IMO NOx TECHNICAL FILE

Hull No.

HMDS003

Engine Type

6S50MC-C

Engine No.

AA3382





DET NORSKE VERITAS

Certificate no.: EIAPP-953-3-A Date of issue: 2009-09-15

ENGINE INTERNATIONAL AIR POLLUTION PREVENTION CERTIFICATE

This Certificate shall be supplemented by a Record of Construction, a Technical File and Means of Verification

Issued under the provisions of the Protocol of 1997 to amend 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 REPUBLIC OF LIBERIA

by Det Norske Veritas

Particulars of engine	
Engine manufacturer;	Hyundai Heavy Industries Co., Ltd.
Model number:	HYUNDAI-MAN B&W 6S50MC-C7
Serial number:	AA3382
Test cycles(s):	E3
Rated power [kW] and speed [rpm]:	8820 kW @ 119 rpm
Engine approval number:	EIAPP-G-0953-0003
THIS IS TO CERTIFY:	
That the above mentioned marine diesel en Technical Code on Control of Emission of N Convention; and	ngine has been surveyed for pre-certification in accordance with requirements of the Nitrogen Oxides from Marine Diesel Engines made mandatory by Annex VI of the
	the engine, its components, adjustable features, and technical file, prior to the engine's fully comply with the applicable regulation 13 of Annex VI of the Convention.
Remarks/Recommendations:	
40	
This Certificate is valid for the life of the engine, subjective installed in ships under the authority of this Government	ect to surveys in accordance with Regulation 5 of the ANNEX VI of the Convention, ent.
Issued at Oslo	on 2009-09-15 (date)
	for Det Norske Veritas AS
	Tomas Heber Tronstad Head of Section
	4864.**

DET NORSKE VERITAS AS, Veritasveien 1, NO-1322 Høvik, Norway, Telephone: +47 67 57 99 00, Telefax: +47 67 57 99 11, Org.No. NO 945 748 931 MVA
Form No.: EIAPP 101a Issue: October 2005 Page 1 of 2

DET NORSKE VERITAS

Record no.: EIAPP-953-3-A Date of issue: 2009-09-15

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 "NO_X Technical Code"). Notes:

- 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

2

2	If the language of the original Record is neither English nor French, the text shall include a translation into one of these lan								
3	Unle	ess otherwise stated, regulations mentioned in this Record refer to regulations of A irements for an engine's technical file and means of verifications refer to mandato	Annex VI of the Convention and the						
1.	Parti	iculars of the engine							
	.1	Name and address of manufacturer Hyundai Heavy Industries Co.	, Ltd.						
		1, Cheonha-Dong, Dong-Gu, ւ	ılsan, Korea						
	.2	Place of engine build	As above						
	.3	Date of engine build	June 2009						
	:4	Place of pre-certification survey	As above						
	.5	Date of pre-certification survey	2009-06-18						
	.6	Engine type and model number	HYUNDAI-MAN B&W 6S50MC-C7						
	.7	Engine serial number	AA3382						
	.8	If applicable, the engine is a parent engine $\boxed{-}$ or a member engine $\boxed{\!\!\!\!/}$ of the fo	llowing						
		engine family - or engine group X HYUNDAI-MAN E	3&W 6S50MC-C-2008-15						
	.9	Test cycle(s) (see chapter 3 of the NO _X Technical Code)	E3						
	10	Rated power [kW] and speed [rpm]	8820 kW @ 119 rpm						
	:11	Engine approval number	EIAPP-G-0953-0003						
	.12	Specifications of the test fuel	ISO 8217-F-DMC Grade						
	,13	NO _x -reducing device designated approval number (if installed)	Not Applicable						
	.14	Applicable NO _x emission limit [g/kWh] (regulation 13 of Annex VI)	17.0						
	.15	Engine's actual NO _x emission value, cycle E3, [g/kWh]	15.4						
2	Parti	iculars of the technical file							
	.1	Technical file identification/approval number	EIAPP-G-0953-0003						
	.2	Technical file approval date	2009-09-15						
	.3	The technical file, as required by Ch. 2 of the NO_X Technical Code, is an essen always accompany an engine throughout its life and always be available on bo	tial part of the EIAPP Certificate and must ard a ship.						
3.	Spec	cification for the On-board NO _x verification procedure for the engine parame	eter survey						
	:1	On-board NO _X verification procedures identification/approval number	EIAPP-G-0953-0003						
	2	On-board NO _x verification procedures approval date	2009-09-15						
	.3	The specifications for the on-board $NO_{\rm X}$ verification procedures, as required by essential part of the EIAPP Certificate and must always accompany an engine on board a ship.	Ch. 6 of the NO _x Technical Code, are an throughout its life and always be available						
THIS	IS TO CE	ERTIFY that this Record is correct in all respects:	1						
Issued	d at O)slo (on 2009-09-15 (date)						

Tomas Heber Tronstad

Head of Section



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 related thereto (MARPOL 73/78)

for

HYUNDAI-MAN B&W 6S50MC-C7

Certified as a 'Member' engine

Prepared by, HYUNDAI HEAVY INDUSTRIES CO., LTD., ENGINE & MACHINERY DIVISION, ENGINE DEVELOPMENT & TEST DEPARTMENT

Identification/approval number HYUNDAI-MAN B&W 6S50MC-C-2008-15-AA3382/

HYUNDAI HEAVY INDUSTRIES CO., LTD., ULSAN, KOREA

Date of issue

Issued at

Signature of duly authorized official issuing the certificate

(Seal or Stamp of the authority, as appropriate)

VERITAS

FIAPP- G-0953-0003





CONTENTS

Description	Page
A. General	3
B. Summary	4
C. Particulars of the Engine	5
D. Particulars of the Technical File	6
E. Specifications for the On-board NOx Verification Procedures for the Engine Parameter Survey	7
F. List of NOx Relevant Components and Settings	8
G. Guideline for Components Replacements	11
H. Measurements for IMO Compliance Test at Test Bed	12
I. On Board Verification Procedure	13
J. Concept of Parent, Member Engine and Engine Group	19
K. Marking of Identification Number of NOx Relevant Components	20
L. Test Report and Certificates	25
M. Engine General Information	26
N. Engine Group Information	27
O. Test Cell Information (For Information)	28
P. Ambient and Gaseous Emission Data (For Information)	29
Q. Results of NOx Emission (For Information)	30
R. Fuel Analysis (For Information)	31
S. Engine Performance Data ten (10) sheets	32





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 IMO NOx Technical Code")

for

HYUNDAI-MAN B&W 6S50MC-C7

1. (Certified as an a 🗌 Individual	I / □ Parent / ■ Member Engine of Engine Group
	Engine Manufacturer Engine Type Engine Number Number of Engine Test Cycle Rated Power Rated Speed M.E.P.	: Hyundai Heavy Industries Co., Ltd. : HYUNDAI-MAN B&W 6S50MC-C7 : AA3382 : One(1) set as a Member Engine : E3 : 8820 kW : 119 RPM : 18.9 bar
T N m	his is to certify that this Tech Ox emission limits on board narine diesel engine, prior to	ai Heavy Industries Co., Ltd., Engine & Machinery Division inical File including procedures for demonstrating compliance with a ship, Engine Parameter Check Method, for the above mentioned the engine's installation and/or service on load a ship, fully comply with NOx Technical Code made mandatory by Annex VI of the Convention.
	Identification/approval num	nber : HYUNDAI-MAN B&W 6S50MC-C-2008-15-AA3382/
	Date of issue	(Signature of duly authorized official issuing the certificate)
		(Seal or Stamp of the authority, as appropriate)





B. Summary

IMO NOx emission test on one(1) main propulsion engine for Hyundai Vinashin Shipyard Co., Ltd. Hull No. S001 was carried out as parent engine of the HYUNDAI-MAN B&W 6S50MC-C-2008-15-AA3182 at test bed in order to fully meet the IMO NOx Technical code.

However, if this group has member engines, additional IMO NOx compliance test for them is not to be performed because it can be considered as identical engines having the same NOx relevant components, rated power, rated RPM, nearly similar setting values and also identical IMO ID numbers compared with the Parent Engine.

- Calibrations of Zero & Span for gas analyzers were successfully carried out under the presence of the surveyor (s).
- 2. Analyzers and calibration gases have been confirmed in compliance with the IMO NOx Technical Code by the surveyor(s).
- 3. Calculations of the emission value and exhaust, gases emission have been done according to the IMO NOx Technical Code as follows:
 - (1) Humidity correction factors for NOx for diesel engines (Khdies) have been calculated according to formula(14) of 5.12.3.6 on the IMO NOx Technical Code.
 - (2) Humidity of intake air(Ha) according to formula(10) of 5.12.2.1 on the IMO NOx Technical Code.
 - (3) Dry to wet correction factor (Kw,r) for the raw exhaust gas according to formula(11) of 5.12.2.2 on the IMO NOx Technical Code.
 - (4) The exhaust gas mass flows were calculated according to Method 2, Universal, Carbon/Oxygen-balance, 3 of Appendix 6 on the IMO NOx Technical Code.
 - (5) The NOx emission value was corrected to reference conditions as shown in Chapter I.8 which includes a scavenge air cooler fresh water coolant inlet temperature of 36 °C when operating under reference conditions-25 °C sea water temperature for central fresh water cooling system, whereas a scavenge air cooler sea water coolant inlet temperature of 25 °C for conventional sea water cooling system. Basically, charge air cooling system for this group is shown in the Chapter F, "List of NOx Relevant Components and Setting" and the Chapter N, "Engine Group Information".
- 4. The certificates for analytical instruments and calibration gases were not included in this Technical File because they had been checked and confirmed by surveyor during NOx emissions test.

 However, summarized information on the analytical instruments can be seen on Chapter O, Test Cell Information in this Technical File.

Finally, the test result (NOx: 15.40 g/kWh) for parent engine which is corrected to ISO NOx values based on reference Pmax and scavenge air temperature as mentioned in Chapter I.8, HYUNDAI-MAN B&W 6S50MC-C-2008-15-AA3182 is showed far less than IMO NOx limit (17.0 g/kWh).





C. Particulars of the Engine

Two-stroke, single acting, direct reversible, cross head, constant pressure turbocharging diesel engine, and using heavy fuel oil.

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

: June 2009

4. Place of pre-certification survey

: Hyundai Heavy Industries Co., Ltd.

1, Cheonha-Dong, Dong-Gu, Ulsan, Korea

5. Date of pre-certification survey

: June 17, 2009

6. Engine type

: HYUNDAI-MAN B&W 6S50MC-C7

7. Engine number

: AA3382

8. If applicable, the Engine is □ an Individual Engine, □ Parent / ■ Member Engine of Engine Group of the following □ Engine Family, or ■ Engine Group,

Engine Group Name : HYUNDAI-MAN B&W 6S50MC-C-2008-15

9. Test cycle(s)(acc. to Chapter 3 of the IMO NOx Technical Code) : E3

10. Rated Power & Speed

: 8820 kW at 119 RPM

11. Mean effective pressure

: 18.9 bar

12. Max. combustion pressure

: 150 bar

13. Engine approval number

:

14. Specification of test fuel

(and/or Certification number of fuel sample analysis): Bunker-A (ISO 8217, DMC)

(Parent engine of engine group)

15. NOx reducing device designated approval number (if installed): Not applicable

16. Applicable NOx emission limit (Regulation 13 of Annex VI)

: 17.0 g/kWh

17. Engine's actual NOx emission value

: 15.40 g/kWh (AA3182)

(Parent engine of engine group)



D. Particulars of the Technical File

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

1	Technical File identification/a	pproval number:
2	Tochnical File approval data	
2.	Technical File approval date	·





E. Specifications of the On-board NOx Verification Procedures for the Engine Parameter Survey

The Specifications for the on-board NOx verification procedures, as required by Chapter 6 of the IMO NOx Technical Code, is a essential part of the EIAPP Certificate and must always accompany and engine throughout its life and always be available on-board a ship.

	On-board NOx verification procedures identification/approval number :
2	2. On-board NOx verification procedures approval date :





F. List of NOx Relevant Components and Settings

1. Components (Standard Engine set-up plus listing of allowed inter-changeable components)

Description	Value	Identification Number	Range/ Alternative	Note			
Engine Specification							
Number of cylinders	6	© -	•	1)			
Cylinder liner (bore, Ø mm)	500	A19-266039-5, A19-212323-4, 3170262-7	-	1), 2			
Stroke (mm)	2000	-	-	1)			
Combustion chamber (compres	sion r	atio : see settings)					
Cylinder cover	-	A10-212926-7, 5025583-3	-	2)			
Piston crown	-	A10-255133-2, 5012873-6	-	2)			
Fuel injection equipment (per c	ylinde	r unit)	• / / / / / / / / / / / / / / / / / / /				
Barrel of fuel pump	-	1170729-8	-	2)			
Plunger of fuel pump (dia., Φmm)	52	1171182-5	-	1), 2)			
Fuel injection valve (number of fuel valve(s))	2	•	-	1)			
Atomizer of fuel valve (number, Фmm) (opening/closing : see settings)	-	3062332-6x115	-	2)			
Fuel cam	-	A19-124775-1, 1173321-5	-	2)			
Exhaust cam	-	A19-124779-9, 1173320-3	-	2)			
Auxiliary blower	2	Serial No.: 08B0276-01-05, 08B0276-01-06					
Turbocharger maker/type : Hyu	ındai-	ABB TPL77B12					
\		Serial No.: XH002480		T			
Number & S/No. of turbocharger(s)	1			1), 2)			
Compressor wheel	-	CV12 CT65	-	2)			
Diffuser	-	CT65 CA17	-	2)			
Turbine rotor	-	TT40 TF15	-	2)			
Nozzle ring	-	TT40 TA22	-	2)			
Charging air cooling system : C	entral	fresh water cooling system					
Charge air cooler	1	Serial No. : 76667	A19-274025-8	1), 2)			
Charge air cooling water inlet temp.(℃)	36		1-	1), 3)			





2. Settings (Engine matching at test bed)

Description		Value	Drawing/ Ident. No.	Range/ Alternative	Notes		
Engine Layout		,					
Rated power (MC	R, kW)	8820	-	-	1)		
Rated speed (RPI	M)	119	-	-	1)		
Mean effective pressure							
at rated power (M.E	.P., bar)	18.9	-	-	1)		
Maximum combustion pressure (bar)		150	-	150 ± 3	1)		
Performance set-up		1	,				
Compression ratio (mm) (Compression shim thickness)	1	8	-	Piston rod effective length 2635 mm	1), 4)		
Fuel valve opening pressure (bar)		350	1.5	350 ± 30	1)		
Fuel cam lead angle (deg	CA)	Refer to Chap	ter I and S.	-	4)		
Fuel cam lift (mm))	Refer to Chap	ter I and S.	Tolerance + 1	4)		
Number of fuel pump shim (EA Thickness of fuel pump shim (r		Refer to Chap	ter I and S.	Tolerance ± 1	4)		
Fuel pump orifice (φmm, if a	ipplicable)	Refer to Chap	ter I.	-	-		
Exhaust cam lead angle (deg.	CA)	Refer to Chap	ter I and S.	Tolerance ± 1	4)		
Certified range for maximur	n combus	tion pressrue	(measured) - without VI	г			
Parameters	Actual ad		Certified range for adjustment	Checking of adjustment			
Combustion pressure at 50% power	105.2	bar	111 bar or below	Pressure measurement			
Combustion pressure at 75% power	132.2	bar	136 bar or below	Pressure measurement			
Combustion pressure at 100% power	149.8	bar	153 bar or below	See chapter I and S.			



Notes)

- 1) Parameters, operating values and settings can be verified through an engine performance check.
- 2) The Identification numbers for cylinder liner, cylinder cover, piston crown, exhaust cam and fuel cam are marked with one(1) or over two(2) kinds of numbers (i.e., HHI's number: XXX-XXXXXX-X, licensor's number as alternative: XXXXXXX-X). And even if only one of the above and/or both kinds of numbers can be marked on the above components, they are identical components each other. In addition, identification or serial numbers for fuel injection barrel, plunger, atomizer, turbocharger(s), charge air cooler(s) and auxiliary blowers are marked with sub-manufacturer's number.

Some NOx relevant components may have over two(2) IMO identification numbers as an alternative. Therefore, one of mentioned IMO Identification numbers in this technical file can be available on this engine.

The revision number of IMO identification number for each NOx relevant components does not have an effect on NOx emission value because this revision number is only for HHI's drawing management system. (for instance, XXX-XXXXXX-X.X)

(revision number)

3) For central fresh water cooling system, the temperature(36°C) is for cooling water inlet under reference conditions - 25°C sea water temperature.

For conventional sea water cooling system, the inlet temperature (25°C) is for cooling water inlet reference conditions and the Tsc. tolerance are given to the stated reference value in Chapter I-8 for each load, i.e., if the sea water temperature is 10°C higher than the reference sea water temperature, the nominal Tsc. at 100% load would be 54°C and actual max. allowable Tsc. Would be 60°C.

For sea water cooling system, there is no intermediate cooler between sea water and the scavenge air coolant the maximum temperature under reference condition is 25°C.

4) Compression shim thickness, fuel cam lead angle, fuel pump top lift, fuel pump shim thickness/numbers and exhaust cam lead angle can be adjusted and changed in order to keep maximum combustion pressure within the approved ranges as given in Chapter F.2

Note: Any adjustment(s) and change(s) should be recorded in the 'Record Book' of engine parameters.





G. Guideline for Components Replacements

1. General

If any of the components listed under "List of NOx Relevant Components and Settings" on Chapter F 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 components through the engine manufacturer.

2. Proceeding for the replacement

- 1. Order the component indicating the ID numbers specified in this Technical File through the engine manufacturer.
- 2. Substitute the old component by the new one.
- 3 Record the substitution including component specification, date of replacement and component supplier in the "Engine's Record Book of engine parameters" which has to keep on board of the ship.



H. 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 F.2.

Table 1. Measured Performance Parameters at Test Bed

- Engine rated power (kW)
- Engine rated speed (RPM)
 - Mean effective pressure (bar)
 - Cylinder maximum pressure (bar)
 - Compression pressure (bar)
 - Fuel injection timing (deg. CA bTDC)
- * Fuel consumption (kg/h)
 - Turbocharger speed (RPM)
 - Exhaust gas temperature after cylinder outlet (℃)
- * * Exhaust gas flow (kg/h)
- * * Air consumption (kg/h)
- * Exhaust gas emissions
- Exhaust gas pressure (at sampling position, mmWC)
- * Exhaust gas temperature (at sampling position, °C)
- * Air inlet temperature (at turbocharger compressor side, °C)
- Atmospheric pressure (kPa)
- Intake air humidity (%)
- * Ambient temperature (℃)
- * Charge air pressure (kg/cm2)
- * Charge air temperature (℃)
- * Charge air cooling water inlet/outlet temperature (°C)
- * Lubricating oil cooler (i.e., oil side) inlet/outlet (°C)
- * 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 IMO NOx Technical Code.
- 2. The measurements marked ' * * ' shall be carried out through the carbon balance method according to the IMO NOx Technical Code 5.5.3.
- 3. Concerning the engine dynamometer specified in the IMO 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 shall be applied.





I. On Board Verification Procedure

1. General

The following described procedure shows an easy and reliable verification of the engine in order to confirm its compliance with 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. The procedure can be performed during the stop in the harbor without running the engine except for some setting parameters. All ID-numbers, settings and dimensions mentioned in the following verification procedure are defined in the "List of NOx Relevant Components and Settings" on Chapter F.

2. The procedure for on board verification

The procedure of an engine for on-board verification shall be carried out as follows;

Firstly,

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

Secondly,

The engine components and parameter setting values shall be reviewed by surveyor.



ElAPP- G-0953-0003



3. Check for engine components and parameters

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

Engine Specification

1. Rated power & RPM

: Check the name plate on engine body.

Combustion chamber

1. Cylinder liner : Check the IMO ID-number. 2. Cylinder cover : Check the IMO ID-number. 3. Piston crown : Check the IMO ID-number.

Fuel injection equipment

1. Barrel of fuel pump : Check the IMO ID-number.

2. Plunger of fuel pump : Check the IMO ID-number and diameter.

3. Number of fuel valve(s) : Check the number of the fuel valve(s) per cylinder.

4. Atomizer of fuel valve : Check the IMO ID-number. 5. Fuel cam : Check the IMO ID-number. 6. Exhaust cam : Check the IMO ID-number.

Turbocharger

1. Maker : Check the name plate.

2. Number of T/C(s) : Check the number of the turbocharger(s). 3. Serial No./Model : Check the serial number/model on name plate.

4. Compressor wheel : Check the IMO ID-number. 5. Diffuser : Check the IMO ID-number. 6. Turbine rotor : Check the IMO ID-number. 7. Nozzle ring : Check the IMO ID-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. Serial No./IMO ID : Check the name plate.

4. Cooling system : Check cooling system corresponds to Chapter F/M/N.

Governor

1. Maker : Check the name plate. 2. Model Check the model name.

Aux. Blower

1. Maker : Check the name plate. 2. Serial No. : Check the name plate.

Performance set-up

A14-369785-0.0

1. Compression ratio : Check the thickness of compression shim.

2. Exhaust cam lead angel : Check the lead angle. 3. Fuel cam lead angel & top lift : Check the lift of fuel pump.

: Check the lead angle (only for reference) 4. Fuel pump lead angle

Fuel pump shim(s) : Check the number and thickness of fuel pump shim(s).

(only for without VIT system)

: Check the size of orifice of fuel pump (if applicable) 6. Fuel pump orifice



4. Procedures for an engine parameter check method

No.		Inspection	Remarks						
1	Inspection of document		-						
1.1	Inspection of Technical File)							
1.2	Inspection of Record Book	of engine parameters							
1.3	Inspection of Technical Do	cumentation of engine components modification							
2	Inspection of engine components								
2.1	Piston crown	Ident. No. : A10-255133-2, 5012873-6							
2.2	Cylinder cover	Ident. No. : A10-212926-7, 5025583-3							
2.3	Cylinder liner	Ident. No. : A19-266039-5, A19-212323-4, 3170262-7							
2.4	Barrel of fuel pump	Ident. No. : 1170729-8							
2.5	Plunger of fuel pump	Ident. No. : 1171182-5	Dia. : 52 mm						
2.6	Fuel injection valve (number of fuel valve(s))	Number : 2/cylinder							
2.7	Atomizer of fuel valve	Ident. No. : 3062332-6x115							
2.8	Fuel cam	Ident. No. : A19-124775-1, 1173321-5							
2.9	Exhaust cam	Ident. No. : A19-124779-9, 1173320-3							
2.10	Governor	Maker : Kongsberg Maritime Korea	Serial No. :						
2.,0	Governor	Model : AC C20 DGS	Name plate						
		Maker : Hyundai-ABB	Serial No. :						
2.11	Turbocharger	Model : TPL77B12 Serial No. : XH002480	Name plate						
		Maker : Vestas Aircoil	Serial No. :						
2.12	Scavenge air cooler	Ident. No. : A19-274025-8 Serial No. : 76667	Name plate						
		Maker : Tae II Blower Mfg. Co., Ltd.							
2.13	Auxiliary blower	Serial No. : 08B0276-01-05, 08B0276-01-06	Serial No. : Name plate						
3	Inspection of setting val	ues							
3.1	Rated power	8820 kW : See N.P. & T.F.							
3.2	Rated speed	119 RPM : See N.P. & T.F.							
3.3	Max. combustion pressure	150.0 bar at rated power							
3.4	Compression ratio (shim thickness)	8 mm (beneath piston rod)							
3.5	Exhaust cam	Lead angle : See next page.							
3.6	Fuel cam / Fuel pump	Lead angle and top lift : See next page.							
3.7	Fuel pump shim / thickness	Number and thickness : See next page.							
3.8	Fuel pump orifice	Diameter : See next page.							
4	Review of operating valuif available	ues with fuel oil analysis as well as shop test report,	for reference						
4.1	Scav. air temperature	See I.8							
4.2	Max. cylinder pressure	See I.8							
Not		10000001 10							

Notes)

- (1) T.F.: Technical File.
- (2) N.P.: Name Plate of engine
- (3) The most important: Atomizer of fuel valve
- (4) The surveyor shall have the option of checking one or all the identified components, settings or operating values to ensure that the engine with number, or minor, adjustment or modifications complies with the applicable emission limits and that only components of the current specification are being used. Especially, if it is necessary to survey a combustion pressure, the combustion pressure at 50% and 75% load can be measured and evaluated according to the maximum combustion pressure table on page 9.



5. Inspection of turbocharger components

No.	Components	Identification No.	Remarks
1	Compressor wheel	CV12 CT65	-
2	Diffuser	CT65 CA17	.=:
3	Turbine rotor	TT40 TF15	-
4	Nozzle ring	TT40 TA22	-

6. Exhaust cam lead (advance angle)

* for parent engine *

Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Measured angle (before TDC) at shop test bed	-3.40	-3.35	-3.45	-3.40	-3.35	-3.40	-	-	-	_	-	-	-3.39

(Design Value: Angle A: 112.9*, Lift = 10 mm / Angle B: 254.1*, Lift = 10 mm)

* for member engine *

Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Measured angle (before TDC) at shop test bed	-3.40	-3.20	-3.35	-3.20	-3.35	-3.35	-	-	-	-	_	-	-3.31

(Design Value: Angle A: 112.9°, Lift = 10.0 mm / Angle B: 254.1°, Lift = 10.0 mm)

7. Fuel cam (lead angle) / Fuel pump(top lift)

* for parent engine *

Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Measured angle													
(before TDC)	9.40	9.80	9.70	10.30	9.70	9.80	-	-	-	_	_	-	9.78
at shop test bed													
Number of fuel													_
pump shim (EA)	8	8	8	8	8	8	-	-	-	_	-	_	8
Thickness of fuel	0.5	0.5	0.5	0.5	0.5	0.5							0.5
pump shim (mm)	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	_	-	_	0.5
Top lift(mm)	10.64	11.36	11.09	11.93	11.07	11.28							11 22
at shop test bed	10.04	11.30	11.09	11.93	11.07	11.20	_		-	-	-	-	11.23
Fuel pump orifice		_			_								
φmm, if applicable)		L		_			-	-		-	_	_	-

* for member engine *

Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Measured angle													
(before TDC)	10.30	10.50	10.50	10.20	10.20	9.80	-	-	-	-	-	-	10.25
at shop test bed													1
Number of fuel	8	8	8	8		0							_
pump shim (EA)	0	0	0	0	8	8	-	-	-	-	-	_	8
Thickness of fuel	0.5	0.5	0.5	0.5	0.5	0.5							0.5
pump shim (mm)	0.5	0.5	0.5	0.5	0.5	0.5	_	_	-	-	-	-	0.5
Top lift(mm)	11.97	11.98	12.18	11.67	11.76	11.25							11.00
at shop test bed	11.57	11.90	12.10	11.07	11.76	11.23	-	_	_	-	_	_	11.80
Fuel pump orifice	_	_			_			_					
(φmm, if applicable)		_	_	_		-	-	_	_	_			_

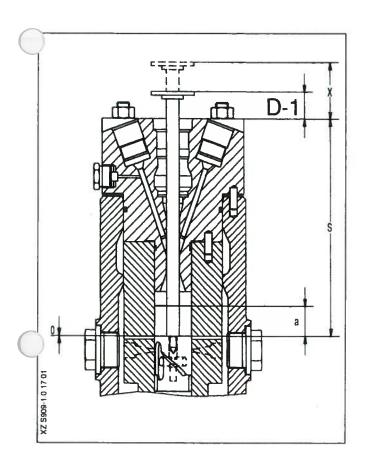
Remarks)

Compression shim thickness, fuel cam lead angle, fuel pump top lift, fuel pump shim thickness/numbers and exhaust cam lead angle can be adjusted and changed in order to keep maximum combustion pressure within the approved ranges as given in Chapter F.2

Note: Any adjustment(s) and change(s) should be recorded in the 'Record Book' of engine parameters.







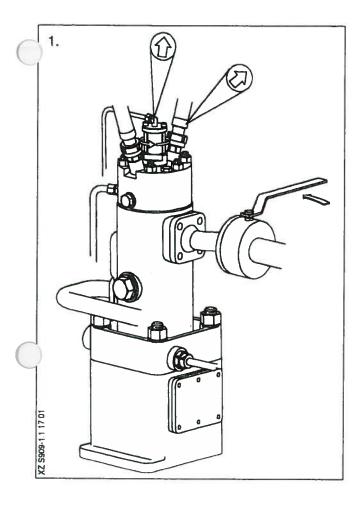
The fuel pump lead a (= the effective lead) is defined as the distance the top of the fuel pump plunger is lifted above the upper edge of the upper cut-off holes in the fuel pump barrel, when the piston of the cylinder concerned is in TDC.

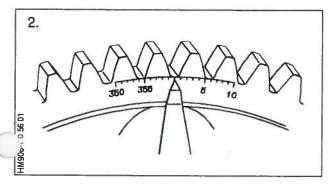
Barrel + Top cover = s

Tool length = s + "D-1"

Fuel pump lead a = x - "D-1"







 To be able to measure the fuel pump lead, it is necessary to dismantle one of the high-pressure pipes and the combined puncture/suction valve from the top cover.

Note!

Before dismantling any part of the fuel pump, make sure the pump has been relieved of pressure and that all oil has been drained off.

Shut off the fuel oil inlet.

Open the fuel pump drain cock, and drain off the oil

Dismount one of the high-pressure pipes.

Dismount the air pipe on the puncture valve.

Dismount the puncture valve.

2.

Note!

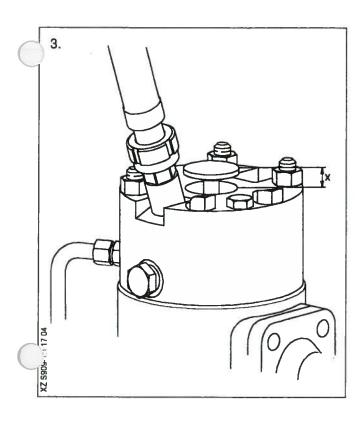
The correct distance **x** can only be measured when the fuel pump plunger is in its delivery stroke.

Turn the engine in AHEAD direction until the main piston of the cylinder concerned is exactly at TDC.

See Procedure 906-3.1.







3. Mount the measuring tool on top of the fuel pump plunger, through the hole in the fuel pump top cover.

Measure the distance \mathbf{x} from the top of the measuring tool to the top of the fuel pump top cover.

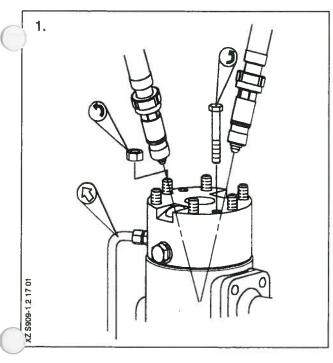
The fuel pump lead is then calculated as: a = x - D-1"

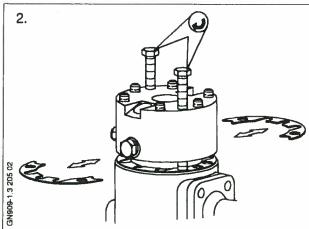
Note down the result for future reference.

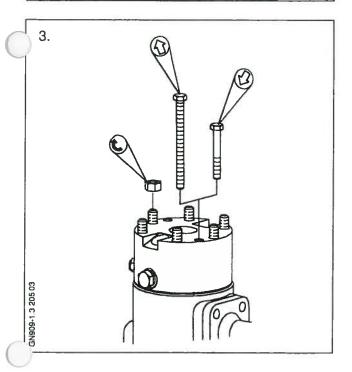
For adjustment of fuel pump lead. See Procedure 909-1.3.











To insert or remove shims from the fuel pump, use the following procedure:

Note!

If the required adjustment of the fuel pump lead cannot be attained by inserting or removing shims (see Data D-2), the adjustment must be carried out on the fuel cam disc.

See Procedure 909-3.3.

1. Dismount the high-pressure pipes.

Dismount the drain oil pipe on the top cover.

Dismount the top cover fixing nuts. Remove the two screws in the threaded holes of the top cover.

Screw the two dismantling screws (from the tool panel) into the threaded holes of the top cover, thus lifting the top cover to provide space for inserting or removing shims.

The number of shims can now be adjusted. See Data D-2.

Note down the new shim thickness.

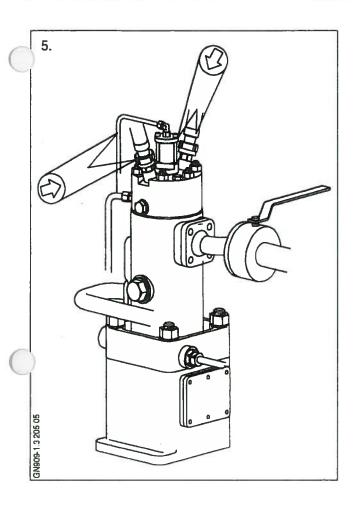
3. Replace the dismantling screws with the two original screws, and press down the top cover.

Mount the nuts for fastening the top cover, and tighten them diagonally, see Data D-4.

If any of the top cover studs have come loose, tighten them, see Data D-5.







- 4. Measure the fuel pump lead again and note down the result for future reference.

 See Procedure 909-1.1
- 5. Close the drain cock in the pump housing.

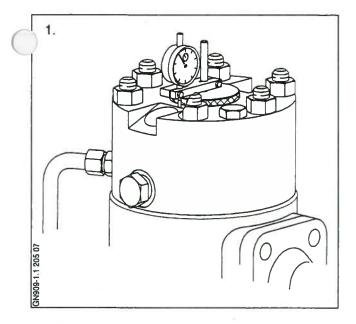
Mount the combined puncture/suction valve in the top cover, see Data D-3.

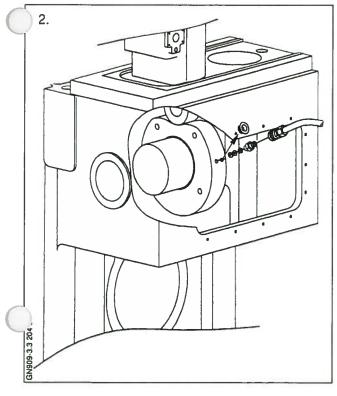
Connect the drain oil pipe to the top cover and the pipe connection to the puncture valve.

Mount the two high-pressure pipes on the top cover/fuel valves, see Data D-6.

6. Open the fuel oil inlet.







If the required adjustment of the fuel pump lead cannot be accomplished by inserting or removing shims, the fuel pump lead must be altered by adjusting the fuel cam disc as described below. See Procedure 909-1.3.

1 Turn AHEAD until the piston of the cylinder concerned is in TDC. (If the engine is of the reversible type, ensure that the roller guide is in AHEAD position).

Mount the measuring tool and adjust the dial gauge to zero.

2 Remove the inspection cover from the camshaft housing.

Remove the plugs from the oil ducts on the fuel cam.

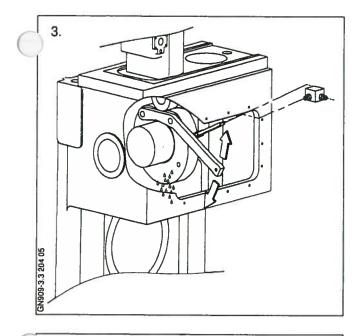
Insert three copper gaskets in each oil duct.

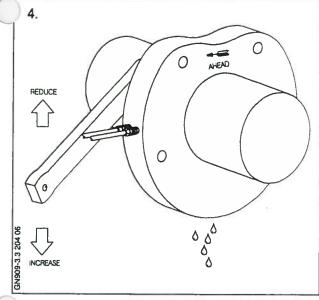
Mount quick couplings in the ducts, but do not tighten them.

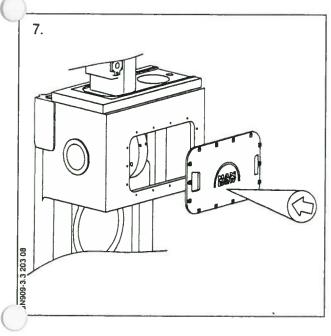
Fit hydraulic hoses between the snap-on couplings, the distributor block and the high pressure pump.











Mount the special spanner on the fuel cam disc and keep it close against the cam during the adjustment.

Apply light pressure to the hydraulic system and, after venting the system, tighten the quick coupings.

Raise the hydraulic pressure until oil seeps out between the camshaft and the cam disc.

Turn the cam disc, using the fitted spanner, until the desired change of lead is read directly on the measuring tool.

(The necessary turning of the cam disc is calculated as described in Procedure 909-1.1).

4. To increase the lead and Pmax:

·turn the cam disc AHEAD.

To reduce the lead and Pmax:

turn the cam disc ASTERN.

5. After completing the desired turning of the cam disc, relieve the hydraulic system of pressure and dismount the spanner and the hydraulic equipment.

Wait at least 15 minutes - the cam must be allowed time to "settle" - before mounting the plugs again in the oil ducts of the cam disc.

- 6. Again measure the lead of the fuel pump. See Procedure 909-1.1.
- 7. Mount the inspection cover on the camshaft housing.





8. Evaluation of the performance influence on the ISO corrected NOx values

(Parent Engine of Engine Group)

A method to check NOx compliance for varying maximum combustion pressure and scavenge air temperature is shown in the following example neglecting the influence of turbine back pressure. The back pressure has been found out to have only a minor influence on NOx values.

Reference table for Ha, Khdies and Ta

Load(%)	Hsc	На	Khdies(*)	Та	Khdies(**)
100	12.72	1.80	0.9158	22.0	0.9300
75	11.40	1.47	0.9057	18.0	0.9125
50	14.38	1.18	0.8917	15.0	0.8982
25	12.13	0.95	0.9200	13.0	0.9269

Remarks;

Khdies(*) : Based on Tscref.

Khdies(**): Based on max. allowable Tsc.

Table 8.1 Estimation of maximum combustion pressure and scavenge air temperature at 100%, 75%, 50% and 25% load and derive the equivalent change in NOx emission (g/kWh).

Load (%)	Max. combustion pressure(bar)		Absolute change in NOx (g/kWh)	1 "	air temperature ΔT)	Absolute change in NOx (g/kWh)
(70)	Ref. value	ΔΡ	111 140x (g/kvvii)	Tscref	ΔΤ	III NOX (g/kvvii)
100	150.0	increase 1 bar	0.1816	48.0	increase 1 °C	Khdies
75	133.0	increase 1 bar	0.1760	43.0	increase 1 °C	Khdies
50	108.0	increase 1 bar	0.1760	39.0	increase 1 °C	Khdies
25	83.0	increase 1 bar	0.1760	44.0	increase 1 °C	Khdies

Table 8.2 Maximum allowed tolerances of max. combustion pressure and scavenge air temperature at ISO ambient conditions and the relative change in NOx.

	100 4111	pient conditions a	ind the r	CIALIVE	andinge in it	IOX.			
Load (%)	NOx (g/kWh) (Not corrected-Pmax.)		(0)		Change	Scav	venge air temp. (℃)	Scavenge	
	Corr. Tscref	Not corrTscref	Actual value	Ref. value	Max. allowable Pmax	in NOx (g/kWh)	Tsc ref	Max. allowable Tsc	Air temp. actual (℃)
100	13.78	15.05	150.0	150.0	153.0	0.5448	48.0	54.0	40.0
75	15.13	16.71	131.7	133.0	136.0	0.7568	43.0	46.0	34.0
50	17.60	19.74	105.8	108.0	111.0	0.9152	39.0	42.0	32.0
25	18.72	20.35	80.3	83.0	86.0	1.0032	44.0	47.0	22.0

Note: Tscref. - 48℃, 43℃, 39℃, 44℃ at load 100%, 75%, 50%, and 25% respectively.

Tscref. values are based on operation with a fresh water temperature of 36 °C.

Corrected ISO NOx values(Based on reference Pmax. and scavenge air temperature)





Example 'Calculation of expected NOx at the given combustion pressure and scavenge air temperature.

1) Measure the maximum combustion pressure and scavenge air temperature at 100%, 75%, 50% and 25% load as following table.

Power (%)		Max. combustion pressure(bar)		Absolute change in NOx (g/kWh)	Scavenge air (ΔT		Absolute change in NOx (g/kWh)	
	Actual value	ΔΡ		11110x (g/kvvii)	Actual value	ΔΤ	111 140x (g/kvvii)	
100	149.0	-1	bar	-0.1816	54	14 °C	-1.0535	
75	129.7	-2	bar	-0.3520	46	12 ℃	-1.4625	
50	103.8	-2	bar	-0.3520	42	10 ℃	-2.0101	
25	78.3	-2	bar	-0.3520	47	25 ℃	-1.4876	

Note: $\Delta P = Actual \ value - test \ bed \ value(parent \ eng.), \ \Delta T = Actual \ value - test \ bed \ value(parent \ eng.)$

2) Calculate the expected NOx emission at each load condition as a summation of the ISO NOx corrected value and the absolute changes (as given in the table). The ISO NOx corrected values for the E3-cycle load conditions are given in Chapter I-8.

3		
100%	NOx value at shop test (Not corrected- Pmax & Tscref) = 15.05 g/kWh Absolute change as a consequence of different max. pressure = -0.1816 g/kWh Absolute change as a consequence of different scav. temp. = -1.0535 g/kWh Expected NOx emission	
	15.05 + (-0.1816) + (-1.0535) = 13.81 g/kWh	
75%	NOx value at shop test (Not corrected- Pmax & Tscref) = 16.71 g/kWh Absolute change as a consequence of different max. pressure = -0.3520 g/kWh Absolute change as a consequence of different scav. temp. = -1.4625 g/kWh Expected NOx emission	
	16.71 + (-0.3520) + (-1.4625) = 14.89 g/kWh	
50%	NOx value at shop test (Not corrected- Pmax & Tscref) = 19.74 g/kWh Absolute change as a consequence of different max. pressure = -0.3520 g/kWh Absolute change as a consequence of different scav. temp. = -2.0101 g/kWh Expected NOx emission	
	19.74 + (-0.3520) + (-2.0101) = 17.38 g/kWh	
25%	NOx value at shop test (Not corrected- Pmax & Tscref) = 20.35 g/kWh Absolute change as a consequence of different max. pressure = -0.3520 g/kWh Absolute change as a consequence of different scav. temp. = -1.4876 g/kWh Expected NOx emission	
	20.35 + (-0.3520) + (-1.4876) = 18.51 g/kWh	

3) Finally, calculate the ISO corrected IMO NOx value at the given maximum combustion pressure and scavenge air temperature using the following formula.

```
IMO NOx = 0.2909 \times NOx(100\%) + 0.5455 \times NOx(75\%) + 0.1091 \times NOx(50\%) + 0.0545 \times NOx(25\%)
IMO NOx = 0.2909 \times 13.81 + 0.5455 \times 14.89 + 0.1091 \times 17.38 + 0.0545 \times 18.51
= 15.05 g/kWh
```

Since the IMO limit is 17.0 g/kWh, the engine still fulfills the requirements.

Example 2: Calculation of expected NOx at max. allowable combustion pressure and scavenge air temperature.

```
IMO NOx = 0.2909 x 15.05 x 0.9300 + 0.5448 ) + 0.5455 x ( 16.71 x 0.9125 + 0.7568 ) 
+ 0.1091 x 19.74 x 0.8982 + 0.9152 ) + 0.0545 x ( 20.35 x 0.9269 + 1.0032 ) 
= 16.08 g/kWh
```



J. Concept of Parent, Member Engine and Engine Group

Conditions for the application of this group concept are a set of identical engines having the identical components, same maximum power per cylinder and same rated speed.

The engine manufacturer should show a "Conformity of Production" in the production process. This includes ISO 9001 certificates or other quality insuring systems which should guarantee that member engines of engine group are identical.

Idea of this group concept is to have a need for emission measurements only for an engine, the so called "Parent Engine" and not need for emission measurements only for an engine, the so called "Member Engine". All the following identical engines can be adjusted and certified according to the procedures described in this page and according to the "List of NOx Relevant Components and Settings" on Chapter F.

Conditions for an Engine to be a member of the Engine Group

1. Identical Components:

If this is not the case the engine manufacturer has to show that the modified or exchanged components behave in the same way.

2. Same settings:

All settings and measured values according to the "List of NOx Relevant Components and Settings" on Chapter F should be within the limits approved for the Engine group.





K. Marking of Identification Number of the NOx Relevant Components

1. Application range

This is valid for components and engines which are built at Hyundai Heavy Industries Co., Ltd., Engine & Machinery Division works (HHI-EMD), in accordance with the requirements of the International Maritime Organization (IMO) document MP/CONF.3/35 - Resolution 2, Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines.

2. 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 numbers.

Checking

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

4. ID numbers of NOx relevant components

The ID number of NOx relevant components mentioned in the "List of the NOx Relevant Component and Settings" on Chapter F are marked as shown on the following sheets.

No.	Location of the IMO ID	IMO ID	Drawing No.
1	Auxiliary blower	Serial No. 08B0276-01-05 08B0276-01-06	A14-321343-6
2	Air cooler	A19-274025-8 Serial No. 76667	A14-332495-8
			ORSKE A



No.	Location of the IMO ID	IMO ID	Drawing No.
3	Cylinder cover	A10-212926-7 5025583-3	A10-212926-7
4	Piston crown	A10-255133-2 5012873-6	A10-255133-2
5	Cylinder liner IMO ID	A19-266039-5 A19-212323-4 3170262-7	A10-214402-3
6	Barrel of fuel pump	1170729-8	A10-188640-2





No.	Location of the IMO ID	IMO ID	Drawing No.
7	Plunger of fuel pump IMO ID	1171182-5	A11-188641-4
8	Atomizer of fuel valve	3062332-6x115	A12-224009-0
9	Fuel cam	A19-124775-1 1173321-5	A10-169928-8 A10-169929-0 (for template dwg.)
10	Exhaust cam	A19-124779-9 1173320-3	A10-169931-0 A10-169932-2 (for template dwg.)

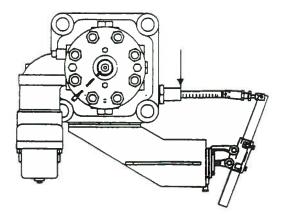


No.	Location of the IMO ID	IMO ID
	Turbocharger	Type : TPL77B12
11	IMO ID	Serial No. : XH002480
11-1	Compressor wheel	CV12 CT65
	Diffuser	CT65 CA17
11-2	IMO ID	
	Turbine rotor IMO ID for	TT40 TF15
11-3	IMO ID for VTR, TPL, TCA & NA	
	Nozzle ring	TT40 TA22
	IMO ID for only VTR	
11-4		
	IMO ID for TPL, MET, TCA & NA	OF SKE



5. Read the actual VIT-index

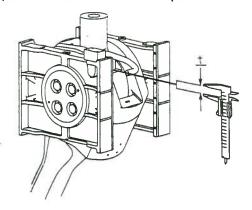
Read the actual VIT-index on the scale of the fuel pump timing racks.



6. Checking the shims

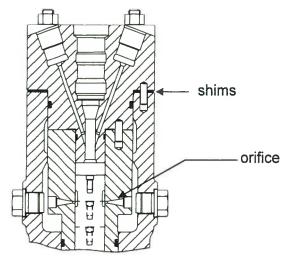
A. Checking the compression shims thickness (t), (compression volume)

Turning the crankthrow towards the exhaust side, to provide access for measuring the thickness of the shim which is inserted between piston rod and crosshead pin.



B. Number of shims in the fuel pump, (injection timing)

For engines without VIT, visually check the number of shims between the fuel pump top cover and the pump housing.





L. Test Report and Certificates

After the IMO NOx pre-certification test at test bed,

1. The test report is included in the Technical File.

After issuing of the EIAPP certificate (or 'the Statement of Compliance'),

2. The EIAPP Certificate(or the Statement of Compliance) shall be attached to the Technical File.

Number of Certificate	•	
Issued Date	:	

After issuing of the IAPP certificate (or 'the Statement of Compliance'),

3. The IAPP Certificate(or the Statement of Compliance) shall be attached to the Technical File.

Number of Certificate	:	

Issued Date	*	





M. Engine General Information

Project HMDS003 MAIN ENGINE

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3382 (Member engine of engine group)

Engine	
Manufacturer	Hyundai Heavy Industries Co., Ltd., Engine & Machinery Division
Rated speed	119 RPM
Rated power	8820 kW
Family / Group Identification	HYUNDAI-MAN B&W 6S50MC-C-2008-15
Serial number	AA3382
Intermediate speed	N/A
Maximum torque at intermediate speed	N/A
Static injection timing	-
Electronic injection control	Yes (-), No (◆)
Variable turbocharger geometry	Yes (-), No (●)
Bore	500 mm
Stroke	2000 mm
Compression shim	8 mm
Mean effective pressure at rated power	18.9 bar
Maximum cylinder pressure at rated power	150 bar
Cylinder number, configuration	Number: 6, In-line(●), V(-)
Auxiliaries	N/A
Specified ambient conditions	
Maximum cooling water temperature	36 ℃ *
Maximum charge air temperature	54 °C *
Cooling system spec. intermediate cooler	Yes (●) , No (-)
Cooling system spec. charge air stages	One (1) stage
Low temp. cooling system set point	40 ℃
High temp. cooling system set point	90 ℃
Maximum inlet depression	150 mmWC
Maximum exhaust back pressure	450 mmWC
Fuel oil temp. (100% load at shop test, measured at the inlet to the fuel injection	See Chapter S.
Lubricating oil specification	MELINA 30S
Application / Intended for	
Customer	E.R.SCHIFFAHRT
Final application / installation, Ship	Hyundai Vinashin Shipyard Co., Ltd. Hull No. S003
Final application / installation, Engine	Main (●) , Aux (-)
Emission test results (Parent engine of	
Cycle	E3
NOx	15.40 g/kWh
Date	November 18, 2008
Test site / shop	HHI-EMD test shop
Surveyor	Mr. D. I. Park of DNV
Signature	Mr. J. W. Lee of HHI-EMD
Date and Place of report	July 22, 2009, HHI-EMD

^{&#}x27;*': mark: Based on the engine design condition.



N. Engine Group Information

Project	HMDS003 MAIN ENGINE
Engine Type	HYUNDAI-MAN B&W 6S50MC-C7
Engine No	AA3382 (Member engine of engine group)

Combustion cycle	: 2-stroke cycle	☐ : 4-stroke cycle
Cooling medium (Air cooler)	☐ : Air	: Water
Cylinder configuration	6 cylinders, In-Line	
Method of aspiration	■ : Constant pressure	: Natural aspired
Fuel type to be used on board	■ : Heavy fuel ■ : Distillate	☐ : Dual
Combustion chamber	■ : Open chamber	: Divided chamber
Valve port configuration	: Cylinder head	☐ : Cylinder wall
Valve port size and number	Fuel valve : 2/cylinder	Exh. valve : 1/cylinder
Fuel system type	One fuel pump per cylinder	
Miscellaneous Features		
Exhaust gas recirculation	☐ : Yes	■ : No
Water injection / emulsion	☐ : Yes	■ : No
Air injection	☐ : Yes	■ : No
Charge cooling system	■:Yes	□ : No
Exhaust after - treatment	□: Yes	■ : No
Exhaust after - treatment type	N/A	
Dual fuel	☐ : Yes	■ : No
Engine Group Information (select	tion of parent engine for test bed)	
Group identification	HYUNDAI-MAN B&W 6S50MC-C-2008-	15
Method of pressure charging	Constant pressure	
Charge air cooling system	Central fresh water cooling system	
Number of cylinder	6	
Max. rated power per cylinder	1470 kW	
Rated speed	119 RPM	
Selected parent engine	AA3182	
Application	Hyundai Vinashin Shipyard Co., Ltd. Hul	l No. S001





O. Test Cell Information (For Information)

Project HMDS001 MAIN ENGINE

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3182 (Parent engine of engine group)

		<u>t</u>	34 3.1 .			Calib				
		Manufacturer	Model or Serial No.	Measureme	nt range	Calib Span gas conc.				
Analyzers (HOR	IBA ME	KA-9100F) 403	9070001							
NOx Analyzer		HORIBA	CLA-155	2000	ppm	1886	± 0.1 %			
CO Analyzer		HORIBA	AIA-120	500	ppm	473	0.5 %			
CO2 Analyzer		HORIBA	AIA-120	10	%	9.23	0.5 %			
O2 Analyzer		HORIBA	FMA-126D	25	%	23.2	0.3 %			
HC Analyzer		HORIBA	FMA-126D	500	ppmC	454	± 0.1 %			
Speed (engine tach	ometer)	YOKOGAWA	62GE0178	0.1~30000	rpm	-	0.0 %			
Torque		-	-	-		-	-			
Power meter (wate	r brake)	PROUDE	97033	36000	bhp	-	0.17 %			
Weighing machine	(SFOC)	CAS	806LS0030300:	5000	kg	-	0.02 %			
Air flow				_						
Exhaust flow		Ca	lculated-IMO L	Jniversal, Ca	rbon/Oxy	gen balance meth	od			
Temperatures										
1	in	RUEGER	3TH-9	0~120	°C		-2 ℃			
Scavenge air		RUEGER	K48-043	0~120		-	-1 °C			
cooler	out	-	_	_		-	-			
		RUEGER	81878021	0~650	°C	-	- 3 °C			
Exh. Gas at T/C ou	tiet	-	_	-		-	-			
	22	RUEGER	K48-032	0~120	°C	-	0.0 °C			
		RUEGER	K48-035	0~120 °C		_	0.0 ℃			
	ĺ	=_	-	-		-	_			
latalia ala at TIO		-	-			-				
ntake air at T/C		-	-	-		-	-			
		-	•			-	-			
		-				-	· - 2			
		-	-	-		-	-			
Casuanas sis sassis		RUEGER	3-TH1	0~160 °C		-	- 1 °C			
Scavenge air receiv	er	-	-	-		-	-			
Ambient air		VAISALA	X3620034	-20~60	°C	-	0.2 ℃			
Fuel inlet		WIKA	1TH-23	0~120	°C	-	- 0.5 ℃			
Pressures	,		···································							
Exh. Gas (manome	ter)	DIGITRON	441281463	0~700	kPa	-	- 0.14 %			
Scavenge air	,	DIGITRON	441281463	0~700	kPa	-	- 0.14 %			
Atmospheric		SATO	81023	970~1040	hPa	_	0.2 %			
lumidity										
ntake air		VAISALA	X3620034	0~100	%RH	-	1.3 %RH			
		VANOALA	7.0020004	0-100	701311	-	1.5 /01/11			
Exhaust pipe				4000	mm					
Diameter			, Ma	1000	(1111)	Vo-				
nsulation			■: No	hasharra /0	n f	: Yes				
Probe location		6.0 m after turbocharger (30 m from exhaust gas exit) Sampling gas temperature : min. 190°C at all loads								



P. Ambient and Gaseous Emission Data (For Information)

Project HMDS001 MAIN ENGINE

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3182 (Parent engine of engine group)

Test Date November 18, 2008

Mode	-	-	-	-	
Test number	-	01	02	03	0
Running time	-	12:10-13:10	11:10-11:40	10:40-11:10	10:10-10:4
Recorded time	-	12:25-12:38	11:23-11:37	10:51-11:05	10:21-10:3
Engine nower	%	100	75	50	2
Engine power	kW	8820.0	6615.0	4410.0	2205.
Engine speed	%	100	91	79	6
Engine speed	rpm	119.0	108.1	94.5	75.
Max. combustion pressure	bar	150.0	131.7	105.8	80.
Max. compression pressure	bar	133.8	106.5	75.0	49
Mean effective pressure	bar	18.9	15.6	11.9	7
Exhaust gas temp. at T/C outlet	°C	230	208	221	21
Turbocharger speed	rpm	15119	13352	10618	641
Ambient Data	· · _ · _ · _ · _ · _ · _ · _ · _ ·				
Charge air pressure	kg/cm²	2.78	2.01	1.13	0.3
Barometric pressure	kPa	101.7	101.8	101.8	101
Intaka air humidibu	%	11.1	11.6	11.3	10
Intake air humidity	g/kg	1.80	1.47	1.18	0.9
Intake air temperature	°C	22.0	18.0	15.0	13
Scavenge air temperature	°C	40.0	34.0	32.0	22
Intercooled air reference temperature	°C	48.0	43.0	39.0	44
Governor					
Pump index	mm	71.2	58.0	45.2	31
Load indicator governor	-	73.5	60.1	48.0	34
Fuel					
Uncorrected fuel consumption	kg/h	1588.2	1170.5	790.0	403
Charge Air					
Air flow	kg/h	77134	63057	47072	261
Exhaust Gas					
Gas flow	kg/h	78722	64228	47862	2651
Gaseous Emission Data					
CO concentration (Dry)	ppm	41.5	37.0	26.5	20
CO2 concentration (Dry)	%	4.41	3.98	3.59	3.3
HC concentration (Wet)	ppmC	64.0	59.5	57.0	54
O2 concentration (Dry)	%	15.15	15.75	16.25	16.6
NOx concentration (Dry)	ppm	1110.0	1128.0	1188.0	1102
NOx humidity/temp. correction factor	-	0.916	0.906	0.892	0.92
Dry / Wet correction factor	-	0.963	0.967	0.970	0.97
NOx mass flow	kg/h	121.56	100.10	77.63	41.2
NOx specific	g/kWh	13.78	15.13	17.60	18.7
Test Cycle (E3)	g/kWh	15.20			

^{*} The IMO NOx value is based on reference scavenge air temperature, but not corrected reference Pmax



Q. Results of NOx Emission (for Information)

Project HMDS001 MAIN ENGINE

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3182 (Parent engine of engine group)

Emission Test No. 01 to 04

Kind of fuel Bunker-A (ISO 8217, DMC)

Engine output	kW	8,820
Output per cylinder	kW	1,470
Engine speed	RPM	119

Load	%	100	75	50	25			
Oxides of Nitrogen (NOx)	g/kWh	13.78	15.13	17.60	18.72			
IMO NOx-Cycle E3	g/kWh	15.20						
IMO NOx-Cycle E2	g/kWh							
IMO NOx-Cycle D2	g/kWh							

Maximum Allowable NOx	g/kWh	17.0
-----------------------	-------	------

E3: Test cycle for "Propeller law operated main & propeller law operated aux. engine" application

E2: Test cycle for "Constant speed main propulsion engine" application including diesel electric drive

and variable pitch propeller installation

D2: Test cycle for "Constant speed auxiliary engine" application

* The IMO NOx value is based on reference scavenge air temperature, but not corrected reference Pmax.





R. Fuel Analysis (For Information)

Project HMDS001 MAIN ENGINE

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3182 (Parent engine of engine group)

Test Date November 18, 2008

Kind of Fuel Marine Diesel Oil, Bunker-A

ISO 8217, DMC

Fuel elemental analysis & properties

Description	Unit	Result	Test Method
C (Carbon)	%, mass	87.48	Elementary Analysis
H (Hydrogen)	%, mass	11.63	Elementary Analysis
N (Nitrogen)	%, mass	0.1	Elementary Analysis
O (Oxygen)	%, mass	0.56	Elementary Analysis
S (Sulphur)	%, mass	0.21	ISO-8754
Density at 15℃	kg/ℓ	0.9107	ISO-3675
Viscosity at 40℃	mm2/s	6.80	ISO-3104
Carbon residue (Micro r	method) %, mass	1.10	ISO-10370
Water	%, V/V	0.01	ISO-3733
Cetane Index	-	N/A	ISO-4264

^{*} N/A: Not available due to mixed-bunker.



S. Engine Performance Data

Refer to the enclosed ten (10) sheets.

Doc. No.: K630-IR09A-3383 Engine No. AA3382 Engine type **SHOP TEST RESULT** 6S50MC-C7 Hull No. **FOR** HMDS003 Owner **MAIN ENGINE** E.R.SCHIFFAHRT Class DNV Ship yard HMD

HYUNDAI - MAN B&W

QUALITY MANAGEMENT DEPARTMENT HHI-EMD

Rev.	Prepared	Checked	Approved	Description
2	-,,			
1		- 6		
0	J. W. Lee	S. J. KIM 2009.06	2009, 7, 6	First issue





Official shop t	est result	tor —	ull No.	HMDS003	Owner	E.R.SCHIFFAHR					
Main I		Ei	ngine No.	AA3382	Class	DNV					
			ngine Type	6S50MC-C7	Test Date	June.17, 2009					
Specification of	Main Eng	ine 🛌	eed(MCR)	8820 kW 119 rpm	Engineer Operator	J.S.LIM H.Y.KIM					
	DA	RTICULA			Operator	II. I . KIIVI					
NUMBER OF CVI DIDI		TICULA	KS OF E								
NUMBER OF CYLINDE		_		6							
DIAMETER OF CYLINI	DER			500	mm						
STROKE				2000	mm						
FIRING ORDER		Al		1-5-3-4-	2 - 6 - 1	←AS					
CYLINDER CONSTANT	Γ			0.654	5						
	PARTIC	ULARS O	F TURB	OCHARG	ER						
ТҮРЕ				1 × TPL7	7B12						
SPECIFICATION				CT65CA17 T	F15TA22						
nMax / nBMax				17040 rpm	550°C						
tMax / tBMax			16200 rpm / 520℃								
SERIAL No.		XH002480									
MANUFACTURER		HYUNDAI HEAVY INDUSTRIES CO., LTD.									
	PARTIC	CULARS O	F DYNA	MOMETE	ER .	· · · · · · · · · · · · · · · · · · ·					
MAKER / TYPE			FUCHINO CFSR-20								
CONSTANT (kW)	<u></u>	1 / 1.35962									
MAXIMUM CAPACITY		26500 kW x 200 rpm									
SP	ECIFICAT	ION OF O	IL USEI	O AT SHO	P TEST						
		F.O	System	Oil Cam O	il Cyl. C	Oil T/C Oil					
KIND OF OIL		BUNKER	VERIT	AS VERIT	AS ALEX	IA VERITAS					
KIND OF OIL		BUINER	800 M	30 800 M	30 LS	800 M 30					
SPEC. GRAVITY	(15 ℃)	0.9171	0.8809	0.8809	0.914	4 0.8809					
FLASH POINT	C	78/	258	258	260	258					
VISCOSITY	cSt	(50C)	(40℃	(40℃	(40℃) (40℃)					
413CO311 I	CSt	\$ 72	103.1	103.1	198.7	7 103.1					
WATER	vol%	0.05									
SULFUR	wt%	0.248									
CALORIFIC VALUE		1/222									
(LOWER)	kcal / kg	9993	\setminus								



TIE.	AVY INDUSTRIES CO., LTD.		a sala us a sala sala sa		to the second second second					
Ot	fficial shop test result f	or	Hull No.	HMDS003	Owner	E.R.SCHIFFAHRT				
	Main Engine		Engine No. Engine Type	AA3382 6S50MC-C7	Class Test Date	DNV June.17, 2009				
		· · · · · · · · · · · · · · · · · · ·	Output(MCR)	8820 kW	Engineer	J.S.LIM				
	Specifiction of Accessory		Speed(MCR)	119 rpm	Operator	H.Y.KIM				
		GO	VERNOR							
TYPE		AC C20 DGS								
SERIA	L No.	B00	82B781140091							
MANU	FACTURER	KO	NGSBERG M	ARITIME KO	DREA					
	FUE	L VAL	VE (ATON	MIZER)	·····					
ТҮРЕ		3062	2332-6 x 115							
OPENI	NG PRESSURE	350	±30 bar							
SPEC.	HOLE No.	1	2	3	4					
	DIA. OF HOLE(Φ)	1.15	1.15	1.15	1.15					
	VERTI. ANGLE(α°)	27	17	13	12					
	HORIZ. ANGLE(β°)	-2	12	30	48					
	A	UXILL	ARY BLOV	VER						
TYPE /	CAPACITY		TBCS-0600	C-4526 /	1.92 / 3.9	00 m³/sec				
SPEED	/ PRESSURE		3560	rpm /	571/32	27 mmAq				
SERIAI	L No. 1 / 2	08B02760105 / 08B02760106								
MANU	FACTURER		TAE	-IL BLOWE	R MFG. Co.,l	LTD.				
ELECT.	TYPE / VOLTAGE		HK-SD/F	/		440 V				
MOTOR	FREQUENCY / POWER / Amp		60 Hz /	45	kW /	72.1 A				
	SERIAL No. 1 / 2	8F696F11-001 / 8F696F11-002								
	MANUFACTURER	HYUNDAI HEAVY INDUSTRIES Co., LTD.								
		AIR	COOLER							
TYPE			LK	MY-C1-1420-	EK-080822					
SERIAL	No.			76667	,					
MANUF	ACTURER	VESTAS AIRCOIL								
	CYI	LINDE	R LUBRIC	ATOR	_					
TYPE		ELE	CTRIC CON	FROLLED L	UBRICATO	R(ALPHA)				
MANUF	ACTURER	HAN	IMI HYDRAU	RIC MACHI	NERY CO.,I	LTD.				
						OSKE				



- Independent		STRIES C	Wild Ent				Hull	No	Ш	MDS	10.2	Wea	ther	///- E- 10	W	FINE	
l – Ullicial chun tect recilit tur – L								Engine No. AA3382						8:40			
	N	Iain	Eng	ine				Type		50MC			Date	Time	Jun	e.17, 2	2009
Data shoot of 250/ I and test							0 71			Engineer				J.S.LIM			
Data sheet of 25% Load test							Class	3		DNV		Ope	rator		H	H.Y.KIM	
* Room Te	* Room Temperature : 22.3 °C * Atmosph																
Engine	Speed		Wa	ater Br	ake	Bra	ake Po	wer	Indic	cated F	ower	Mec	h.Effic	ciency		NOTO	Ή
75	5.0	rpm	40	0.0	kNm	22	205	kW	25	504	kW	88	3.07	%		4.40	
Sys	stem		N	lain L	.О		P.C.O		(Cam L.	О.]	Fuel O	il	Co	oling F	.W
Pres	ss.(kg	/cm ²)				,	2.13						8.20			4.03	
ın —	np.(°C						43.0						30.0			70.5	
Cyl	l. No.		Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pmax.		bar	79.8	80	80	80	80	79	80								
Pcomp.		bar	48.8	49	49	49	48	49	49								
Pi		bar	8.50	8.47	8.49	8.52	8.56	8.40	8.57								
F 0 P		Рθ	30.3	30.0	30.0	31.0	31.0	30.0	30.0								
F.O Pump)	VIT	-	-	-	-	_	-	-								
Exh.Gas C	Out.	C	253.7	260	252	250	260	260	240								
C.F.W Ou	ıt.	$^{\circ}$	73.9	73.0	73.5	74.0	75.0	74.0	74.0								0.0
Cam L.O	Out.	\mathbb{C}	41.0	41.0													
P.C.O Out	t	${\mathbb C}$	48.8	49.0	49.0	49.0	49.0	48.0	49.0								
			Air C	oole	r			Scavenging Air									
N	lo.		1	2	3	4	Avg. Pressure				Temperature						
Bef. Cooler	Press	mmHg	200				20	0.0		0.34		kg/cui	2		28	8 °C	
Press. Drop	р	mmAq	50				50	0.0	Air r	eceive	r press	ure			250		
Air In.		°C	44	R	LAN	K	44	.0	Exha	ust Ma	anifold	Press	ure		0.26	kg/	/cur²
Air Out.		${\mathbb C}$	20.0		LIAL VI		20	.0		Spe	ecific	Fue	l Oil	Cons	umpt	ion	
Cooling	In	${\mathcal C}$	19.0				19	0.0	Mea	as.(kg/	h)	Mea	as.(g/k	Wh)	Corr	ect(g/k	:Wh)
Water	Out	\mathbb{C}	21.0				21	.0	4	108.00	0	1	85.03	4	1	81.877	1
							Turb	ocha	irger								
Turbochar	rger	Spe	ed	Blo	wer I	nlet	Befo	re Tur	bine	Afte	er Turl	oine	L.O.	(℃, k	g/cu²)	F.W	Гетр
		rpı	m	ຶ(2	mmAq	$^{\circ}$	mn	nHg	${\mathbb C}$	mm	ıAq	In	Out	Press.	ຶ່	3
No. 1		635	50	22.0	28.0	5	262	19	90	215	1	6	43	44	1.58	•	
No. 2																	
No. 3			BLA	NK													
No. 4			į	DLA	111												
Avg.		635	50	25.	00	5	262	19	0.0	215	1	6	43	44	1.58	-	
* Pressure v	/it:	-	kg/cm²			*Gove	ernor P	ositio	n :	36.0			* Thr	ust Pac	i :	43.0	$^{\circ}$
Note: The	e Fuel	Oil Co	nsump	otion is	corre	cted to	Lowe	er Calc	orific V	/alue 1	10200	kcal/k	g & I.	S.O co	nditio	1	



Of	Official shop test result for					or			-	MDS		Weather			FINE		
		/Iain						ne No.	+	AA338			suring	Time	+	9:55	
<u> </u>			25				Eng. Own	Туре		50MC CHIFF			Date ineer			ie.17, : J.S.LII	
Data	a sheet	of 5	60%	Loa	d tes	t	Class		E.R.S	DNV		_	rator			I.Y.KI	
* Room	Tempera	ature :	22.	7 °C	* Atı	nosph		-	:		0 mb		ar				
Engi	ne Speed	i	Wa	ater Br	ake	Bra	ake Po	wer	Indic	cated F	ower	Med	h.Effic	ciency		NOTO	CH
	94.5	rpm	63.	.45	kNm	44	10 kW		4802 kW		91.83 %		%	6.40			
	System		N	1ain L.	О.		P.C.O		C	Cam L.O		Fuel Oil		il	Cooling 1		F.W
In I	ress.(kg	/cm ²)					2.10						7.80			4.00	
	Temp.(°	C)					43.0			32.0			72.0				
	Cyl. No.		Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pmax.		bar	105.2	105	105	106	105	105	105								
Pcomp		bar	74.5	74	75	74	74	75	75								
Pi		bar	12.94	12.93	12.92	12.89	12.89	13.00	13.00								
F.O Pu	mp	Pθ	44.0	44.0	44.0	44.0	44.0	44.0	44.0							-	
	•	VIT	-	-	-	-	-	-	-								
Exh.Ga		°C	291.5		290	291	292	294	287							ļ	
C.F.W		C	75.7	75.0	75.0	75.0	77.0	76.0	76.0								
Cam L.		C	44.0	44.0													
P.C.O	Jut		50.6	50.5	51.0	51.0	50.5	50.0	50.5				<u> L.</u>				
	N T		Air C			4							engir	ig Ai			
Bef. Coo	No.		700	2	3	4	Avg. 780.0		Pressure						mperature		
Press. D		mmHg mmAq		,					A :	1.08		kg/cm	<u></u>		760		C
Air In.	тор	mmAq °C	88				94 88			eceiver ust Ma					0.90		ıHg
Air Out.		c	30.0	B	LAN	K			EXIIA					Cons			/cm²
Cooling	Τ.	C	19.5					30.0 Specific Fuel Oil Co			Sumption Correct(g/kWh)						
Water	Out	°C	51.0				51			93.00			79.81			75.729	
			0100					ocha									
Turboc	harger	Spe	ed	Blo	wer In	nlet		re Tur		Afte	er Turl	oine	L.O.	.(℃, k	g/cm²)	F.W	Temp
	Ü	rp		ີ (mmAq	°C		ıHg	°C		ıAq	In	1	Press.	٥(
No	. 1	117		22.0	32.0	17	322	63	30	232		2	43	52	1.50		
No	. 2																
No	3			BLA	NV												
No	. 4			DLA	111							-					
Av	g.	117	00	27.0	00	17	322	630	0.0	232	4	2	43.0	52	1.50		
* Pressur	e vit :	-	kg/cm²			*Gove	rnor P	ositio	n :	50.0			* Thr	ust Pac	d :	45.0	${\mathbb C}$
Note:	Γhe Fuel	Oil Co	nsump	otion is	corre	cted to	Lowe	r Calc	rific V	alue 1	0200	kcal/k	g & I.S	S.O co	nditio	n	KE.



OCC -: -1 -1-			14 C		Hull	No.	Н	MDS0	003	Wea	ther			FINE	
Official sho	•		ilt 10	r		ne No.	+	AA338			suring	Time		10:25	
Mai Mai	n Eng	ine			Eng.	Туре	6S:	50MC	-C7	Test	Date		Jun	ie.17, 2	2009
Data sheet of	75%	Loa	d tes	t	Own	er	E.R.S	CHIFF		Engi				I.S.LII	
Data sheet of	7570	1.04	u tes		Class			DNV		Oper	ator		H	I.Y.KI	M
* Room Temperature	: 23.	8 °C	* Atı	nosph	eric Pr	essure	:	1015.	0 mb	ar					
Engine Speed	W	ater Br	ake	Bra	ake Po	wer	Indic	ated P	ower	Mec	h.Effic	ciency		NOTO	H
108.1 rpn	n 83	.20	kNm	66	15 kW		7051 kW		93.82 %		%	7.60			
System	N	/Iain L	.О		P.C.O		C	am L.	0]	Fuel O	il	Co	oling I	F.W
In Press.(kg/cm ²)				2.20						7.60		4.00		
Temp.(°C)					43.0						32.0			70.0	
Cyl. No.	Avg	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pmax. ba	r 132.2	132	133	132	132	132	132								
Pcomp. ba	r 105.3	105	106	106	105	105	105								
Pi ba	r 16.61	16.63	16.70	16.66	16.52	16.57	16.58								
PO P	56.0	56.0	56.0	56.0	56.0	56.0	56.0								
F.O Pump	T -	-	-	_	-	_	_								
Exh.Gas Out. °C	300.0	300	295	300	305	305	295								
C.F.W Out.	77.7	77.0	78.0	77.0	78.0	78.0	78.0								
Cam L.O Out. °C	46.0	46.0													
P.C.O Out °C	52.0	52.0	52.0	52.0	52.0	52.0	52.0								
	Air (Coole	r						1	Scav	engin	ıg Ai	r		
No.	1	2	3	4	A	/g.		P	ressur	e			Temp	erature	
Bef. Cooler Press mml	Hg 1440				144	0.0		1.98		kg/cm²	!		34	٦(C
Press. Drop mm.	Aq 120				120	0.0	Air re	eceive	r press	ure			1420	mn	нHg
Air In. °C	145	R	LAN	K	14:	5.0	Exha	ust Ma	nifold	Press	ure		1.71	kg/	CIII
Air Out. °C	35.0				35	.0		Spe	cific	Fuel	l Oil	Cons	umpt	ion	
Cooling In °C	22.0				22	.0	Mea	s.(kg/	h)	Mea	as.(g/k	Wh)	Corr	ect(g/k	Wh)
Water Out C	55.0				55	.0	1	175.00	0	1	77.62	7	1	73.605	5
					Turb	ocha	rger								
Turbocharger S	Speed	Blo	wer Ir	nlet	Befo	re Tur	bine	Afte	er Turl	oine	L.O.	(℃, k	g/cw²)	F.W	Гетр
	rpm	ຶ່	C	mmAg	\mathbb{C}	mn	nHg	$^{\circ}$	mm	Αq	In	Out	Press.	ຶ (C _
No. 1 1	3500	23.0	36.0	40	350	12	40	220	10	00	43	66	1.50		
No. 2															
No. 3		BLA	NK												
No. 4		DLA													
Avg. 1	3500	29.	50	40	350	124	0.0	220	10	0	43	66	1.50	-	
* Pressure vit : -	kg/cm	!		*Gove	ernor P	ositio	n :	63.3			* Thr	ust Pac	1:	46.0	${\mathbb C}$
Note: The Fuel Oil	Consum	ption is	corre	cted to	Lowe	er Calc	orific \	alue l	0200	kcal/k	g & I.S	S.O co	nditio	n	

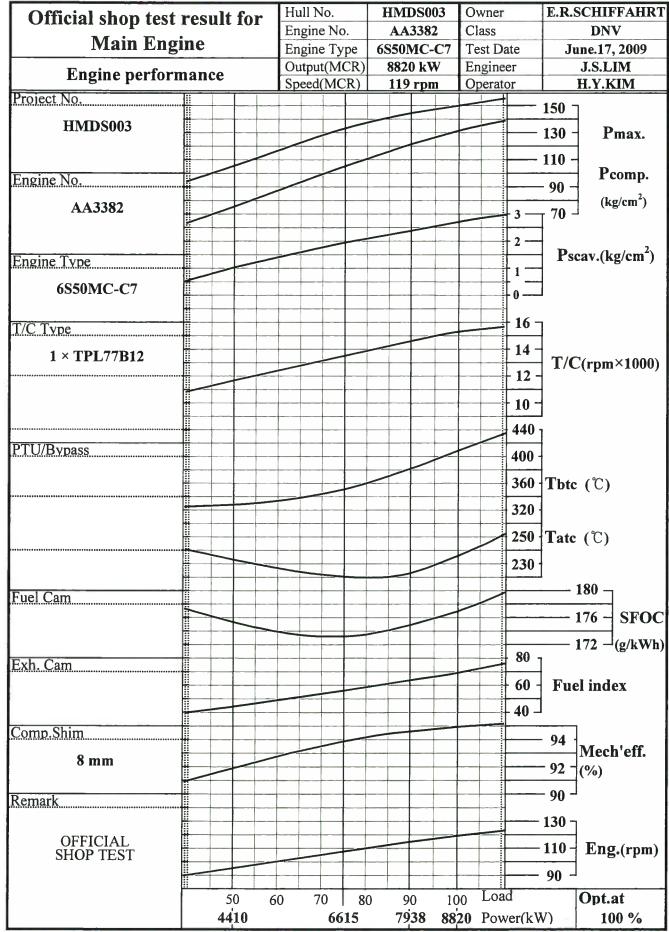


			shop		raci	lt f) P	Hull	No.	Н	MDS	003	Wea	ther			FINE	
	/ 1 1 1		Jain			111 11	,1		ne No.		AA338			suring	Time		11:10	
<u> </u>		14	14111	Lilg	<u>.</u>				Type		50MC			Date		-	e.17, 2	
Da	ata	sheet	of 9	0%	Loa	d tes	t	Own Class		E.R.S	DNV	AHRT	Ope	neer			I.S.LII I.Y.KI	
* Roc	m T	`empera	oture :	23 '	7 °C	* A+	mosph			: :		0 mb					IVI	
-		e Speed			ter Br		-						T	h Effic	ionav		NOTO	עי
Li		114.9		93.		kNm	+			Indicated Power		Mech.Efficiency		8.30		,1 1		
-			rpm	-				38 kW		 	8401 kW		94.49 %			1		
		ystem	, 2,	IV.	Iain L.	.0		P.C.O Cam L.O				Fuel Oil			Co	Cooling F.W		
In		ess.(kg				2.20					7.50			4.00				
<u> </u>	-	emp.(°	3)	<u> </u>			1 -	43.0	I	1 -		1 -	_	32.0	1		70.0	
		yl. No.	T .	Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pma			bar	144.8		144	145	145	145	145		-					-	-
Pcor	np.		bar	121.5		121	121	122	122	122		-						
Pi			bar	18.62			18.59	18.63	18.68	18.64								
F.O	Pum	מו	Pθ	64.2	64.0	64.0	64.0	64.0	65.0	64.0								
			VIT	-	-	-	-	-	-	-								
Exh.	Gas	Out.	°C	314.2	320	310	315	315	320	305								
C.F.	W O	ut.	C	79.2	79.0	79.0	79.0	79.0	80.0	79.0								
Cam	L.C	Out.	C	48.0	48.0													
P.C.	O O	ut	\mathbb{C}	53.7	54.0	54.0	54.0	53.0	53.0	54.0								
				Air C	oole	r							Scav	engir	ng Ai	r		
		No.		1	2	3	4	Av	/g.	Pressure					Temp	erature	;	
Bef. C	Coole	r Press	mmHg	1790		·		179	0.0		2.45		kg/cm	:		36	۳(C
Press	. Dro	ор	mmAq	130				130	0.0	Air re	eceive	r press	ure			1770	mn	пНg
Air Iı	1.		°C	167	D	T A BY	17	16'	7.0	Exha	ust Ma	anifold	Press	ure		2.15	kg/	/cm²
Air C	ut.		$^{\circ}$	35.0	В	LAN		35	5.0		Spe	ecific	Fue	Oil	Cons	umpt	ion	
Cool	ing	In	C	23.0				23	.0	Mea	s.(kg/	h)	Mea	as.(g/k	Wh)	Corr	ect(g/k	·Wh)
Wat	_	Out	${\mathbb C}$	50.0				50	.0	1	420.50	00	1	78.949	9	1	74.976	
								Turt	ocha	rger	-					1		
Turt	och	arger	Spe	ed	Blo	wer I	nlet		re Tur		Afte	er Turl	oine	L.O.	(°C, k	g/cui²)	F.W	Temp
			rpi		"(mmAq	$^{\circ}$		ıHg	$^{\circ}$		ıAq	In		Press.	"(
]			145		23.5	37.0	50	380	15		222	10		43	71	1.60		
	No. :																	
	No. :			I														
	No. 4				BLA	NK												
	Avg		145	50	30.2	25	50	380	156	0.0	222	16	 60	43	71	1.60	_	
										46.0	°C							
					-	COTTE						10200	kcal/k					$\check{-}$
14016	Note: The Fuel Oil Consumption is corrected to Lower Calorific Value 10200 kcal/kg & I.S.O condition																	



Official	ahan	toot	MOG 1	.14 £.		Hull	No.	Н	MDS	03	Wea	ther			FINE	
Official	_			111 10)[Engi	ne No.	A	AA338	2	Mea	suring	Time		11:40)
I N	Iain	Eng	ine			Eng.	Туре	6S:	50MC	-C7		Date			e.17, 2	
Data sheet	of 10	00%	% I	oad	test	Own		E.R.S	CHIFF		Engi				.S.LI	
						Class			DNV		Oper	ator		H	.Y.KI	<u>M</u>
* Room Tempera	ature :	1	0°C		mosph	eric Pr	essure	:	1015.	0 mb	ar					
Engine Speed	i 	Wa	ater Br	ake	Bra	ake Po	wer	Indic	ated P	ower	Mec	h.Effic	ciency		NOTO	:H
119.0	rpm	100	.77	kNm	88	320 kW		9296 kW		94.88 %		%	8.60			
System		M	Iain L.	О.		P.C.O)	C	Cam L.	О	1	Fuel O	il	Co	oling l	F.W
In Press.(kg	/cm ²)					2.20						7.50			4.00	
Temp.(*C	C)				43.0					34.0			70.0			
Cyl. No.		Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pmax.	bar	149.8	150	150	149	150	150	150								
Pcomp.	bar	131.7	131	131	132	132	132	132								
Pi	bar	19.89	19.82	19.85	19.86	19.94	19.98	19.90								
	Рθ	69.8	70.0	70.0	69.0	70.0	70.0	70.0								
F.O Pump	VIT	-	-	-	-	_	_	-								
Exh.Gas Out.	c	337.5	345	335	335	340	340	330				-				
C.F.W Out.	°C	80.0	80.0	80.0	80.0	80.0	80.0	80.0								
Cam L.O Out.	C	48.0	48.0	l												
P.C.O Out	°C	54.3	54.0	55.0	55.0	54.0	54.0	54.0								
		Air C	oole	r				Scavengin				ig Ai	r	-		
No.		1	2	3	4	A	vg.	Pressure			e			Temperature		
Bef. Cooler Press	mmHg	2010				201	0.0		2.77		kg/cm²	!		38	-"(C
Press. Drop	mmAq	135				13:	5.0	Air re	eceive	r press	ure			2000	mn	пНg
Air In.	$^{\circ}$	180				18	0.0	Exha	ust Ma	nifold	Press	ure		2.45	kg	/cm²
Air Out.	$^{\circ}$	38.0	B	LAN	K	38	3.0		Spe	cific	Fuel	Oil	Cons	umpt	ion	
Cooling In	°C	24.0				24	1.0	Mea	ıs.(kg/	h)	Mea	as.(g/k	Wh)	Corr	ect(g/k	(Wh)
Water Out	$^{\circ}$	55.0				55	5.0	1:	594.20	0	1	80.74	8	1	76.81	1
						Turb	ocha	rger					•			
Turbocharger	Spe	ed	Blo	wer I	nlet	Befo	re Tur	bine	Afte	er Turl	oine	L.O.	.(℃, k	g/cur²)	F.W	Temp
	rpı	m	ຶ(C	mmAq	°C	mn	ıHg	$^{\circ}$	mm	ıAq	In	Out	Press.	ີ່ໃ	C
No. 1	152	09	23.0	39.0	60	410	17	80	235	20)0	43	73	1.50		-
No. 2											~ -					
No. 3			DT 4	NITZ												
No. 4			BLA	JNK												
Avg.	152	09	31.	00	60	410	178	0.0	235	20	00	43	73	1.50		
* Pressure vit :	-	kg/cm²			*Gove	ernor F	ositio	n :	77.9			* Thr	ust Pa	d :	47.0	$^{\circ}$
Note: The Fuel	l Oil Co	nsump	otion is	corre	cted to	Lowe	er Calc	rific V	/alue 1	0200	kcal/k	g & I.	S.O co	nditio	n	







HEAVY INDUSTRIES CO	., L I U.	- Contract					-					-	- turns		
Official shop tos	Official shop test result for				Hull No.			HMDS003			Owner		E.R.SCHIFFAHRT		
_			UI	Engi	ne No.		1	AA338	32	Clas	S		DNV		
Main En	gine			_	е Туре		68	50MC	-C7	Test	Date	Jun	e.17, 2	2009	
					it(MCF			820 k					.S.LII		
Inspection R	epor	t		<u> </u>	<u> </u>	<u> </u>	119 rpm			Engineer Operator					
<u> </u>				Spee	d(MC	K)		117 t pin			rator	Н	.Y.KI	IVI	
Kind of Inspection.		Place	of Ins	spection			Work Condition				Judger			nent	
Timing Data		As	ss'y Sł	hop			After Shop Test				Reference				
1. Exhaust Cam Lead (Advance Angle)															
Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Measured Timing(Ahead)	Fiming(Ahead) -3.40 -3.20 -3.35					-3.35				BLA	NK				
* Angle A: 112.9° * Lift: 10.0 mm															
* Angle B: 254.1° * Lift: 10.0 mm															
2. Fuel Pump															
Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Number of Shim(EA)/ Thickness of Shim(mm)	8/0.5	8/0.5	8/0,5	8/0.5	8/0.5	8/0.5				BLA	NK				
Top Lift (mm)	11.97	11.98	12.18	11.67	11.76	11.25				BLA	NK				
							L								
I 14 1 (D (N# 2			····	
Lead Angle(Before T.D.C)	10.30	10.50	10.50	10.20	10.20	9.80	L			BLA	INK				
3. Compression Sh	im		-		1										
Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Thickness (mm)	8	8	8	8	8	8				BLA	NK				
4. Starting Air Dist	ribu	tor I	_ead	(Ad	vanc	e An	gle))		_					
Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Open Aft T.D.C (Ahead)		Fana	al of C	י זער	Vo. 1	T D (' Car	atch n	10 10 17						



DET NORSKE VERITAS

Certificate no.: EIAPP-953-3-A Date of issue: 2009-09-15

ENGINE INTERNATIONAL AIR POLLUTION PREVENTION CERTIFICATE

This Certificate shall be supplemented by a Record of Construction, a Technical File and Means of Verification

Issued under the provisions of the Protocol of 1997 to amend 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 REPUBLIC OF LIBERIA

by Det Norske Veritas

Particulars of engine	
Engine manufacturer	Hyundai Heavy Industries Co., Ltd.
Model number:	HYUNDAI-MAN B&W 6S50MC-C7
Serial number:	AA3382
Test cycles(s):	E3
Rated power [kW] and speed [rpm]:	8820 kW @ 119 rpm
Engine approval number:	EIAPP-G-0953-0003
THIS IS TO CERTIFY:	
	ne has been surveyed for pre-certification in accordance with requirements of the rogen Oxides from Marine Diesel Engines made mandatory by Annex VI of the
	ne engine, its components, adjustable features, and technical file, prior to the engine's y comply with the applicable regulation 13 of Annex VI of the Convention.
Remarks/Recommendations:	
This Certificate is valid for the life of the engine, subject installed in ships under the authority of this Government	t to surveys in accordance with Regulation 5 of the ANNEX VI of the Convention, it.
Issued at Oslo	on 2009-09-15 (date)
	for Det Norske Veritas AS
	Tomas Heber Tronstad Head of Section
	्र १०० के म

DET NORSKE VERITAS

Record no .: EIAPP-953-3-A Date of issue: 2009-09-15

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: 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. Unless otherwise stated, regulations mentioned in this Record refer to regulations of Annex VI of the Convention and the 3 requirements for an engine's technical file and means of verifications refer to mandatory requirements from the NO_x Technical Code. 1. Particulars of the engine Name and address of manufacturer...... Hyundai Heavy Industries Co., Ltd. 1, Cheonha-Dong, Dong-Gu, ulsan, Korea 2 .3 .4 .5 .6 .7 If applicable, the engine is a parent engine or a member engine X of the following .8 engine family - or engine group 🗓 HYUNDAI-MAN B&W 6S50MC-C-2008-15 Test cycle(s) (see chapter 3 of the NO_x Technical Code) E3 9 .10 Engine approval number EIAPP-G-0953-0003 .11 Specifications of the test fuel ISO 8217-F-DMC Grade .12 NOx-reducing device designated approval number (if installed) Not Applicable .13 .14 .15 Particulars of the technical file .1 .2 The technical file, as required by Ch. 2 of the NO_X Technical Code, is an essential part of the EIAPP Certificate and must 3 always accompany an engine throughout its life and always be available on board a ship. Specification for the On-board NO_X verification procedure for the engine parameter survey

On-board NO_x verification procedures identification/approval number EIAPP-G-0953-0003 .1

2

The specifications for the on-board NO_x verification procedures, as required by Ch. 6 of the NO_x Technical Code, are an .3 essential part of the EIAPP Certificate and must always accompany an engine throughout its life and always b→ available on board a ship.

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

Issued at Oslo

for Det Norske Veritas AS

Head of Section

(date)

Tomas Heber Tronstad

DET NORSKE VERITAS AS, Veritasveien 1, NO-1322 Høvik. Norway, Telephone: +47 67 57 99 00, Telefax. +47 67 57 99 11, Org. NO. 945 748 931 MVA Form No.: EIAPP 101a Issue: October 2005



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 related thereto (MARPOL 73/78)

for

HYUNDAI-MAN B&W 6S50MC-C7

Certified as a 'Member' engine

HYUNDAI HEAVY INDUSTRIES CO., LTD., ENGINE & MACHINERY DIVISION, Prepared by, **ENGINE DEVELOPMENT & TEST DEPARTMENT** HYUNDAI-MAN B&W 6S50MC-C-2008-15-AA3382/ Identification/approval number Issued at HYUNDAI HEAVY INDUSTRIES CO., LTD., ULSAN, KOREA Signature of duly authorized official issuing the certificate Date of issue (Seal or Stamp of the authority, as appropriate)



CONTENTS

Description	Page
A. General	3
B. Summary	4
C. Particulars of the Engine	5
D. Particulars of the Technical File	6
E. Specifications for the On-board NOx Verification Procedures for the Engine Parameter Survey	7
F. List of NOx Relevant Components and Settings	8
G. Guideline for Components Replacements	11
H. Measurements for IMO Compliance Test at Test Bed	12
I. On Board Verification Procedure	13
J. Concept of Parent, Member Engine and Engine Group	19
K. Marking of Identification Number of NOx Relevant Components	20
L. Test Report and Certificates	25
M. Engine General Information	26
N. Engine Group Information	27
O. Test Cell Information (For Information)	28
P. Ambient and Gaseous Emission Data (For Information)	29
Q. Results of NOx Emission (For Information)	30
R. Fuel Analysis (For Information)	31
S. Engine Performance Data ten (10) sheets	32



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 IMO NOx Technical Code")

for

	HYUNDAI-MAN B&W 6S50MC-C7
1. Certified as an a □ Individ	ual / ☐ Parent / ■ Member Engine of Engine Group
Engine Manufacturer	: Hyundai Heavy Industries Co., Ltd.
Engine Type	: HYUNDAI-MAN B&W 6S50MC-C7
Engine Number	: AA3382
Number of Engine	: One(1) set as a Member Engine
Test Cycle	: E3
Rated Power	: 8820 kW
Rated Speed	: 119 RPM
M.E.P.	: 18.9 bar
Identification/approval	NOx Technical Code made mandatory by Annex VI of the Convention. umber : HYUNDAI-MAN B&W 6S50MC-C-2008-15-AA3382/
 Date of issue	(Signature of duly authorized official issuing the certificate)





B. Summary

IMO NOx emission test on one(1) main propulsion engine for Hyundai Vinashin Shipyard Co., Ltd. Hull No. S001 was carried out as parent engine of the HYUNDAI-MAN B&W 6S50MC-C-2008-15-AA3182 at test bed in order to fully meet the IMO NOx Technical code.

However, if this group has member engines, additional IMO NOx compliance test for them is not to be performed because it can be considered as identical engines having the same NOx relevant components, rated power, rated RPM, nearly similar setting values and also identical IMO ID numbers compared with the Parent Engine.

- 1. Calibrations of Zero & Span for gas analyzers were successfully carried out under the presence of the surveyor (s).
- 2. Analyzers and calibration gases have been confirmed in compliance with the IMO NOx Technical Code by the surveyor(s).
- 3. Calculations of the emission value and exhaust, gases emission have been done according to the IMO NOx Technical Code as follows:
 - (1) Humidity correction factors for NOx for diesel engines (Khdies) have been calculated according to formula(14) of 5.12.3.6 on the IMO NOx Technical Code.
 - (2) Humidity of intake air(Ha) according to formula(10) of 5.12.2.1 on the IMO NOx Technical Code.
 - (3) Dry to wet correction factor (Kw,r) for the raw exhaust gas according to formula(11) of 5.12.2.2 on the IMO NOx Technical Code.
 - (4) The exhaust gas mass flows were calculated according to Method 2, Universal, Carbon/Oxygen-balance, 3 of Appendix 6 on the IMO NOx Technical Code.
 - (5) The NOx emission value was corrected to reference conditions as shown in Chapter I.8 which includes a scavenge air cooler fresh water coolant inlet temperature of 36 ℃ when operating under reference conditions-25 ℃ sea water temperature for central fresh water cooling system, whereas a scavenge air cooler sea water coolant inlet temperature of 25 ℃ for conventional sea water cooling system. Basically, charge air cooling system for this group is shown in the Chapter F, "List of NOx Relevant Components and Setting" and the Chapter N, "Engine Group Information".
- 4. The certificates for analytical instruments and calibration gases were not included in this Technical File because they had been checked and confirmed by surveyor during NOx emissions test.

 However, summarized information on the analytical instruments can be seen on Chapter O, Test Cell Information in this Technical File.

Finally, the test result (NOx: 15.40 g/kWh) for parent engine which is corrected to ISO NOx values based on reference Pmax and scavenge air temperature as mentioned in Chapter I.8, HYUNDAI-MAN B&W 6S50MC-C-2008-15-AA3182 is showed far less than IMO NOx limit (17.0 g/kWh).





C. Particulars of the Engine

Two-stroke, single acting, direct reversible, cross head, constant pressure turbocharging diesel engine, and using heavy fuel oil.

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 : June 2009

4. Place of pre-certification survey : Hyundai Heavy Industries Co., Ltd.

1, Cheonha-Dong, Dong-Gu, Ulsan, Korea

5. Date of pre-certification survey : June 17, 2009

6. Engine type : HYUNDAI-MAN B&W 6S50MC-C7

7. Engine number : AA3382

8. If applicable, the Engine is □ an Individual Engine, □ Parent / ■ Member Engine of Engine Group of the following □ Engine Family, or ■ Engine Group,

Engine Group Name : HYUNDAI-MAN B&W 6S50MC-C-2008-15

9. Test cycle(s)(acc. to Chapter 3 of the IMO NOx Technical Code) : E3

10. Rated Power & Speed : 8820 kW at 119 RPM

11. Mean effective pressure : 18.9 bar

12. Max. combustion pressure : 150 bar

13. Engine approval number :

14. Specification of test fuel

(and/or Certification number of fuel sample analysis): Bunker-A (ISO 8217, DMC)

(Parent engine of engine group)

15. NOx reducing device designated approval number (if installed): Not applicable

16. Applicable NOx emission limit (Regulation 13 of Annex VI) : 17.0 g/kWh

17. Engine's actual NOx emission value : 15.40 g/kWh (AA3182)

(Parent engine of engine group)



D. Particulars of the Technical File

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

1. Technical File identification/a	pproval number	·:	
		······································	
	•••••••••••		
2. Technical File approval date			
		ie.	





E. Specifications of the On-board NOx Verification Procedures for the Engine Parameter Survey

The Specifications for the on-board NOx verification procedures, as required by Chapter 6 of the IMO NOx Technical Code, is a essential part of the EIAPP Certificate and must always accompany and engine throughout its life and always be available on-board a ship.

1. On-board NOx verification procedures identification/approval number :
2. On-board NOx verification procedures approval date :





F. List of NOx Relevant Components and Settings

1. Components (Standard Engine set-up plus listing of allowed inter-changeable components)

Description	Value	Identification Number	Range/ Alternative	Notes
Engine Specification				
Number of cylinders	6	- *		1)
Cylinder liner (bore, Ø mm)	500	A19-266039-5, A19-212323-4, 3170262-7	-	1), 2)
Stroke (mm)	2000	-	_	1)
Combustion chamber (compres	sion r	atio : see settings)		
Cylinder cover	_	A10-212926-7, 5025583-3	-	2)
Piston crown	-	A10-255133-2, 5012873-6	-	2)
Fuel injection equipment (per c	ylinde	r unit)		
Barrel of fuel pump	-	1170729-8	-	2)
Plunger of fuel pump (dia., Φmm)	52	1171182-5	_	1), 2)
Fuel injection valve (number of fuel valve(s))	2	-	-	1)
Atomizer of fuel valve (number, Φmm) (opening/closing : see settings)	_	3062332-6x115	-	2)
Fuel cam	-	A19-124775-1, 1173321-5	-	2)
Exhaust cam	-	A19-124779-9, 1173320-3	-	2)
Auxiliary blower	2	Serial No.: 08B0276-01-05, 08B0276-01-06	-	1), 2)
Turbocharger maker/type : Hy	ındai-	ABB TPL77B12		,
Number & S/No. of turbocharger(s)	1	Serial No. : XH002480	-	1), 2)
Compressor wheel	-	CV12 CT65	-	2)
Diffuser	-	CT65 CA17	-	2)
Turbine rotor	-	TT40 TF15	-	2)
Nozzle ring	-	TT40 TA22	-	2)
Charging air cooling system : C	entral	fresh water cooling system		
Charge air cooler	1	Serial No. : 76667	A19-274025-8	1), 2)
Charge air cooling water inlet temp.(°C)	36	-	-	1), 3)





2. Settings (Engine matching at test bed)

Description		Value		awing/ nt. No.	Range/ Alternative	Notes	
Engine Layout		a.					
Rated power (MC	R, kW)	8820		•	-	1)	
Rated speed (RP	M)	119		-	-	1)	
Mean effective pressure		40.0				4)	
at rated power (M.E	.P., bar)	18.9		-	-	1)	
Maximum combustion pressur (bar		150		•	150 ± 3	1)	
Performance set-up							
Compression ratio (mm (Compression shim thickness)	•	8		-	Piston rod effective length 2635 mm	1), 4)	
Fuel valve opening pressure		350		-	350 ± 30	<u>1</u>)	
(bar)						
Fuel cam lead angle (deg	J. CA)	Refer to Chap	ter I and S.		- th	4)	
Fuel cam lift (mn	1)	Refer to Chap	ter I and S.	Tolerance + 1	4)		
Number of fuel pump shim (E/Thickness of fuel pump shim (Refer to Chap	ter I and S.		Tolerance ± 1	4)	
Fuel pump orifice (φmm, if	applicable)	Refer to Chap	ter I.		-	-	
Exhaust cam lead angle (deg	j. CA)	Refer to Chap	ter I and S.		Tolerance ± 1	4)	
Certified range for maximu	m combus	tion pressrue	e(measured) - without VIT	-		
Parameters	Actual ac		Certified r adjustmer		Checking of adjust	ment	
Combustion pressure at 50% 105.2		bar	111	bar or below	Pressure measurement		
Combustion pressure at 75% power	132.2	bar	136	bar or below	Pressure measurement		
Combustion pressure at 100% power	149.8	bar	153	bar or below	See chapter I and S		





Notes)

- 1) Parameters, operating values and settings can be verified through an engine performance check.
- 2) The Identification numbers for cylinder liner, cylinder cover, piston crown, exhaust cam and fuel cam are marked with one(1) or over two(2) kinds of numbers (i.e., HHI's number: XXX-XXXXX-X, licensor's number as alternative: XXXXXXX-X). And even if only one of the above and/or both kinds of numbers can be marked on the above components, they are identical components each other. In addition, identification or serial numbers for fuel injection barrel, plunger, atomizer, turbocharger(s), charge air cooler(s) and auxiliary blowers are marked with sub-manufacturer's number.

Some NOx relevant components may have over two(2) IMO identification numbers as an alternative. Therefore, one of mentioned IMO Identification numbers in this technical file can be available on this engine.

The revision number of IMO identification number for each NOx relevant components does not have an effect on NOx emission value because this revision number is only for HHI's drawing management system. (for instance, XXX-XXXXXX-X.X)

(revision number)

3) For central fresh water cooling system, the temperature(36℃) is for cooling water inlet under reference conditions - 25℃ sea water temperature.

For conventional sea water cooling system, the inlet temperature (25°C) is for cooling water inlet reference conditions and the Tsc. tolerance are given to the stated reference value in Chapter I-8 for each load, i.e., if the sea water temperature is 10°C higher than the reference sea water temperature, the nominal Tsc. at 100% load would be 54°C and actual max. allowable Tsc. Would be 60°C.

For sea water cooling system, there is no intermediate cooler between sea water and the scavenge air coolant the maximum temperature under reference condition is 25°C.

4) Compression shim thickness, fuel cam lead angle, fuel pump top lift, fuel pump shim thickness/numbers and exhaust cam lead angle can be adjusted and changed in order to keep maximum combustion pressure within the approved ranges as given in Chapter F.2

Note: Any adjustment(s) and change(s) should be recorded in the 'Record Book' of engine parameters.





G. Guideline for Components Replacements

1. General

If any of the components listed under "List of NOx Relevant Components and Settings" on Chapter F 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 components through the engine manufacturer.

2. Proceeding for the replacement

- 1. Order the component indicating the ID numbers specified in this Technical File through the engine manufacturer.
- 2. Substitute the old component by the new one.
- 3 Record the substitution including component specification, date of replacement and component supplier in the "Engine's Record Book of engine parameters" which has to keep on board of the ship.





H. 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 F.2.

Table 1. Measured Performance Parameters at Test Bed

- Engine rated power (kW)
- * Engine rated speed (RPM)
 - Mean effective pressure (bar)
 - Cylinder maximum pressure (bar)
 - Compression pressure (bar)
 - Fuel injection timing (deg. CA bTDC)
- Fuel consumption (kg/h)
 - Turbocharger speed (RPM)
 - Exhaust gas temperature after cylinder outlet (°C)
- * * Exhaust gas flow (kg/h)
- * * Air consumption (kg/h)
- * Exhaust gas emissions
- Exhaust gas pressure (at sampling position, mmWC)
- * Exhaust gas temperature (at sampling position, ℃)
- * Air inlet temperature (at turbocharger compressor side, ℃)
- Atmospheric pressure (kPa)
- * Intake air humidity (%)
- * Ambient temperature (°C)
- Charge air pressure (kg/cm2)
- * Charge air temperature (℃)
- * Charge air cooling water inlet/outlet temperature (℃)
- * Lubricating oil cooler (i.e., oil side) inlet/outlet (°C)
- * 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 IMO NOx Technical Code.
- 2. The measurements marked ' * * ' shall be carried out through the carbon balance method according to the IMO NOx Technical Code 5.5.3.
- Concerning the engine dynamometer specified in the IMO 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 shall be applied.





I. On Board Verification Procedure

1. General

The following described procedure shows an easy and reliable verification of the engine in order to confirm its compliance with 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. The procedure can be performed during the stop in the harbor without running the engine except for some setting parameters. All ID-numbers, settings and dimensions mentioned in the following verification procedure are defined in the "List of NOx Relevant Components and Settings" on Chapter F.

2. The procedure for on board verification

The procedure of an engine for on-board verification shall be carried out as follows;

Firstly,

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

Secondly,

The engine components and parameter setting values shall be reviewed by surveyor.



ELAPP - G-0953 -000 3





3. Check for engine components and parameters

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

Engine Specification

1. Rated power & RPM : Check the name plate on engine body.

Combustion chamber

Cylinder liner
 Cylinder cover
 Check the IMO ID-number.
 Check the IMO ID-number.
 Check the IMO ID-number.

Fuel injection equipment

1. Barrel of fuel pump : Check the IMO ID-number.

2. Plunger of fuel pump : Check the IMO ID-number and diameter.

3. Number of fuel valve(s) : Check the number of the fuel valve(s) per cylinder.

4. Atomizer of fuel valve : Check the IMO ID-number.
5. Fuel cam : Check the IMO ID-number.
6. Exhaust cam : Check the IMO ID-number.

Turbocharger

1. Maker : Check the name plate.

Number of T/C(s)
 Check the number of the turbocharger(s).
 Serial No./Model
 Check the serial number/model on name plate.

4. Compressor wheel : Check the IMO ID-number.
5. Diffuser : Check the IMO ID-number.
6. Turbine rotor : Check the IMO ID-number.
7. Nozzle ring : Check the IMO ID-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. Serial No./IMO ID : Check the name plate.

4. Cooling system : Check cooling system corresponds to Chapter F/M/N.

Governor

Maker
 Check the name plate.
 Check the model name.

Aux. Blower

Maker
 Check the name plate.
 Serial No.
 Check the name plate.

Performance set-up

1. Compression ratio : Check the thickness of compression shim.

2. Exhaust cam lead angel3. Fuel cam lead angel & top lift5. Check the lead angle.6. Check the lift of fuel pump.

4. Fuel pump lead angle : Check the lead angle (only for reference)

5. Fuel pump shim(s) : Check the number and thickness of fuel pump shim(s).

(only for without VIT system)

6. Fuel pump orifice : Check the size of orifice of fuel pump (if applicable)



4. Procedures for an engine parameter check method

No.		Inspection	Remarks
1	Inspection of document	S	
1.1	Inspection of Technical File		
1.2	Inspection of Record Book	of engine parameters	
1.3		cumentation of engine components modification	
2	Inspection of engine co	mponents	
2.1	Piston crown	Ident. No. : A10-255133-2, 5012873-6	
2.2	Cylinder cover	Ident. No. : A10-212926-7, 5025583-3	
2.3	Cylinder liner	Ident. No. : A19-266039-5, A19-212323-4, 3170262-7	
2.4	Barrel of fuel pump	Ident. No. : 1170729-8	
2.5	Plunger of fuel pump	Ident. No. : 1171182-5	Dia. : 52 mm
2.6	Fuel injection valve (number of fuel valve(s))	Number : 2/cylinder	
2.7	Atomizer of fuel valve	Ident. No. : 3062332-6x115	
2.8	Fuel cam	Ident. No. : A19-124775-1, 1173321-5	•
2.9	Exhaust cam	Ident. No. : A19-124779-9, 1173320-3	
2.40	C	Maker : Kongsberg Maritime Korea	Serial No. :
2.10	Governor	Model : AC C20 DGS	Name plate
2.11	Turbocharger	Maker : Hyundai-ABB Model : TPL77B12 Serial No. : XH002480	Serial No. : Name plate
2.12	Scavenge air cooler	Maker : Vestas Aircoil Ident. No. : A19-274025-8 Serial No. : 76667	Serial No. : Name plate
2.13	Auxiliary blower	Maker : Tae II Blower Mfg. Co., Ltd. Serial No. : 08B0276-01-05, 08B0276-01-06	Serial No. : Name plate
3	Inspection of setting val	ues	
3.1	Rated power	8820 kW : See N.P. & T.F.	
3.2	Rated speed	119 RPM : See N.P. & T.F.	
3.3	Max. combustion pressure	150.0 bar at rated power	
3.4	Compression ratio (shim thickness)	8 mm (beneath piston rod)	
3.5	Exhaust cam	Lead angle : See next page.	
3.6	Fuel cam / Fuel pump	Lead angle and top lift : See next page.	
3.7	Fuel pump shim / thickness	Number and thickness : See next page.	
3.8	Fuel pump orifice	Diameter : See next page.	
4	Review of operating valuif available	ues with fuel oil analysis as well as shop test report,	for reference
4.1	Scav. air temperature	See I.8	
4.2	Max. cylinder pressure	See I.8	

Notes)

- (1) T.F.: Technical File.
- (2) N.P.: Name Plate of engine
- (3) The most important : Atomizer of fuel valve
- (4) The surveyor shall have the option of checking one or all the identified components, settings or operating values to ensure that the engine with number, or minor, adjustment or modifications complies with the applicable emission limits and that only components of the current specification are being used. Especially, if it is necessary to survey a combustion pressure, the combustion pressure at 50% and 75% load can be measured and evaluated according to the maximum combustion pressure table on page 9.



5. Inspection of turbocharger components

No.	Components	Identification No.	Remarks
1	Compressor wheel	CV12 CT65	•
2	Diffuser	CT65 CA17	~
3	Turbine rotor	TT40 TF15	-
4	Nozzle ring	TT40 TA22	<u>0</u>

6. Exhaust cam lead (advance angle)

* for parent engine *

Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Measured angle (before TDC) at shop test bed	-3.40	-3.35	-3.45	-3.40	-3.35	-3.40	-	-	-	-	_	-	-3.39

(Design Value: Angle A: 112.9°, Lift = 10 mm / Angle B: 254.1°, Lift = 10 mm)

* for member engine *

Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Measured angle (before TDC) at shop test bed	-3.40	-3.20	-3.35	-3.20	-3.35	-3.35	-	-	-	-	-	-	-3.31

(Design Value: Angle A: 112.9° , Lift = 10.0 mm / Angle B : 254.1° , Lift = 10.0 mm)

7. Fuel cam (lead angle) / Fuel pump(top lift)

* for parent engine *

Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Measured angle													
(before TDC)	9.40	9.80	9.70	10.30	9.70	9.80	-	-	-	-	-	-	9.78
at shop test bed													
Number of fuel	8	8	8	8	8	8	-	_	_	-	_	_	8
pump shim (EA)											ļ		
Thickness of fuel	0.5	0.5	0.5	0.5	0.5	0.5	_	-	-	-	-	-	0.5
pump shim (mm)													
Top lift(mm)	10.64	11.36	11.09	11.93	11.07	11.28	-	-	-	-	-	-	11.23
at shop test bed	-							-					
Fuel pump orifice	-	_	_	_	-	-	-	-	-	_	-	-	_
(φmm, if applicable)			ļ			i			ļ		l		

* for member engine *

Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Measured angle (before TDC) at shop test bed	10.30	10.50	10.50	10.20	10.20	9.80	-	-	-	-	-	-	10.25
Number of fuel pump shim (EA)	8	8	8	8	8	8	-	-	-	-	-	-	8
Thickness of fuel pump shim (mm)	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	-	-	-	0.5
Top lift(mm) at shop test bed	11.97	11.98	12.18	11.67	11.76	11.25	-	-	-	-	<u>-</u>	-	11.80
Fuel pump orifice (φmm, if applicable)	_	-	-	-	-	-	-	-	-	-	-		-

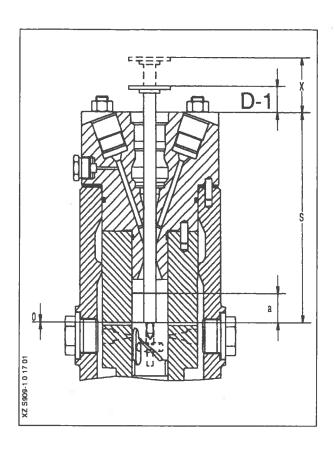
Remarks)

Compression shim thickness, fuel cam lead angle, fuel pump top lift, fuel pump shim thickness/numbers and exhaust cam lead angle can be adjusted and changed in order to keep maximum combustion pressure within the approved ranges as given in Chapter F.2

Note: Any adjustment(s) and change(s) should be recorded in the 'Record Book' of engine parameters.







The fuel pump lead **a** (= the effective lead) is defined as the distance the top of the fuel pump plunger is lifted above the upper edge of the upper cut-off holes in the fuel pump barrel, when the piston of the cylinder concerned is in TDC.

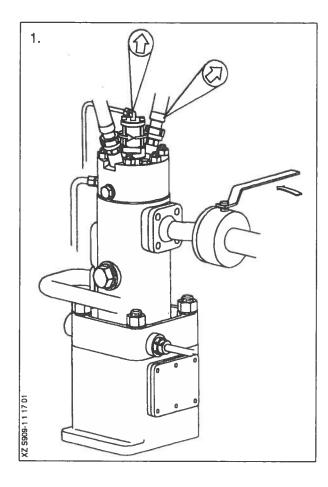
Barrel + Top cover = s

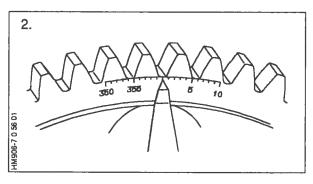
Tool length = s + "D-1"

Fuel pump lead a = x - "D-1"









 To be able to measure the fuel pump lead, it is necessary to dismantle one of the high-pressure pipes and the combined puncture/suction valve from the top cover.

Note!

Before dismantling any part of the fuel pump, make sure the pump has been relieved of pressure and that all oil has been drained off.

Shut off the fuel oil inlet.

Open the fuel pump drain cock, and drain off the oil

Dismount one of the high-pressure pipes.

Dismount the air pipe on the puncture valve.

Dismount the puncture valve.

2.

Note!

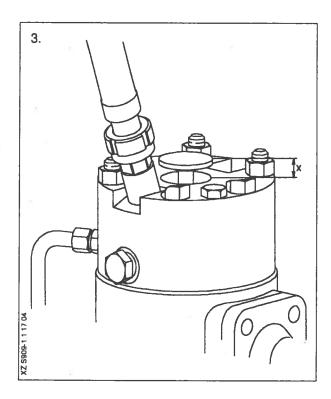
The correct distance **x** can only be measured when the fuel pump plunger is in its delivery stroke.

Turn the engine in AHEAD direction until the main piston of the cylinder concerned is exactly at TDC.

See Procedure 906-3.1.







3. Mount the measuring tool on top of the fuel pump plunger, through the hole in the fuel pump top cover.

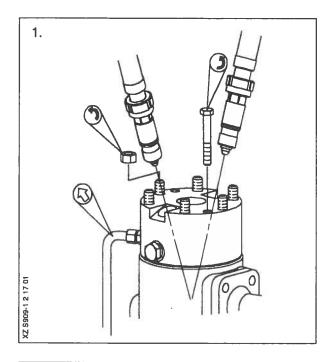
Measure the distance x from the top of the measuring tool to the top of the fuel pump top cover.

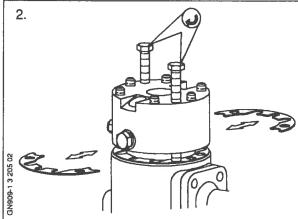
The fuel pump lead is then calculated as: a = x - D-1"

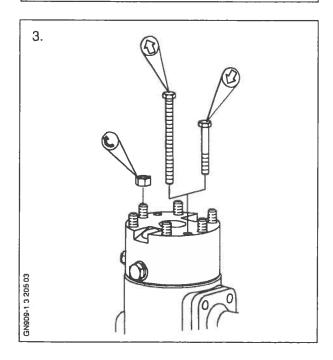
Note down the result for future reference.

For adjustment of fuel pump lead. See Procedure 909-1.3.









To insert or remove shims from the fuel pump, use the following procedure:

Note!

If the required adjustment of the fuel pump lead cannot be attained by inserting or removing shims (see Data D-2), the adjustment must be carried out on the fuel cam disc.

See Procedure 909-3.3.

1. Dismount the high-pressure pipes.

Dismount the drain oil pipe on the top cover.

Dismount the top cover fixing nuts. Remove the two screws in the threaded holes of the top cover.

Screw the two dismantling screws (from the tool panel) into the threaded holes of the top cover, thus lifting the top cover to provide space for inserting or removing shims.

The number of shims can now be adjusted. See Data D-2.

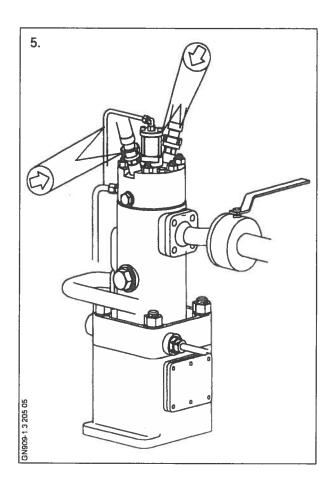
Note down the new shim thickness.

3. Replace the dismantling screws with the two original screws, and press down the top cover.

Mount the nuts for fastening the top cover, and tighten them diagonally, see Data D-4.

If any of the top cover studs have come loose, tighten them, see Data D-5.





- 4. Measure the fuel pump lead again and note down the result for future reference.

 See Procedure 909-1.1
- 5. Close the drain cock in the pump housing.

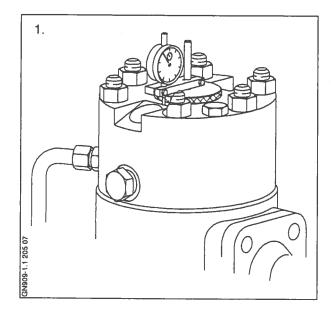
Mount the combined puncture/suction valve in the top cover, see Data D-3.

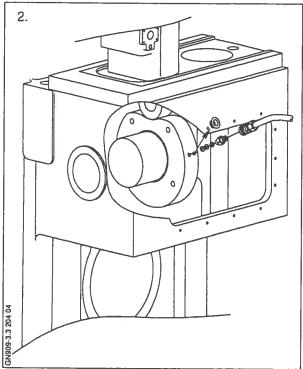
Connect the drain oil pipe to the top cover and the pipe connection to the puncture valve.

Mount the two high-pressure pipes on the top cover/fuel valves, see Data D-6.

6. Open the fuel oil inlet.







If the required adjustment of the fuel pump lead cannot be accomplished by inserting or removing shims, the fuel pump lead must be altered by adjusting the fuel cam disc as described below. See Procedure 909-1.3.

1 Turn AHEAD until the piston of the cylinder concerned is in TDC. (If the engine is of the reversible type, ensure that the roller guide is in AHEAD position).

Mount the measuring tool and adjust the dial gauge to zero.

2 Remove the inspection cover from the camshaft housing.

Remove the plugs from the oil ducts on the fuel cam.

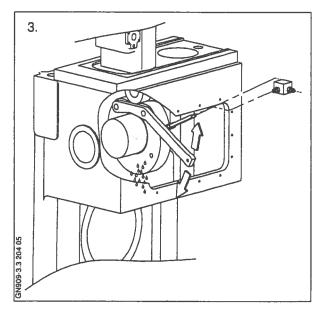
Insert three copper gaskets in each oil duct.

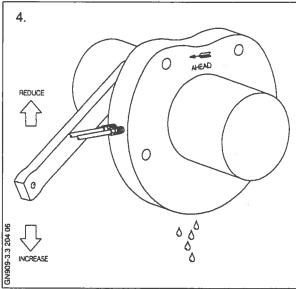
Mount quick couplings in the ducts, but do not tighten them.

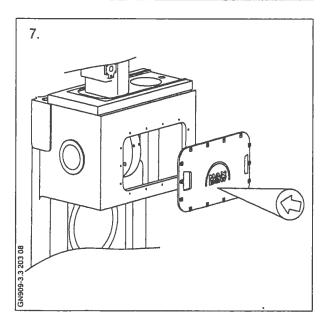
Fit hydraulic hoses between the snap-on couplings, the distributor block and the high pressure pump.











Mount the special spanner on the fuel cam disc and keep it close against the cam during the adjustment.

Apply light pressure to the hydraulic system and, after venting the system, tighten the quick coupings.

Raise the hydraulic pressure until oil seeps out between the camshaft and the cam disc.

Turn the cam disc, using the fitted spanner, until the desired change of lead is read directly on the measuring tool.

(The necessary turning of the cam disc is calculated as described in Procedure 909-1.1).

4. To increase the lead and Pmax:

turn the cam disc AHEAD.

To reduce the lead and Pmax:

·turn the cam disc ASTERN.

After completing the desired turning of the cam disc, relieve the hydraulic system of pressure and dismount the spanner and the hydraulic equipment.

Wait at least 15 minutes - the cam must be allowed time to "settle" - before mounting the plugs again in the oil ducts of the cam disc.

- 6. Again measure the lead of the fuel pump. See Procedure 909-1.1.
- 7. Mount the inspection cover on the camshaft housing.





8. Evaluation of the performance influence on the ISO corrected NOx values

(Parent Engine of Engine Group)

A method to check NOx compliance for varying maximum combustion pressure and scavenge air temperature is shown in the following example neglecting the influence of turbine back pressure. The back pressure has been found out to have only a minor influence on NOx values.

Reference table for Ha, Khdies and Ta

Load(%)	Hsc	На	Khdies(*)	Та	Khdies(**)
100	12.72	1.80	0.9158	22.0	0.9300
75	11.40	1.47	0.9057	18.0	0.9125
50	14.38	1.18	0.8917	15.0	0.8982
25	12.13	0.95	0.9200	13.0	0.9269

Remarks;

Khdies(*) : Based on Tscref.

Khdies(**): Based on max. allowable Tsc.

Table 8.1 Estimation of maximum combustion pressure and scavenge air temperature at 100%, 75%, 50% and 25% load and derive the equivalent change in NOx emission (g/kWh).

			THE THE Equitations of any	90 111 1107 0111	ioolott (g/ittiti).	
Load (%)	Max. combustion pressure(bar)		Absolute change in NOx (g/kWh)	Scavenge	air temperature (ΔT)	Absolute change in NOx (g/kWh)
(70)	Ref. value	ΔΡ	III IVOX (G/KVVII)	Tscref	ΔΤ	III IVOX (g/KVVII)
100	150.0	increase 1 bar	0.1816	48.0	increase 1 °C	Khdies
75	133.0	increase 1 bar	0.1760	43.0	increase 1 °C	Khdies
50	108.0	increase 1 bar	0.1760	39.0	increase 1 °C	Khdies
25	83.0	increase 1 bar	0.1760	44.0	increase 1 °C	Khdies

Table 8.2 Maximum allowed tolerances of max. combustion pressure and scavenge air temperature at ISO ambient conditions and the relative change in NOx.

Load (%)	(9)				Change	Scav	venge air temp.	Scavenge	
	Corr. Tscref	Not corrTscref	Actual value	· 	Max. allowable Pmax	in NOx (g/kWh)	Tsc ref	Max. allowable Tsc	Air temp.
100	13.78	15.05	150.0	150.0	153.0	0.5448	48.0	54.0	40.0
75	15.13	16.71	131.7	133.0	136.0	0.7568	43.0	46.0	34.0
50	17.60	19.74	105.8	108.0	111.0	0.9152	39.0	42.0	32.0
25	18.72	20.35	80.3	83.0	86.0	1.0032	44.0	47.0	22.0

Note: Tscref. - 48°C, 43°C, 39°C, 44°C at load 100%, 75%, 50%, and 25% respectively.

Tscref. values are based on operation with a fresh water temperature of 36 °C.

Corrected ISO NOx values(Based on reference Pmax. and scavenge air temperature)

IMO NOx = 0.2909 x 13.78 + 0.0000) + 0.5455 x 15.13 + 0.2288) +

 $0.1091 \times 17.60 + 0.3872) +$

 $0.0545 \times 18.72 + 0.4752$)

= 15.40 g/kWh





Example 'Calculation of expected NOx at the given combustion pressure and scavenge air temperature.

1) Measure the maximum combustion pressure and scavenge air temperature at 100%, 75%, 50% and 25% load as following table.

Power (%)	l	Max. combustion pressure(bar)		Absolute change in NOx (g/kWh)	Scavenge air t (ΔT		Absolute change in NOx (g/kWh)	
	Actual value	ΔΕ		(g/kvvii)	Actual value	ΔΤ	111 140x (g/kvvii)	
100	149.0	-1	bar	-0.1816	54	14 ℃	-1.0535	
75	129.7	-2	bar	-0.3520	46	12 ℃	-1.4625	
50	103.8	-2	bar	-0.3520	42	10 ℃	-2.0101	
25	78.3	-2	bar	-0.3520	47	25 ℃	-1.4876	

Note: $\Delta P = Actual \ value - test \ bed \ value(parent eng.), \ \Delta T = Actual \ value - test \ bed \ value(parent eng.)$

2) Calculate the expected NOx emission at each load condition as a summation of the ISO NOx corrected value and the absolute changes (as given in the table). The ISO NOx corrected values for the E3-cycle load conditions are given in Chapter I-8.

100%	NOx value at shop test (Not corrected- Pmax & Tscref) Absolute change as a consequence of different max. pressure		=	-0.1816	
	Absolute change as a consequence of different scav. temp. Expected NOx emission 15.05 + (-0.1816) + (-1.0535)	=	-1.0535 13.81	g/kWh
75%	NOx value at shop test (Not corrected- Pmax & Tscref) Absolute change as a consequence of different max. pressure Absolute change as a consequence of different scav. temp. Expected NOx emission			16.71 -0.3520 -1.4625	
	16.71 + (-0.3520) + (-1.4625)	=	14.89	g/kWh
50%	NOx value at shop test (Not corrected- Pmax & Tscref) Absolute change as a consequence of different max. pressure Absolute change as a consequence of different scav. temp. Expected NOx emission			19.74 -0.3520 -2.0101	g/kWh
	19.74 + (-0.3520) + (-2.0101)	=	17.38	g/kWh
25%	NOx value at shop test (Not corrected- Pmax & Tscref) Absolute change as a consequence of different max. pressure Absolute change as a consequence of different scav. temp. Expected NOx emission			20.35 -0.3520 -1.4876	
	20.35 + (-0.3520) + (-1.4876)	=	18.51	g/kWh

3) Finally, calculate the ISO corrected IMO NOx value at the given maximum combustion pressure and scavenge air temperature using the following formula.

```
 \begin{split} & \text{IMO NOx} = 0.2909 \  \, \text{x} \  \, \text{NOx} (100\%) \  \, + \  \, 0.5455 \  \, \text{x} \  \, \text{NOx} (75\%) \  \, + \  \, 0.1091 \  \, \text{x} \  \, \text{NOx} (50\%) \  \, + \  \, 0.0545 \  \, \text{x} \  \, \text{NOx} (25\%) \\ & \text{IMO NOx} = 0.2909 \  \, \text{x} \  \, 13.81 \  \, + \  \, 0.5455 \  \, \text{x} \  \, 14.89 \  \, + \  \, 0.1091 \  \, \text{x} \  \, \, 17.38 \  \, + \  \, 0.0545 \  \, \text{x} \  \, 18.51 \\ & = \  \, 15.05 \  \, \text{g/kWh} \end{split}
```

Since the IMO limit is 17.0 g/kWh, the engine still fulfills the requirements.

Example 2: Calculation of expected NOx at max. allowable combustion pressure and scavenge air temperature.

```
IMO NOx = 0.2909 \times 15.05 \times 0.9300 + 0.5448 + 0.5455 \times (16.71 \times 0.9125 + 0.7568) + 0.1091 \times 19.74 \times 0.8982 + 0.9152 + 0.0545 \times (20.35 \times 0.9269 + 1.0032) = 16.08 \text{ g/kWh}
```



J. Concept of Parent, Member Engine and Engine Group

Conditions for the application of this group concept are a set of identical engines having the identical components, same maximum power per cylinder and same rated speed.

The engine manufacturer should show a "Conformity of Production" in the production process. This includes ISO 9001 certificates or other quality insuring systems which should guarantee that member engines of engine group are identical.

Idea of this group concept is to have a need for emission measurements only for an engine, the so called "Parent Engine" and not need for emission measurements only for an engine, the so called "Member Engine". All the following identical engines can be adjusted and certified according to the procedures described in this page and according to the "List of NOx Relevant Components and Settings" on Chapter F.

Conditions for an Engine to be a member of the Engine Group

1. Identical Components:

If this is not the case the engine manufacturer has to show that the modified or exchanged components behave in the same way.

2. Same settings:

All settings and measured values according to the "List of NOx Relevant Components and Settings" on Chapter F should be within the limits approved for the Engine group.



K. Marking of Identification Number of the NOx Relevant Components

1. Application range

This is valid for components and engines which are built at Hyundai Heavy Industries Co., Ltd., Engine & Machinery Division works (HHI-EMD), in accordance with the requirements of the International Maritime Organization (IMO) document MP/CONF.3/35 - Resolution 2, Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines.

2. 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 numbers.

3. Checking

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

4. ID numbers of NOx relevant components

The ID number of NOx relevant components mentioned in the "List of the NOx Relevant Component and Settings" on Chapter F are marked as shown on the following sheets.

No.	Location of the IMO ID	IMO ID	Drawing No.
1	Auxiliary blower	Serial No. 08B0276-01-05 08B0276-01-06	A14-321343-6
2	Air cooler IMO ID	A19-274025-8 Serial No. 76667	A14-332495-8



No.	Location of the IMO ID	IMO ID	Drawing No.
3	Cylinder cover	A10-212926-7 5025583-3	A10-212926-7
4	Piston crown	A10-255133-2 5012873-6	A10-255133-2
5	Cylinder liner IMO ID	A19-266039-5 A19-212323-4 3170262-7	A10-214402-3
6	Barrel of fuel pump	1170729-8	A10-188640-2



No.	Location of the IMO ID	IMO ID	Drawing No.
7	Plunger of fuel pump	1171182-5	A11-188641-4
8	Atomizer of fuel valve	3062332-6x115	A12-224009-0
9	Fuel cam	A19-124775-1 1173321-5	A10-169928-8 A10-169929-0 (for template dwg.)
10	Exhaust cam IMO ID	A19-124779-9 1173320-3	A10-169931-0 A10-169932-2 (for template dwg.)



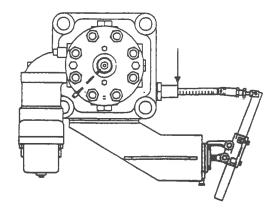


No.	Location of the IMO ID	IMO ID
	Turbocharger	Type : TPL77B12
11	IMO ID	Serial No. : XH002480
	Compressor wheel	CV12 CT65
11-1	IMO ID	
	Diffuser	CT65 CA17
11-2	IMO ID	×
	Turbine rotor IMO ID for	TT40 TF15
11-3	IMO ID for VTR, TPL, TCA & NA	
	Nozzle ring	TT40 TA22
11-4	IMO ID for only VTR IMO ID for TPL, MET, TCA & NA	CRSKE V.



5. Read the actual VIT-index

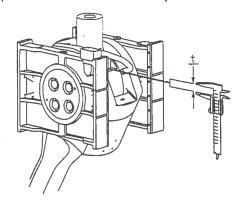
Read the actual VIT-index on the scale of the fuel pump timing racks.



6. Checking the shims

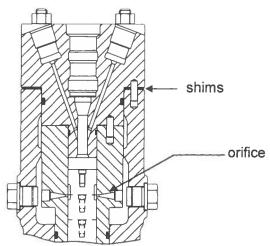
A. Checking the compression shims thickness (t), (compression volume)

Turning the crankthrow towards the exhaust side, to provide access for measuring the thickness of the shim which is inserted between piston rod and crosshead pin.



B. Number of shims in the fuel pump, (injection timing)

For engines without VIT, visually check the number of shims between the fuel pump top cover and the pump housing.





L. Test Report and Certificates

After the IMO NOx pre-certification test at test bed,

1. The test report is included in the Technical File.

After issuing of the EIAPP certificate (or 'the Statement of Compliance'),

2. The EIAPP Certificate(or the Statement of Compliance) shall be attached to the Technical File.

Number of Certificate	:	
Issued Date	:	

After issuing of the IAPP certificate (or 'the Statement of Compliance'),

3. The IAPP Certificate(or the Statement of Compliance) shall be attached to the Technical File.

Number of Certificate	:	
Issued Date	:	
		1971014000000000000000000000000000000000





M. Engine General Information

Project HMDS003 MAIN ENGINE

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3382 (Member engine of engine group)

Engine	
Manufacturer	Hyundai Heavy Industries Co., Ltd., Engine & Machinery Division
Rated speed	119 RPM
Rated power	8820 kW
Family / Group Identification	HYUNDAI-MAN B&W 6S50MC-C-2008-15
Serial number	AA3382
Intermediate speed	N/A
Maximum torque at intermediate speed	N/A
Static injection timing	-
Electronic injection control	Yes (-) , No (•)
Variable turbocharger geometry	Yes (-) , No (●)
Bore	500 mm
Stroke	2000 mm
Compression shim	8 mm
Mean effective pressure at rated power	18.9 bar
Maximum cylinder pressure at rated power	150 bar
Cylinder number, configuration	Number : 6 , In-line(●) , V (-)
Auxiliaries	N/A
Specified ambient conditions	
Maximum cooling water temperature	36 °C *
Maximum charge air temperature	54 °C *
Cooling system spec. intermediate cooler	Yes (●) , No (-)
Cooling system spec. charge air stages	One (1) stage
Low temp. cooling system set point	40 °C
High temp. cooling system set point	90 ℃
Maximum inlet depression	150 mmWC
Maximum exhaust back pressure	450 mmWC
Fuel oil temp. (100% load at shop test,	See Chapter S.
measured at the inlet to the fuel injection	
Lubricating oil specification	MELINA 30S
Application / Intended for	
Customer	E.R.SCHIFFAHRT
Final application / installation, Ship	Hyundai Vinashin Shipyard Co., Ltd. Hull No. S003
Final application / installation, Engine	Main (●) , Aux (-)
Emission test results (Parent engine o	f engine group)
Cycle	E3
NOx	15.40 g/kWh
Date	November 18, 2008
Test site / shop	HHI-EMD test shop
Surveyor	Mr. D. I. Park of DNV
Signature	Mr. J. W. Lee of HHI-EMD
Date and Place of report	July 22, 2009, HHI-EMD

^{&#}x27;*': mark: Based on the engine design condition.



N. Engine Group Information

Project	HMDS003	MAIN	ENGINE
---------	---------	------	--------

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3382 (Member engine of engine group)

Engine Group Information (commo	n specifications)	
Combustion cycle	: 2-stroke cycle	☐ : 4-stroke cycle
Cooling medium (Air cooler)	☐ : Air	: Water
Cylinder configuration	6 cylinders, In-Line	
Method of aspiration	: Constant pressure	: Natural aspired
Fuel type to be used on board	: Heavy fuel : Distillate	☐ : Dual
Combustion chamber	: Open chamber	: Divided chamber
Valve port configuration	: Cylinder head	: Cylinder wall
Valve port size and number	Fuel valve : 2/cylinder	Exh. valve : 1/cylinder
Fuel system type	One fuel pump per cylinder	
Miscellaneous Features		
Exhaust gas recirculation	☐ : Yes	■ : No
Water injection / emulsion	☐:Yes	■ : No
Air injection	☐ : Yes	■ : No
Charge cooling system	: Yes	□ : No
Exhaust after - treatment	☐ : Yes	■ : No
Exhaust after - treatment type	N/A	
Dual fuel	☐:Yes	■ : No
Engine Group Information (selection	on of parent engine for test bed)	
Group identification	HYUNDAI-MAN B&W 6S50MC-C-2008-	15
Method of pressure charging	Constant pressure	
Charge air cooling system	Central fresh water cooling system	
Number of cylinder	6	
Max. rated power per cylinder	1470 kW	
Rated speed	119 RPM	
Selected parent engine	AA3182	
Application	Hyundai Vinashin Shipyard Co., Ltd. Hul	l No. S001
		* -
		•





O. Test Cell Information (For Information)

Project HMDS001 MAIN ENGINE

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3182 (Parent engine of engine group)

Measurement Ed	uipmen	t				2	
		Manufacturer	Model or Serial No.	Measuremer	it range	Calib Span gas conc.	ration Deviation
Analyzers (HOR	IBA ME	KA-9100F) 403	9070001				87
NOx Analyzer		HORIBA	CLA-155	2000	ppm	1886	± 0.1 %
CO Analyzer		HORIBA	AIA-120	500	ppm	473	0.5 %
CO2 Analyzer		HORIBA	AIA-120	10	%	9.23	0.5 %
O2 Analyzer		HORIBA	FMA-126D	25	%	23.2	0.3 %
HC Analyzer		HORIBA	FMA-126D	500	ppmC	454	± 0.1 %
Speed (engine tach	ometer)	YOKOGAWA	62GE0178	0.1~30000	rpm	-	0.0 %
Torque		-	-	-	-	-	_ %
Power meter (water	r brake)	PROUDE	97033	36000	bhp	-	0.17 %
Weighing machine	(SFOC)	CAS	806LS0030300	5000	kg	-	0.02 %
Air flow				-			
Exhaust flow		Са	lculated-IMO (Jniversal, Car	bon/Oxyg	gen balance meth	od
Temperatures							
	in	RUEGER	3TH-9	0~120	°C	-	-2°C
Scavenge air		RUEGER	K48-043	0~120	°C	- 11	-1 ℃
cooler	out	-	_	-		-	-
- · · · · · · ·		RUEGER	81878021	0~650	°C	-	-3 ℃
Exh. Gas at T/C outlet		-	-	-		-	-
		RUEGER	K48-032	0~120	°C	-	0.0 °C
		RUEGER	K48-035		°C	-	0.0 ℃
		-	_	_		-	-
		_	-	_		-	-
Intake air at T/C		-	-	-		-	-
		-	-	_		-	-
	Ì	-	_	_			_
		••	_	_		-	_
		RUEGER	3-TH1	0~160	°C	-	-1℃
Scavenge air receiv	er		- 1	_		_	-
Ambient air		VAISALA	X3620034	-20~60	င	_	0.2 ℃
Fuel inlet		WIKA	1TH-23	0~120	Ĉ	_	- 0.5 °C
Pressures							
Exh. Gas (manome	ter)	DIGITRON	441281463	0~700	kPa	_	- 0.14 %
Scavenge air	,	DIGITRON	441281463		kPa		- 0.14 %
Atmospheric		SATO	81023		hPa	_	0.2 %
Humidity			1	0,0 1010			/v
Intake air		VAISALA	X3620034	0~100	%RH		1.3 %RH
Exhaust pipe		VAIOALA	7,0020004	0.3100	701311		1.0 /01/11
Diameter	— Т			1000	mm		
			■ : No	1000		□ : Yes	
Insulation				rhochargar /2/) m from		
Probe location 6.0 m after turbocharger (30 m from exhaust gas exit) Remarks Sampling gas temperature : min. 190°C at all loads							



P. Ambient and Gaseous Emission Data (For Information)

Project HMDS001 MAIN ENGINE

Engine Type HYUNDAI-MAN B&W 6S50MC-C7

Engine No. AA3182 (Parent engine of engine group)

Test Date November 18, 2008

Mode	-	15	-	_	-
Test number	-	01	. 02	03	04
Running time	-	12:10-13:10	11:10-11:40	10:40-11:10	10:10-10:40
Recorded time	-	12:25-12:38	11:23-11:37	10:51-11:05	10:21-10:36
Facina	%	100	75	50	25
Engine power	kW	8820.0	6615.0	4410.0	2205.0
Facing around	%	100	91	79	63
Engine speed	rpm	119.0	108.1	94.5	75.0
Max. combustion pressure	bar	150.0	131.7	105.8	80.3
Max. compression pressure	bar	133.8	106.5	75.0	49.5
Mean effective pressure	bar	18.9	15.6	11.9	7.5
Exhaust gas temp. at T/C outlet	°C	230	208	221	212
Turbocharger speed	rpm	15119	13352	10618	6413
Ambient Data					
Charge air pressure	kg/cm²	2.78	2.01	1.13	0.38
Barometric pressure	kPa	101.7	101.8	101.8	101.8
total a sin to considite.	%	11.1	11.6	11.3	10.4
Intake air humidity	g/kg	1.80	1.47	1.18	0.98
Intake air temperature	°C	22.0	18.0	15.0	13.0
Scavenge air temperature	°C	40.0	34.0	32.0	22.0
Intercooled air reference temperature	°C	48.0	43.0	39.0	44.0
Governor					
Pump index	mm	71.2	58.0	45.2	31.0
Load indicator governor	-	73.5	60.1	48.0	34.6
Fuel					
Uncorrected fuel consumption	kg/h	1588.2	1170.5	790.0	403.
Charge Air				-	
Air flow	kg/h	77134	63057	47072	2611
Exhaust Gas					
Gas flow	kg/h	78722	64228	47862	26516
Gaseous Emission Data					
CO concentration (Dry)	ppm	41.5	37.0	26.5	20.
CO2 concentration (Dry)	%	4.41	3.98	3.59	3.30
HC concentration (Wet)	ppmC	64.0	59.5	57.0	54.0
O2 concentration (Dry)	%	15.15	15.75	16.25	16.63
NOx concentration (Dry)	ppm	1110.0	1128.0	1188.0	1102.0
NOx humidity/temp. correction factor	-	0.916	0.906	0.892	0.92
Dry / Wet correction factor	-	0.963	0.967	0.970	0.97
NOx mass flow	kg/h	121.56	100.10	77.63	41.28
NOx specific	g/kWh	13.78	15.13	17.60	18.72
Test Cycle (E3)	g/kWh	15.20			

^{*} The IMO NOx value is based on reference scavenge air temperature, but not corrected reference Pmax.





Q. Results of NOx Emission (for Information)

Project

HMDS001 MAIN ENGINE

Engine Type

HYUNDAI-MAN B&W 6S50MC-C7

Engine No.

AA3182 (Parent engine of engine group)

Emission Test No.

01 to 04

Kind of fuel

Bunker-A (ISO 8217, DMC)

Engine output	kW	8,820
Output per cylinder	kW	1,470
Engine speed	RPM	119

Load	%	100	75	50	25
Oxides of Nitrogen (NOx)	g/kWh	13.78	15.13	17.60	18.72
IMO NOx-Cycle E3	g/kWh		15	.20	
IMO NOx-Cycle E2	g/kWh				
IMO NOx-Cycle D2	g/kWh			0	

Maximum Allowable NOx	g/kWh	17.0
-----------------------	-------	------

E3: Test cycle for "Propeller law operated main & propeller law operated aux. engine" application

E2: Test cycle for "Constant speed main propulsion engine" application including diesel electric drive

and variable pitch propeller installation

D2: Test cycle for "Constant speed auxiliary engine" application



^{*} The IMO NOx value is based on reference scavenge air temperature, but not corrected reference Pmax.



R. Fuel Analysis (For Information)

Project

HMDS001 MAIN ENGINE

Engine Type

HYUNDAI-MAN B&W 6S50MC-C7

Engine No.

AA3182 (Parent engine of engine group)

Test Date

November 18, 2008

Kind of Fuel

Marine Diesel Oil, Bunker-A

ISO 8217, DMC

Fuel elemental analysis & properties

Description	Unit	Result	Test Method
C (Carbon)	%, mass	87.48	Elementary Analysis
H (Hydrogen)	%, mass	11.63	Elementary Analysis
N (Nitrogen)	%, mass	0.1	Elementary Analysis
O (Oxygen)	%, mass	0.56	Elementary Analysis
S (Sulphur)	%, mass	0.21	ISO-8754
Density at 15℃	kg/£	0.9107	ISO-3675
Viscosity at 40°C	mm2/s	6.80	ISO-3104
Carbon residue (Micro method)	%, mass	1.10	ISO-10370
Water	%, V/V	0.01	ISO-3733
Cetane Index	-	N/A	ISO-4264

^{*} N/A: Not available due to mixed-bunker.





S. Engine Performance Data

Refer to the enclosed ten (10) sheets.



HYUNDAI HEAVY INDUSTRIES CD., LTD.

SHOP TEST RESULT FOR MAIN ENGINE

	Doc. No.: K630-IR09A-3383
Engine No.	AA3382
Engine type	6S50MC-C7
Hull No.	HMDS003
Owner	E.R.SCHIFFAHRT
Class	DNV
Ship yard	HMD

HYUNDAI - MAN B&W

QUALITY MANAGEMENT DEPARTMENT HHI-EMD

Rev.	Prepared	Checked	Approved	Description
2				8
1		4		
0	J. W. Lee	S. J. KLA 7 2009.07.06	S. D. PARK 2009, 7, 6	First issue





Official shop to	est result f	inr ⊨	l No.	HMDS003	Owner	E.R.SCHIF	-		
-	Eng	ine No.	AA3382	Class	DN				
Main E	ngme		ine Type	6S50MC-C7		June.17,			
Specification of	Main Engi	ne 🗀	out(MCR)	8820 kW	Engineer Operator	J.S.L H.Y.K			
		Spe	ed(MCR)	119 rpm	Operator	11.1.1	CHIVI		
		RTICULAR	SOFE	NGINE					
NUMBER OF CYLINDE	RS			6					
DIAMETER OF CYLIND	DER			500	mm				
STROKE				2000	mm				
FIRING ORDER		AH	→	1-5-3-4-	2 - 6 - 1	←AS	5		
CYLINDER CONSTANT				0.654	5				
	PARTIC	ULARS OF	TURB	OCHARG	ER				
TYPE				1 × TPL7	7B12				
SPECIFICATION				CT65CA17 T	F15TA22				
nMax / nBMax			17040 rpm / 550℃						
tMax / tBMax		16200 rpm / 520℃							
SERIAL No.		XH002480							
MANUFACTURER		HYUNDAI HEAVY INDUSTRIES CO., LTD.							
	PARTIC	ULARS OI	DYNA	MOMETI	ER	-			
MAKER / TYPE			FUCHI	NO CFSR-2	0				
CONSTANT (kW)			1/	1.35962					
MAXIMUM CAPACITY			26500	kW x 200 rp	m				
SPI	ECIFICAT	ION OF O	L USE	D AT SHO	P TEST				
		F.O	System	Oil Cam C	Oil Cyl. (Oil T/	C Oil		
KIND OF OIL		BUNKER-A	VERIT	AS VERIT	AS ALEX	(IA VE	RITAS		
KIND OF OIL		BUNKERYA	800 M	30 800 M	30 LS	800	M 30		
SPEC. GRAVITY	(15 ℃)	0.9171/	0.880	9 0.880	9 0.914	14 0.5	8809		
FLASH POINT	\mathbb{C}	78/	258	258	260) :	258		
VISCOSITY	cSt	(50/C)	(40℃	(40℃	(40 °C	(4	0℃)		
VISCOSITY	CSt	5/.72	103.	1 103.	1 198.	.7 1	03.1		
WATER	vol%	0.05							
SULFUR	wt%	0.248							
CALORIFIC VALUE	1- 1/1	0002							
(LOWER)	kcal / kg	9993							



	NY INDUSTRIES CO., LTD.	T	Hull No.	HMDS003	Owner	E.R.SCHIFFAHRT		
Of	ficial shop test result for	or	Engine No.	AA3382	Class	DNV		
	Main Engine		Engine Type	6S50MC-C7		June.17, 2009		
	Specifiction of Accessory		Output(MCR)	8820 kW	Engineer	J.S.LIM H.Y.KIM		
			Speed(MCR)	119 rpm	Operator	n.i.klivi		
		GO	VERNOR					
TYPE		AC (C20 DGS					
SERIAI	No.	B008	2B781140091					
MANU	FACTURER	KON	GSBERG M	ARITIME KO	OREA			
	FUEI	LVAL	E (ATON	MIZER)				
TYPE		3062	332-6 x 115					
OPENII	NG PRESSURE	350 =	±30 bar			1		
SPEC.	HOLE No.	1	2	3	4			
	DIA. OF HOLE(Φ)	1.15	1.15	1.15	1.15			
	VERTI. ANGLE(α°)	27	17	13	12			
	HORIZ. ANGLE(β°)	-2	12	30	48			
	Al	UXILIA	ARY BLOV	WER				
TYPE /	CAPACITY	TBCS-060C-4526 / 1.92 / 3.90 m³/sec						
SPEED	/ PRESSURE		3560	rpm /	571/32	27 mmAq		
SERIAL	. No. 1 / 2	08B02760105 / 08B02760106						
MANUI	FACTURER	TAE-IL BLOWER MFG. Co.,LTD.						
ELECT.	TYPE / VOLTAGE		HK-SD/F	' /		440 V		
MOTOR	FREQUENCY / POWER / Amp		60 Hz /	45	kW /	72.1 A		
	SERIAL No. 1/2		8F696F1	1-001 / 8F696	F11-002			
	MANUFACTURER	I	HYUNDAI HEAVY INDUSTRIES Co., LTD.					
		AIR	COOLER					
TYPE		LKMY-C1-1420-EK-080822						
SERIAL	No.	76667						
MANUF	ACTURER	VESTAS AIRCOIL .						
	CYI	LINDE	R LUBRIC	ATOR				
ТҮРЕ		ELECTRIC CONTROLLED LUBRICATOR(ALPHA)						
MANUF	ACTURER	HANMI HYDRAURIC MACHINERY CO.,LTD.						



Main Engine Main Engine Data sheet of 25% Load test *Room Temperature: 22.3 °C * Atmospheric Pressure : 1015.0 mbar Engine Speed Water Brake Brake Power Brake Power Indicated Power Mech.Efficiency NO 75.0 rpm 40.0 kNm 2205 kW 2504 kW 88.07 % 4.4 System Measuring Time 8: Engine No. AA3382 Measuring Time 8: Class DNV Operator H.Y. *Room Temperature: 22.3 °C * Atmospheric Pressure : 1015.0 mbar Indicated Power Mech.Efficiency NO 4.4 System Main L.O P.C.O Cam L.O Fuel Oil Cooling Press.(kg/cm²) AA3382 Measuring Time 8: Brake Power Indicated Power Mech.Efficiency NO 4.4 System Press.(kg/cm²) AA3382 Measuring Time 8: Class DNV Operator H.Y. ** AA3382 Engine No. Class DNV Operator H.Y. ** AA3382 Engine No. Class DNV Operator H.Y. ** AA3382 Engine No. Class DNV Operator H.Y. ** AA3382 AB3382 AB	NE 40 7, 2009 LIM .KIM			
Main Engine Eng. Type 6S50MC-C7 Test Date June.1 Data sheet of 25% Load test Owner Class E.R.SCHIFFAHRT Engineer Class J.S. DNV * Room Temperature : 22.3 °C * Atmospheric Pressure : 1015.0 mbar Engine Speed Water Brake Brake Power Indicated Power Mech.Efficiency NO 75.0 rpm 40.0 kNm 2205 kW 2504 kW 88.07 % 4.4 System Main L.O P.C.O Cam L.O Fuel Oil Cooling In Press.(kg/cm²) 2.13 8.20 4.6	7, 2009 LIM .KIM			
Data sheet of 25% Load test Owner E.R.SCHIFFAHRT Engineer Class J.S. DNV * Room Temperature : 22.3 °C * Atmospheric Pressure : 1015.0 mbar Engine Speed Water Brake Brake Power Indicated Power Mech.Efficiency NO 75.0 rpm 40.0 kNm 2205 kW 2504 kW 88.07 % 4.4 System Main L.O P.C.O Cam L.O Fuel Oil Cooling In Press.(kg/cm²) 2.13 8.20 4.6	LIM .KIM			
* Room Temperature : 22.3 °C * Atmospheric Pressure : 1015.0 mbar Engine Speed Water Brake Brake Power Indicated Power Mech.Efficiency NO 75.0 rpm 40.0 kNm 2205 kW 2504 kW 88.07 % 4.4 System Main L.O P.C.O Cam L.O Fuel Oil Cooling In Press.(kg/cm²) 2.13 8.20 4.6				
Engine Speed Water Brake Brake Power Indicated Power Mech.Efficiency NO 75.0 rpm 40.0 kNm 2205 kW 2504 kW 88.07 % 4.4 System Main L.O P.C.O Cam L.O Fuel Oil Cooling In Press.(kg/cm²) 2.13 8.20 4.0	тсн			
75.0 rpm 40.0 kNm 2205 kW 2504 kW 88.07 % 4.4 System Main L.O P.C.O Cam L.O Fuel Oil Cooling In Press.(kg/cm²) 2.13 8.20 4.5	ТСН			
System Main L.O P.C.O Cam L.O Fuel Oil Coolin In Press.(kg/cm²) 2.13 8.20 4.0				
In Press.(kg/cm ²) 2.13 8.20 4.0	40			
In Tress(ag ear)	Cooling F.W			
ln ln	03			
Temp.(℃) 43.0 70	70.5			
	13 14			
Pmax. bar 79.8 80 80 80 79 80				
Pcomp. bar 48.8 49 49 48 49 49				
Pi bar 8.50 8.47 8.49 8.52 8.56 8.40 8.57				
РӨ 30.3 30.0 30.0 31.0 31.0 30.0 30.0				
F.O Pump VIT				
Exh.Gas Out. °C 253.7 260 252 250 260 260 240				
C.F.W Out. C 73.9 73.0 73.5 74.0 75.0 74.0 74.0				
Cam L.O Out. C 41.0 41.0				
P.C.O Out C 48.8 49.0 49.0 49.0 49.0 49.0 49.0				
Air Cooler Scavenging Air				
	Temperature			
200 000	°C			
	250 mmHg			
BLANK	kg/cm²			
Air Out. C 20.0 Specific Fuel Oil Consumption				
Colling	(g/kWh)			
9 11.50	.877			
Turbocharger				
	.W Temp			
rpm °C mmAq °C mmHg °C mmAq In Out Press.	℃ '			
No. 1 6350 22.0 28.0 5 262 190 215 16 43 44 1.58	-			
No. 2				
No. 3				
No. 4 BLANK				
Avg. 6350 25.00 5 262 190.0 215 16 43 44 1.58	-			
* Pressure vit : - kg/cm² *Governor Position : 36.0 * Thrust Pad : 43	3.0 ℃			
Note: The Fuel Oil Consumption is corrected to Lower Calorific Value 10200 kcal/kg & I.S.O condition				



0.000 1		J., LTD.		14 C		Hull No. HMDS003					Weat	Weather						
Official s	_			it to	r	Engine No. AA3382					Meas	uring	Time	FINE 9:55				
N	Iain :	Engi	ine			Eng.	Туре	6S5	OMC-	-C7	Test	Date		Jun	e.17, 2	2009		
Data sheet	of 5	Nº/a	Logo	d test	-	Own		E.R.SC	CHIFF	AHRT				J.S.LIM				
Data sirect	01 5	0 /0	Loav	u test		Class			DNV		Oper	ator		H.Y.KIM				
* Room Tempera	ture :	22.7	7 ℃	* Atn	nosphe	eric Pr	essure	:	1016.	0 mb	ar							
Engine Speed		Wa	ter Br	ake	Bra	ke Po	wer	Indic	ated P	ower	Mecl	n.Effic	iency	NOTCH				
94.5	rpm	63.	45 kNm			10	kW	4802 kW			91	.83	%	6.40				
System		M	Iain L.	О		P.C.O		C	Cam L.O			Tuel O	il	Cooling F.W				
Press.(kg	/cm ²)											7.80			4.00			
In Temp.(°C	2)											32.0		72.0				
Cyl. No.		Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Pmax. bar		105.2	105	105	106	105	105	105										
Pcomp.	bar	74.5	74	75	74	74	4 75 75											
Pi	bar	12.94	12.93	12.92	12.89	12.89	13.00	13.00										
	Рθ	44.0	44.0	44.0	44.0	44.0	44.0	44.0										
F.O Pump	VIT	-	-	-	-	-	-	-										
Exh.Gas Out.	°C 291.5 295 290 291 292 294 2		287															
C.F.W Out. °C		75.7	75.0	75.0	75.0	77.0	76.0	76.0										
Cam L.O Out. ℃		44.0	44.0															
P.C.O Out °C		50.6	50.5	51.0	51.0	50.5	50.0	50.5										
		Air C	oole	r							Scav	engin	ıg Ai	r		,		
No.		1	2	3	4	A	√g.		P	ressur		Tempe	erature	;				
Bef. Cooler Press	mmHg	780				78	0.0		1.08		kg/cm			31	°	C		
Press. Drop	mmAq	94				94	1.0	Air re	Air receiver pressure					760 mmHg				
Air In.	$^{\circ}$	88	D	LAN	V	88	8.0	Exha	Exhaust Manifold Pressure						0.90 kg/cm²			
Air Out.	$^{\circ}$ C	30.0	В	LAIN		30	0.0		Spe	cific	Fue	Oil (Cons	umpt	ion	,		
Cooling In	$^{\circ}$	19.5				19	.5	Mea	s.(kg/	h)	Mea	as.(g/k	Wh)	Corr	orrect(g/kWh)			
Water Out	$^{\circ}$	51.0				51	.0	7	93.00	0	1	79.819	9	1	75.729)		
,						Turt	ocha	arger						_	-			
Turbocharger	Spe	ed	Blo	wer I	ılet	Befo	re Tui	rbine	Afte	er Tur	bine	L.O.	(℃, k	g/cm²)	F.W	Temp		
	rp	m	ຶ່າ	C	mmAq	$^{\circ}$	mn	nHg	${\mathbb C}$	mn	nAq	In	Out	Press.	°(C		
No. 1 11		00	22.0	32.0	17	322	63	30	232	4	12	43	52	1.50		-		
No. 2																		
No. 3			BLA	NK														
No. 4			ארני	1111														
Avg.	117	00	27.	00	17	322 63		0.0	232 4		12	43.0	52	1.50		-		
* Pressure vit :		kg/cm²			*Gov	ernor I	Positio	n :	50.0			* Thr	ust Pac	i :	45.0 ℃			
Note : The Fue	l Oil Co	nsum	ption i	s corre	cted to	Low	er Calo	orific \	/alue	10200	kcal/k	g & I.S	S.O co	nditio	n			



HEAV		Hull No. HMDS003					Weat	ther	-	FINE								
Offic	cial s	shop	test	resu	ılt fo	r		ne No.					suring	Time		10:25		
	\mathbf{N}	Iain i	Eng	ine			Eng.			50MC		Test		7 77770		e.17, 2		
75. /			50 /				Own				AHRT	Engi	neer		J.S.LIM			
Data s	sheet	01 7	5%	Load	d tesi	ţ.	Class		DNV			Operator			H.Y.KIM			
* Room Te	mpera	ture :	23.8	3 °C	* Atr	nosphe	eric Pr	essure	•	1015.	0 mba	ar						
Engine	Speed		Wa	ter Br	ake	Bra	ke Po	wer	Indic	ated F	ower	Mecl	h.Effic	iency	NOTCH			
10)8. 1	rpm	83.20 kNm			66	15	kW	7051 kW			93.82 %			7.60			
Sy	stem		M	lain L.	0		P.C.O		Cam L.O			I	Fuel O	il	Cooling F.W			
In Pre	ss.(kg	/cm ²)					2.20						7.60			4.00		
Ter	mp.(°C	2)					43.0						32.0		70.0			
Су	l. No.		Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Pmax.	x. bar 132.2 132 133 132		132	132	132													
Pcomp.		bar	105.3	105	106	106	105	105	105									
Pi		bar	16.61	16.63	16.70	16.66	16.52	16.57	16.58									
F.O Pump	2	Pθ	56.0	56.0	56.0	56.0	56.0	56.0	56.0		-							
1.01 ump		VIT	-	-	-				-									
Exh.Gas (Out.	${\mathbb C}$	300.0	300	295	300	305	305	295									
C.F.W Ou	ut.	${\mathbb C}$	77.7	77.0	78.0	77.0	78.0 78.0 78.		78.0									
Cam L.O	Out.	°C	46.0	46.0														
P.C.O Out C		52.0	52.0	52.0	52.0	52.0	52.0	52.0										
			Air C	oole	r							Scav	engin	ıg Ai	r			
1	No.		1	2	3	4	A	vg.	Pressure						Temperature			
Bef. Cooler	Press	mmHg	1440				144	0.0		1.98 kg/cm²					34		℃	
Press. Dro	р	mmAq	120				12	0.0	Air re	eceive	r press	ure			1420	420 mmHg		
Air In.		°C	145	В	LAN]	K –	14	5.0	Exha		anifold				1.71			
Air Out.		$^{\circ}$ C	35.0					5.0		Specific			Fuel Oil Cons					
Cooling	In	°C	22.0					2.0		s.(kg/			as.(g/k			ect(g/l		
Water	Out	°C	55.0					5.0		175.00)0	1	77.62	7	1	73.60	5	
				1				ocha										
Turbocha	arger	Spe	eed		wer I	nlet		re Tui	rbine		er Turl	oine	1	(℃, k			Temp	
	rpm		m	ຶ່	<u> </u>	mmAq	$^{\circ}\mathbb{C}$		nHg	°C		ıAq	In		Press.	· °	C	
	No. 1 13500		500	23.0	36.0	40	350	12	40	220	10	00	43	66	1.50			
No. 2																		
No. 3				BLA	NK													
No. 4																		
Avg.		135		29.50 40			350 1240.0			220		00	43	66	1.50		-	
* Pressure		-	kg/cmi				ernor I			63.3				ust Pac		46.0	<u>C</u>	
Note: Th	ne Fuel	Oil Co	onsum	ption i	s corre	cted to	Low	er Calo	orific V	/alue	10200	kcal/k	g & I.	S.O co	nditio	n		



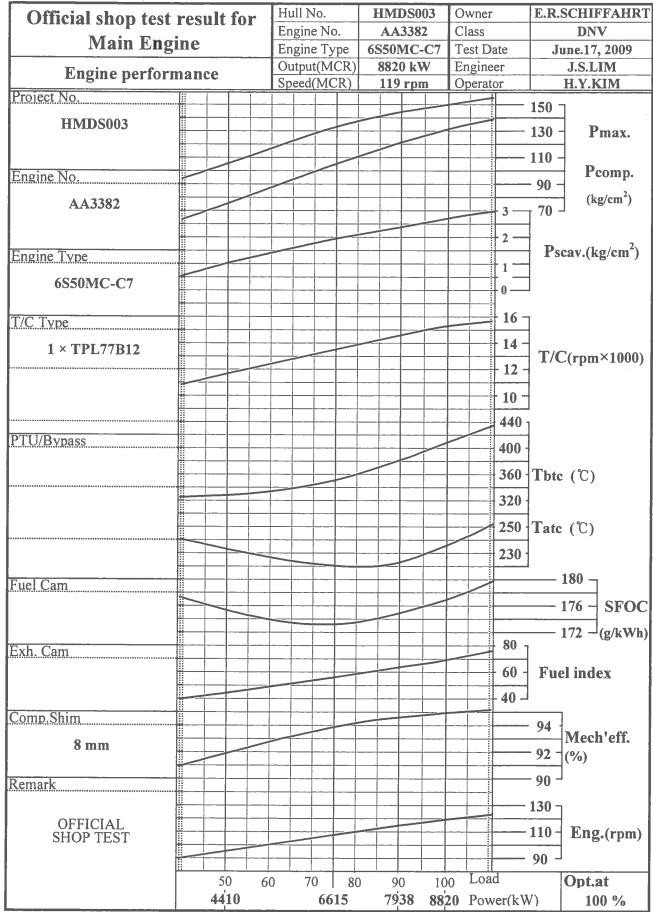
HEAVY INDUSTRIE	4 15	Hull 1	Nο	Н	MDS0	03	Weather				FINE					
Official sho	p test	resu	lt fo	r		ne No.					uring '	Time	11:10			
Mai	in Engi	ine			Eng.			OMC		Test		1		e.17, 2		
D 4 1 .4 .6	000/	Y	1 4 4		Owne		E.R.SC	CHIFF	AHRT	Engir	neer		J.S.LIM			
Data sheet of	90%	Load	ı tesi	[Class			DNV		Operator				H.Y.KIM		
* Room Temperature	e : 23.7	7 ℃	* Atn	nosphe	eric Pr	essure	:	1015.	0 mba	ar						
Engine Speed	Wa	ter Br	ake	Bra	ke Po	wer	Indic	ated P	ower	Mech	n.Effic	iency	Ì	NOTO	H	
114.9 rpi	m 93.	93.93 kNm 793				kW	8401 kW			94	.49	%	8.30			
System	M	Main L.O					C	Cam L.O			uel O	il	Cooling F.W			
Press.(kg/cm	2)				2.20						7.50		4.00			
In Temp.(°C)					43.0						32.0		70.0			
Cyl. No.	Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
			145	145												
Pcomp. b	ar 121.5	121	121	121	122	122	122									
•		18.60	18.58	18.59	18.63	18.68	18.64									
P	θ 64.2	64.0	64.0	64.0	64.0	65.0	64.0									
F.O Pump	IT -	-	-	-	-	-	-									
Exh.Gas Out.	C 314.2	320	310	315	315	320	305									
C.F.W Out.	C 79.2	79.0	79.0	79.0	79.0 80.0		79.0									
Cam L.O Out.	C 48.0	48.0			_											
P.C.O Out	O Out °C 53.7 54.0 54.0		54.0	53.0	53.0	54.0										
	Air C	Coole	r							Scav	engin	ıg Aiı	•			
No.	1	2	3	4	Avg.			F	Pressui	e			Tempe	erature	•	
Bef. Cooler Press mn	nHg 1790				179	0.0		2.45 kg/cm²					36 ℃			
Press. Drop mn	nAq 130				130.0		Air r	eceive	r press	ure			1770 mmHg		nHg	
Air In.	C 167	R	LAN	K	167.0 Exhaust Manifold					d Pressure 2.15				kg/cui		
Air Out.	C 35.0				35	5.0	Specific Fuel Oil					Cons	umpt	ion		
Cooling In °	C 23.0				23	3.0	Mea	as.(kg/	h)	Mea	as.(g/k	Wh)	Corr	ect(g/l	kWh)	
Water Out °	C 50.0				50).0	1	420.50	00	1	78.949	9	1	74.97	6	
				_	Turl	oocha	arger									
Turbocharger	Speed	Blo	ower II	nlet	Befo	ore Tu	rbine	Aft	er Tur	bine	L.O.	(℃, k	g/cm²)	F.W	Temp	
	rpm	°	C	mmAq	${\mathbb C}$	mn	nHg	$^{\circ}$ C	mn	nAq	In	Out	Press.	. °C		
No. 1	14550	550 23.5 37.0 5		50	380	15	60	222	1	60	43	71	1.60	-		
No. 2																
No. 3 BLANK																
No. 4		DLA	7111/													
Avg.	14550	30.	25	50	380	156	50.0	222	1	60	43	71	1.60		-	
* Pressure vit :	- kg/cm	2	-	*Gov	ernor l	Positio	n:	71.3			* Thr	ust Pac	i :	46.0	$^{\circ}\!\mathbb{C}$	



Official shop test result for							Hull No. HMDS003			03	Wea	ther		FINE				
Off		_			ilt fo	r		ne No.		A338			suring	Time	11:40			
	N	Iain	Eng	ine				Туре		50MC		-	Date		Jun	e.17, 2		
Data	sheet	of 10	100/ ₋	0/_ T	ood	tost	Own		E.R.S	CHIFF	AHRT	Engi	neer		J	.S.LI	M	
Data	SHEEL	01 10	JU /0	/0 L	wau	test	Class	3	DNV			Ope	ator		H.Y.KIM			
* Room '	Tempera	ature :	24.0	0°C	* Atı	nosph	eric Pr	essure	:	1015.	0 mb	ar						
Engin	e Speed	1	Wa	ake	Bra	ake Power Indicated Power					Mec	h.Effic	ciency	NOTCH				
	119.0	rpm	100	.77	kNm	88	20	$\mathbf{k}\mathbf{W}$	9296 kW			94.88 %			8.60			
5	System		M	lain L.	0		P.C.O)	C	am L.	0]	Fuel O	il	Cooling F.W			
, P	ress.(kg	/cm ²)					2.20						7.50			4.00		
In T	emp.(°(C)					43.0						34.0		70.0			
C	yl. No.		Avg.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Pmax. bar		bar	149.8	150	150	149	150	150	150									
Pcomp.		bar	131.7	131	131	132	132	132	132									
Pi		bar				19.86												
		Pθ	69.8	70.0	70.0	69.0	70.0	70.0	70.0									
F.O Pun	np	VIT	-	_	_	-	-	_	-									
Exh.Gas	s Out.	c	337.5 345 335 335 340 340		340	330												
C.F.W (Out.	C	80.0	80.0	80.0	80.0	80.0 80.0		80.0									
Cam L.0	Out.	°C	48.0	48.0														
P.C.O C	P.C.O Out °C		54.3	54.0	55.0	55.0	54.0	54.0	54.0									
			Air C	oole	r	-						Scav	engin	ng Ai	r			
	No.		1	2	3	4	A	√g.	Pressure						Temperature			
Bef. Cool	er Press	mmHg	2010				201	0.0	2.77 kg/cm²						38	ື (
Press. Di	rop	mmAq	135				13:	5.0	Air re	eceive	press	ure			2000 mmHg			
Air In.		$^{\circ}$	180		T A BT		18	0.0	Exha	ust Ma	mifold	Press	ure		2.45 kg/cm²			
Air Out.		°C	38.0	В	LAN		38	3.0		Spe	cific	Fue	Oil	Cons	umpt	ion		
Cooling	In	$^{\circ}$	24.0				24	.0	Mea	s.(kg/l	h)	Mea	as.(g/k	Wh)	Corr	ect(g/k	(Wh)	
Water	Out	℃	55.0				55	.0	1:	594.20	0	1	80.748	8	1	76.8 14		
							Turk	ocha	rger			,						
Turboch	narger	Spe	ed	Blo	wer I	ılet	Befo	re Tur	bine	Afte	er Turl	bine	L.O.	(°C, k	g/cur²)	F.W	Temp	
		rpı	n	°(2	mmAq	°C	mn	пHg	$^{\circ}$ C	mn	ıAq	In	Out	Press.	°(3	
No.	1	152	09	09 23.0 39.0 60 41		410	17	80	235	20	00	43	73	1.50	_			
No.	2																	
No.	3			BLA	NE													
No.	4			DLA	111													
Avį	g.	152	09	31.	00	60	410	178	0.0	235	20	00	43	73	1.50			
* Pressure	e vit :	-	kg/cm²			*Gove	ernor F	ositio	n :	77.9			* Thr	ust Pac	1 :	47.0	\mathbb{C}	
Note: T	he Fuel	Oil Co	nsump	otion is	corre	cted to	Lowe	er Calc	rific V	alue 1	0200	kcal/k	g & I.S	S.O co	nditio	n		

1864*







Official at 4		Hull 1	No.		Н	MDS	003	Own	wner E.R.SCHIFFAHRT							
Official shop test		uit I	or		e No.			A338		Class		DNV				
Main Eng	gine			Engin	е Туре		6S:	50MC	-C7	Test	Date	Jun	e.17, 2	009		
				Outpu	t(MCR	2)	8	820 k	W	Engi	neer	J	.S.LIN	1		
Inspection R	epor	t		<u> </u>	(MCF			19 rp		Operator		H.Y.KIM		M		
				i op vo.	(-/										
Kind of Inspection.		Place	of Insp	ection	1		Work Condition				Judgement					
Timing Data	s'y Sh	юр			Afte	r Shop	Test		Reference							
1. Exhaust Cam Le	ead (Adv	ance	Ang	le)											
Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Measured Timing(Ahead)	-3.40	-3.20	-3.35	-3.20	-3.35	-3.35				BLA	NK					
				* Ang	gle A:	112	2.9°		* Lift	:	10.0	mm				
				* Ang	gle B :	254	1.1°		* Lifi	::	10.0	mm				
2. Fuel Pump												75-30				
Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Number of Shim(EA)/ Thickness of Shim(mm)	8/0.5	8/0.5	8/0.5	8/0.5	8/0.5	8/0.5			I	BLANK						
Top Lift (mm)	11.97	11.98	12.18	11.67	11.76	11.25				BLA	NK					
Lead Angle(Before T.D.C)	10.30	10.50	10.50	10.20	10.20	9.80	BLANK									
3. Compression Sh	im	1	1	1			l	ı	<u> </u>	<u> </u>						
Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Thickness (mm)	8	8	8	8	8	8				BLA	NK					
4. Starting Air Disc	tribu	tor I	Lead	(Ad	vano	e An	gle))	·					·		
Cylinder No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Open Aft T.D.C (Ahead)			,	'												
Open Alt 1.D.C (Allead)				OT / -		T.D.C	7.0									

