100-120	0~120 ℃	-	0.5 ℃
	out	WIKA	2H100-120	0~120 ℃	-	-1.0 ℃
Exh. Gas at T/C outlet		WIKA	15TC220	0~650 ℃	-	-9.0 ℃
Charge air receiver		WIKA	4H100-120	0~120 ℃	-	0.5 ℃
Intake air		VAISALA	A4850016	-20~60 ℃	-	0.0 ℃
Fuel inlet		WIKA	7H60-120	0~200 ℃	-	-1.0 ℃
L.O. cooler	in	WIKA	3H100-120	0~120 ℃	-	-1.0 ℃
				℃		℃
Pressures						
Exh. Gas (manometer)		Confirmed by calibrated rule				
Charge air		WIKA	PA06-15	0~6 bar	-	0.80 %
Atmospheric		SATO	85813	950~1040 hPa	-	0.20 %
Humidity						
Intake air		VAISALA	A4850016	0~100 %RH	-	-0.3 %
Exhaust pipe						
Diameter		600 mm				
Insulation		■ : No □ : Yes				
Probe location		3.5 m after turbocharger (30 m from exhaust gas exit)				
Remark		Sampling gas temperature : min. 190℃ at all loads				

I. Ambient & Gaseous Emission Data (For Information)

Parent engine of engine group

Project	**JHY4800-05 main propulsion engine**
Engine Type	**HYUNDAI-HiMSEN 8H25/33**
Engine No.	**BA2763**
Test Date	**September 17, 2008**

Mode	-	1	2	3	4
Test No.	-	01	02	03	04
Running time	-	20:30-21:00	21:00-21:30	21:30-22:00	22:00-22:30
Recorded time	-	20:45-20:58	21:15-21:28	21:45-21:58	22:15-22:28
Engine power (actual)	%	100	75	50	25
	kW	2320.0	1740.0	1160.0	580.0
Engine speed (actual)	%	100	100	100	100
	rpm	900	900	900	900
Load on brake	kg	3504.8	2628.6	1752.4	876.2
Max. cylinder pressure	bar	195.0	161.9	128.9	95.4
Mean effective pressure	bar	23.9	17.9	11.9	6.0
Exhaust gas temp. at T/C outlet	℃	310.0	330.0	345.0	350.0
Turbocharger speed	rpm	30210	26380	21870	15630
Ambient Data					
Charge air pressure	kg/㎠	2.80	1.92	1.16	0.49
Barometric pressure	kPa	100.8	100.8	100.8	100.8
Intake air humidity	%	68.4	67.8	69.8	69.2
	g/kg	19.59	19.38	19.16	18.77
Intake air temperature	℃	31.9	31.0	30.3	30.1
Charge air temperature	℃	48.0	46.0	44.0	42.0
Intercooled air reference temp.	℃	48.0	46.0	44.0	42.0
Governor					
Pump index	mm	32.8	26.8	20.8	14.8
Indicator position	-	6.3	5.2	4.0	2.7
Fuel					
Uncorrected fuel consumption	kg/h	452.0	342.0	246.0	146.0
Charge air					
Air flow	kg/h	14876	10887	8149	5462
Exhaust gas					
Exhaust gas flow	kg/h	15328	11229	8395	5608
Gaseous Emissions Data					
CO concentration (Dry)	ppm	23.1	39.3	58.5	93.6
CO_2 concentration (Dry)	%	6.70	6.94	6.65	5.84
T.HC concentration (Wet)	ppmC	120.5	147.0	170.5	178.5
O_2 concentration (Dry)	%	12.23	11.93	12.30	13.30
NOx concentration (Dry)	ppm	944	928	792	650
NOx humidity/temp. corr. factor	-	1.144	1.138	1.132	1.125
Dry / wet corr. factor exhaust	-	0.920	0.919	0.921	0.927
NOx mass flow	kg/h	24.16	17.27	10.99	6.04
NOx specific	g/kWh	10.41	9.92	9.48	10.41
Test Cycle (E2)	**g/kWh**	**10.04**			

J. Results of NOx Emission (For Information)

Parent engine of engine group

Project	**JHY4800-05 main propulsion engine**
Engine Type	**HYUNDAI-HiMSEN 8H25/33**
Engine No.	**BA2763**
Emission Test No.	**01 ~ 04**
Kind of Fuel	**Bunker-A (ISO 8217, DMC grade)**

Engine output	kW	2320
Output per cylinder	kW	290.0
Engine speed	rpm	900

Load	%	100	75	50	25	
Oxides of Nitrogen (NOx)	g/kWh	10.41	9.92	9.48	10.41	
NOx IMO-Cycle E3	g/kWh					
NOx IMO-Cycle E2	g/kWh	**10.04**				
NOx IMO-Cycle D2	g/kWh					

Maximum Allowable NOx emission	g/kWh	11.54

E3 : Test cycle for "Propeller law operated main & propeller law operated aux. engine" application
E2 : Test cycle for "Constant speed main propulsion engine" application (incl. variable pitch propeller installation)
D2 : Test cycle for "Constant speed auxiliary engine" application

K. Fuel Analysis (For Information)

Project JHY4800-05 main propulsion engine
Engine Type HYUNDAI-HiMSEN 8H25/33
Engine No. BA2763
Test Date September 17, 2008

Kind of Fuel Bunker-A
ISO 8217, DMC grade

Description	Unit	Result	Test Procedure
Density at 15℃	kg/ℓ	0.9152	ISO 3675
Viscosity at 40℃	mm^2/s [cSt]	6.5	ISO 3104
C (Carbon)	%, (m/m)	87.64	Elementary Analysis
H (Hydrogen)	%, (m/m)	11.45	Elementary Analysis
N (Nitrogen)	%, (m/m)	0.10	Elementary Analysis
O (Oxygen)	%, (m/m)	0.53	Elementary Analysis
S (Sulphur)	%, (m/m)	0.26	ISO 8754
For more information			
Carbon residue (*)	%, (m/m)	1.3	ISO 10370
Water	%, (V/V)	0.01	ISO 3733

(*) Micro method

L. Engine Performance Data at Test Bed

Refer to the enclosed four (4) sheets.

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Doc. No : K630-IR10B-0475

SHOP TEST RESULT FOR MAIN ENGINE		
	Engine No.	BA2975
	Engine Type	8H25/33P
	Hull No.	JHY4800-01
	Owner	EIGHT SHIPS LIMITED
	Class	CCS
	Ship Yard	Yizheng Jianghaiyang Ship-building Co.,Ltd.

HYUNDAI HiMSEN

Hi-Touch and Hi-Tech Medium Speed Engine

QUALITY MANAGEMENT DEPARTMENT
HHI-EMD

Rev.	Prepared	Checked	Approved	Description
2				
1				
0	K.S.JUNG 2010-04-07	C.S.C 2010-04-08	H.S.JANG 2010-04-08	First issue

KOREAN REGISTER OF SHIPPING FOUNDED 1960

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE	Project	JHY4800-01	Owner	EIGHT SHIPS LIMITED
SPECIFICATION OF ENGINE & ACCESSORIES	Eng. Type	8H25/33P	Class	CCS
	Eng. No.	BA2975	Test Date	2010.03.19
	Eng. Output	2320 kW x 900rpm	Evaluated by	J.H.Choi
			Operated by	K.D.Oh

Description		
Engine	Eng.No.	BA2975
	Type	8H25/33P
	Diameter of Cyl. x Stroke	250 mm x 330 mm
	Output(M.C.R) × rpm	2320 kW x 900 rpm
	Rotating of Direction	Clockwise view from Flywheel side
	Firing Order	1 - 3 - 5 - 7 - 8 - 6 - 4 - 2
Paticular of Dynamometer	Type	CFSR-8.0
	Coefficient	1 / 1000
	Maximum Capacity	9248 PS x 2200 rpm
	Maker	FUCHINO(JAPAN)
Turbocharger	Type	HPR6000
	Max. rpm & Temp.	34600 rpm 650 ℃
	Maker	KBB
	Ser. No.	817 / 08
Governor	Type	UG-10D
	Maker	WOODWARD
	Ser. No.	16298973
Air Cooler	Cooling Surface	152.7 ㎡
	Maker	Dong Hwa Entec
	Ser. No.	DHJ7F 370-A
Lub.Oil Cooler	Cooling Surface	
	Maker	
	Ser. No.	

USED OIL AT SHOP TEST

Description		Fuel Oil	Lub.Oil
Kind of Oil		Bunker - A	DELO 1000 M 40
Specific Gravity (15/4 ℃)		0.9106	0.8760
Flash Point (℃)		70	-
Viscosity	50℃/cSt	5.41	-
	40℃/cSt		132.5
Carbon Residue (wt%)		1.5	-
Ash (wt%)		0.005	-
Water & Sediment (vol%)		0.05	-
Sulfur (wt%)		0.200	-
Net.Cal.Value (kcal/kg)		10017	-

HYUNDAI HEAVY INDUSTRIES CO.,LTD. HiMSEN

H25/33P

OFFICIAL SHOP TEST RESULT FOR DIESEL ENGINE Doc. No : K630-IR10B-0475	Project	JHY4800-01	Owner	EIGHT SHIPS LIMITED
	Eng. Type	8H25/33P	Class	CCS
MEASURING RECORD	Eng. No.	BA2975	Test Date	2010.03.19
	Eng. Output	2320 kW x 900rpm	Evaluated by	J.H.Choi
			Operated by	K.D.Oh

Time	hh:mm	09:50~10:20		10:20~10:50		10:50~11:20		11:20~11:50		11:50~12:20		12:20~12:50	
Ambient Press. / Temp.	mbar/℃	1018.0	14.6	1018.0	14.9	1017.0	15.7	1017.0	16.3	1017.0	15.9	1016.5	15.9
Load Point	%	25%		50%		75%		100%				110%	
Engine Speed	rpm	567.0		714.3		817.7		900.0				929.0	
Load on Brake	kg	1390.8		2208.0		2893.2		3504.8				3734.9	
Engine Output	kW	580.0		1160.0		1740.0		2320.0				2552.0	
Fuel oil consumption	kg/h	-		-		-		450.000				-	
specific consumption	g/kW.h	-		-		-		193.966				-	
at ISO conditions	g/kW.h	-		-		-		190.143				-	
Governor Indicator Position	%	2.5		3.4		4.2		5.1		5.1		5.4	
Turbocharger Speed	rpm	11,020		19,800		25,500		30,020		30,100		31,540	
H.T. Water Temp. in /Outlet Engine	℃	65.0	70.0	65.0	71.0	66.0	72.0	71.0	79.0	74.0	82.0	75.0	83.0
H.T. Water Press. Inlet Engine	bar	3.05		3.55		3.80		4.00		3.95		4.10	
L.T. Water Temp. In / Outlet Air Cooler	℃	28.0	30.0	29.0	32.0	33.0	36.0	36.0	40.0	36.0	40.0	36.0	40.0
L.T. Water Press. Inlet Air Cooler	bar	2.6		2.8		3.1		3.3		3.4		3.3	
Lub. Oil Temp. Inlet engine	℃	66.0		66.0		68.0		68.0		68.0		68.0	
Lub. Oil Press. Inlet Filter	bar	4.00		4.20		4.30		4.30		4.20		4.20	
Lub. Oil Press. Inlet Engine	bar	3.80		4.00		4.10		4.10		4.00		4.00	
Lub. Oil Press. Inlet Turbocharger	bar	3.05		3.05		3.05		3.00		2.95		2.95	
Fuel Oil Temp. Inlet Engine	℃	18.0		18.0		18.0		18.0		18.0		19.0	
Fuel Oil Press. Inlet Engine	bar	6.4		5.8		5.4		5.0		5.0		5.0	
Charge Air Temp. After A/C	℃	33.0		35.0		41.0		48.0		48.0		53.0	
Charge Air Press. After A/C	bar	0.10		0.85		1.85		2.90		2.90		3.20	
Exhaust Gas Temp. Outlet T/C	℃	435		460		390		345		350		345	
Exhaust Gas Temp. Inlet T/C (A/B)	℃	575	494	523	534	501	503	495	500	498	500	514	516

Exh.gas Temp / Pump Index / Firing Press / BRG. Temp	Cyl.No.	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃	℃	mm	bar	℃
Cylinder Unit	No.1	365	16.0	112	-	375	21.0	140	-	350	27.0	165	-	360	32.0	190	-	365	32.0	190	-	375	33.5	196	-
	No.2	365	16.0	112	-	380	21.0	140	-	365	27.0	165	-	375	32.0	190	-	380	32.0	190	-	390	33.5	197	-
	No.3	360	16.0	112	-	360	21.0	139	-	360	27.0	164	-	375	32.0	190	-	375	32.0	190	-	390	33.5	197	-
	No.4	365	16.0	113	-	370	21.0	139	-	355	27.0	165	-	360	32.0	191	-	365	32.0	191	-	380	33.5	197	-
	No.5	360	16.0	112	-	360	21.0	139	-	358	27.0	165	-	355	32.0	190	-	355	32.0	190	-	365	33.5	196	-
	No.6	350	16.0	111	-	355	21.0	138	-	360	27.0	164	-	370	32.0	191	-	375	32.0	191	-	390	33.5	196	-
	No.7	335	16.0	111	-	350	21.0	139	-	350	27.0	163	-	365	32.0	191	-	365	32.0	191	-	380	33.5	197	-
	No.8	335	16.0	111	-	370	21.0	138	-	365	27.0	163	-	370	32.0	190	-	370	32.0	190	-	385	33.5	196	-
	No.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	mean	354.4	16.0	111.8	--	365.0	21.0	139.0	--	357.9	27.0	164.3	--	366.3	32.0	190.4	--	368.8	32.0	190.4	--	381.5	33.5	196.5	--

HYUNDAI HEAVY INDUSTRIES CO.,LTD. HiMSEN

H25/33P

CIAL SHOP TEST RESULT FOR DIESEL EN	Doc. No : K630-IR10B-047	Project	JHY4800-01	Owner	EIGHT SHIPS LIMITED
SETTING TABLE		Eng. Type	8H25/33P	Class	CCS
		Eng. No.	BA2975	Test Date	2010.03.19
		Eng. Output	2320 kW x 900rpm	Evaluated by	J.H.Choi
				Operated by	K.D.Oh

Atomizer

Mark No. : H25FV1

Injection Hole : 10 Holes X φ 0.38 mm X 155°

Clearance of Valves

Inlet Valve : 0.5 mm (Cold Condition)

Exhaust Valve : 0.5 mm (Cold Condition)

Adjustment of Fuel Injection Pump

[UNIT : mm]

Cylinder No.	1	2	3	4	5	6	7	8	9
Shim	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
Washer	4.00	4.30	4.30	4.30	4.10	4.30	4.10	4.10	-
Index by Maximum Supply of F.O	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	-
Index with Handle Stop	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-

Crankshaft Deflection

Coupling Type Between Engine

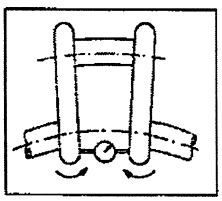
[UNIT : 1/100mm]

Cylinder No.		1	2	3	4	5	6	7	8	9
Cold Condition	Near Bottom X	0	0	0	0	0	0	0	0	-
	Camshaft Side P	-2.0	-1.0	+1.0	+1.0	+2.0	+1.0	0	-1.0	-
	Top T	-3.0	-1.0	+2.0	+4.0	+5.0	+4.0	+1.0	-4.0	-
	Exhaust Side S	-1.0	0	+1.0	+3.0	+3.0	+3.0	+1.0	-3.0	-
	Near Bottom Y	0	0	0	0	0	0	0	0	-
Hot Condition	Near Bottom X	0	0	0	0	0	0	0	0	-
	Camshaft Side P	-2.0	-2.0	0	+1.0	+1.0	0	0	-3.0	-
	Top T	-4.0	-2.0	-1.0	+1.0	+2.0	+3.0	-1.0	-6.0	-
	Exhaust Side S	-2.0	-2.0	0	+1.0	+1.0	0	0	-3.0	-
	Near Bottom Y	0	0	0	0	0	0	0	0	-
Bearing Temp.		69	69	69	70	69	69	69	69	69

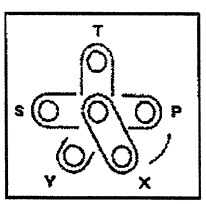
Reference Temperature Data for Hot Condition

Room Temperature : 13 ℃

Lub. Oil Temperature in Oil Sump : 70 ℃



"Closing" of The Crankthrow is Considered Negative.



Viewed from the Front End

Start in Position X

Turn Counter Clockwise

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Appendix

1. Guidance of Engine Adjustment

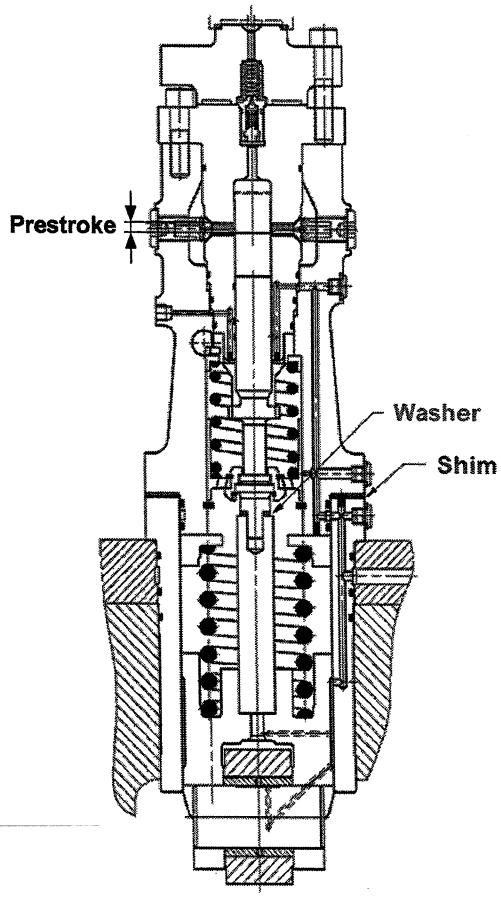
1.1 Adjustment of the maximum cylinder pressure

1.1.1 General

If fuel oil valve, piston, inlet and exhaust valves as well as turbocharger and charge air cooler are working correct and the compression pressure is normal, the maximum cylinder pressure will indicate the injection timing for the fuel oil pump.

If cylinder pressure is too low, it indicates that the injection timing is delayed.
If cylinder pressure is too high, it indicates that the injection timing is advanced.

The injection timing can be changed by inserting or removing fuel pump shims between fuel pump and cylinder head and/or replacement of washer, thus changing the pre-stroke.



Thinner fuel pump shim plate and/or thicker washer (decrease of the pre-stroke) results in advanced injection timing and higher cylinder pressure.

Thicker fuel pump shim plate and/or thinner washer (increase of the pre-stroke) results in delayed injection timing and lower cylinder pressure.

By 0.10 mm changing of pre-stroke, the maximum cylinder pressure will be changed about 1.5 bar.

Action		Results		
Shim	Washer	Prestroke	Injection timing	Max. Cylinder pressure
Increased	Decreased	Increased	Delayed	Decreased
Decreased	Inceased	Decreased	Advanced	Increased

1.1.2 Changing method of the washer

1) Place the pump in a dismantling fixture in fixture in inverted position and press the roller of tappet ass'y(43) into the pump housing and remove the pin with bolt.

2) Release the force on the tappet ass'y.

3) Remove the tappet ass'y.

4) Change the thickness of the washer(51) from the tappet ass'y.

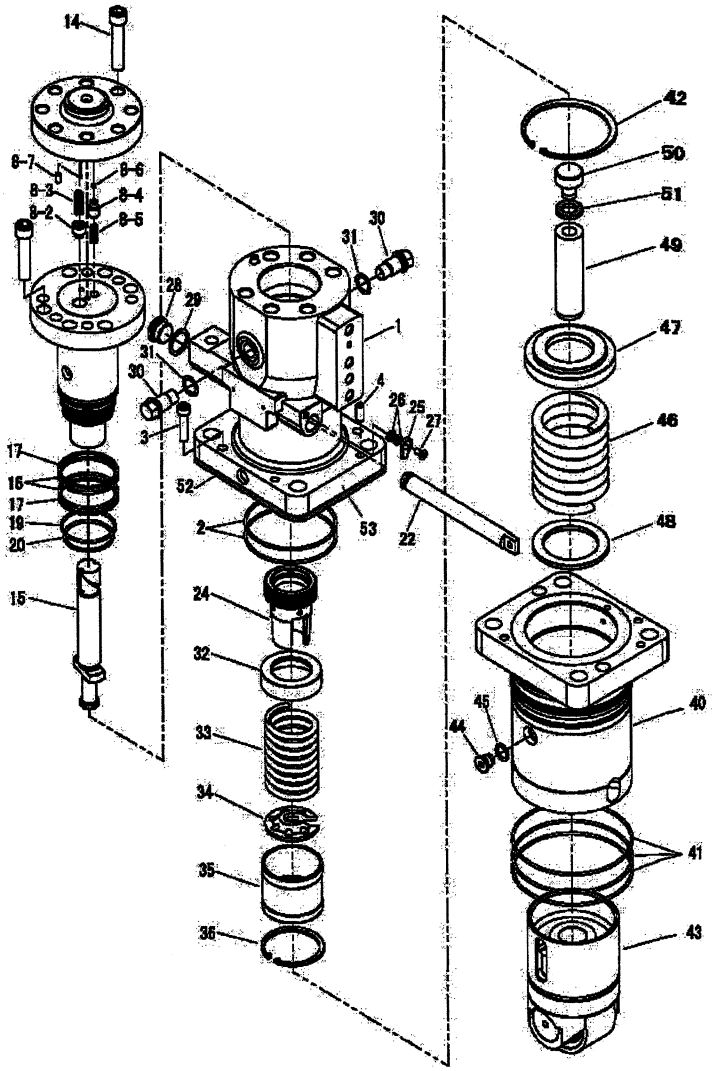
5) Thickness of the washer can be changed.

1.1.3 Changing method of the fuel pump shim plate

1) Unscrew four bolts from the fuel pump flange(53).

2) Remove the fuel pump housing(1).

3) Thickness and/or the number of the fuel pump shim(52) can be changed.



1 Fuel pump housing assembly
43 Tappet assembly
51 Washer
52 Fuel pump shim
53 Fuel pump flange

1.2 Maximum cylinder pressure indicator

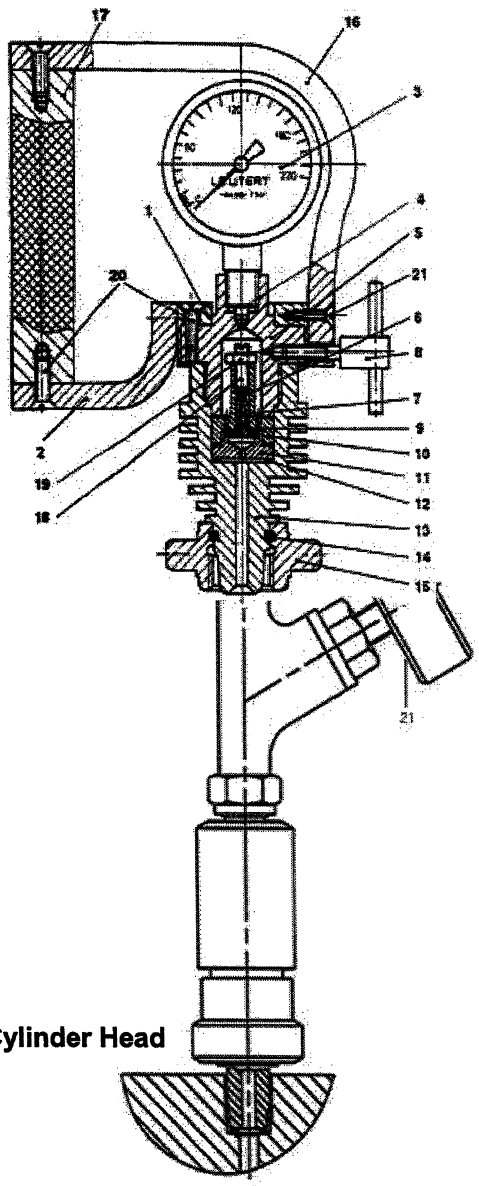
1.2.1 Application

The maximum pressure indicator is designed for displaying the maximum value of cylinder pressure subject to constant rapid variations.

1.2.2 Design

The maximum pressure indicator consists of a sturdy handle section as well as a solid stainless-steel lower section (13) with connector nut (15) and venting screw (8).

The indicator is hallmarked by simple operation and a high degree of instrumental precision in all speed ranges. Its sturdy design makes if immune to vibration, with extremely low maintenance requirements. Its sturdy design makes if immune to vibration, with extremely low maintenance requirements.



Cylinder Head

1.2.3 Measuring procedure

1) Open the indicator valve (21), blow out any dirt, and close it design.

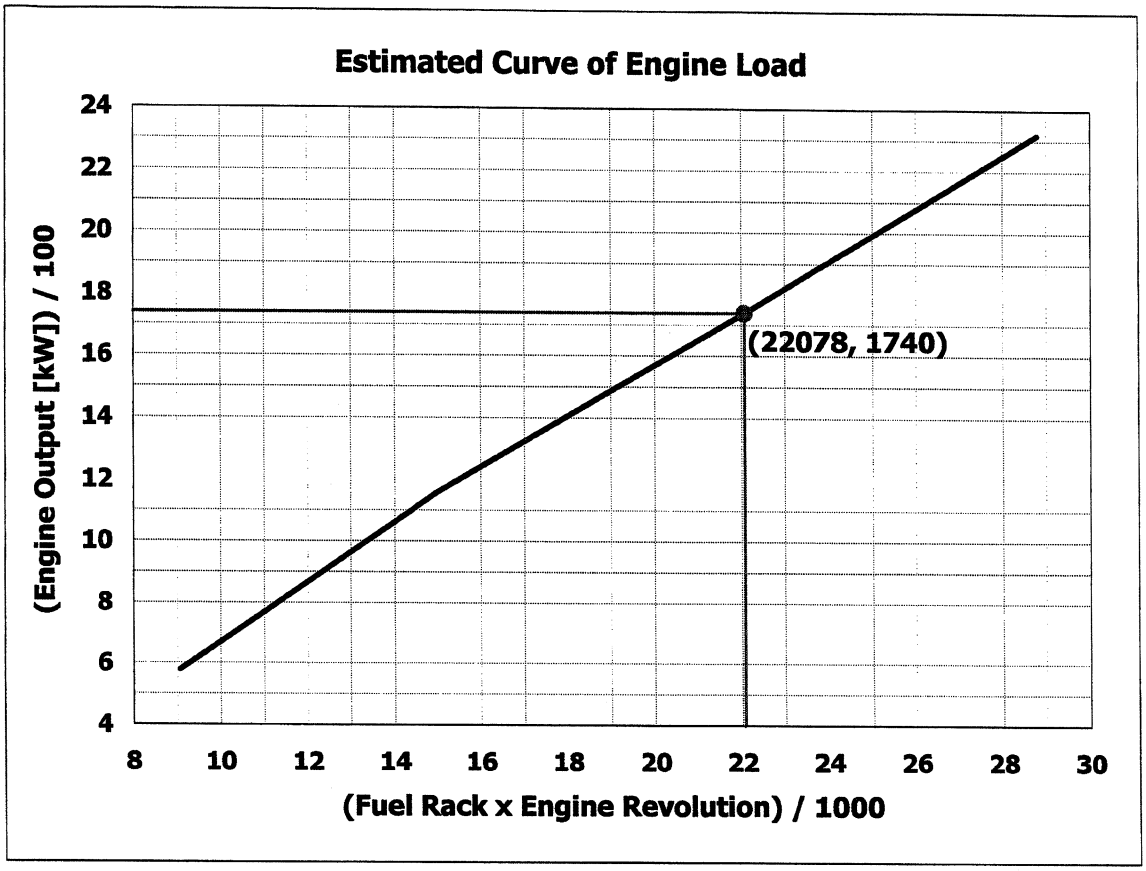
Attention

The valve ejects hot gas under high pressure.
anger of sparks and burning !

2) Close the venting valve screw on the indicator and mount the peak-pressure indicator on the valve using the connector nut (15).
3) Tighten the connector nut using the spanner included in the scope of supply.
4) Open the valve as far as it will go.
   After a measuring period of approx. 5-10 seconds, You can take a peak-pressure a reading and enter it in the log program.
5) Close the valve completely
   Suitable gloves should be worn as the lower section (13) will get very hot during operation
6) After the measuring procedure is complete, detach the indicator immediately from the valve to prevent any unnecessary buildup of heat in the instrument.
7) Open the venting screw
   Actuation of the venting screw resets the device to its zero position and terminates measurement.
   Whenever the indicator valve is open, the venting screw. must remain in closed position and not be opened.

1.2.4 Pmax gauge is to be maintained, calibrated, adjusted and serviced in accordance with the manufacture's instructions and recommendations.

1.3 Estimation of engine load on board



1. Check the fuel pump rack position (mm) and engine revolution (rpm)

2. Multiply above two figures and find the result on the x-axis of above curve

3. Draw the vertical line from the result on the x-axis to the curve, and draw the horizontal line from the curve to y-axis

4. The value of y-axis is engine output (kW)

Example)

1) Fuel rack position is 27 mm and engine revolustion is 817.7 rpm
2) 27 x 817.7 = 22078, find this figure (22078) on the x-axis, and draw the vertical line
3) Draw the vertical line (x-axis to curve) and the horizontal line (curve to y-axis) and read the y-value
4) Engine output is 1740 kW (Engine Load 75 %)

Appendix

2. Record Book of Engine Settings

This Record Book of engine parameters is the document for recording all parameter changes, including components and engine settings which may influence the NOx emission of the engine.

2.1. Record Book of engine settings

If any adjustments or modifications are made to the engine after its pre-certification, a full record of such adjustments or modifications shall be recorded in this Record book.

Parameters	Adjustments carried out	Date	Signature	Remark

Parameters	Adjustments carried out	Date	Signature	Remark

Parameters	Adjustments carried out	Date	Signature	Remark

Parameters	Adjustments carried out	Date	Signature	Remark

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Appendix

3. Record Book of Engine Components

If any replacements of components are made to the engine after its pre-certification, a full record of such replacements should be in this Record Book.

Components	IMO ident. no.	Manufacturer	Date	Signature	Remark

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Components	IMO ident. no.	Manufacturer	Date	Signature	Remark

Components	IMO ident. no.	Manufacturer	Date	Signature	Remark

Components	IMO ident. no.	Manufacturer	Date	Signature	Remark

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