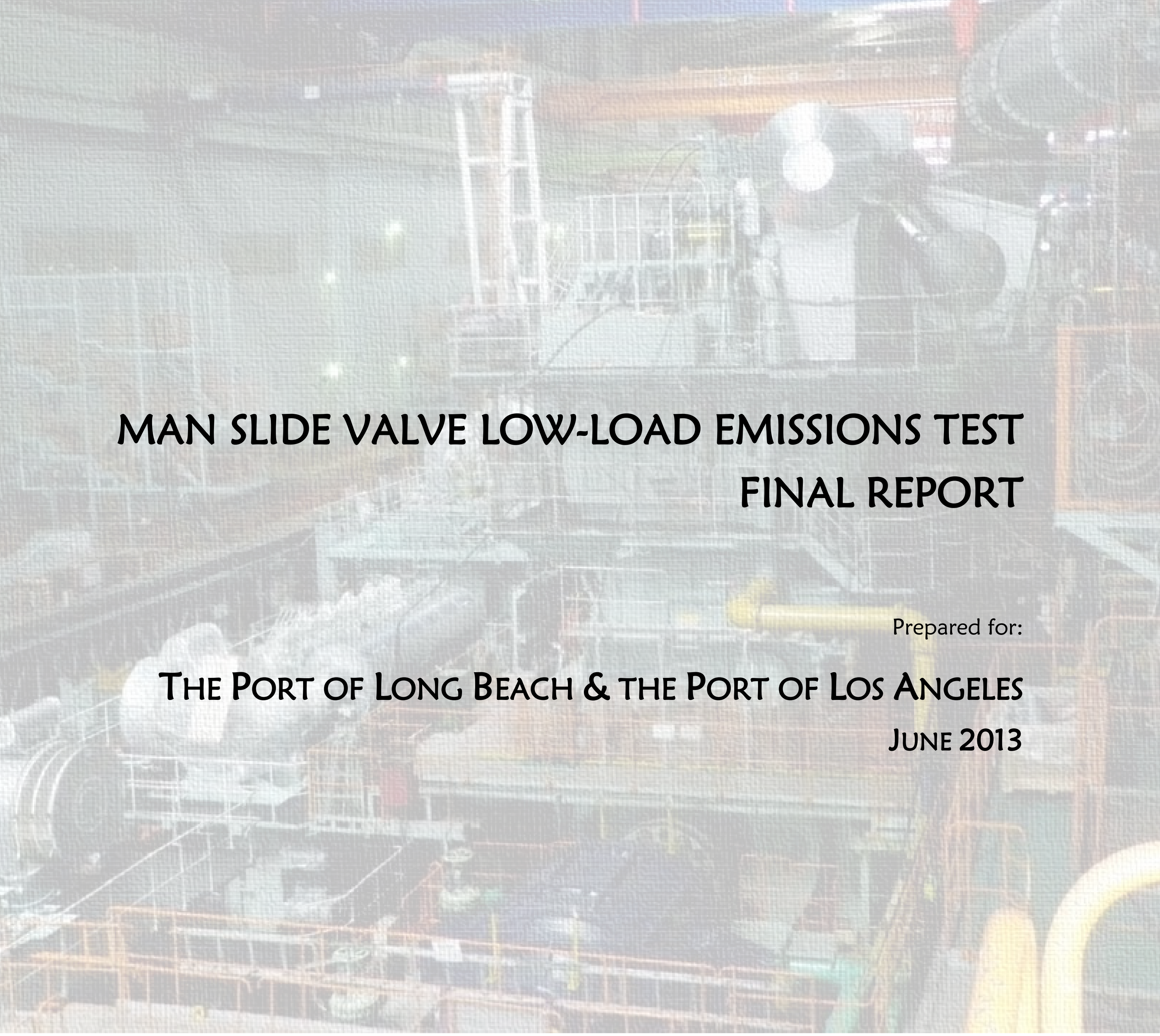


MAN SLIDE VALVE LOW-LOAD EMISSIONS TEST FINAL REPORT

Prepared for:

THE PORT OF LONG BEACH & THE PORT OF LOS ANGELES

JUNE 2013

Prepared by

Starcrest Consulting Group, LLC

Mitsui Engineering & Shipbuilding Co., LTD

MAN Diesel & Turbo A/S

ACKNOWLEDGEMENTS

The following individuals and their respective companies and organizations were vital to the technical information described in this report and in facilitating the process to obtain this information. We truly appreciate their time, effort, expertise, and cooperation. The Port of Long Beach, Port of Los Angeles, and Starcrest Consulting Group, LLC would like to recognize all who contributed their knowledge and considerable effort to ensure successful completion of this project, most notably:

Kazutaka Shimada, Mitsui Engineering & Shipbuilding Co., LTD
Junpei Shiki, Mitsui Engineering & Shipbuilding Co., LTD
Hiroyuki Taguchi, Mitsui Engineering & Shipbuilding Co., LTD
Tomohiko Kimoto, Mitsui Engineering & Shipbuilding Co., LTD
Dr. Svend Henningsen, MAN Diesel
Jannik Pedersen, MAN Diesel & Turbo A/S
Dr. Dongbo Tian, MAN Diesel & Turbo Japan Ltd.
Ray Gorski, Starcrest Consulting Group, LLC.
Bruce Anderson, Starcrest Consulting Group, LLC.

A special thanks goes to the many Mitsui Engineering & Shipbuilding Co., LTD technicians whose names are not available, but who performed an essential role in collecting the gaseous emissions measurements documented herein.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

APL	wholly owned subsidiary of Neptune Orient Lines (formerly known as American Presidents Line)
AQMP	Air Quality Management Plan
BSN	Bosch Smoke Number
°C	degrees Celsius
C3	conventional nozzle fuel valve
C11	low-NOx conventional fuel valve
C26	slide valve nozzle fuel valve
CARB	California Air Resources Board
CO	carbon monoxide
CO_2	carbon dioxide
DPM	diesel particulate matter
DTU-MEK	Technical University of Denmark – Dept. of Mech. Eng.
EC	elemental carbon
E3	type E3 ISO 8178 emissions test cycle
EI	emissions inventory
EPA 17	EPA Method 17 – Determination of Particulate Matter
FV	fuel valve
g/kW-hr	grams per kilowatt-hour
GC	gas chromatography
HC	hydrocarbons
H_2O	water
kW	kilowatt
IMO	International Maritime Organization
ISO	International Organization for Standardization
JIS	Japanese Industrial Standards
OGV	ocean-going vessel
OGV6	San Pedro Bay Ports Clean Air Action Plan OGV Measure Number 6
OM	organic matter
MARPOL	abbreviation for Marine Pollution
MCR	maximum continuous rating
MDO	marine diesel oil
MDT	MAN Diesel & Turbo A/S
MES	Mitsui Engineering & Shipbuilding Co., LTD
MEP	mean effective pressure
NO	nitrogen oxide
NOx	oxides of nitrogen
O_2	oxygen
PM	particulate matter
POLA	Port of Los Angeles
POLB	Port of Long Beach
RPM	revolutions per minute
SCAQMD	South Coast Air Quality Management District
SFOC	specific fuel oil consumption

ACRONYMS AND ABBREVIATIONS (CONTD)

SO_4	sulfate
SOF	soluble organic fraction
SV	slide valve
TGA	thermo-gravimetric analysis
THC	total hydrocarbons
USEPA	United States Environmental Protection Agency
VSR	vessel speed reduction

EXECUTIVE SUMMARY

In 2012, the Port of Los Angeles and the Port of Long Beach participated in a demonstration of slide-type fuel valves to quantify their effectiveness as an emissions reduction retrofit technology for ocean-going vessels (OGVs) equipped with Tier 0 and Tier 1 two-stroke diesel main engines[1]. The demonstration was designed to validate the results of previous slide valve studies, including an ultimately inconclusive demonstration project aboard the APL Singapore in 2008 and MAN Diesel & Turbo A/S (MDT)'s own data on slide valve emission performance.

Additionally, the demonstration sought to determine the emission reductions specifically for large slow-speed, two-stroke propulsion engines below 25% load for which no data currently exist. Knowing the emission levels at low loads is important given the high participation levels of vessels complying with the Vessel Speed Reduction (VSR) program in San Pedro Bay.

Test Program Overview

The ports, with support from their project partners, developed a comprehensive test plan to quantify emissions from OGV fuel valves as a function of fuel valve nozzle design and engine load. Three fuel valve nozzle designs underwent performance and emissions testing:

- Slide-valve nozzle C26 – this is standard equipment on new slow-speed marine diesel engines manufactured by MDT and its licensees;
- Conventional C3 nozzle – this is the fuel valve design used on Tier 0 and Tier 1 MDT marine diesel engines;
- Conventional C11 nozzle – this is a "low-NOx" conventional fuel valve, equipped with a nozzle that delivers a fuel spray pattern designed to minimize NOx emissions.

The MAN 6S70MC-C7 marine diesel engine was selected as the test bed for the low-load emissions testing. This six-cylinder, slow-speed two-stroke marine engine was selected based on call activity data from both ports over the past several years and is the most representative propulsion engine available for testing in the fleet of vessels that has called at both ports.

Three test cycles consisting of the following load profiles were specified for each fuel valve configuration:

- Test Cycle #1: E3 duty cycle (engine loads of 25%, 50%, 75%, and 100%) while temperature is stable;
- Test Cycle #2: Engine load of 15% while temperature is stable;
- Test Cycle #3: Engine load of 10% while temperature is stable.

Tests were conducted for particulate matter and gaseous emissions.

[1] New Tier 2 vessels already incorporate slide valves and therefore no additional reduction is applicable to their use.

Results and Conclusions

Findings from the Mitsui Engineering & Shipbuilding, Co., LTD., Gaseous Measurements and MDT Particulate Measurements of Fuel-Valve Tests on 6S70MC-C7 at Tamano Works, Japan can be summarized as follows:

- SV emit the same level or more NOx (g/kW-hr basis) at low loads compared to the two conventional fuel valve configurations;
- The conventional C11 fuel valve was found to emit ~15% less NOx (g/kW-hr basis) at low loads than the SV and C11 fuel valves;
- Below loads of 75%, SV emitted more NOx (g/kW-hr basis) than the two conventional fuel valve configurations and the C11 emitted the least NOx of all three fuel valve configurations;
- SV were confirmed to emit less diesel particulate matter (DPM) at low loads compared to the two conventional fuel valve configurations. At low loads, SV emits up to 50% less DPM than conventional C3 and C11 fuel valves and up to 65% less DPM for cylinder-lubrication-corrected particulate-emission results;
- SV emit over 90% less total hydrocarbons compared to the two conventional fuel valve configurations.

SECTION 1 INTRODUCTION

1.1 Reason for Study

In 2008, the Port of Los Angeles and the Port of Long Beach participated in a demonstration of slide-type fuel valves to quantify their effectiveness as an emissions reduction retrofit technology for ocean-going vessels (OGVs) equipped with Tier 0 and Tier 1 two-stroke diesel main engines[2].

The demonstration was conducted aboard the APL *Singapore*. This new type of OGV main engine fuel valve is designed to improve combustion properties by eliminating sac volume (i.e., fuel drips) at the valve nozzle. The elimination of the sac volume results in lower fuel oil consumption. In addition, slide valve nozzles incorporate an optimized spray pattern designed to improve the combustion process - this is intended to reduce overall emissions, including hydrocarbon, NOx and particulate matter. The visible smoke level is also greatly reduced as a result of the improved combustion.

The manufacturer, MAN Diesel & Turbo A/S (MDT), had previously published data suggesting slide valves offered a potential for a 30% reduction in NOx emissions and 25% reduction in DPM emissions when the technology is optimized in new engines.

The results from the 2008 APL *Singapore* slide valve retrofit demonstration, although ultimately inconclusive, seemed to suggest that the use of slide valves as an OGV main engine retrofit technology might not provide the level of emission reductions originally anticipated. In addition to the APL data, new information provided by the manufacturer also indicated that potential benefits from slide valves could be eroded as engine load is reduced. Ships complying with the vessel speed reduction (VSR) program, which has upwards of 95% participation in San Pedro Bay, generally have main engine loads below 25%, which is the lowest load point at which slide valves had been previously tested. Discussions with MDT determined that there had been no low-load engine tests for slide valve emission reductions conducted specifically on large slow-speed, two-stroke propulsion engines below 25% load and, therefore, no data to determine whether the slide valve benefit is appropriate at these lower loads.

The emission reduction benefits associated with slide valves is currently being applied in both port's emissions inventories for all vessel main engine loads. Due to the high participation levels of vessels complying with the VSR program, the Port of Los Angeles (POLA) and Port of Long Beach (POLB) sponsored additional emissions testing to determine what, if any, benefit results from MAN slide valves, especially at engine loads below 25%. Over 41% of all 2012 vessel arrivals to both ports are made by vessels with MAN slide valve equipped propulsion engines. This testing was conducted in support of the San Pedro Bay Ports Clean Air Action Plan OGV Measure Number 6 (OGV6) and is intended to improve the annual emissions inventories.

[2] New Tier 2 vessels already incorporate slide valves and therefore no additional reduction is applicable to their use.

1.2 Project Overview

The ports, with support from their project partners, developed a comprehensive test plan to quantify emissions from OGV fuel valves as a function of fuel valve nozzle design and engine load. Three fuel valve nozzle designs underwent performance and emissions testing:

- Slide-valve nozzle C26 – this is standard equipment on new slow-speed marine diesel engines manufactured by MDT and its licensees;
- Conventional C3 nozzle – this is the fuel valve design used on Tier 0 and Tier 1 MDT marine diesel engines;
- Conventional C11 nozzle – this is a "low-NOx" conventional fuel valve, equipped with a nozzle that delivers a fuel spray pattern designed to minimize NOx emissions.

The MAN 6S70MC-C7 marine diesel engine was selected as the most representative engine for the ports available for testing at a test bed for the low-load emissions testing. Mitsui Engineering & Shipbuilding, Co. LTD. (MES) agreed to test the engine at the factory in Tamano, Japan. This six-cylinder, slow-speed two-stroke marine engine was selected based on call activity data from both ports over the past several years and is the most representative propulsion engine available for testing in the fleet of vessels that has called at both ports.

Three test cycles consisting of the following load profiles were specified for each fuel valve configuration:

- Test Cycle #1: Engine load of E3 while temperature is stable;
- Test Cycle #2: Engine load of 15% while temperature is stable;
- Test Cycle #3: Engine load of 10% while temperature is stable.

Testing methods specified in the test plan were consistent with methods outlined in Chapter 5 of the International Maritime Organization (IMO) Marine Pollution (MARPOL) Annex VI, NOx Technical Code 2008 (2009 Edition), and International Organization for Standards (ISO) 8178. Performance parameters measured included the following:

- Engine exhaust temperature in Celsius (ºC);
- Total fuel consumption (metric tons);
- Fuel consumption rate at test loads (metric tons/hour);
- Engine output in kilowatts (kW); and
- Pressures and temperatures equivalent to a 'standard MDT observation form', including specific fuel oil consumption (SFOC).

The following exhaust compounds were specified for measurement and reporting in units of g/kW-hr:

- oxides of nitrogen (NOx)
- hydrocarbons (HC)
- carbon monoxide (CO)
- carbon dioxide (CO_2)
- nitrogen oxide (NO)
- particulate matter (PM) & soot
- total hydrocarbons (THC)
- oxygen (O_2)

Fuel valve test was conducted during the week of September 24, 2012 at MES's factory, located in Tamano, Japan. The testing team consisted of:

- MAN Diesel & Turbo/PrimeServ (MDT), Department DR-CPH, Copenhagen, Denmark;
- Mitsui Engineering & Ship Building Co., LTD (MES), Tamano Works, Tamano, Japan;
- Starcrest Consulting Group, LLC (Starcrest), Poulsbo, WA

MDT's role, as engine design licensor, was to provide technical support relating to the testing and perform emissions and dilution tunnel measurements following ISO 8178 for particulate matter. MES, as engine manufacturer licensee, provided the Mitsui-MAN Model 6S70MC-C7 two-stroke marine diesel engine used in the emissions testing. MES also assumed the lead role in conducting performance and gaseous pollutant measurements. MES also modified the existing test bed exhaust configuration at the Tamano Works to allow for MDT particulate matter testing. Starcrest's role was to provide testing coordination among MDT, MES, POLA, and POLB; support both ports with coordination of the Technology Advancement Program Advisory Committee; and provide third-party oversight of the testing.

Testing was conducted over three consecutive days, with each of the three fuel valve nozzle configurations requiring one full testing day for installation, engine warm-up, and emissions measurement. Fuel used during the testing was Japanese-blend marine diesel oil, whose measured sulfur content was 0.07% - this was deemed compliant with the CARB fuel switch rule of ≤0.1% sulfur marine gas oil.

The three fuel nozzles (two conventional [C3, #3137901-2 & C11, #3138323-0] and one slide-valve type [C26, 1767890-6]) were tested at six loads (10, 15, 25, 50, 75 & 100%, the ISO E3 cycle plus two low loads) following standard IMO Annex VI, NTC 2008 and ISO 8178 procedures. In addition to ISO 8178, EPA Method 17 dust measurements and Bosch type soot measurements were taken.

The following final technical reports on the testing program document test procedures and results:

- *Final Test Report of the Comparison Measurement between the Slide F.V. and the Conventional F.V. on the Mitsui-MAN B&W 6S70MC-C*, Mitsui Engineering & Shipbuilding, Co. LTD., March 2013; (MES Report) provided as Attachment 1
- *Particulate Measurements for Fuel Valve Tests on 6S70MC-C7 at Mitsui, Tamano*, MAN Diesel & Turbo A/S, R&D Dept. LDF4, March 2013; (MDT Report) provided as Attachment 2

SECTION 2 TESTING CONFIGURATION & SETUP

2.1 Engine Specifications

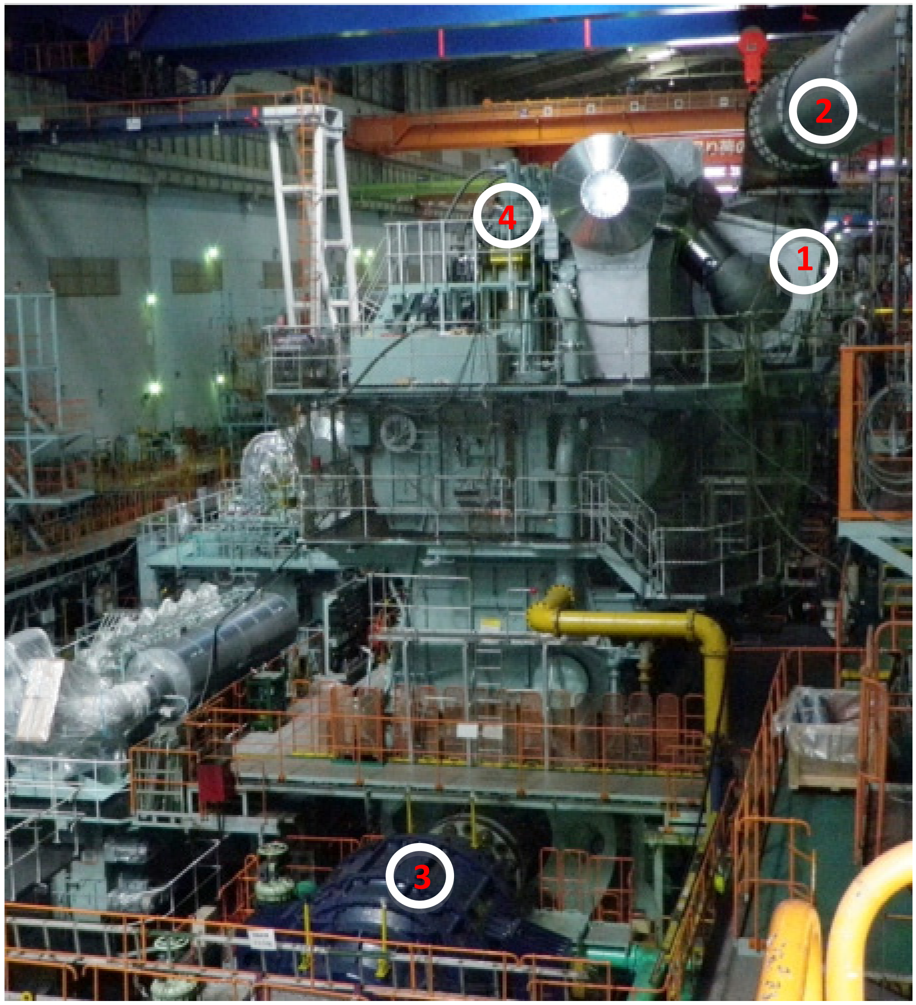
The marine engine used as the testing platform was the Mitsui-MAN 6S70MC-C7. This is a two-stroke, turbo-charged and charge-air cooled, in-line six cylinder, water-cooled and direct-injection diesel engine, with pump-line-nozzle fuel injection for each cylinder. This engine type is typically used in bulk carriers, container vessels, and tankers. Appendix 1 of the MDT Report contains a technical file that details the engine components as well as IMO compliance components from the parent engine. Table 2.1 on the next page lists the specifications of the Mitsui-MAN 6S70MC-C7 engine.

Table 2.1: Specifications of the Test Platform Engine – Mitsui-MAN 6S70MC-C7

<table>
<tr><td colspan="3">Type</td><td>MITSUI-MAN B&W 2-stroke, single acting, direct reversing crosshead diesel engine with exhaust turbocharger</td></tr>
<tr><td colspan="3">Model</td><td>Mitsui-MAN B&W 6S70MC-C7</td></tr>
<tr><td colspan="3">IMO NOx Regulation</td><td>Tier I
(17.0g/kWh@E3)</td></tr>
<tr><td colspan="3">Number of cylinders</td><td>6</td></tr>
<tr><td colspan="2">Cylinder bore</td><td>Mm</td><td>700</td></tr>
<tr><td colspan="2">Stroke</td><td>Mm</td><td>2800</td></tr>
<tr><td rowspan="4">Maximum continuous rating (MCR)</td><td>Output</td><td>kW</td><td>18660</td></tr>
<tr><td>Speed</td><td>Rpm</td><td>91.0</td></tr>
<tr><td>Mean effective Pressure</td><td>MPa</td><td>1.90</td></tr>
<tr><td>Mean Piston Speed</td><td>m/s</td><td>8.49</td></tr>
<tr><td colspan="3">Governor</td><td>MSR MAG-200Ⅲ</td></tr>
<tr><td colspan="3">Cylinder Lubricator</td><td>Alpha Lubricator System</td></tr>
<tr><td colspan="3">Turbocharger type</td><td>1 × Mitsui-MAN TCA88-2</td></tr>
<tr><td colspan="3">Auxiliary blower type
(Motor output)</td><td>2 × TBMS-7538
(75kW)</td></tr>
<tr><td colspan="3">Air Cooler Cooling system</td><td>Direct sea water cooling</td></tr>
<tr><td colspan="3">Air cooler type
Cooling Surface</td><td>1×BBBB50S-M1
1150.9 m2</td></tr>
<tr><td colspan="3">Variable Injection Timing</td><td>Wit (Fixed)</td></tr>
<tr><td colspan="3">Fuel Valve Type</td><td>Slide Type Fuel Valve</td></tr>
</table>

The following photograph (Figure 2.1) shows the Mitsui-MAN 6S70MC-C7 engine in the test stand at MES's Tamano Works, Tamano, Japan.

Figure 2.1: Mitsui-MAN 6S70MC-C7 Marine Engine used as Fuel Valve Test Platform



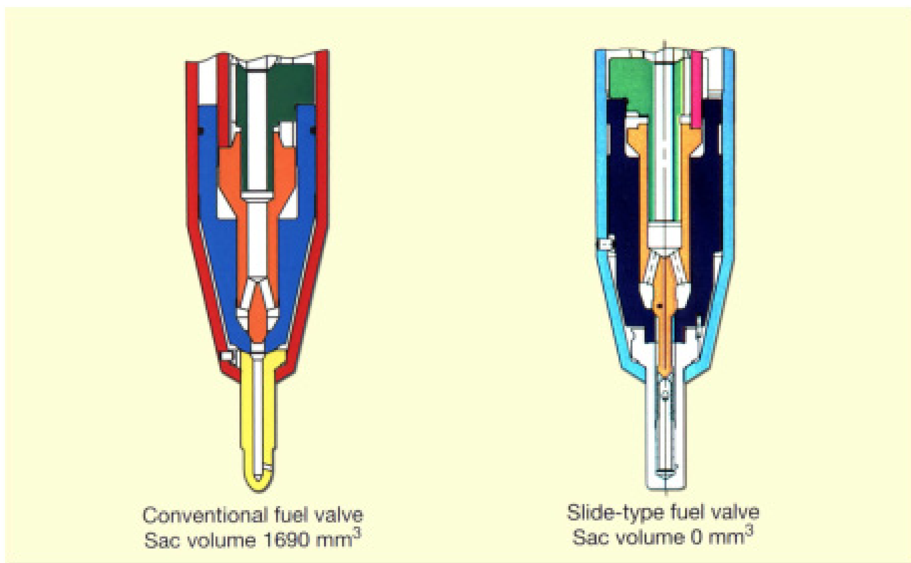
Features notated on the above photo include the following:

1. Engine turbocharger location;
2. Exhaust duct that directs the engine exhaust from the turbocharger outlet to the outside of the building. This duct was modified as an element of this project to include test ports for the measurement of particulate and gaseous emissions.
3. The water brake is attached to the engine crankshaft at the flywheel and used to apply a specified load to the engine during testing;
4. Location of the cylinders and fuel valves.

2.2 Fuel Valve Specifications

The "slide" fuel valve was developed in the late 1990's and is now standard equipment on all MDT marine engines. The slide valve incorporates a design feature that minimizes the sac volume in the nozzle atomizer. Excess sac volume fuel has the potential to increase emissions of particulate matter if allowed to drip into the combustion chamber at low pressure. The slide valve design reduces fuel consumption by more precisely controlling sac volume, and also offers the potential to control particulate matter formation by reducing fuel entry into the combustion chamber. Figure 2.2 illustrates the slide valve nozzle design configuration compared to a conventional marine engine fuel valve:

Figure 2.2: Comparison of the Slide Valve vs. Conventional Fuel Valve



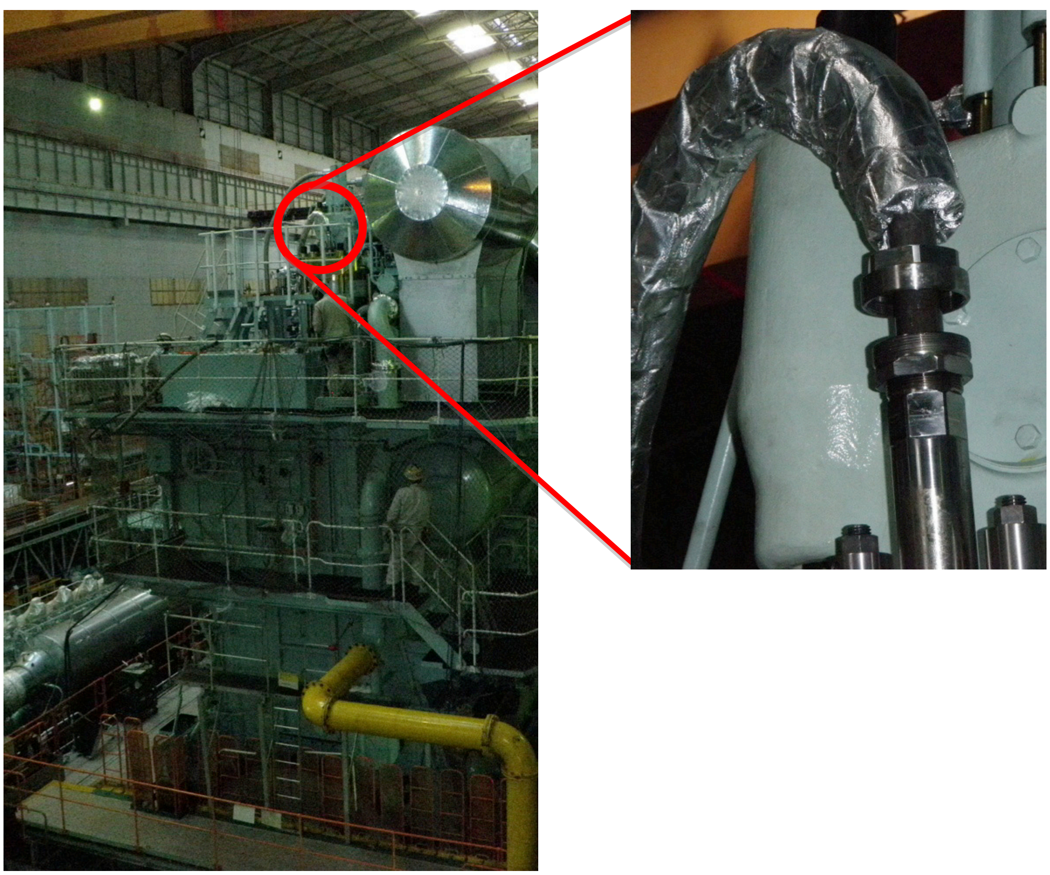
Three fuel valve nozzle designs underwent performance and emissions testing:

- Slide-valve nozzle C26 – this is standard equipment on new slow-speed marine diesel engines manufactured by MDT and its licensees;
- Conventional C3 nozzle – this is the fuel valve design used on Tier 0 and Tier 1 MDT marine diesel engines;
- Conventional C11 nozzle – this is a "low-NOx" conventional fuel valve, equipped with a nozzle that delivers a fuel spray pattern designed to minimize NOx emissions.

Figure 2.3, below, shows the conventional C3 and low-NOx conventional fuel valves prior to installation and testing. The engine uses two fuel valves per cylinder; hence a total of twelve fuel valves of each configuration. Figure 2.4 shows the location of a fuel valve on the test engine.

Figure 2.3: Conventional (C3) Nozzle and Low-NOx Conventional (C11) Nozzle Fuel Valves Prior to Installation and Testing.

Figure 2.4: Conventional Fuel Valve Installed & Undergoing Testing in Mitsui-MAN 6S70MC-C7



The fuel nozzle (atomizer) is key to the performance and emission properties of a marine engine. As stated above, two nozzle configurations for the conventional valve (C3 and C11) and one nozzle for the slide valve were selected for testing. A comparison of fuel valve nozzle specifications is presented below in Table 2.2.

Table 2.2: Nozzle Specifications for the Conventional & Slide Valve

Name	6S70MC-C7 C26	6S70MC-C7 C1	6S70MC-C7 C11
MDT Drawing No.	1767890-6	3137901-2	3138323-0
Type of F.V.	Slide	Conventional	Conventional
NOx Regulation	Tier I	Tier I	Tier I
No. of holes	5	5	5
Diameter of holes	1.5	1.45	1.45
Remarks			Lower NOx

2.3 Fuel Oil & Lubricating Oil Specifications

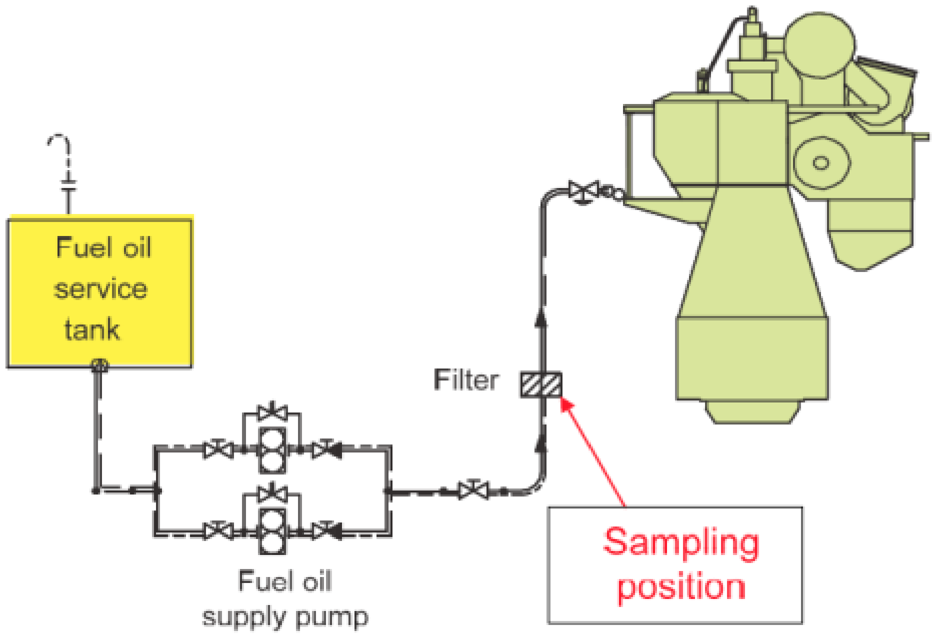
The fuel oil used during testing was Japanese-blend marine diesel oil with a measured sulfur content of 0.07%. Table 2.3 specifies the important properties of the fuel oil used during testing. Copies of the fuel analysis certificates are provided in Enclosure 3 of the MES Report.

Table 2.3: Fuel Oil Properties

	Fuel Oil	Units	Method
Certificate no.	O-2291	-	-
Quality class	FO	-	-
Date of Sampling	27 Sept 12	-	-
Density (at 15 °C)	833.3	kg/m^3	JIS K 2249
Heat of Combustion, Net.	42747	kJ/kg	JIS K 2279
Viscosity (at 50°C)	2.666	mm^2/s	JIS K 2283
Sulfur content	0.07	% mass	JIS K 2541
Nitrogen	<0.01	% mass	JIS K 8813
Carbon	86.2	% mass	JIS K 8813
Hydrogen	13.3	% mass	JIS K 8813
Oxygen	0.23	% mass	JIS K 8813
Water by Dist.	<0.05	% mass	JIS K 2275
Ash	<0.01	% mass	JIS K 2272
Con. Carbon Residue (10%)	0.38	% mass	JIS K 2270
Flash point (P.M)	72	°C	JIS K 2265
Cetane index	58.7	-	JIS K 2280

The fuel oil sampling location is illustrated in Figure 2.5.

Figure 2.5: Fuel Oil Sampling Position



The engine lubrication oil was also analyzed to characterize its properties as detailed below in Table 2.4 and detailed results are provided in Enclosure 3 of the MES Report.

Table 2.4: Lubricating Oil Properties

	Lubrication Oil	Units	Method
Certificate no.	O-2293	-	-
Quality class	LO	-	-
Date of Sampling	26 Sept 12	-	-
Density (at 15°C)	934.6	kg/m³	JIS K 2249
Viscosity (at 40°C)	224.1	mm2/s	JIS K 2283
Sulfur content	0.87	% mass	JIS K 2541
Carbon	81.5	% mass	JIS K 8813
Hydrogen	12.2	% mass	JIS K 8813
Acid no.	0.5	mg KOH/g	JIS K 2501
Base no.	70.2	mg KOH/g	JIS K 2501
Insoluble (Pentane)	<0.05	% mass	ASTM D893
Insoluble (Toluene)	<0.05	% mass	ASTM D893

SECTION 3 EMISSIONS TESTING EQUIPMENT & MEASURING PROCEDURES

3.1 Exhaust Gas Analyzers, Sampling System, & Calibration Gases – Particulate Measurements

Gaseous and particulate emissions were measured downstream of the engine's turbocharger. The particulate matter sampling point positions and the mounting of the dilution tunnel for particulate measurement was done in accordance with ISO 8178 – these sampling positions are depicted graphically in Appendix 2 of the MDT Report. Table 3.1, below, specifies the exhaust gas analyzer used to measure CO_2 concentrations in the diluted and undiluted exhaust gas. CO_2 background measurements were also conducted from the compressed dilution air. Prior to measurement the analyzer was linearized in accordance with IMO - NOx Technical Code 2008. The calibration specification is provided in Appendix 5 of the MDT Report. The MDT dilution tunnel and exhaust gas analyzer are depicted in Figures 3.1 and 3.2, respectively.

Table 3.1: Gas Analyzer Specification

Component	Manufacturer	Model	Device ID.	Measuring range (DSR)
CO_2 (high)	Siemens AG	Ultramat 23	34	0-10 %
CO_2 (low)	Siemens AG	Ultramat 23	34	0-0.5 %

Figure 3.1: MDT Dilution Tunnel Installed on Exhaust Duct

Figure 3.2: Siemens Ultramat 23 Exhaust Gas Analyzer

The calibration gasses used are specified Table 3.2. The calibration gas bottles can be seen directly behind the exhaust gas analyzer in Figure 3.2, above. The calibration gas certificates are included in Appendix 6 of the MDT Report.

Table 3.2: Calibration Gas Properties

Component (s)	Concentration	Cylinder No.	Expiration Date	Supplier
CO_2, High	8.713 %	GT-93980	2013-08-21	Takachiho chemical industrial CO.
CO_2, Low	0.4742 %	NOX-02074	2013-08-22	
N_2	<3 ppm H_2O <0.5 ppm C_nH_m <2 ppm O_2	NA	NA	

Table 3.3 specifies the gas meters used to measure the flow through the particle filters. The calibration of the gas meters is specified in Appendix 7 of the MDT Report.

Table 3.3: Calibration of Gas Meters

Device I.D.	Manufacturer	Model	Calibration I.D.	Measuring Range (DSR)
Volumen måler NR1	ICA	AC-5M	20121025-VMNR1	0-5 m^3/h
Volumen måler NR2	ICA	AC-5M	20121025-VMNR2	0-5 m^3/h

Particulates are measured by the partial-flow dilution method, using a MDT custom-made mini-dilution tunnel. The system is described in detail in the MDT Report. The main dimensions and the conditions for the tunnel are presented in Table 3.4.

Table 3.4: MDT Dilution Tunnel Specifications

Length Transfer Line – mm	300
Temperature Transfer Line – °C	300
Internal Diameter of Transfer Line – ømm	6
Inlet Temperature Dilution Air – °C	25
Ventura Diameter – Ømm	9.5
Needle Tube – Outer Diameter	8
Needle Tube – Inner Diameter	3
Dilution-Tunnel Mixing Length – mm	430
Internal Dilution-Tunnel Diameter – Ømm	50
Dilution-Tunnel Temperature (Mixing Section) – °C	41-49
Filter Type (Teflon Coated Borosilicate Glass Fibers)	Pallflex TX40HI20WW
Filter Type (Quartz For Chemical Analysis)	GL-quartz filters
Filter Diameter – mm	47
Gas-meter Temperature – °C	25-40
Dilution Ratio	17-20

The MDT sample probe is a straight closed-ended multi-hole probe used for gas as well as particulate sampling in the exhaust channel after the turbocharger. The sample probes outer diameter is 8 mm and have 5x3 holes of 1 mm (MES Report). The length is 1,265 and 1,150 mm respectively for particle and gaseous emissions.

3.2 Particulate Measurement Procedures

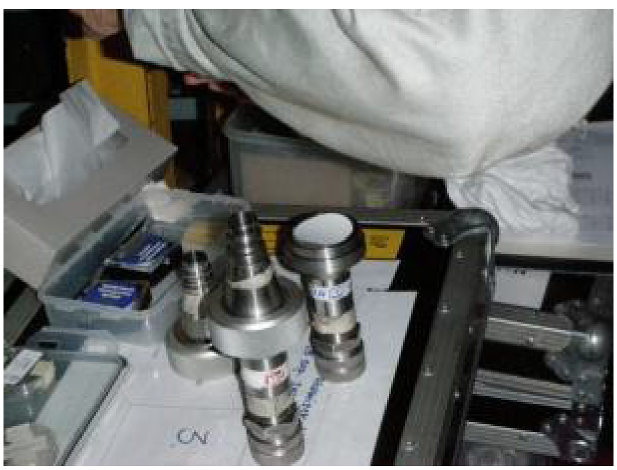
Emission measurements are performed following standard MDT procedures for test-bed measurements, as described in the MDT Report. These procedures closely conform to ISO 8178-4[3]. The chemical analysis of the particulates was performed by Germanischer Lloyd SE, which is provided in Appendix 8 of the MDT Report. Table 3.5 below summarizes the chemical analysis conducted:

Table 3.5: Particulate Matter Measurement Procedures

Analysis for	Symbol	Method
Elemental Carbon	EC	Thermo Gravimetric Analysis (VDI 2465 Part 2)
Organic Matter	OM	Thermo Gravimetric Analysis (VDI 2465 Part 2)
Sulphate	SO4	Ion chromatography system (Dionex DX 500)
Ash + Remaining	AR	The remaining of particle-filter load after analysis (no analysis for Ash alone)

This analysis is described in greater details in Appendix 9 of the MDT Report.

Figure 3.3: MDT Technician Prepares Particulate Filters in Preparation for Sampling in Accordance with ISO 8178



[3] *MAN Diesel A/S Custom made mini-dilution tunnel, version DT-4*, MAN Diesel A/S, R&D Dept. 2431, October 2002.

3.3 Exhaust Gas Analyzers, Sampling System, Calibration Gases & Measurement Procedures – Gaseous Emissions

The engine performance measurements were conducted according to MES's standard procedure. All equipment for the performance readings was calibrated in accordance with MES's standard procedure based on ISO 9001 and/or the NOx Technical Code 2008 (see Enclosure 2 of the MES Report). Table 3.6, below, presents the specific gaseous emissions components measured.

Table 3.6: Gaseous Emissions Testing were Performed by MES

Components	Method	Remark
NO_x	Heated Chemiluminescence Detector (HCLD)	
O_2	Polarization Mode Dispersion (PMD)	
CO	Non-Dispersive Infrared (NDIR)	
CO_2	NDIR	
THC	Heated Flame Ionization Detector (HFID)	
Dust	JIS Z 8808(EPA17)	
Bosch Number	-	Sampling Volume 1l, 3l

Figure 3.4: Gaseous Emissions Measurement Equipment

Figure 3.4, above, shows the gaseous emissions measurement and analysis equipment used during testing. The exhaust gas analyzers depicted in the above photo include the following equipment and specifications presented in Table 3.7.

Table 3.7: Gaseous Emissions Measurement Equipment Specifications

Component	Manufacturer	Model	Serial No.	Method	Dry/Wet	Measuring Range	Date of Calibration
NO_x	HORIBA	MEXA7100D	4454745001	HCLD	Wet	2500ppm	2012.08.06
O_2	HORIBA	MEXA7100D	4454745001	PMD	Dry	25%	2012.08.06
CO	HORIBA	MEXA7100D	4454745001	NDIR	Dry	1000ppm	2012.08.06
CO_2	HORIBA	MEXA7100D	4454745001	NDIR	Dry	10%	2012.08.06
THC	HORIBA	MEXA7100D	4454745001	HFID	Wet	1000ppmC	2012.08.06
PM	SHINAGAWA	DC-2	10946	Glow	-	-	-
		Ng17-B	170253	Discharge	-	-	-

Figure 3.4 also shows the calibration gas bottles (right side of photo) used in the measurement of gaseous emissions. Specifications for the calibration gases are presented in Table 3.8.

Table 3.8: Calibration Gas Specifications for Gaseous Emissions Measurement

Component	Concentration	Cylinder No.	Order No.	Expiration
Zero gas	99.99% N2	GS66905	11211072001	2012.12.07
	-% Zero Air	GT8261	12201077301	2013.02.08
NO span gas	2330 ppm in N2	1J10141	11211061501	2012.11.30
CO span gas	936 ppm in N2	GUA73102	12201077001	2013.02.14
CO_2 span gas	9.29% in N2	1J66949	12204015801	2013.05.01
O_2 span gas	23.33% in N2	1FK-65693	12202037901	2013.03.21
THC span gas	944 ppm C in Air	2BIS54746	12201077101	2013.02.22

Figures 3.5 and 3.6 show MES technicians conducting engine performance and gaseous emissions testing, respectively during the test program.

Figure 3.5: MES Technician Conducting Performance Testing

Figure 3.6: MES Technicians Conducting Gaseous Emissions Testing

SECTION 4 TEST PROGRAM & TESTING CONDITIONS

The MES test plan is described in detail in Appendix 9 of the MDT Report. One day of engine run-in was followed by three days of emissions testing – one full day was allotted to each of the three fuel valve designs- slide valve (C26), conventional fuel valve (C3), and low-NOx fuel valve (C11). The testing matrix is presented in Table 4.1.

Table 4.1: Test Program Matrix

Test no.	-	Fuel Valve	Load	Date
T01	1	SV	10%	2012-09-26
T01	2	SV		
T02	1	SV	15%	
T02	2	SV		
T03	1	SV	25%	
T03	2	SV		
T04	1	SV	50%	
T04	2	SV		
T05	1	SV	75%	
T05	2	SV		
T06	1	SV	100%	
T06	2	SV		
T07	1	C3	10%	2012-09-27
T07	2	C3		
T08	1	C3	15%	
T08	2	C3		
T09	1	C3	25%	
T09	2	C3		
T10	1	C3	50%	
T10	2	C3		
T11	1	C3	75%	
T11	2	C3		
T12	1	C3	100%	
T12	2	C3		
T13	1	C11	10%	2012-09-28
T13	2	C11		
T14	1	C11	15%	
T14	2	C11		
T15	1	C11	25%	
T15	2	C11		
T16	1	C11	50%	
T16	2	C11		
T17	1	C11	75%	
T17	2	C11		
T18	1	C11	100%	
T18	2	C11		

As presented in the above test matrix, two sets of measurements were taken at each engine load for each fuel valve configuration.

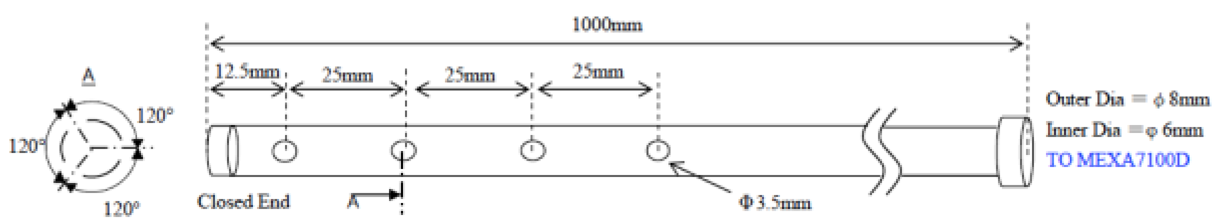
A testing day began with an engine warm up cycle and readiness check followed by emissions measurements in accordance with the schedule presented in Table 4.2, below:

Table 4.2: Example of a Daily Testing Schedule

Load	Time	Remark
	08:00-08:30	Zero/Span Check and Leak Check
10%	08:30-10:30	Emission + PM + Bosch Measurement
15%	10:30-12:30	Emission + PM + Bosch Measurement
25%	12:30-14:30	Emission + PM + Bosch Measurement
50%	14:30-16:30	Emission + PM + Bosch Measurement
75%	16:30-18:30	Emission + PM + Bosch Measurement
100%	18:30-20:30	Emission + PM + Bosch Measurement
	20:30-21:00	Zero/Span Check and Leak Check

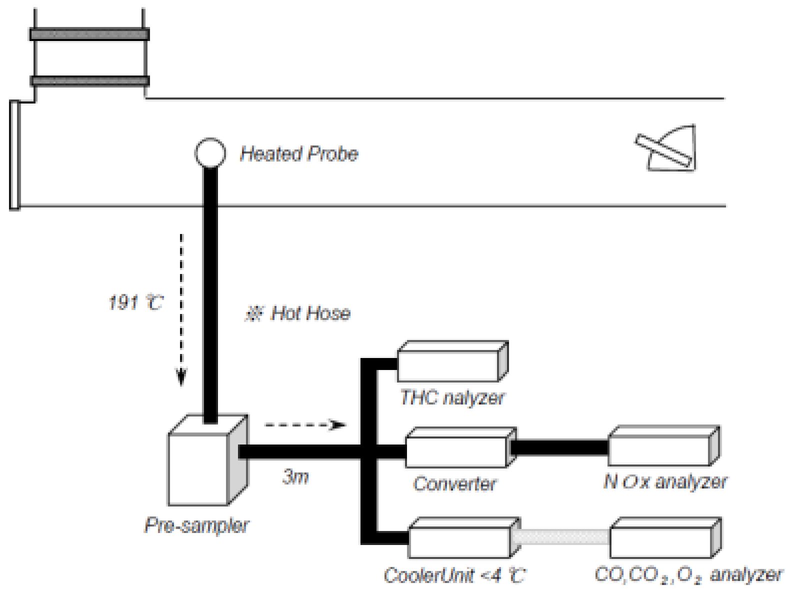
The sampling probe used to capture the emissions measurements is illustrated schematically in Figure 4.1, below.

Figure 4.1: Sampling Probe Dimensions



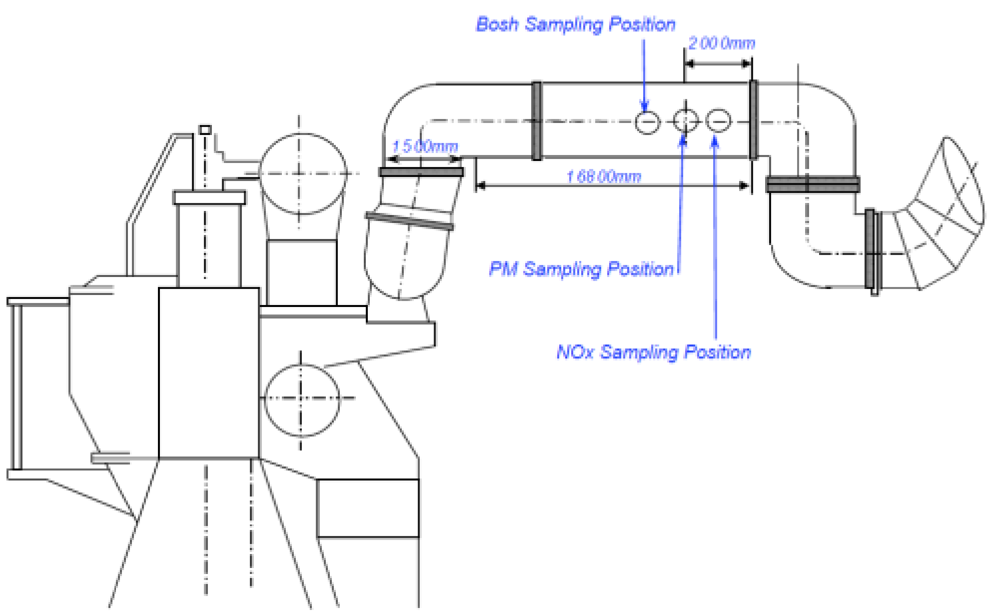
A flow diagram of the measuring system is illustrated below in Figure 4.2.

Figure 4.2: Flow Diagram of the Emissions Measuring System



A schematic of the test bed exhaust system indicating approximate dimensions and distances to the exhaust gas sampling points is illustrated below:

Figure 4.3: Test Bed Exhaust System Sampling Locations



The MES test plan provides addition details on the test cell specifications, measured performance parameters, and measured emissions parameters.

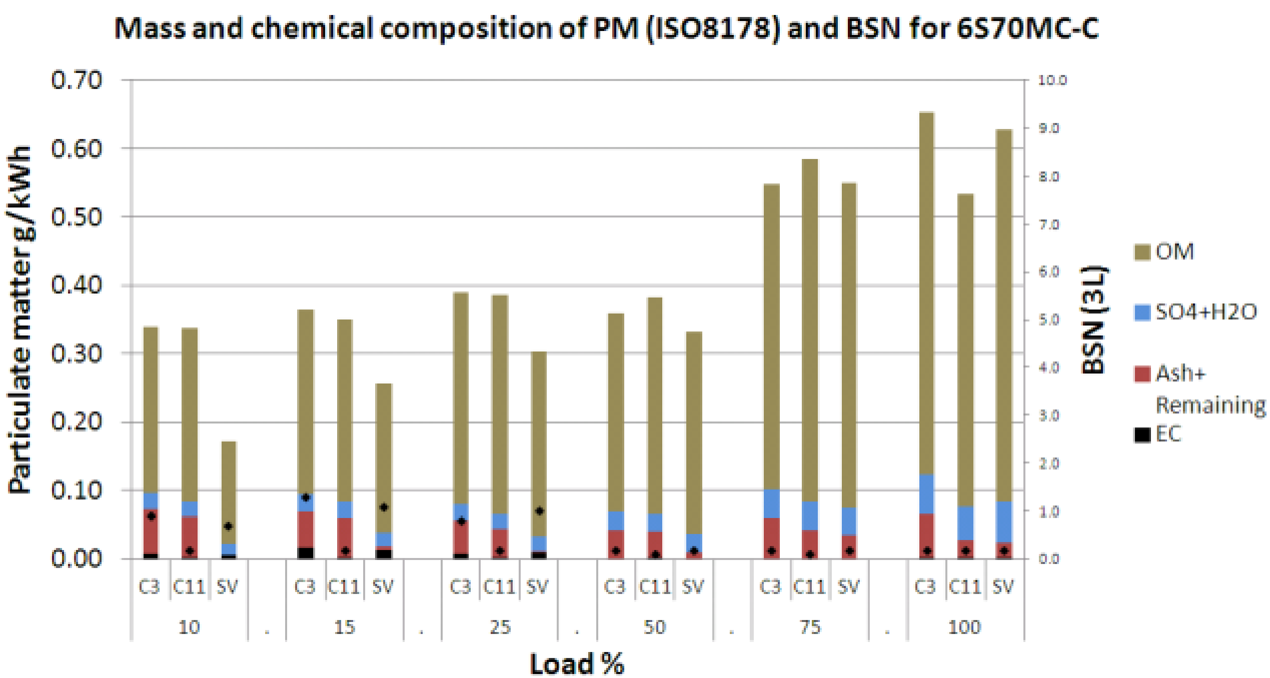
SECTION 5 EMISSIONS MEASUREMENT RESULTS

5.1 Particulate Matter Measurement Results – ISO 8178

The detailed quantified results of the particulate matter measurements are included in Appendix 12 of the MDT Report. Note that EPA 17 dust measurements are included in a subsequent section of this Final Report. In addition, engine performance measurements were calibrated in conformance with MES's standard procedures based on ISO 9001 and/or the NOx Technical Code 2008. Performance measurement results are documented in Enclosure 4 of the MES Report.

The results of the ISO 8178 particulate measurements are presented in graphical form in Figure 5.1.

Figure 5.1: Comparison of Particulate Emissions for Each Fuel Valve Configuration as a Function of Engine Load



BSN – Bosch Smoke Number; OM – organic material, SO4 – sulfate; EC – elemental carbon

As presented in the above figure, at low load (<25% load) the slide valve (SV) emits less particulate matter compared to the conventional C3 and conventional low-NOx C11 fuel valve. Between 10% and 25% engine load, the SV emits 50 to 20% less particulate than C3 and C11. Particulate matter composition is dominated by organic matter (OM) for all tests conducted.

The particulate matter consists of 72 - 89% of OM as presented below in Table 5.1 as a function of engine load.

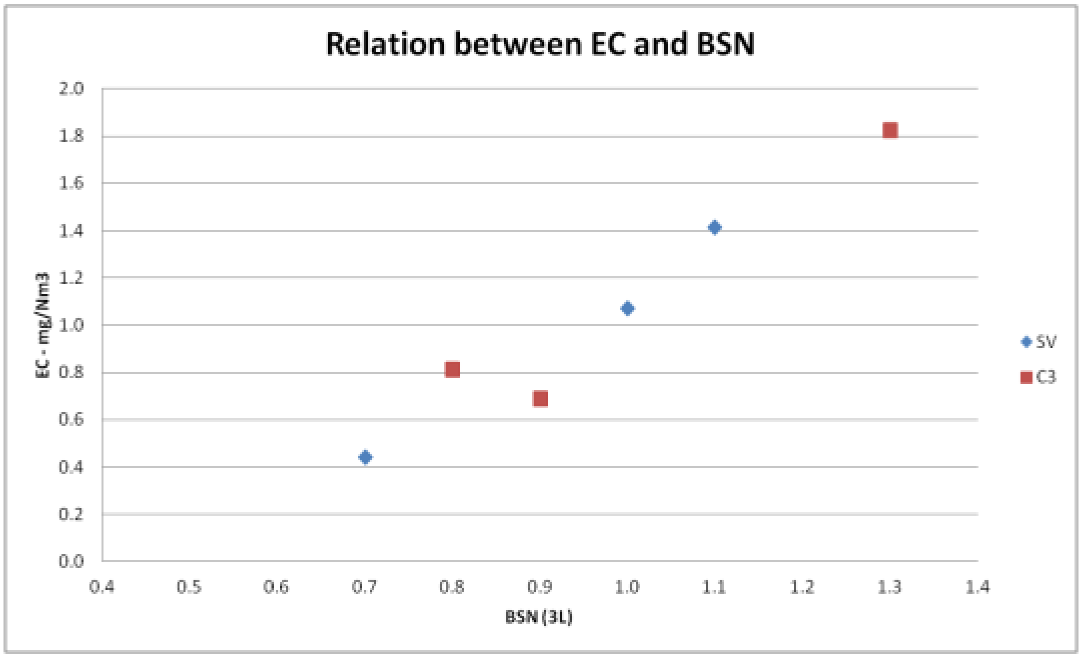
Table 5.1: Particulate Matter Chemical Species (g/kWh)

Load%	FV	EC	SO4+H2O	OM	Ash+ Remaining	PM Total	BOSCH (3L)
10	C3	0.009	0.023	0.245	0.064	0.340	0.9
	C11	0.002*	0.021	0.254	0.060	0.338	0.2
	SV	0.005	0.018	0.150	0.000	0.173	0.7
15	C3	0.017	0.025	0.271	0.052	0.365	1.3
	C11	0.002*	0.022	0.267	0.059	0.350	0.2
	SV	0.014	0.021	0.218	0.004	0.257	1.1
25	C3	0.007	0.024	0.310	0.049	0.390	0.8
	C11	0.002*	0.022	0.321	0.042	0.386	0.2
	SV	0.009	0.020	0.271	0.003	0.303	1
50	C3	0.001*	0.026	0.291	0.041	0.359	0.2
	C11	0.001*	0.026	0.317	0.038	0.383	0.1
	SV	0.001*	0.027	0.296	0.008	0.332	0.2
75	C3	0.001*	0.041	0.447	0.059	0.548	0.2
	C11	0.001*	0.041	0.501	0.041	0.585	0.1
	SV	0.001*	0.040	0.477	0.033	0.551	0.2
100	C3	0.001*	0.057	0.531	0.064	0.654	0.2
	C11	0.002*	0.048	0.458	0.027	0.534	0.2
	SV	0.001*	0.060	0.544	0.023	0.628	0.2

*EC below detection limit calculated based on detection limit value of 0.016 mg/filter

Elemental carbon (EC) is low for each of the three fuel valve types and only detectable for the slide valve (SV, C26) and conventional valve (C3) at 50% engine load and lower. The EC emission correlates with Bosch Smoke Number (BSN) for all analyses above the EC detection limit. This is illustrated in Figure 5.2, below:

Figure 5.2: Particulate EC in Relation to BSN

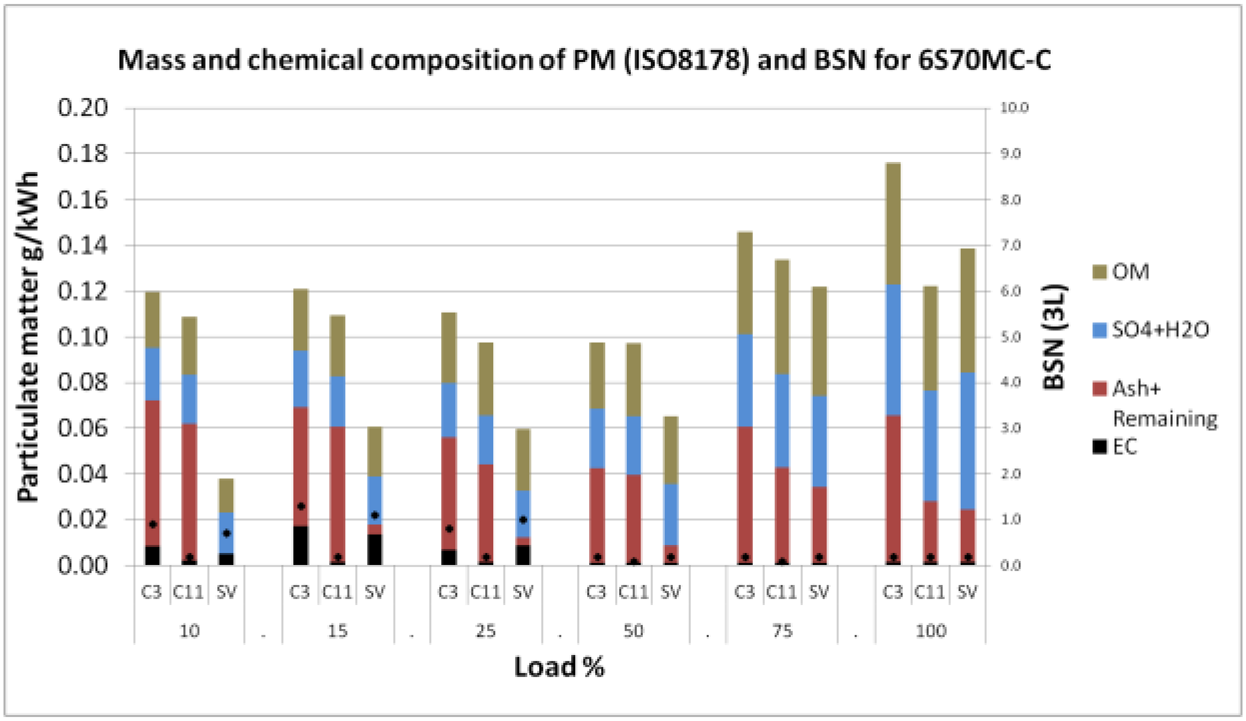


At MCR (100% load) the C11 Low NOx conventional fuel valve emits less particulate compared with the other fuel valves.

The particulate emission level is generally high compared with other MDT 2-stroke engines running on low-sulfur fuel oil. The cylinder lubrication on the test bed was higher than expected and this condition can explain why higher particulate emissions were recorded. It may also explain why the OM fraction is dominant. This is discussed in detail in Appendix 13 of the MDT Report.

If the particulate matter measurement results were corrected to not include cylinder oil-related OM, the particulate emission would be reduced as presented below in Figure 5.3 (assumed OM reduction of 90%).

Figure 5.3: Particulate Corrected not to Include Lubrication-Originated OM

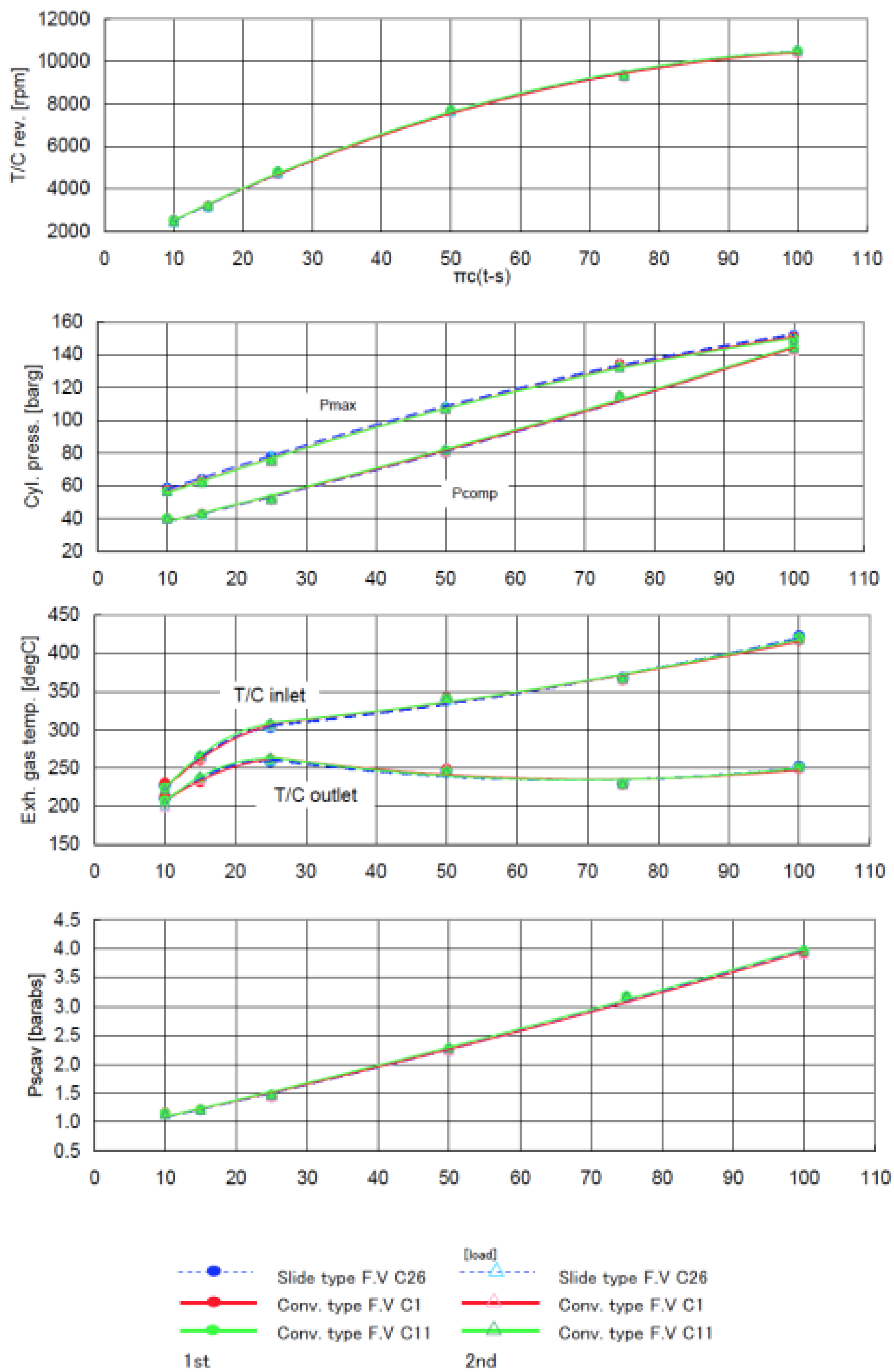


Further analysis of the OM findings is provided in Appendix 1 of this report.

5.2 Gaseous Emissions Measurement Results

Test bed engine performance measurements were calibrated in conformance with MES's standard procedures based on ISO 9001 and/or the NOx Technical Code 2008. Performance measurement results are documented in Appendix 12 of the MDT Report and presented graphically in Figure 5.4.

Figure 5.4: Engine Performance Measurement Results Corrected to ISO Standard Conditions



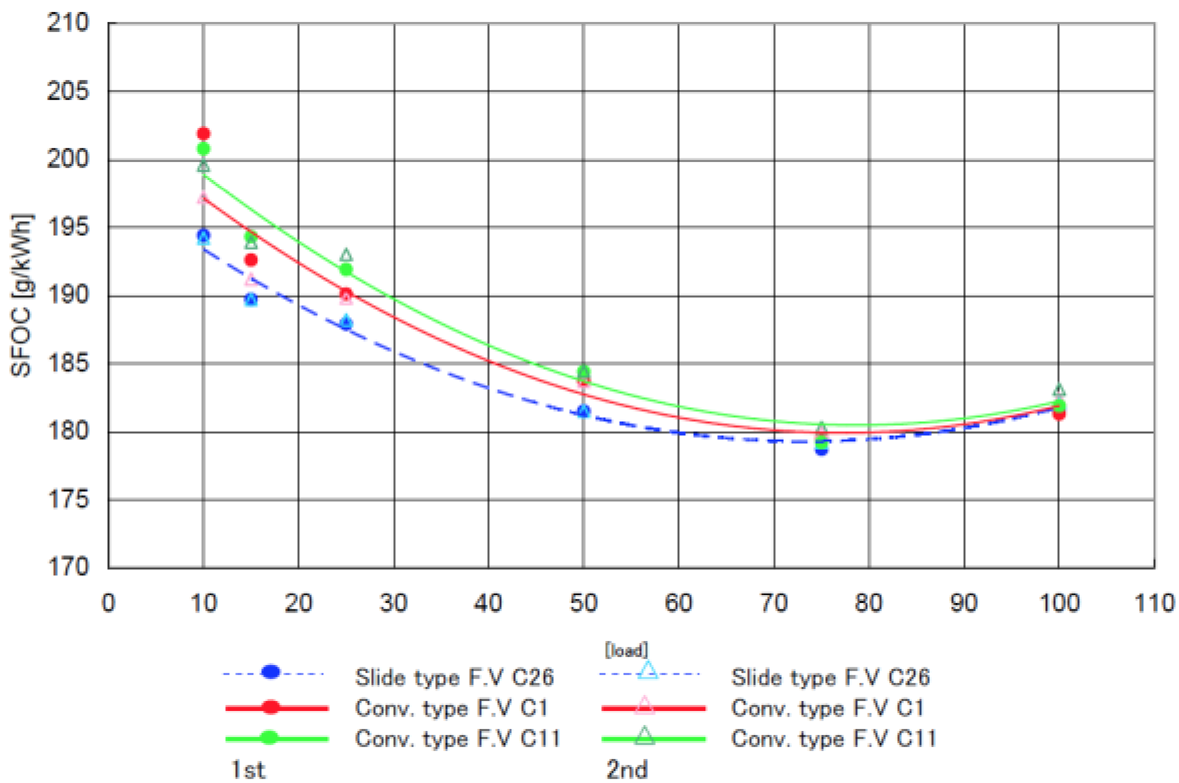
5.2.1 Specific Fuel Oil Consumption

Specific Fuel Oil Consumption (SFOC) results are presented below in Figure 5.5. As shown, there is no appreciable difference in SFOC amongst the three fuel valve types at 100% engine load. At partial engine loads, the slide valve C26 nozzle yields more favorable (lower) SFOC.

Figure 5.5 illustrates the probable effect of reduced fuel sac volume associated with the slide valve. The effect of the sac volume is more apparent at partial loads, as the sac volume accounts for a larger portion of the total fuel injected during each crankshaft revolution. The fuel oil in the sac volume associated with the conventional fuel valves results in greater SFOC.

The highest SFOC across all load points was recorded for the conventional low-NOx valve, as illustrated below.

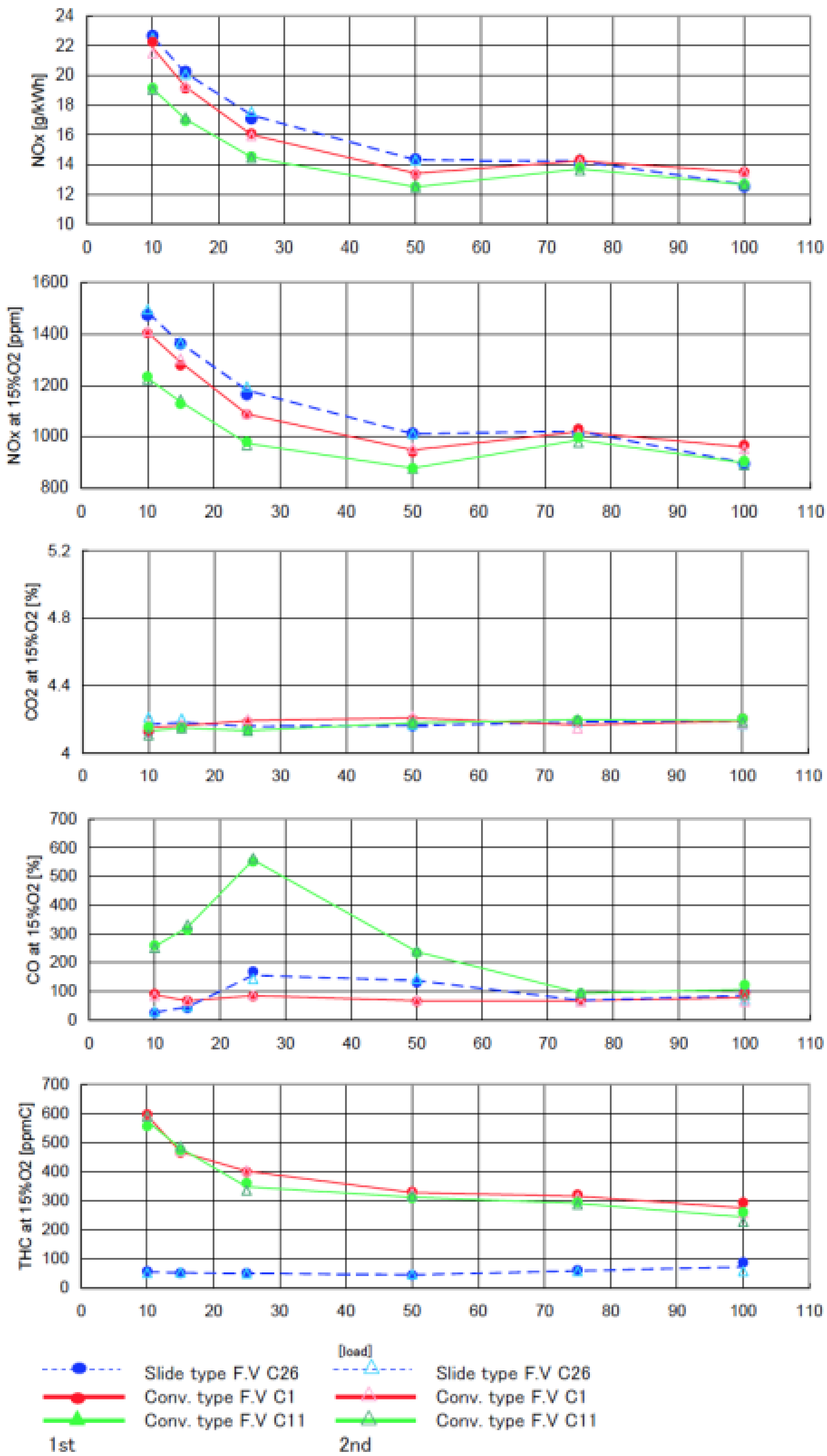
Figure 5.5: SFOC Measurement Results Corrected to ISO Standard Conditions



5.2.2 Gaseous Emission Measurements

Appendix 11 provides detailed documentation of the gaseous emissions measurements - NOx, CO, CO_2, O_2, and THC, as well as documenting Bosch Number and EPA 17 dust measurements. The gaseous emissions measurement results are presented graphically in Figure 5.6.

Figure 5.6: Gaseous Emissions Measurement Results



The results of the gaseous emissions measurements yield the following observations:

NOx Emissions – The conventional low-NOx fuel valve yields lower NOx emissions, especially at partial engine loads. This is reflected in the tradeoff between SFOC and NOx emissions presented in Figures 5.11 and 5.12. It should be noted, however, that the fuel nozzle spray pattern has a much greater influence on the NOx formation process than the fuel valve type.

CO_2 Emissions – CO_2 is linked to the SFOC. No significant differences were observed between fuel valve types and nozzle atomizers.

CO Emissions – In general, CO emissions at 15% load were less than CO emissions at 50% load. It was noted that the conventional valve configured with the low-NOx nozzle demonstrated relatively higher CO levels at partial load, especially at 25% load.

Total Hydrocarbons – THC emissions associated with the slide valves were significantly lower compared with the conventional fuel valves, particularly at engine loads less than 25%. Lower THC emissions are an anticipated result of using the slide valve.

Bosch Number – As documented in Appendix 11, there were no appreciable differences in Bosch Number measurements among the fuel valve types.

EPA 17 Dust Measurement – There was no significant difference among the fuel valve types and nozzles; this is likely due to the influence of the higher lubrication oil rate as discussed in Section 5.1.

SECTION 6 SUMMARY & CONCLUSIONS

Findings from the MES Gaseous Measurements and MDT Particulate Measurements of Fuel-Valve Tests on 6S70MC-C7 at MES, Tamano Works, Japan can be summarized as follows:

- SV emit the same level or more NOx (g/kW-hr basis) at low loads compared to the two conventional fuel valve configurations;
- The conventional C11 fuel valve was found to emit ~15% less NOx (g/kW-hr basis) at low loads than the SV and C11 fuel valves;
- Below loads of 75%, SV emitted more NOx (g/kW-hr basis) than the two conventional fuel valve configurations and the C11 emitted the least NOx of all three fuel valve configurations;
- SV were confirmed to emit less DPM at low loads compared to the two conventional fuel valve configurations. At low loads, SV emits up to 50% less DPM than conventional C3 and C11 fuel valves and up to 65% less DPM for cylinder-lubrication-corrected particulate-emission results;
- SV emit over 90% less THC compared to the two conventional fuel valve configurations.

There was an unanticipated finding associated with the organic fraction of PM compared with similar tests on other MDT engine types. PM for all tests performed was determined through chemical analysis to be dominated by organic matter. DPM is found to consist of 72-89% of organic matter by mass. This finding does not correlate with test results with other MDT engines. A GC analysis was ordered by MDT to determine the source of the organic fraction. The GC analysis showed that 90 percent by mass of the particulate soluble organic fraction originated from the cylinder lube oil. This resulted in the following observations:

- For new engines, there is a "run-in" period where the cylinder lube oil dosing is increased to avoid damaging the engine. The dosing rate for the test bed engine was set at 2.1 g/kW-hr compared to typical basic setting of 1.5 g/kW-hr;
- Previous studies showed no evidence of a correlation between lubrication dosing and PM emissions for older engines prior to 1999;
- When the PM test results are corrected for the additional cylinder-lubrication, the results better correspond with test results for other MDT engine types;
- MDT speculates that the change in DPM with cylinder-lubrication dosing changes could be due to the fact that their alpha lubricator system injects cylinder-lubrication oil directly into the cylinder ring packs. This could create a risk that cylinder oil is trapped in the ring packs and could be blown out into the exhaust system;
- Older engine lubrication systems (pre-alpha lubricator system) introduced cylinder oil to liner above the piston, which might prevent "blow-out" of cylinder oil from the ring packs.

The cylinder lube oil issue identified during the SV test project affects bench testing with new engines and does not affect the ultimate findings as cylinder-lubrication dosing will not be as high as during run-in conditions.

APPENDIX 1: EVALUATION OF PARTICULATE MATTER ORGANIC FRACTION

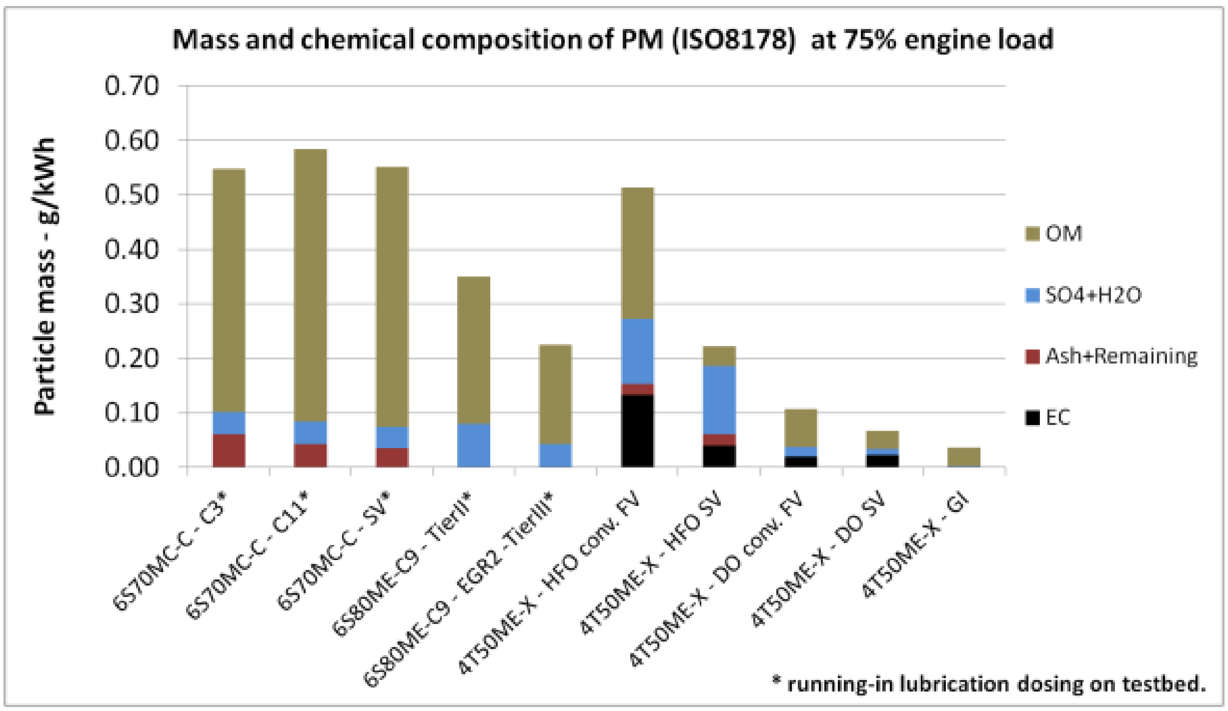
Sources:

1. *Particulate Measurements for Fuel Valve Tests on 6S70MC-C7 at Mitsui, Tamano*, MAN Diesel & Turbo A/S, R&D Dept. LDF4, March 2013.
2. *Final Test Report of the Comparison Measurement between the Slide Fuel valve and the Conventional Fuel Valve on the Mitsui-MAN 6S70MC-C(7),* Mitsui Engineering & Shipbuilding Co., LTD, Ref. No. KEI/KS/OWN0017, March 18, 2013.

Particulate Level & Composition Discussion

Figure 1 presents measured particulate emissions at 75% engine load for different marine engines and fuel types:

Figure 1: Comparison of Particulate Emission with Other Engine Types & Fuels

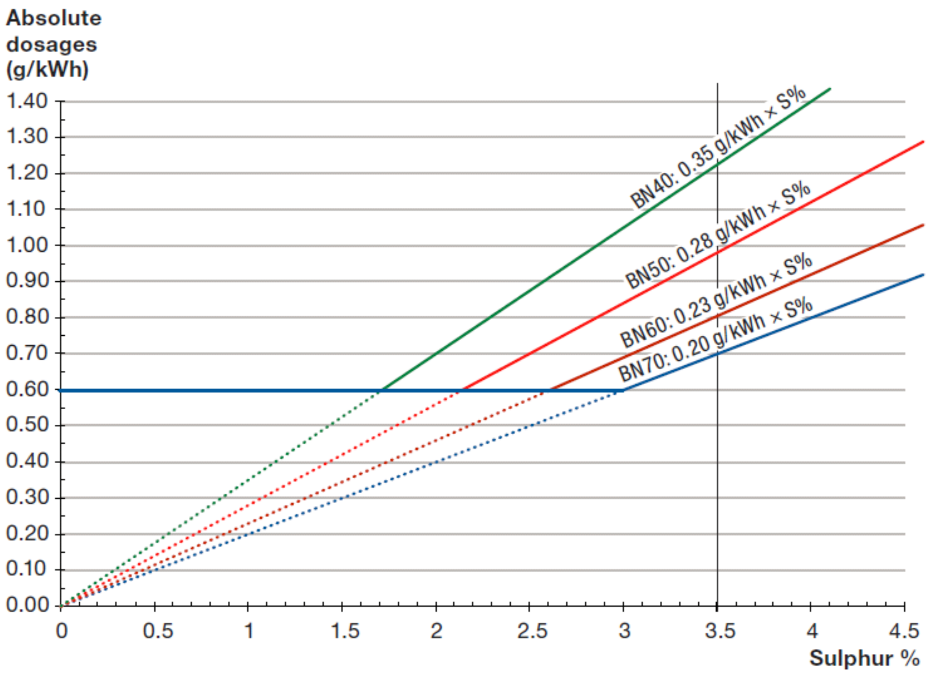


Comparing particulate emissions from the 6S70MC-C7 test bed engine with another engine type using an equivalent low sulfur fuel (e.g., 4T50ME-X running distillate oil fuel with a sulfur content of 0.05 percent by mass), the particulate emissions are four times higher by mass. If the organic matter (OM) fraction is compared, the 6S70MC-C engine emits six times more OM than an engine with comparable fuel type. The particulate emission level is of the same magnitude of heavy fuel oil (fuel sulfur 2 mass %) with a conventional fuel valve. It is expected that the fraction of organic matter is a little higher for MC than ME engines due to the ME engines possibility of better fuel injection tuning. This, however, cannot explain why the particulate emission level is comparable with heavy fuel oil (HFO) particulate emission levels.

It is known that cylinder lubrication contributes to particulate emissions. Unburned cylinder oil can be torn off the cylinder liner and a small fraction will end up on the particulate filters due to the scavenging process.

The MDT Alpha Lubricator controls cylinder lubrication dosing. The cylinder lubrication is normally set according to the sulfur content of the fuel, as shown in Figure 2.

Figure 2: Recommended Cylinder Lubrication in Accordance with SL09-507 (MDT Service Letter)



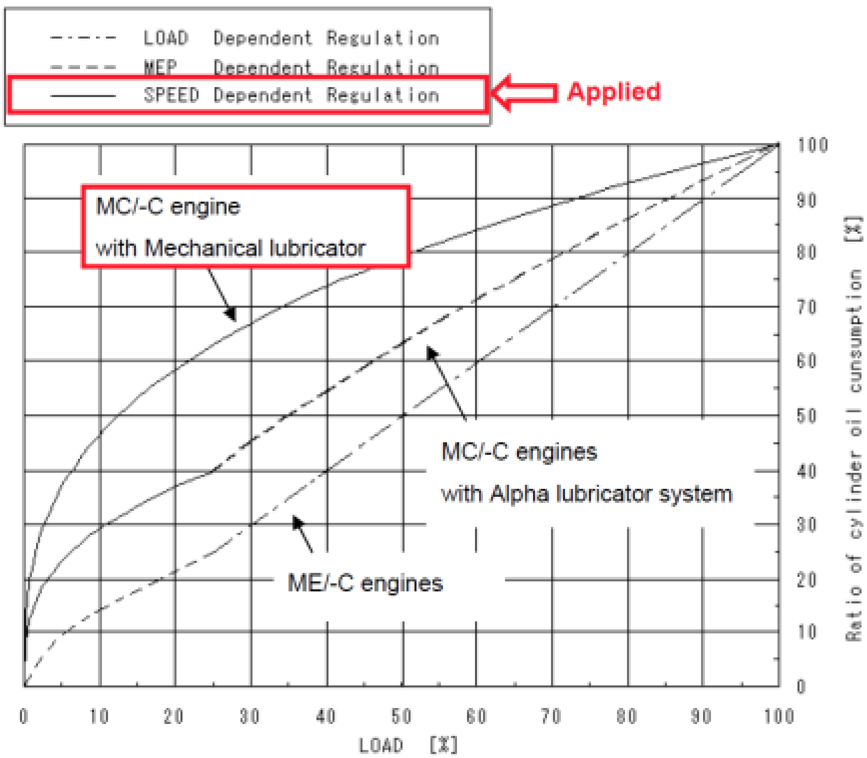
On the test bed however, the cylinder-lubrication dosing is set higher in order to facilitate run-in of the engine cylinder liners. On the 6S70MC-C7 test bed, the cylinder lube-oil dosing was set to 2.1 g/kWh at MCR and the part-load dosing was proportional with the fuel index.

Analysis by MES has provided additional insight into the lubrication oil dosing used during run-in of the test bed 6S70MC-C7 engine. According to MES, while an engine is running in, the amount of cylinder lubrication oil is higher. There are three (3) control settings for the Alpha Lubricator – speed dependent; mean effective pressure (MEP) dependent; and load dependent. The speed, or RPM control mode, is the typical setting for the mechanical lubricator and is widely used on existing engines.

At the time of the test, the Mitsui-MAN B&W standard was the MEP dependent control for the Alpha Lubricator. In this control mode, the speed dependent mode is automatically selected during the running-in phase with higher lubrication oil feed rate (>120% of Basic Setting).

According to the latest setting for the Alpha Lubricator from MDT, the speed dependent mode is not a standard option, even during the running-in phase. After running in, the load-dependent control with Alpha Adaptive Cylinder Oil Control (Alpha ACC) is now standard for all MDT engines. Figure 3 shows a comparison of lubrication dosing for the Alpha Lubricator control settings as a function of engine load.

Figure 3: Comparison of Alpha Lubricator Control Settings



Gas-Chromatography Analysis

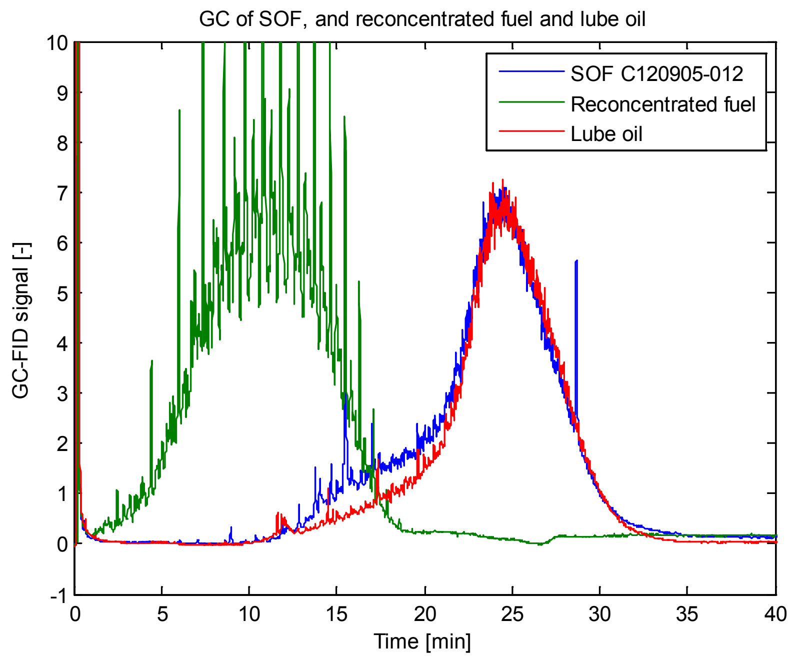
In order to quantify the lube-oil related OM, an additional analysis of particle filters by gas-chromatography (GC) analysis was initiated. The tests were performed by Technical University of Denmark, the Department of Mechanical Engineering (DTU-MEK). The method is described in Appendix 14 of the MDT Report. The table below shows good correlation between particulate OM analyzed by Thermo-Gravimetric Analysis (TGA) and extracted SOF. The deviation between OM and SOF is less than 2 percent.

Table 1: Comparison of Measured Organic Matter By Thermo-Gravimetric Analysis (TGA) & Extracted Soluble-Organic Fraction (SOF), Unit Percent by Mass

Test	1	2	3	4
TGA - Germanischer Lloyd SE	89.3	89.2	86.5	86.6
SOF - DTU-MEK	89.6	89.6	87.9	88.2

Figure 4, below, shows chromatogram from the GC analysis of particulates derived for SOF extraction:

Figure 4: Chromatogram of Fuel Oil, Lube Oil & PM-SOF



The GC chromatogram clearly indicates that the PM-SOF resembles the cylinder lube oil rather than the fuel oil. Based on the GC analysis the fraction of fuel-related OM was found to be between 12.1 - 9.4 percent by mass. Based on these results the conclusion is that the particulate fraction of OM originates primarily from the cylinder lube oil and constitutes approximately 90% by mass of the total fraction of OM.

Cylinder lube-oil-related OM cannot be directly correlated to cylinder lube-oil dosing. MDT has not yet established a correction factor that can account for deviation in lube-oil dosing with satisfactory results. It is therefore considered to be more appropriate to give the results based on GC analysis without any cylinder lube-oil contribution, rather than make estimations of cylinder lube-oil OM contribution that are inconclusive and, in the worst case, incorrect.

The results presented in Figure 4 correspond better with the results for other engine types presented in Figure 1. The low content of ash+remaining (AR) for the C26 slide valve compared with conventional C3 and C11 fuel valves may suggest that that the AR originate from the fuel rather that the lube oil. If AR originated from the cylinder lube-oil FV type, it is expected to have no influence on the AR content of particulate. The low AR content for SV also indicates that the particulate OM is condensate rather than AR containing cylinder lube-oil droplets that have been ripped off the cylinder liner. The lube oil might have been evaporated or partly combusted in the cylinder and after the turbocharger condensed to particulate OM in the exhaust-gas funnel or dilution tunnel. The corrected results also imply that the benefit of SV is also valid for part load (75% engine load). The reduction of PM by mass for SV compared with C3 and C11 is 65% at 10% load and approximately 10% at 75% engine load.

The focus of the discussion has been primarily on cylinder oil-related particulate emissions. There has been no evidence of correlation between lubrication dosing and particulate emission for older engines prior to year 1999. In the GESA report[4], no increase in particulate Organics by doubling the lubrication dosing was observed. In the study by Linda Gratz[5] there was no indication that an increased lubrication dosing contributed to higher particulate emissions.

Figure 5: GESA – 10L67GB-S and 10K67GSCA-S, Mahon and Ibiza 1992, 82% Engine Load

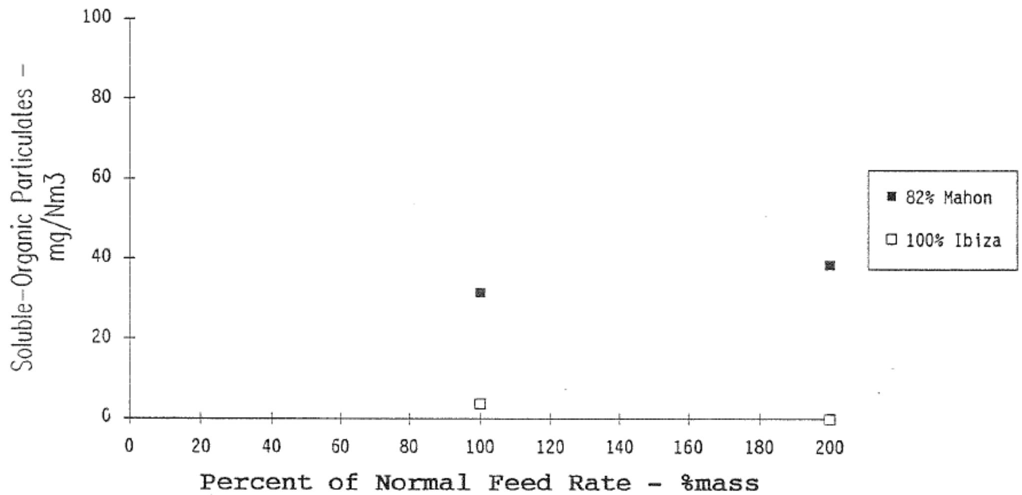
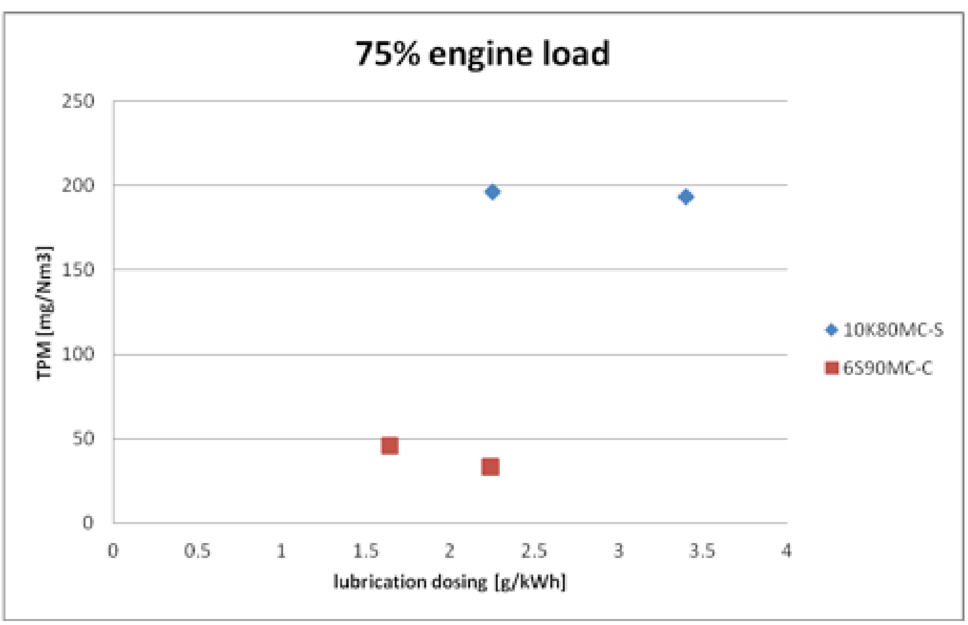


Figure 6: The Contribution of Lubricating Oil to Total Diesel Particulate Emissions, Linda Gratz & Jesper Schramm, 10K80MC-S, 6S90MC-C 1999



[4] *GESA - 10L67GB-S and 10K67GSCA-S*, Mahon and Ibiza 1992.
[5] *The contribution of Lubricating Oil to Diesel Particulate emissions*, Linda Gratz & Jesper Schramm, 10K80MC-S, 6S90MC-C, 1999.

The Alpha Lubricator was first introduced and tested on a large-bore engine in Korea on a 12K90MC engine in September 1999. One of the features of the Alpha Lubricator system is the injection of cylinder lubrication oil directly into the ring pack for every 4, 5, 6 etc. revolutions.

By doing so, there is a risk that cylinder oil is trapped in the ring packs and will be blown out in the exhaust-gas system. For older lubrication systems the cylinder oil is introduced to the liner above the piston. This feature might prevent the blowout of cylinder oil from the ring pack and might be the explanation why an increase in lubrication dosing doesn't influence the particulate mass in case of engine prior to 1999. It must be stated that this is only a theory.

The data for older engines, therefore, do not give a reason to establish correlations between cylinder-oil lubrication and particulate emission. A new attempt to correlate cylinder-oil lubrication to particulate mass needs to be established. This is, however, not straight forward and many parameters will affect the results.

To make particulate measurements on a test bed with decreased cylinder-lubrication dosing after engine run-in is not practical due to the Licensee's delivery schedule. The alternative is to make particulate measurements in service. However, conditions onboard a vessel makes measurement much harder than on a test bed and will require additional resources. This will add to the uncertainties of the particulate measurement and make comparison between particulate measurements more difficult. However, it will make the particulate measurements more realistic.

Attachments

Attachment 1 – Mitsui Engineering & Shipbuilding Co, LTD. Final Report

Final Test Report of the Comparison Measurement between the Slide F.V. and the Conventional F.V. on the Mitsui-MAN B&W 6S70MC-C(7)

Mitsui Engineering & Shipbuilding Co., LTD.

March 2013

Ref. No.: KEI/KS/OWN0017

Final Test Report of the Comparison Measurement between the Slide F.V. and the Conventional F.V. on the Mitsui-MAN B&W 6S70MC-C

2013.3.18

Mitsui Engineering and Shpbuilding Co,. Ltd
Machinery Factory, Diesel Design Department

Approved	Checked	Drawned
K. Shimada	J. Shiki	H.Taguchi

MES 三井造船株式会社
MITSUI ENGINEERING & SHIPBUILDING CO.,LTD.

< Contents > page

1 Purpose

The exhaust emission from the ships is still increasing due to the increase of the world-trading. Even thought the ship is the most clean and the most effective transportation measure, the contribution from the ships to the air quality gets more and more high and therefore its reduction seems be essential.
The IMO (International Marine Organization) had introduced the revised emission regulation (Tier II / Tier III) for NOx, SOx and PM emission in 2008. Accordingly, the emission from the ships can be reduced significantly for the new ships.
However, as the typical ship life time is so long around 30 years, the effect of the new regulation for the new ships is slowly increased and completed after all the old ships are replaced. If there are effective measures to reduce the emission form the existing ships, the improvement of emission from the ships can be accelerated.

MAN B&W 2-stroke engines are the widely used for the main propulsion of the commercial ships. MAN B&W had developed the slide fuel valves, which has nearly zero (wasted) sac volume in the atomizer tip, and it is the standard for their new engines. The feature of the slide fuel valve is to reduce the exhaust emission and to increase the possible operation load range to reduced ship speed.

According to the request from Starcrast Consulting Group in USA, MAN Diesel & Turbo and Mitsui Engineering and Shipbuilding CO, Ltd have carried out the emission comparison test between the conventional fuel valve and the slide fuel valve using a Mitsui-MAN B&W 6S70MC-C engine. The test has been carried out in the workshop of Mitsui cooperated with MAN Diesel A/S and the Starcrast Consulting Group.

2 Engine Specification

Mitsui-MAN B&W 6S70MC-C7 engines are used for the test. This type of the engine is typically used for the bulk carriers, the container vessel and the tankers.

Table.1 shows the engine type specification of Mitsui-MAN B&W 6S70MC-C7.

Table.1 Engine Specification

<table>
<tr><td colspan="3">Type</td><td>MITSUI-MAN B&W 2-stroke, single acting, direct reversing crosshead diesel engine
with exhaust turbocharger</td></tr>
<tr><td colspan="3">Model</td><td>Mitsui-MAN B&W 6S70MC-C7</td></tr>
<tr><td colspan="3">IMO NOx Regulation</td><td>Tier I
(17.0g/kWh@E3)</td></tr>
<tr><td colspan="3">Number of cylinders</td><td>6</td></tr>
<tr><td colspan="2">Cylinder bore</td><td>Mm</td><td>700</td></tr>
<tr><td colspan="2">Stroke</td><td>Mm</td><td>2800</td></tr>
<tr><td rowspan="4">Maximum continuous rating (MCR)</td><td>Output</td><td>kW</td><td>18660</td></tr>
<tr><td>Speed</td><td>Rpm</td><td>91.0</td></tr>
<tr><td>Mean effective Pressure</td><td>MPa</td><td>1.90</td></tr>
<tr><td>Mean Piston Speed</td><td>m/s</td><td>8.49</td></tr>
<tr><td colspan="3">Governor</td><td>MSR MAG-200III</td></tr>
<tr><td colspan="3">Cylinder Lubricator</td><td>Alpha Lubricator System</td></tr>
<tr><td colspan="3">Turbocharger type</td><td>1 × Mitsui-MAN TCA88-2</td></tr>
<tr><td colspan="3">Auxiliary blower type
(Motor output)</td><td>2 × TBMS-7538
(75kW)</td></tr>
<tr><td colspan="3">Air Cooler Cooling system</td><td>Direct sea water cooling</td></tr>
<tr><td colspan="3">Air cooler type
Cooling Surface</td><td>1×BBBB50S-M1
1150.9 m2</td></tr>
<tr><td colspan="3">Variable Injection Timing</td><td>With(Fixed)</td></tr>
<tr><td colspan="3">Fuel Valve Type</td><td>Slide Type Fuel Valve</td></tr>
<tr><td colspan="3"></td><td></td></tr>
</table>

3 Test Fuel Valves and Cylinder Lubricator

3.1 Conventional F.V. and Slide F.V.

The slide F.V. was developed in late 1990s. The slide F.V. is now standard of all of MAN B&W engines.

The design future of the slide F.V. is to minimize the sac volume in the atomizer. The fuel in the sac volume could increase the fuel oriental PM emission as it dropped in the cylinder without pressure.

The purpose of this test is to confirm the difference on the performance and emission between the conventional F.V. and the slide F.V.

Fig. 1 shows the comparison between the slide F.V. and the conventional F.V.

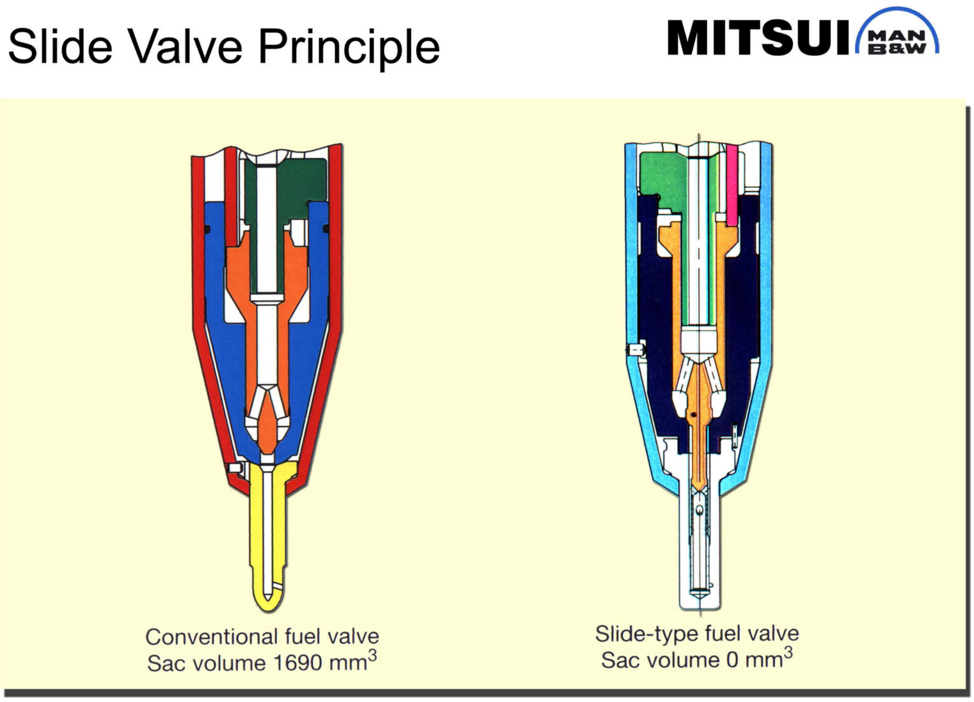


Fig. 1 Comparison between the slide F.V. and the conventional F.V.

3.2 Test Fuel Atomizer

Fuel atomizer is one of main components to decide the performance and emission properties of the engine.

Two atomizers for the conventional fuel (C1 and C11) valve and one atomizer for the slide fuel valve (C26) are selected for the test by MAN and Diesel Turbo A/S. All the tested atomizers had been applied on the Tier I engines in service. Table 2 shows the comparison of the test atomizers.

Table 2 Test Fuel Atomizer

Name	S70MC-C C26	S70MC-C C1	S70MC-C C11
MDT Drawing No.	1767890-6	3137901-2	3138323-0
Type of F.V.	Slide	Conventional	Conventional
NOx Regulation	Tier I	Tier I	Tier I
No. of holes	5	5	5
Diameter of holes	1.5	1.45	1.45
Remarks			Lower NOx

3.3 Cylinder Lubricator

The electrical controlled alpha lubricator is installed on this engine. Since the engine is still in running-in, the amount of the cylinder lub oil is relatively higher. There are several control settings for alpha lubricator (speed dependent, MEP dependent, load dependent). The rpm control mode is typical setting for the mechanical lubricator, which is widely used on the existing engines.

At the time of the test, Mitsui-MAN B&W standard is MEP dependent control for alpha lubricator. In this control mode, the speed dependent is automatically selected during the running-in with higher feed rate (<120% Basic Setting).

According to the latest setting for alpha lubricator of MAN Diesel & Turbo A/S, the speed dependent is not a standard option even during the running-in phase. After the running-in, the load dependent control with ACC is now standard for all MAN B&W engines.

Fig. 2 shows the comparison of control settings. Enclosure 1 shows the instruction book for alpha lubricator.

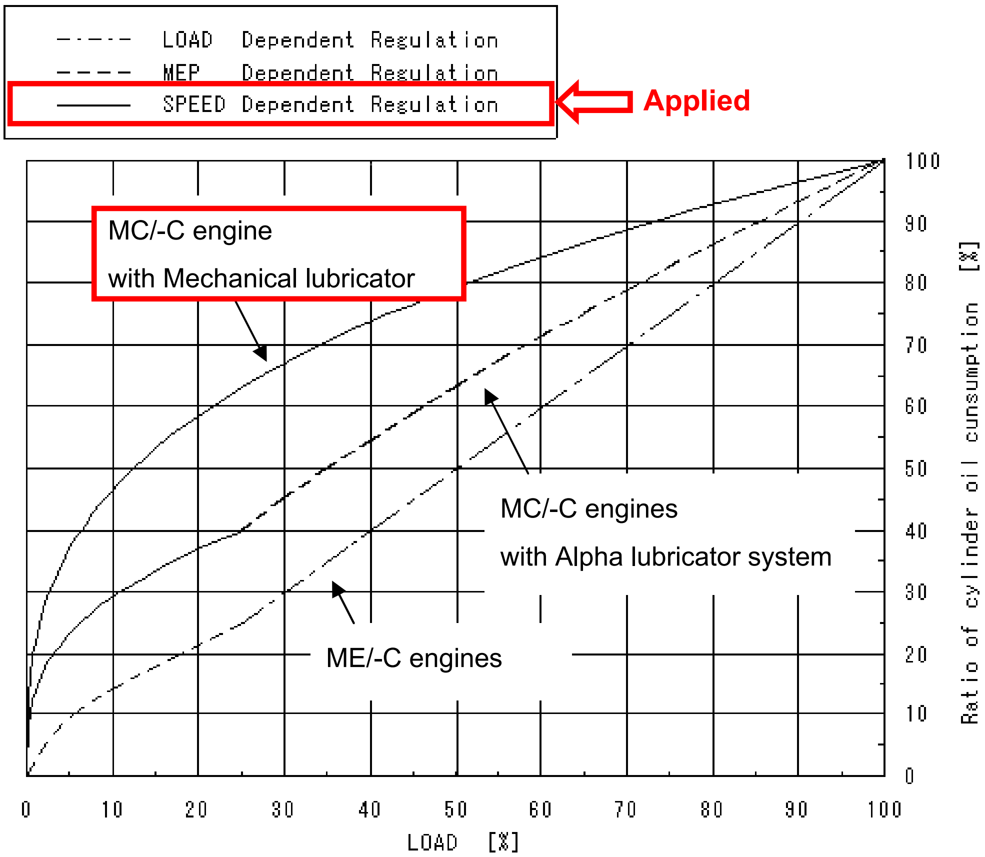


Fig. 2 Comparison of Alpha control settings

4 Test program

The engine load points for E3 test cycle (25%, 50%, 75%, 100%) and some special low load range of 10% and 15% load were selected. The test has been carried out after engine is stabilized and measuring duration is app. one hour. There are two readings for the performance measurements and emission measurements which specified in NOx Technical Code 2008 (NOx, O2, CO2, CO, THC) but one reading for Dust measurement according to JIS Z8808 (EPA17) and Bosch number. However, the continuous operation of 10%, 15%, 25% is not allowed for the conventional fuel valves. It is accepted only for the short running hour within 24 hr.

Table. 2 Test Program

Fuel Valve		Slide F.V.	Conventional F.V.	
		S70MC-C C26	S70MC-C C1	S70MC-C C11
Date of the test		2012.09.26	2012.09.27	2012.09.28
Engine Load	10%	T1	T7	T13
	20%	T2	T8	T14
	25%	T3	T9	T15
	50%	T4	T10	T16
	75%	T5	T11	T17
	100%	T6	T12	T18

5 Measurement System

5.1 Place of the measurements

The test has been carried out at the workshop in Mitsui Engineering and Shipbuilding CO., LTD where located in Tamano city, Okayama Pref, Japan. All the test has been carried out just after the assembling test and before the official commissioning test. As the engine is still in the running-in, the relatively higher cylinder lubrication oil may affect to the PM and Dust emission measurement.

5.2 Performance measurement equipments

The engine performance measurements have been carried out according to Mitsui's standard procedure.

All equipments for the performance readings have been calibrated in accordance with Mitsui's standard procedure based on ISO 9001 and/or the NOx Technical Code 2008. (See Enclosure 2: Supporting Document for Test Bed Report on ENo. 6384)

5.3 Emission Measurement equipments

The following emission components have been measured by Mitsui.

PM emission according to ISO 8178 has also been measured by MAN Diesel & Turbo but it is not included in this report.

Components	Method	Remark
NOx	HCLD	
O_2	PMD	
CO	NDIR	
CO_2	NDIR	
THC	HFID	
Dust	JIS Z 8808(EPA17)	
Bosch Number	-	Sampling Volume 1l, 3l

5.4 Exhaust gas system and sampling position

See also Enclosure 2: Supporting Document for Test Bed Report on ENo. 6384

6 Test Fuel Oil and Cylinder Lub Oil

Three(3) samples of each test fuel were taken for each atomizers and the analysis results are shown in Enclosure 3.

The cylinder lub. oil analysis result is also shown in Enclosure 3.

Specification

Fuel Oil :	LSA by JX NIPPON OIL & ENERGY COPRORATION
Cylinder Oil :	MOBIL GARD 570 by EXXON MOBIL COPRORATION

7 Measurement Results

7.1 Performance Measurement Results

Enclosure 4 shows all of the engine performance sheets.

Fig. 3 shows the comparison on engine performance of turbocharger speed, Pmax, Pcomp , gas temperatures and scavenging pressure.

There are no remarkable differences on those performance parameters.

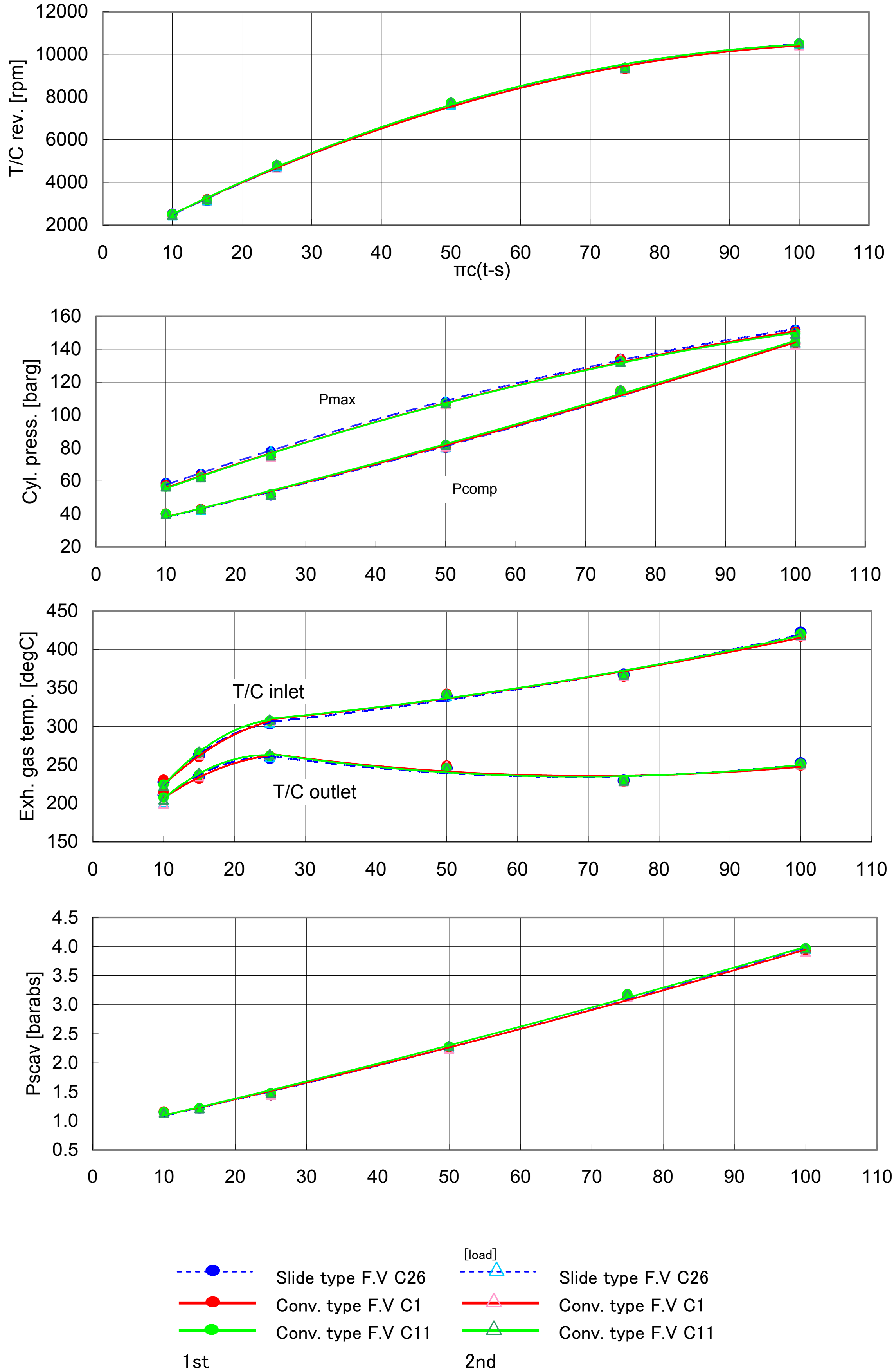


Fig. 3 Performance Measurement Results

(Corrected to ISO standard condition)

7.2 Specific Fuel Oil Consumption

Fig. 4 shows the SFOC measurement results.

There are no remarkable differences on SFOC at 100% load.

However, the better SFOC is measured on the slide fuel valve with S70MC-C C26 atomizer in the partial engine load.

As the influence of the sac volume is increased in the part load (due to the reduction of fuel injection amount per revolution) and the fuel oil in the sac volume may just increase the SFOC, it is considered as the typical influence of the slide type fuel valve. The same improvement on SFOC in the part load has also confirmed by other comparison measurement between the slide F.V. and conventional F.V.

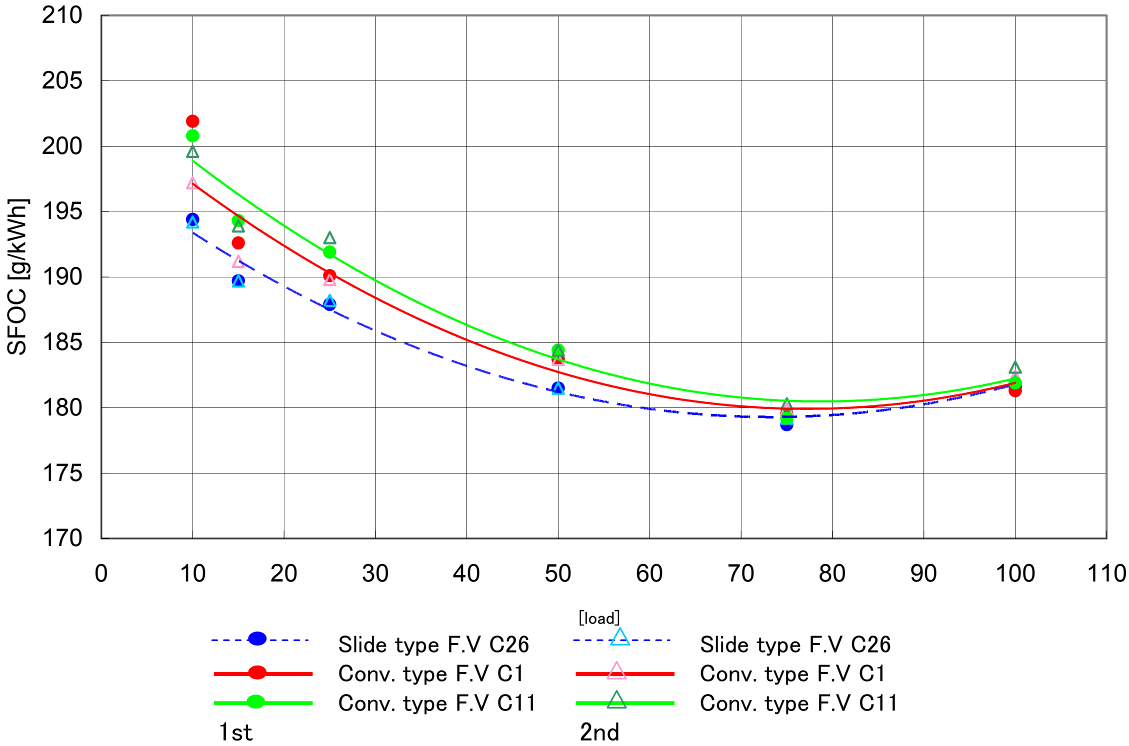


Fig. 4 SFOC Measurement Results

(Corrected to ISO standard condition)

7.3 Emission Measurement Results

Enclosure 5 shows the gaseous emission measurement (NOx, CO, CO_2, O_2, THC), Bosch Number and Dust measurement results.

Fig. 5 shows the gases emission measurement results.

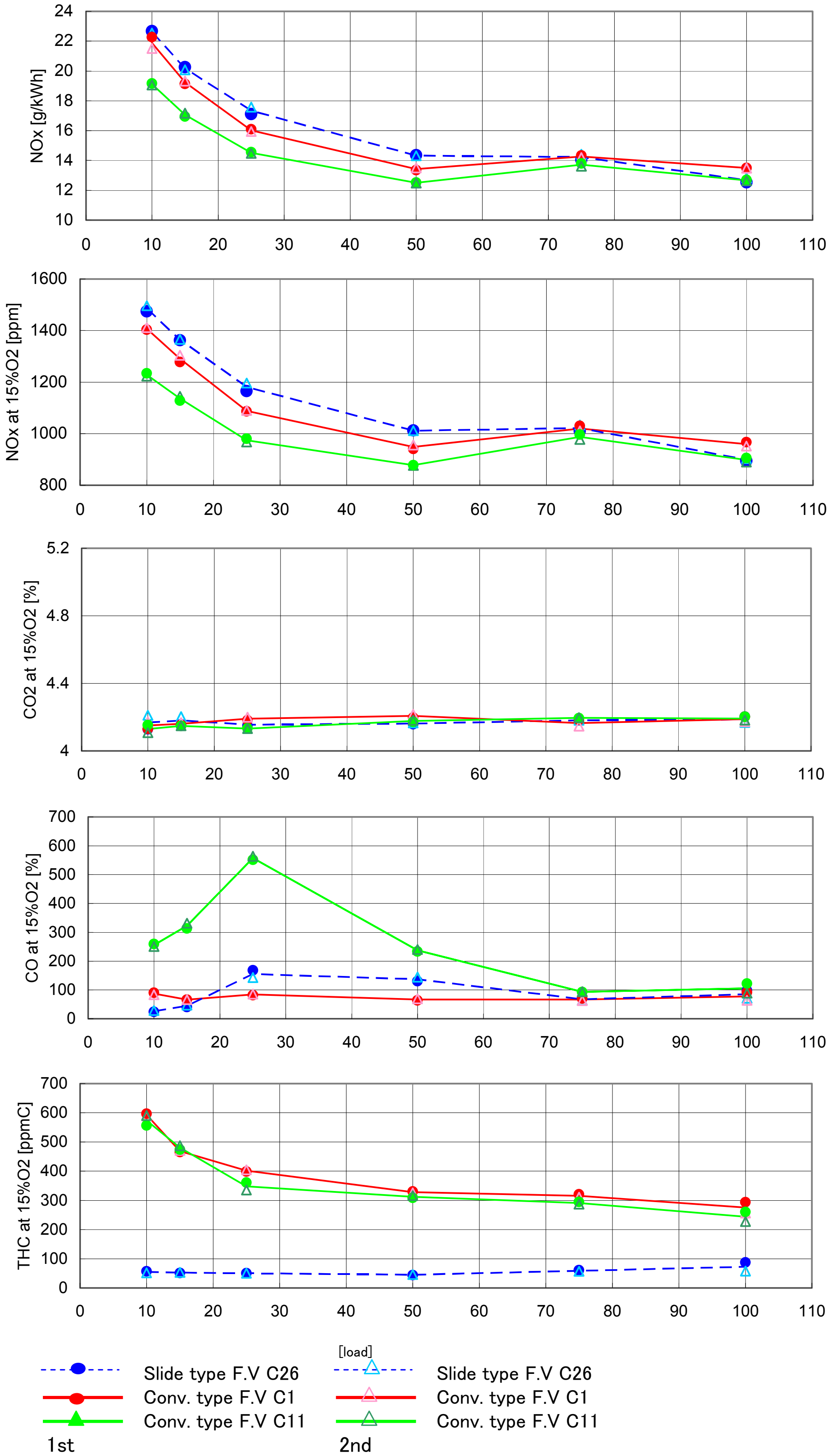


Fig. 5 Gasses Emission Measurement Results

NOx emission :

S70MC-C C11 has lower NOx emission especially in the part load. It is well reflected to the trade-off relation between the SFOC and the NOx emission. It is not confirmed by the measurement that the influence of the difference of the F.V. types. It is because the fuel atomizer pattern has much higher influence on NOx formation process.

CO2 emission:

It is directly rink to the SFOC. There are no remarkable differences among the atomizers.

CO emission:

In general, CO emission level on 2st slow speed diesel engine is lower than that on 4st high speed engine.
S70MC-C C11 has relatively higher CO emission in the part load, especially 50% load.

THC emission:

The slide F.V. with S70MC-C C-26 atomizer has significantly lower THC emission compared with the conventional F.V.
Especially in the part load range, the THC with conventional F.V. is increased, but the THC with slide F.V. keep in the lower value.
The lower THC emission is typical feature of the slide F.V.

Bosch Number:

In case of 2st diesel engine using the MDO, the black carbon emission from the fuel oil is relatively lower except the engine start. The cylinder lub. oil consumption also affects the Bosch Number measurement.
Therefore, it is rather difficult to recognize the remarkable difference on the Bosch Number measurement.

Dust measurement:

There are no remarkable difference among the F.V. type and atomizers due to the higher influence of higher cylinder lub oil feed rate.
All the measured Dust emission according to JIS Z8808 is within the range of

40mg/Nm3. It is relatively lower than we have normally measured at the shop test using the MDO (40-110 mg/Nm3: depending on the load and cylinder Lub oil amount).

7.4 Cylinder Lub Oil Consumption

Fig. 6 shows the measurement results of the cylinder lub oil. It is controlled by the alpha lubricator based on the engine speed. Therefore, there are no remarkable differences among the atomizers. As explained in the chapter 3.3 in this report, the test is done in relatively higher cylinder lub oil consumption, especially in the part load.

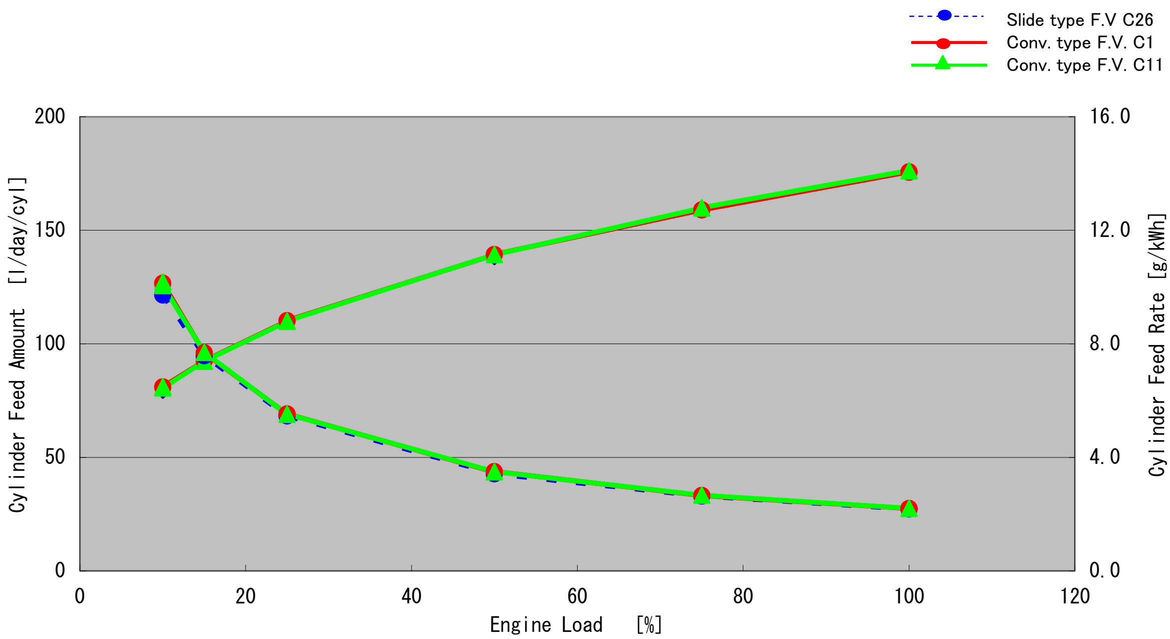


Fig. 6 Cylinder Lub Oil Consumption

8 Summary

The performance and emission comparison measurement between the slide F.V. and the conventional F.V. was carried out on a Mitsui MAN B&W 6S70MC-C engine.

The SFOC (CO2/GHG emission) in the part load can be improved by using the slide F.V. Also, THC emission which is a part of un-burned fuel oriental soot emission can be reduced by the slide F.V.

However, the Bosch number and Dust measurement cannot see any remarkable differences among the F.V. types. It is because of the higher influence of the cylinder lub oil consumption, as the test is carried out during the engine running-in.

Enclosure 1

4. Cylinder Oil Feed Rate (dosage)

⚠ Adjust the feed rate for specific engine in accordance with "INSTRUCTION MANUAL FOR ADJUSTMENT & MEASUREMENT" of this instruction book.

4.1 General

The following guidelines are based on service experience, and take into consideration the specific design criteria of the MITSUI-MAN B&W engines (such as mean pressure, maximum pressure, and lubricated liner area) as well as today's fuel qualities and operating conditions.

The recommendations are valid for fixed pitch and controllable pitch propeller plants.

Regarding adjustment and operation of the lubricators, see the instruction book "COMPONENT DESCRIPTION (ACCESSORIES)".

4.2 BASIC SETTING

The cylinder oil feed rate shown in below tables are only for guidance and are not guaranteed.

For the Mechanical type lubricator

	S-MC(-C) engines	L-MC(-C) engines K-MC(-C) engines
BASIC SETTING	1.5 g/kWh	1.2 g/kWh
Min. Feed Rate	0.95 g/kWh	0.8 g/kWh

For the Alpha lubricator system

S-MC(-C) engines

	Cylinder bore 65cm and larger engines	Cylinder bore 60cm and smaller engines
BASIC SETTING	1.4 g/kWh	1.1 g/kWh
Min. Feed Rate	0.8 g/kWh	0.8 g/kWh

L-MC(-C), K-MC(-C) engines

BASIC SETTING	1.1 g/kWh
Min. Feed Rate	0.8 g/kWh

Use these values for calculating the cylinder oil amount equivalent to BASIC SETTING and Min. Feed Rate at specified MCR, see Item 4.3.

4.3 Calculating the Feed Rate at Specified MCR

The specific cylinder oil consumption [liter/day/cyl.] at specified MCR can be calculated as follows:

$$Q_{MCR} = BS \times \frac{OUTPUT_{MCR}}{C} \times \frac{24}{\rho \times 1000}$$

where

Q_{MCR}	:	Specific cylinder oil consumption at specified MCR	[liter/day/cyl.]
BS	:	BASIC SETTING, see Item 4.2.	[g/kWh]
ρ	:	specific density (guidance value; 0.92)	[kg/liter]
C	:	number of engine cylinders	
$OUTPUT_{MCR}$	:	engine output at specified MCR	[kW]

4.4 Recalculating of the Feed Rate at Part Load

As the above mentioned specific cylinder oil consumption are based on specified MCR, before evaluating part load lube oil consumption, the actual dosage should be recalculated to what it would have been at specified MCR.

For the Mechanical type lubricator

The cylinder oil feed rate at part load will normally be decreased in proportion to the ratio between speed at part load and at specified MCR (SPEED dependent regulation).

SPEED dependent regulation

$$Q_{part} = Q_{MCR} \times \frac{SPEED_{part}}{SPEED_{MCR}}$$

where

Q_{part}	:	cylinder oil feed rate at part load	[liter/day/cyl.]
$SPEED_{part}$	:	engine speed at part load	[min^{-1}]
$SPEED_{MCR}$	:	engine speed at specified MCR	[min^{-1}]

In case the MEP dependent cylinder lubrication system is mounted (Option), the cylinder oil feed rate at part load will automatically be decreased in proportion to the ratio between mean effective pressure at part load and at specified MCR (MEP dependent regulation).
The MEP dependent regulation performed by this system is available in the range of 40–100% MEP.

For the engine without this system, the cylinder oil feed rate running on part load for long period (low load operation) can also be adjusted manually as same procedure.

The feed rate of low load operation should not be below 40% of rate for specified MCR.
Remember to adjust the feed rate to the nominal level, when low load operation is finished.

MEP dependent regulation

$$Q_{part} = Q_{MCR} \times \frac{MEP_{part}}{MEP_{MCR}} \approx Q_{MCR} \times \left(\frac{SPPED_{part}}{SPEED_{MCR}} \right)^2$$

where

MEP_{part}	:	engine mep at part load	[MPa]
MEP_{MCR}	:	engine mep at specified MCR	[MPa]

For the Alpha lubricator system

The cylinder oil feed rate at part load will normally be decreased in proportion to the ratio between mean effective pressure at part load and at specified MCR (MEP dependent regulation mode).

Note that at following condition the MEP dependent regulation mode is automatically taken over to SPEED dependent regulation mode;

- Feed rate setting value on the HMI panel ≥ 120%
- MEP% / SPEED% ≤ 63% (63% of specified MCR speed on nominal propeller curve)

MEP dependent regulation

$$Q_{part} = Q_{MCR} \times \frac{MEP_{part}}{MEP_{MCR}} = Q_{MCR} \times (MEP\%)$$

SPEED dependent regulation (after taken over from above)

$$Q_{part} = Q_{25\%MCR} \times \frac{SPEED_{part}}{SPEED_{25\%MCR}} = Q_{MCR} \times 0.25^{\frac{1}{3}} \times \frac{SPEED_{part}}{SPEED_{MCR}}$$

where

Q_{part}	:	cylinder oil feed rate at part load	[liter/day/cyl.]
$Q_{25\%MCR}$	:	cylinder oil feed rate at 25% MCR	[liter/day/cyl.]
MEP_{part}	:	engine mep at part load	[MPa]
MEP_{MCR}	:	engine mep at specified MCR	[MPa]
$MEP\%$	:	mep ratio between part load and specified MCR = (displayed value in the HMI panel) / 100	
$SPEED_{part}$	:	engine speed at part load	[min^{-1}]
$SPEED_{MCR}$	:	engine speed at specified MCR	[min^{-1}]
$SPEED_{25\%MCR}$	:	engine speed at 25% MCR load	[min^{-1}]

4.5 Guidance Schedule of Cylinder Oil Feed Rate Adjustment

The guidance schedule of cylinder oil feed rate is described in *Plate 70710A–70710D*, in which the values are valid for specified MCR, see Item 4.4.

After recondition or renewal of cylinder liners and/or piston rings, allowance must be made for a breaking-in and running-in period.
In case for the running-in one or two cylinders, see also Item 4.5.2.

The actual feed rate and its period should be adjusted in accordance with the service experience for the actual trade obtained from the scavenge port inspection.

Before reduction toward lower feed rate, the scavenge port inspection should be carried out and it should be confirmed that the cylinder condition is good enough, see "Cylinder Condition", Item 3.
After reducing the feed rate, the cylinder condition should be inspected at the next engine standstill condition.

⚠ In order to prevent the excessive wear of the cylinder liner and the piston ring, the sudden reduction of the feed rate is to be avoided at the initial breaking/running-in period.

Breaking-in period:

A breaking-in feed rate and its period can be adjusted as shown *Plate 70710A–70710D*.
The load on main engine during braking-in period should be increased carefully as *Plate 70714*.

Running-in period:

A running-in feed rate and its period can be adjusted as shown *Plate 70710A–70710D*.
Before reduction toward lower feed rate, the scavenge port inspection should be carried out and it should be confirmed that the cylinder condition is good enough.

Feed rate adjustment after running-in period:

After breaking/running-in period, in order to prevent the excessive cylinder oil dosage, appropriate cylinder oil feed rate adjustment is recommended.

Feed rate reduction toward Min. Feed Rate may be done in steps not exceeding 0.068 g/kWh, at intervals of 600 hours.
Before reduction toward lower feed rate, the scavenge port inspection should be carried out and it should be confirmed that the cylinder condition is good enough.

Increase or decrease the feed rate during the continued service, based on the regular:

- scavenge port inspection, and
- piston/liner overhauls, see "Cylinder Condition", Item 4.1.

See the instruction book "MAINTENANCE", Chapter 900.
See also Item 4.6.

4.5.1 Running-in Rings after a Piston Overhaul

Running-in new piston rings in already run-in liners;

The breaking-in and running-in feed rate and its period onto the corresponding cylinder should be followed the same pattern as when running-in new liners, however, the duration of the reduction step can be shortened according to result of scavenge ports inspection.
The load on main engine during braking-in period should be increased carefully as *Plate 70714*.

Continuous use of piston rings;

The feed rate should be adjusted to approx. 125% BASIC SETTING onto the corresponding cylinder.
After approx. 15 hours running, the feed rate before piston overhaul can be applied.

See the instruction book "MAINTENANCE", Chapter 902.

4.5.2 Running-in one or two cylinders

If only one or two cylinders have been renewed or have undergone reconditioning, the fuel index for the cylinders in question can be decreased in proportion to the required load reduction.
Increase the fuel index stepwise in accordance with the breaking-in schedule, see *Plate 70714*.

⚠ The pressure rise *pcomp–pmax* must not exceed the value measured on test bed at the reduced mean effective pressure or fuel index.

⚠ If the engine is fitted with the Turbo Compound System (TCS), the TCS must be out of operation if running-in with reduced fuel index is chosen in order to safeguard the gear.

4.6 Special Conditions

It is recommended to adjust the actual feed rate in the following cases:

a) During start, manoeuvring;
Increase the cylinder oil feed rate; at least approx. +25% after initial breaking-in period.

For the engine with only Mechanical type lubricator, move the regulating handle on the lubricator to one step-up position manually.
In case that the Mechanical lubricators with LCD system are operated in LCD mode, the cylinder oil feed rate is increased automatically.

For the engine with Alpha lubricator system, the cylinder oil feed rate is increased automatically up to +25% (having upper limit of 150% BASIC SETTING).

b) If abnormal cylinder conditions are found;
The cylinder oil feed rate should be adjusted to approx. 150% BASIC SETTING onto the corresponding cylinder.
Maintain this over-lubrication until the cause of the problem has been eliminated, and scavenge port inspections proved that a safe condition has been re-established.

Run-in the cylinder(s) as described in Item 4.5.

The deterioration of the cylinder condition may be caused by incompatibility high alkaline cylinder oil and certain low sulphur fuels, or some diesel oils, see Item 3.1.

c) If the load pattern changes or if the fuel oil quality deteriorates;
readjust the cylinder oil feed rate to the100% BASIC SETTING.

Find the new adequate feed rate by repeating the stepwise reduction described in "Cylinder Condition", Item 4.13.

4.7 Calculating the Pump Stroke and Cylinder Oil Consumption of the Mechanical type Lubricator

a) Calculation of the pump stroke at specified MCR

Use the results from Item 4.4 for calculating the pump stroke at specified MCR.

The pump stroke can be calculated as follows:

$$S = \frac{Q_{MCR} \times 4 \times 10^6}{\pi \times D^2 \times \eta \times G \times N \times 60 \times 24}$$

where

S	:	pump stroke	[mm]
Q_{MCR}	:	cylinder oil feed rate, see Item 4.4	[liter/day/cyl.]
D	:	diameter of pump piston	[mm]
η	:	volumetric efficiency (0.9)	
G	:	number of oil inlets per engine cylinder	
N	:	lubricator speed	[min^{-1}]
		for 42–98MC(-C) : lubricator speed = engine speed	
		for 26–35MC : lubricator speed = engine speed / 2	

Example: 6S50MC-C (9480kW × 127 min^{-1})

BS = 1.5 g/kWh, $OUTPUT_{MCR}$ = 9480 kW, C = 6,
D = 4.5 mm, G = 6 point/cyl., N = 127 min^{-1}

then,

Q_{MCR} = 1.5 × 9480 / 6 × 24 / (0.92 × 1000)
= 61.8 liter/day/cyl.

S = 61.8 × 4 × 10^6 / (π × 4.5^2 × 0.9 × 6 × 127 × 60 × 24)
= 3.93 mm

b) Calculation of the cylinder oil consumption by measuring the pump stroke

The daily oil consumption per cylinder, based on the lubricator's pump stroke, i.e. free movement of the individual adjusting screws, can be carried out as follows:
See also Chapter 703 "Starting-up, Manoeuvring, and Arrival in Port", Item 2.4, Check 8.
However, actual oil consumption should be measured.

$$Q = \frac{S \times \pi \times D^2 \times \eta \times G \times N \times 60 \times 24}{4 \times 10^6}$$

Regarding explanation of the equation, see above a).

Example: 6S50MC-C (9480kW × 127 min^{-1})

D = 4.5 mm, G = 6 point/cyl., N = 127 min^{-1}
Measured stroke: 3.93 mm

then,

Q = 3.93 × π × 4.5^2 × 0.9 × 6 × 127 × 60 × 24 / (4 × 10^6)
= 61.7 liter/day/cyl.

4.8 Calculating the Cylinder Oil Consumption of the Alpha Lubricator System

Regarding to the calculation of the cylinder oil consumption, see the "INSTRUCTION MANUAL FOR ADJUSTMENT & MEASUREMENT" of this instruction book, and the instruction book "COMPONENT DESCRIPITION (ACCESSORIES)".

Plate 70710A Guidance Schedule of Cylinder Oil Feed Rate Adjustment (with Mechanical type lubricators)

For L-MC(-C), K-MC(-C) engines
with Mechanical type Lubricators

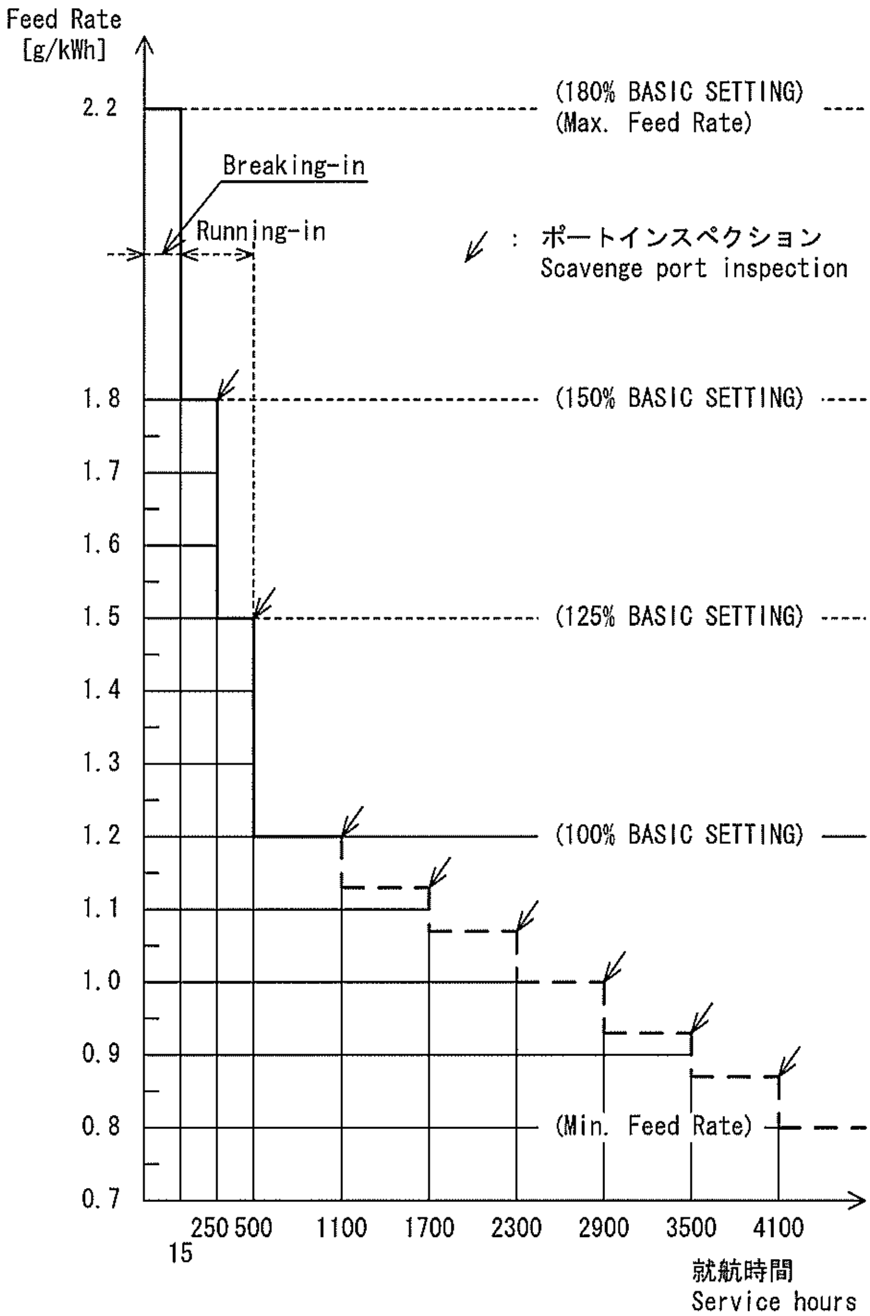


Plate 70710B Guidance Schedule of Cylinder Oil Feed Rate Adjustment (with Mechanical type lubricators)

For S-MC(-C) engines
with Mechanical type Lubricators

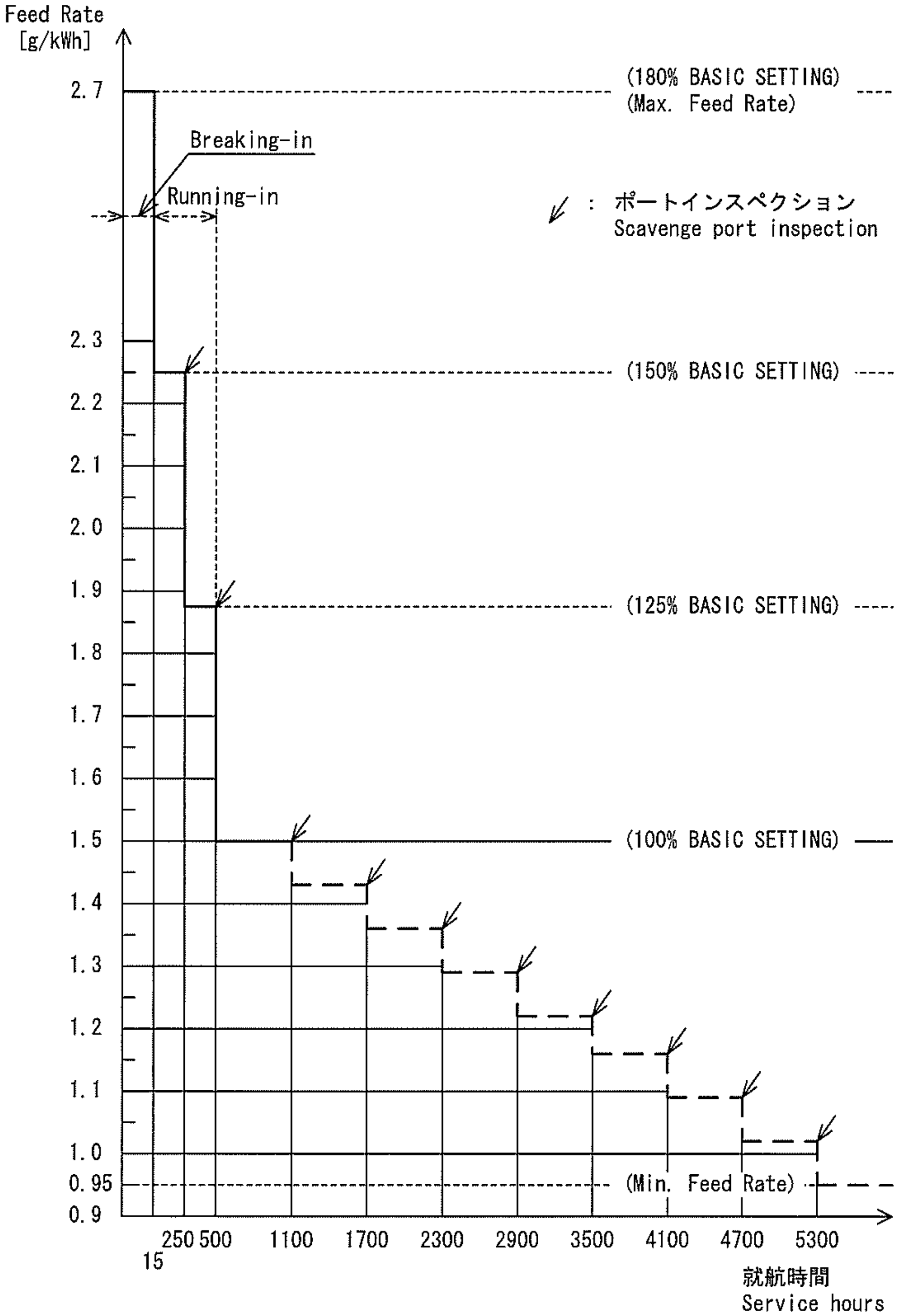


Plate 70710C Guidance Schedule of Cylinder Oil Feed Rate Adjustment (with Alpha Lubricator System)

For L-MC(-C), K-MC(-C) engines
For S-MC(-C) engines (cylinder bore 60cm and smaller)
with Alpha Lubricator System

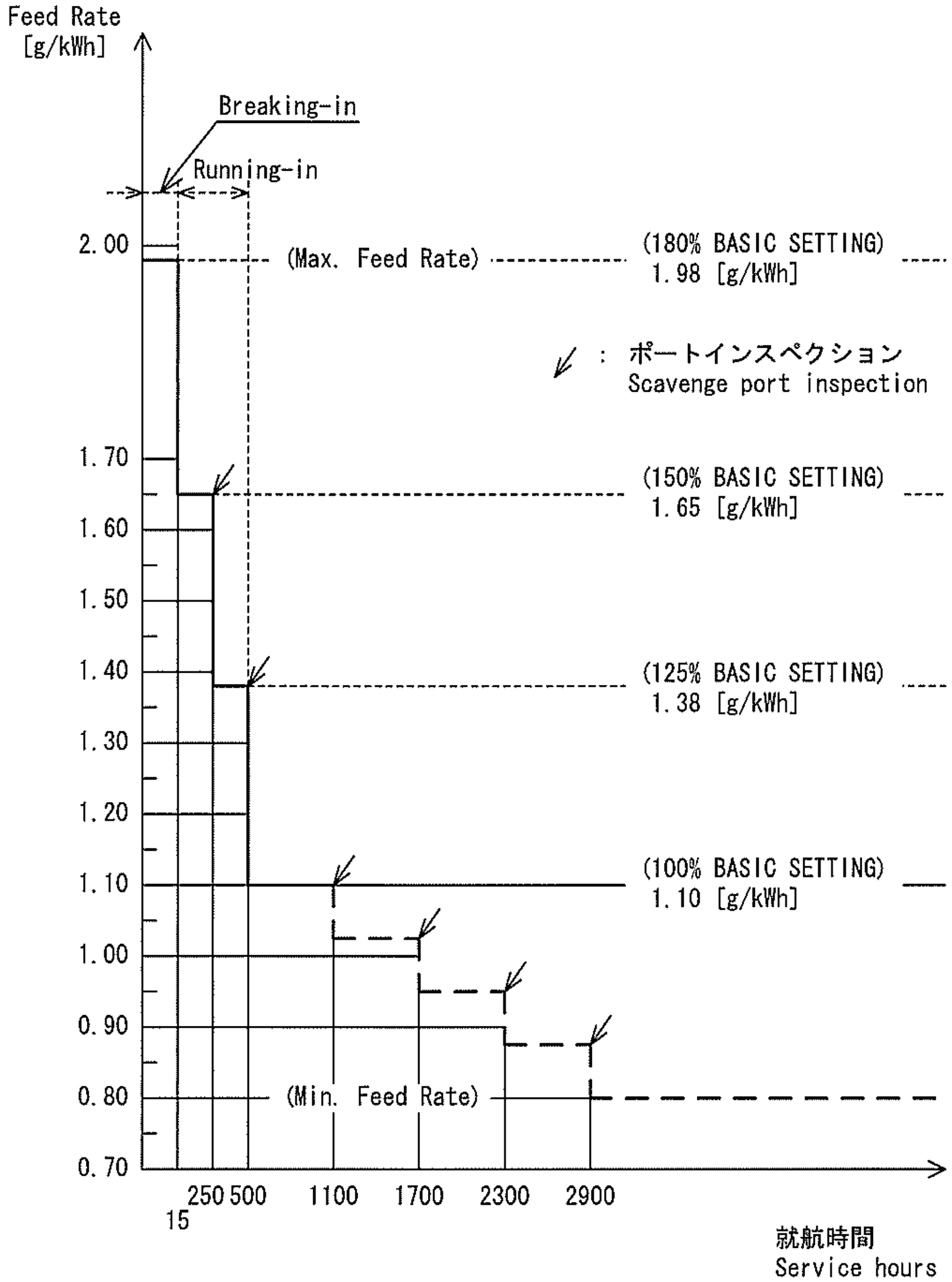
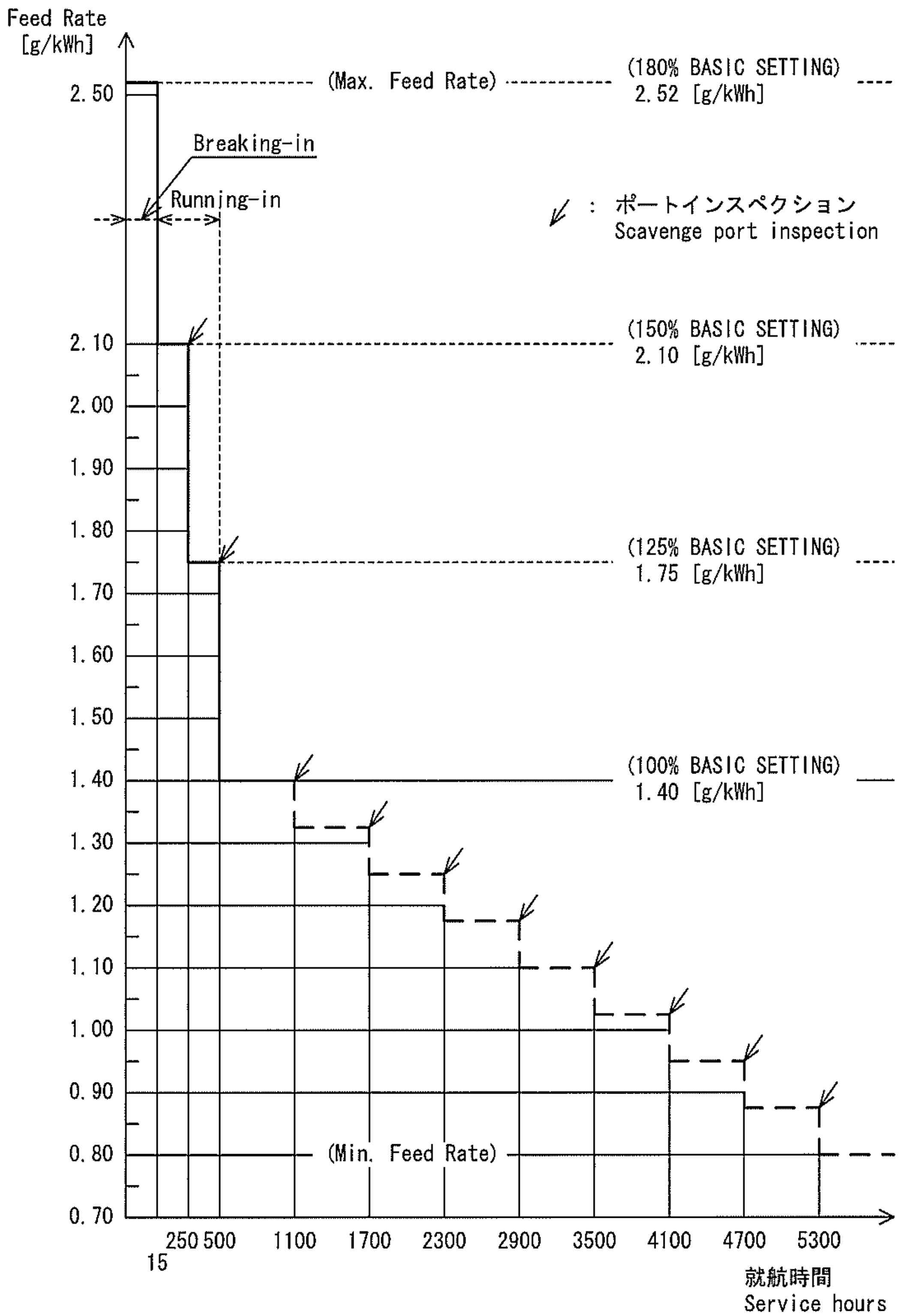


Plate 70710D Guidance Schedule of Cylinder Oil Feed Rate Adjustment (with Alpha Lubricator System)

For S-MC(-C) engines (cylinder bore 65cm and larger)
with Alpha Lubricator System



Enclosure 2

M Mitsui-MAN B&W

Enclosure 2

Supporting Document
for
Test Bed Report on ENo. 6384

Page

類似参考図	代替図	製作参考図
	計画図	

日付 DATE	課員 STAFF	担当 CHG.ENGR.	課補 ASST.CHIEF		新図番		R
							4
							3
							2
							1
2012.12.26	窪田	志岐	島田		旧図番		0

機械システム事業部 機械工場 ディーゼル設計部 Machine & Systems Headquarters Machine Factory Diesel Design Department	REG.No.(組立区分)	図面番号 DRG.No. TE3P46-SD

M MITSUI ENGINEERING&SHIPBUILDING CO.,LTD

Member Engine-Measurement equipment-Calibration summary

	Manufacturer	Model	Serial Number	Calibrated Range	Used Range	Calibration		Verified NK Surveyor
						Date	Calibration date attached	
Coolant temp CAC/SAC inlet	OMRON	CS1W-PTS56	-	0～75℃	0～75℃	2012.08.30	*	
Charge/Scavenge air temperature (at receiver)	OMRON	CS1W-PTS56	-	0～75℃	0～75℃	2012.08.30	*	
Engine speed	OMRON	H7EC-BM	-	0～150rpm	0～150rpm	2012.08.30	*	
turbocharger inlet air temperature	ANRITSU	HA-100K	-	0～100℃	0～100℃	2012.07.13	*	
Charge/Scavenge air pressure (at receiver)	COPAL ELECTRONICS	PG-100	-	0～0.4MPa	0～0.4MPa	2012.07.13	*	
Torque Meter	ZOLLNER	WB-7.5-0-10	-	0～2100kNm	0～2100kNm	2012.07.18	*	
Fuel Consumption	YAMATO	PL-LLC2(No.3)	-	0～1205kg	0～1205kg	2012.06.04	*	
Atomospheric pressure	OTA KEIKI SEISAKUSYO	Aneroid barometar	16443	930～1070hPa	930～1070hPa	2010.06.08	*	
Max cylinder pressure	MAN Diesel & Turbo	On-line PMI system	1476331	0～25MPa	0～25MPa	2012.09.19	*	
Max compression pressure				0～25MPa	0～25MPa	2012.09.19	*	
Power	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Exhaust backpressure	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Ambient air temperature	YOSHINO	Glass Bar Type	985039	0～50℃	0～50℃	2012.07.27	*	
Ambient air humidity	YOSHINO	Glass Bar Type	14629	0～50℃	0～50℃	2012.08.31	*	
NOx Analyser	HORIBA	MEXA7100D	4454745001	0～2500ppm	0～2500ppm	2012.08.06	*	
NOx Water quench checks	-	-	Measured	-1.90%	-	2012.08.06	*	
NOx Converter efficiency check	-	-	Measured	95.7%	-	2012.08.06	*	
CO Analyser	HORIBA	MEXA7100D	4454745001	0～1000ppm	0～1000ppm	2012.08.06	*	
CO_2 Interfrrence check	-	-	Measured	0.02%	-	2012.08.06	*	
CO_2 Analyser	HORIBA	MEXA7100D	4454745001	0～10%	0～10%	2012.08.06	*	
O_2 Analyser	HORIBA	MEXA7100D	4454745001	0～25%	0～25%	2012.08.06	*	
THC Analyser	HORIBA	MEXA7100D	4454745001	0～1000ppmC	0～1000ppmC	2012.08.06	*	
Hybrid Recorder	GRAPHTEC	GL-220	-	-	0～1V	-	-	

Calibration results of exhaust gas analyzer - NOx

Date:2012/08/06

Analyzer specification

Type	MEXA-7100D
Sensor	HCLD
Manufacture	HORIBA
Serial no.	4454745001
Measuring range	0-2500ppm
Sensitivy	1ppm

Span gas data

gastype	NO in Nitrogen
Concentration	2330ppm
Serial no.	1J10141
Certifficate no.	11211061501
Expiration date	2012/11/30
Supplier	Takachiho Chemical

Zero gas data

Specification	Nitrogen
Serial no.	GS66905
Certifficate no.	11211072001
Expiration date	2012/12/07
Supplier	Takachiho Chemical

Zero/Span drift

Zero	Span
0.04%F.S./h(<±2%F.S./h)	0.32%F.S./h(<±2%F.S./h)

Repeatability test	CO2 quench test(Date 2011/11/04)	Water quench test(Date 2011/11/04)
0.33%(<±1%Nom.val.)	-0.38%F.S.(<±2%F.S.)	-1.90%F.S.(<±3%F.S.)

Efficiency of converter

95.7%

Control of zero and span response

	Before adjustment	After adjustment
Span	2336	2330
Zero	1	0

Establishment at calibration results (Precision Blending Device(GDC-703) was used)

%(Full Scale)	Nom.val.	Measured	Deviation
0	0	0	0.00%F.S.(<±0.3%F.S.)
2	47	46	-0.04%F.S.(<±0.3%F.S.)
5	117	117	0.00%F.S.(<±0.3%F.S.)
9	233	233	0.00%F.S.(<±0.3%F.S.)
19	466	464	-0.43%(<±2%Nom.val.)
28	699	696	-0.43%(<±2%Nom.val.)
37	932	927	-0.54%(<±2%Nom.val.)
47	1165	1163	-0.17%(<±2%Nom.val.)
56	1398	1394	-0.29%(<±2%Nom.val.)
65	1631	1629	-0.12%(<±2%Nom.val.)
93	2330	2330	0.00%(<±2%Nom.val.)

Reported by

MES TESTING & RESEARCH CENTER / h. Matsubara

Calibration results of exhaust gas analyzer - O2

Date:2012/08/06

Analyzer specification

Type	MEXA-7100D
Sensor	PMD
Manufacture	HORIBA
Serial no.	4454745001
Measuring range	0-25%
Sensitivy	0.01%

Span gas data

gastype	O2 in Nitrogen
Concentration	23.33%
Serial no.	1FK-65693
Certifficate no.	12202037901
Expiration date	2013/03/21
Supplier	Takachiho Chemical

Zero gas data

Specification	Nitrogen
Serial no.	GS66905
Certifficate no.	11211072001
Expiration date	2012/12/07
Supplier	Takachiho Chemical

Zero/Span drift

Zero	Span
0.04%F.S./h(<±2%F.S./h)	0.12%F.S./h(<±2%F.S./h)

Repeatability test

0.11%F.S.(<1%F.S.)

Control of zero and span response

	Before adjustment	After adjustment
Span	23.82	23.33
Zero	0.02	0.00

Establishment at calibration results (Precision Blending Device(GDC-703) was used)

%(Full Scale)	Nom.val.	Measured	Deviation
0	0.00	0.00	0.00%F.S.(<±0.3%F.S.)
9	2.33	2.33	0.00%F.S.(<±0.3%F.S.)
19	4.66	4.63	-0.64%(<±2%Nom.val.)
28	6.99	6.96	-0.43%(<±2%Nom.val.)
37	9.33	9.29	-0.43%(<±2%Nom.val.)
47	11.66	11.63	-0.26%(<±2%Nom.val.)
56	13.99	13.92	-0.50%(<±2%Nom.val.)
65	16.33	16.31	-0.12%(<±2%Nom.val.)
75	18.66	18.64	-0.11%(<±2%Nom.val.)
84	20.99	20.99	0.00%(<±2%Nom.val.)
93	23.33	23.33	0.00%(<±2%Nom.val.)

Reported by

MES TESTING & RESEARCH CENTER / N. Matsubara

Calibration results of exhaust gas analyzer - CO_2

Date:2012/08/06

Analyzer specification

Type	MEXA-7100D
Sensor	NDIR
Manufacture	HORIBA
Serial no.	4454745001
Measuring range	0-10%
Sensitivy	0.01%

Span gas data

gastype	CO2 in Nitrogen
Concentration	9.29%
Serial no.	1J66949
Certifficate no.	12204015801
Expiration date	2013/05/01
Supplier	Takachiho Chemical

Zero gas data

Specification	Nitrogen
Serial no.	GS66905
Certifficate no.	11211072001
Expiration date	2012/12/07
Supplier	Takachiho Chemical

Zero/Span drift

Zero	Span
0.00%F.S./h(<±2%F.S./h)	0.20%F.S./h(<±2%F.S./h)

Repeatability test

0.16%F.S.(<1%F.S.)

Control of zero and span response

	Before adjustment	After adjustment
Span	9.28	9.29
Zero	0.00	0.00

Establishment at calibration results (Precision Blending Device(GDC-703) was used)

%(Full Scale)	Nom.val.	Measured	Deviation
0	0.00	0.00	0.00%F.S.(<±0.3%F.S.)
4	0.37	0.37	0.00%F.S.(<±0.3%F.S.)
7	0.74	0.73	-0.10%F.S.(<±0.3%F.S.)
9	0.93	0.91	-0.20%F.S.(<±0.3%F.S.)
19	1.86	1.83	-1.61%(<±2%Nom.val.)
28	2.79	2.74	-1.79%(<±2%Nom.val.)
37	3.72	3.66	-1.61%(<±2%Nom.val.)
47	4.65	4.60	-1.08%(<±2%Nom.val.)
56	5.57	5.54	-0.54%(<±2%Nom.val.)
74	7.43	7.43	0.00%(<±2%Nom.val.)
93	9.29	9.29	0.00%(<±2%Nom.val.)

Reported by

MES TESTING & RESEARCH CENTER / N. Matsubara

Calibration results of exhaust gas analyzer - CO

Date:2012/08/06

Analyzer specification

Type	MEXA-7100D
Sensor	NDIR
Manufacture	HORIBA
Serial no.	4454745001
Measuring range	0-1000ppm
Sensitivy	1ppm

Span gas data

gastype	CO in Nitrogen
Concentration	936ppm
Serial no.	GUA73102
Certifficate no.	12201077001
Expiration date	2013/02/14
Supplier	Takachiho Chemical

Zero gas data

Specification	Nitrogen
Serial no.	GS66905
Certifficate no.	11211072001
Expiration date	2012/12/07
Supplier	Takachiho Chemical

Zero/Span drift

Zero	Span
0.20%F.S./h(<±2%F.S./h)	0.40%F.S./h(<±2%F.S./h)

Repeatability test	CO2 interference check(Date 2011/11/04)
0.11%F.S.(<1%F.S.)	0.02%F.S.(<±1%F.S.)

Control of zero and span response

	Before adjustment	After adjustment
Span	937	936
Zero	3	0

Establishment at calibration results (Precision Blending Device(GDC-703) was used)

%(Full Scale)	Nom.val.	Measured	Deviation
0	0	0	0.00%F.S.(<±0.3%F.S.)
1	9	9	0.00%F.S.(<±0.3%F.S.)
2	19	18	-0.10%F.S.(<±0.3%F.S.)
4	37	36	-0.10%F.S.(<±0.3%F.S.)
6	56	55	-0.10%F.S.(<±0.3%F.S.)
8	75	74	-0.10%F.S.(<±0.3%F.S.)
9	94	93	-0.10%F.S.(<±0.3%F.S.)
19	187	186	-0.53%(<±2%Nom.val.)
37	373	375	0.54%(<±2%Nom.val.)
66	655	659	0.61%(<±2%Nom.val.)
94	936	936	0.00%(<±2%Nom.val.)

Reported by

MES TESTING & RESEARCH CENTER / N. Matsubara

Calibration results of exhaust gas analyzer - THC

Date:2012/08/06

Analyzer specification

Type	MEXA-7100D
Sensor	HFID
Manufacture	HORIBA
Serial no.	4454745001
Measuring range	0-1000ppmC
Sensitivy	1ppmC

Span gas data

gastype	C3H8 in Air
Concentration	944ppmC
Serial no.	2BIS54746
Certificate no.	12201077101
Expiration date	2013/02/22
Supplier	Takachiho Chemical

Zero gas data

Specification	Air Zero-K
Serial no.	GT8261
Certificate no.	12201077301
Expiration date	2013/02/08
Supplier	Sumitomo Seika

Zero/Span drift

Zero	Span
0.20%F.S./h(<±2%F.S./h)	1.70%F.S./h(<±2%F.S./h)

Repeatability test

0.26%F.S.(<1%F.S.)

Control of zero and span response

	Before adjustment	After adjustment
Span	940	944
Zero	2	0

Establishment at calibration results (Precision Blending Device(GDC-703) was used)

%(Full Scale)	Nom.val.	Measured	Deviation
0	0	0	0.00%F.S.(<±0.3%F.S.)
1	9	9	0.00%F.S.(<±0.3%F.S.)
2	19	18	-0.10%F.S.(<±0.3%F.S.)
4	38	38	0.00%F.S.(<±0.3%F.S.)
6	57	56	-0.10%F.S.(<±0.3%F.S.)
8	76	75	-0.10%F.S.(<±0.3%F.S.)
9	94	95	0.10%F.S.(<±0.3%F.S.)
19	189	188	-0.53%(<±2%Nom.val.)
38	378	377	-0.26%(<±2%Nom.val.)
66	661	661	0.00%(<±2%Nom.val.)
94	944	944	0.00%(<±2%Nom.val.)

Reported by

MES TESTING & RESEARCH CENTER / A. Matsubara

MEXA7100D

THC analyzer interference check

1. Oxygen interference check

Date	**2012/04/25**
Results	**Good**
Date of validity	**2013/04/24**

	O2interference (5%)	O2interference (10%)
% NominalVal.	2.18%(<±3%)	1.80%(<±3%)

Used gas

CH4(ppmC)	353.5	O2(%)	5	Cyl.No. KDB46932
CH4(ppmC)	351.2	O2(%)	10	Cyl.No. FVN30273
C3H8(ppmC)	374.0	O2(%)	20	Cyl.No. 3BIS0508

2. Hydrocarbon response factors

Date	**2012/04/25**
Results	**Good**
Date of validity	**2013/04/24**

	CH4(ppmC)	C3H6(ppmC)	C7H8(ppmC)
Nominal Value	798.0	793.5	802.9
Measured Value	870.0	781.0	764.0
Response factor	1.09(1.00~1.15)	0.98(0.9~1.1)	0.95(0.9~1.1)

Used gas

CH4(ppm)	798.0	Cyl.No. VN62151
C3H6(ppm)	264.5	Cyl.No. VN62638
C7H8(ppm)	114.7	Cyl.No. DIB01877

3. Adjustment of the HFID

Date	**2012/04/25**
Results	**Good**
Date of validity	**2013/04/24**

Reported by

MES TESTING & RESEARCH CENTER / H. Matsubara

Examination accuracy of Precision Blending Device

(Date;2011/09/12 Checked Instrument;MEXA7100D THC Analyzer)

Model	GDC-03 (Reference Divice)		Difference 1	Deviation 1	GDC-703(Used Divice)		Difference 2	Deviation 2	Difference (2-1)
Cut Point	Nominal Val.	Measured Val.			Nominal Val.	Measured Val.			
1	0 ppmC	0 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	0 ppmC	0 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	0 ppmC
2	18 ppmC	18 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	19 ppmC	19 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	0 ppmC
3	37 ppmC	37 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	37 ppmC	37 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	0 ppmC
4	56 ppmC	55 ppmC	-1 ppmC	-0.10%F.S.(<±0.3%F.S.)	56 ppmC	56 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	1 ppmC
5	74 ppmC	74 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	74 ppmC	75 ppmC	1 ppmC	0.10%F.S.(<±0.3%F.S.)	1 ppmC
6	93 ppmC	93 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	93 ppmC	93 ppmC	0 ppmC	0.00%F.S.(<±0.3%F.S.)	0 ppmC
7	184 ppmC	185 ppmC	1 ppmC	0.12%(<±1%Nom.val.)	187 ppmC	186 ppmC	-1 ppmC	-0.10%(<±1%Nom.val.)	-2 ppmC
8	372 ppmC	373 ppmC	1 ppmC	0.27%(<±1%Nom.val.)	374 ppmC	374 ppmC	0 ppmC	0.00%(<±1%Nom.val.)	-1 ppmC
9	559 ppmC	560 ppmC	1 ppmC	0.18%(<±1%Nom.val.)	561 ppmC	562 ppmC	1 ppmC	0.18%(<±1%Nom.val.)	0 ppmC
10	748 ppmC	748 ppmC	0 ppmC	0.00%(<±1%Nom.val.)	748 ppmC	749 ppmC	1 ppmC	0.13%(<±1%Nom.val.)	1 ppmC
11	935 ppmC	935 ppmC	0 ppmC	0.00%(<±1%Nom.val.)	935 ppmC	935 ppmC	0 ppmC	0.00%(<±1%Nom.val.)	0 ppmC

Reported by

MES TESTING & RESEARCH CENTER / N. Motubara

10

for Span Check
for Cal. Curve

（総数1頁）

JCSS
0013

証明書番号 11211061501

証 明 書

品　　名：一酸化窒素標準ガス(窒素希釈) 2級

容器記号番号：1J 10141

値付け結果：NO　2330 ppm
N2　BALANCE
不確かさ　(相対)±1.0% (k=2)

値付け方法：標準物質校正方法の規定に基づき、特定二次標準ガス(窒素希釈)を用いて値付けを実施

値付け年月日：平成23年11月21日

値付け結果は、上記に示すとおりであることを証明します。

発行日　平成23年12月1日

登録事業者　東京都町田市鶴間1557番地
（製造者）　高千穂化学工業株式会社

町田事業所 計測ガス工場

検査課課長　武笠 修二郎

****
この証明書は、計量法第144条(第一項)に基づくものであり、特定標準物質(国家標準)にトレーサブルな標準物質により校正した結果を示すものです。発行機関の事前の承認なしにこの証明書の一部分のみを複製して用いることは禁じられています。

11

for Span Check
for Cal. Curve
(総数1頁)

JCSS
0013

証明書番号 12202037901

証 明 書

品　　　名 : 酸素標準ガス(窒素希釈) 2級

容器記号番号 : 1FK-65693

値付け結果 : O2　23.33 %
N2　BALANCE
不確かさ　(相対)±1.0% (k=2)

値付け方法 : 標準物質校正方法の規定に基づき、特定二次標準ガス(窒素希釈)を用いて値付けを実施

値付け年月日 : 平成24年3月13日

値付け結果は、上記に示すとおりであることを証明します。

発行日　平成24年3月22日

登録事業者　東京都町田市鶴間1557番地
(製造者)　**高千穂化学工業株式会社**
町田事業所　計測ガス工場

検査課課長　武笠　修二郎 (武笠)

****
この証明書は、計量法第144条(第一項)に基づくものであり、特定標準物質(国家標準)にトレーサブルな標準物質により校正した結果を示すものです。発行機関の事前の承認なしにこの証明書の一部分のみを複製して用いることは禁じられています。

for Span Check

（総数1頁）

JCSS
0013

証明書番号 11206069801

証 明 書

品　　名 ： 二酸化炭素標準ガス（窒素希釈）2級

容器記号番号 ： 2BIS 8094

値付け結果 ： CO2　9.320 %
N2　BALANCE
不確かさ　（相対）±1.0% (k=2)

値付け方法 ： 標準物質校正方法の規定に基づき、特定二次標準ガス（窒素希釈）を用いて値付けを実施

値付け年月日 ： 平成23年6月29日

値付け結果は、上記に示すとおりであることを証明します。

発行日　平成23年7月12日

登録事業者　東京都町田市鶴間1557番地
（製造者）　**高千穂化学工業株式会社**
町田事業所　計測ガス工場

検査課課長　武笠　修二郎

****

for Cal. Curve
(総数1頁)

JCSS
0013

証明書番号 12204015801

証 明 書

品　　名 ：二酸化炭素標準ガス(窒素希釈) 2級

容器記号番号：1J 66949

値付け結果：CO_2　9.289 %
N2　BALANCE
不確かさ　(相対)±1.0% (k=2)

値付け方法：標準物質校正方法の規定に基づき、特定二次標準ガス(窒素希釈)を用いて値付けを実施

値付け年月日：平成24年4月19日

値付け結果は、上記に示すとおりであることを証明します。

発行日　平成24年5月2日

登録事業者　東京都町田市鶴間1557番地
(製造者)　高千穂化学工業株式会社
町田事業所　計測技術工場

検査課課長　武笠　修二郎

****
この証明書は、計量法第144条(第一項)に基づくものであり、特定標準物質(国家標準)にトレーサブルな標準物質により校正した結果を示すものです。発行機関の事前の承認なしにこの証明書の一部分のみを複製して用いることは禁じられています。

14

for Span Check
for Cal. Curve
（総数1頁）

JCSS
0013

証明書番号 12201077001

証 明 書

品　　　名 ：一酸化炭素標準ガス(窒素希釈) 2級

容器記号番号：GUA 73102

値付け結果：CO　936.4 ppm
N2　BALANCE
不確かさ　(相対)±1.0% (k=2)

値付け方法：標準物質校正方法の規定に基づき、特定二次標準ガス(窒素希釈)を用いて値付けを実施

値付け年月日：平成24年2月2日

値付け結果は、上記に示すとおりであることを証明します。

発行日　平成24年2月14日

登録事業者　東京都町田市鶴間1557番地
（製造者）　**高千穂化学工業株式会社**
町田事業所　計測ガス工場

検査課課長　武笠　修二郎

****

この証明書は、計量法第144条(第一項)に基づくものであり、特定標準物質(国家標準)にトレーサブルな標準物質により校正した結果を示すものです。発行機関の事前の承認なしにこの証明書の一部分のみを複製して用いることは禁じられています。

15

for Span Check
for Cal. Curve

(総数1頁)

JCSS
0013

証明書番号 12201077101

証 明 書

品　　　名 : プロパン標準ガス(エアー(AIR)希釈) 2級

容器記号番号 : 2BIS 54746

値付け結果 : C_3H_8　314.5 ppm
Air　BALANCE
不確かさ　(相対)±1.0% (k=2)

値付け方法 : 標準物質校正方法の規定に基づき、特定二次標準ガス(エアー(AIR)希釈)を用いて値付けを実施

値付け年月日 : 平成24年2月10日

値付け結果は、上記に示すとおりであることを証明します。

発行日　平成24年2月23日

登録事業者　東京都町田市鶴間1557番地
(製造者)　**高千穂化学工業株式会社**

町田事業所 計測ガス工場

検査課課長　武笠 修二郎

****
この証明書は、計量法第144条(第一項)に基づくものであり、特定標準物質(国家標準)にトレーサブルな標準物質により校正した結果を示すものです。発行機関の事前の承認なしにこの証明書の一部分のみを複製して用いることは禁じられています。

16

for Zero Check

for Cal. Curve

（総数1頁）

JCSS
0013

証明書番号 12201077301

証 明 書

品　　　名 : 酸素標準ガス(窒素希釈) 2級

容器記号番号 : GT 8261

値付け結果 : O2　20.27 %
N2　BALANCE
不確かさ　(相対)±1.0% (k=2)

値付け方法 : 標準物質校正方法の規定に基づき、特定二次標準ガス(窒素希釈)を用いて値付けを実施

値付け年月日 : 平成24年1月31日

値付け結果は、上記に示すとおりであることを証明します。

発行日　平成24年2月9日

登録事業者　東京都町田市鶴間1557番地
(製造者)　**高千穂化学工業株式会社**
町田事業所 計測ガス工場

検査課課長　武笠 修二郎

****
この証明書は、計量法第144条(第一項)に基づくものであり、特定標準物質(国家標準)にトレーサブルな標準物質により校正した結果を示すものです。発行機関の事前の承認なしにこの証明書の一部分のみを複製して用いることは禁じられています。

17

for Zero Check
for Cal. Curve

（総数1頁）

JCSS
0013

証明書番号 11211072001

証　明　書

品　　　名：零位調整用　標準ガス（発生源用）

容器記号番号：GS-66905

値付け結果：N2

CO　< 1.0PPM　NO+NO2 < 0.1PPM

CO2　< 1.0PPM　SO2　< 0.1PPM

CH4　< 0.5PPM

値付け方法：標準物質校正方法の規定に基づき、特定二次標準ガスを用いて値付けを実施

値付け年月日：平成23年12月5日

値付け結果は、上記に示すとおりであることを証明します。

発行日　平成23年12月8日

登録事業者　東京都町田市鶴間1557番地
（製造者）　**高千穂化学工業株式会社**

町田事業所　計測ガス工場

検査課課長　武笠　修二郎

****
この証明書は、計量法第144条（第一項）に基づくものであり、特定標準物質（国家標準）にトレーサブルな標準物質により校正した結果を示すものです。発行機関の事前の承認なしにこの証明書の一部分のみを複製して用いることは禁じられています。

RESULTS OF THERMOMETER CALIBRATION

CUSTOMER : Chemical Analysis Group of TRC　　DATE : Jul. 27th 2012　　SHEET No. 12TA-012

JOB No.　　PURPOSE : for NOx Measurement of D.E.　　MITSUI ENGINEERING & SHIPBUILDING CO., LTD.

TYPE OF THERMOMETER : Glass bar type thermometer

Manufacturer : YOSHINO KEIRYOUKI MFG. CO., LTD.

QUANTITY : 2

No.	Calibrated temp. (℃)	0.0	10.0	20.0	30.0	40.0	50.0	Range of temp. (℃)	Min. scale (℃)	Result
985039 (DRY)	Indicated temp.	0.1	10.2	20.0	30.0	40.1	50.0	-30 ～ 50	0.2	Good
	error (℃)	+0.1	+0.2	0.0	0.0	+0.1	0.0			
14629 (WET)	Indicated temp.	0.1	10.1	20.0	30.1	40.0	50.0	-30 ～ 50	0.2	Good
	error (℃)	+0.1	+0.1	0.0	+0.1	0.0	0.0			

Remarks	Applied Rule : Japanese Law of Measurement Permissible Error : ±0.4 (℃) Standard Instruments : Standard glass bar type thermometer No.2053

Chief of Material Testing Group
Tamano Testing Department
MES TESTING & RESEARCH CENTER CO., LTD.

Calibration of the Hyglometer

Manufacture	YOSHINO
Model	Glass bar type

Calibration data

			Calibration Data					
Date		Standard temp.(℃)	0.0	10.0	20.0	30.0	40.0	50.0
	14629	Indicated temp.(℃)	0.1	10.1	20.0	30.1	40.0	50.0
2012/7/27	(WET)	error(℃)	0.1	0.1	0.0	0.1	0.0	0.0
MES TESTING & RESEARCH CENTER / Inspector			N.Murayama					
Date		985039DRY temp.(℃)	0.0	10.0	20.0	30.0	40.0	50.0
	14629	Indicated temp.(℃)	0.1	10.0	20.1	30.0	40.0	50.0
	(WET)	Deviation(℃)	0.1	0.0	0.1	0.0	0.0	0.0
2012/8/31		error(℃)	0.2	0.2	0.1	0.0	0.1	0.0
MES TESTING & RESEARCH CENTER / Inspector			M. Kubota					
Date		985039DRY temp.(℃)						
	14629	Indicated temp.(℃)						
	(WET)	Deviation(℃)						
		error(℃)						
MES TESTING & RESEARCH CENTER / Inspector								
Date		Standard temp.(℃)						
	14629	Indicated temp.(℃)						
	(WET)	error(℃)						
MES TESTING & RESEARCH CENTER / Inspector								
Date		Standard temp.(℃)						
	14629	Indicated temp.(℃)						
	(WET)	error(℃)						
MES TESTING & RESEARCH CENTER / Inspector								
Date		985039DRY temp.(℃)						
	14629	Indicated temp.(℃)						
	(WET)	Deviation(℃)						
		error(℃)						
MES TESTING & RESEARCH CENTER / Inspector								
Date		985039DRY temp.(℃)						
	14629	Indicated temp.(℃)						
	(WET)	Deviation(℃)						
		error(℃)						
MES TESTING & RESEARCH CENTER / Inspector								
Date		Standard temp.(℃)						
	14629	Indicated temp.(℃)						
	(WET)	error(℃)						
MES TESTING & RESEARCH CENTER / Inspector								
Date		985039DRY temp.(℃)						
	14629	Indicated temp.(℃)						
	(WET)	Deviation(℃)						
		error(℃)						
MES TESTING & RESEARCH CENTER / Inspector								

2011.09 更新 4A

計量証明
~~DC~~ 9C

ガスメータ試験成績表

型　　式：DC-5C　　製造年月：2009 年 3 月
器物番号：20553　　試験年月：2009 年 3 月

試験結果

流　量	偏　差
1.2 m^3/h	-0.1 %
3.0 m^3/h	-0.5 %
m^3/h	%
m^3/h	%
m^3/h	%

本結果は標準仕様にて有効となります。

使用作業標準器
能　　力：計量室体積10L
器物番号：　538118

偏差使用方法
本試験成績表の裏面を参照下さい。

試験課	出荷判定
渡部	合

ガスメータ試験成績表に記載されている偏差は、所定流量と通過量を定め国家標準にトレーサブルな標準ガスメータとの比較試験から得られた値です。

上記の偏差は、使用ガスや環境により異なる場合があります。

弊社では、ガスメータ試験成績表の有効期限を特に定めておりません。
全てお客様のご判断によりますが、標準的には1～2年です。

SINAGAWA
株式会社 シナガワ
〒206-0811 東京都稲城市押立8-6-3番地
TEL 042-378-2210(代)　FAX 042-378-2416

ガスメーター器差校正表

型　　式：DC-2C　　製造年月：1999 年 9 月
器物番号：No, 10946　　校正年月：1999 年 9 月

器差校正表

流量(流速)	校正器差
0.6 m³/h	+0.1 %
1.2 m³/h	+0.3 %
m³/h	%
m³/h	%
m³/h	%

使用校正基準器
種　　類：基準ガスメーター
能　　力：計量室体積　5 L
器物番号：No, 529733

器差補正の方法
真実の量は表わす量から校正器差を減じて求める。

検査員	大谷

このガスメーター器差校正表は、規定の流速と通過量を定め、基準器と比較して正確に校正した成績です。尚、有効期限は原則として正常な雰囲気に於いて測定する気体が空気、燃料ガスを基準にして7年です。
但し、ガス質その他により大巾な精度低下があります。正確な精度維持のため、2年に1度当社工場の基準器と比較校正をして下さい。

SINAGAWA
株式会社 シナガワ 東京工場
〒206-0801 東京都稲城市大丸2 2 1 1番地
TEL 042－378－2210・FAX042－378－2416

天秤自主検査観測紙(特定計量器外)

(1)一般事項

製造業者	島津製作所	ひょう量レンジ	0 g～180 g	事業所名	㈱三造試験センター
型式	AEX-180	ひょう量	180 g	観測者	近藤浩二
器物番号	D404400295	目量の10倍	e= 1 mg	観測年月日	2012. 1. 17
設置場所	天秤室	目量	d= 0.1mg	分銅精度等級	F1級
				分銅証明書No.	第115239号　別紙コピー

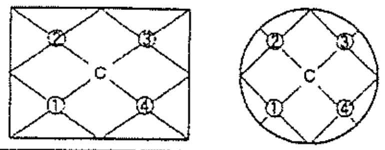
(2)外観及び機能検査

検査箇所	合否判定	検査箇所	合否判定	検査箇所	合否判定
表記・記号・形状	異常なし	風袋引きの機能	合・否	表示部の状態	合・否
水平器の状態	合・否	操作レバー、スイッチ	合・否	校正機能	合・否

(3)精度検査

① 感じ	零 (付近)	1.0	荷重なし	変位量 1mg	○	零、ひょう量の1/2、ひょう量、通常使用する量などの分銅を載せ、さらに 1mgの分銅を載せたとき、1mgの変位があるかを観測し、記録する。変位があれば○、スムースに動かなければ×　分銅の精度はF2, F1, E2のいずれでもよい。天秤が微量の重量変化に反応するかのチェック。
	ひょう量の1/2	1.0	100 g分銅使用	変位量 1mg	○	
	ひょう量	1.0	150 g分銅使用	変位量 1mg	○	
	(常用)	1.0	約30 gの 秤量びん	変位量 1mg	○	

				誤差(c)	公差(D)・基準等 (mg)	合否判定 ○ c≦D × c>D	
② 偏置誤差	C (中心)	x= 50000.7	—				四隅誤差:ひょう量の1/4程度の分銅を中心に載せ観測する[xmg]。下図の各点に分銅を移し観測する[ymg]。(y-x) mgを＊欄に記録する。 xを風袋消去した場合は各点の読値を＊欄に記録。
	1 (左前)	—	y_1= 50000.7	＊ 0.0	D=3e 3	○	
	2 (左後)	—	y_2= 50000.7	＊ 0.0	D=3e 3	○	
	3 (右後)	—	y_3= 50000.7	＊ 0.0	D=3e 3	○	
	4 (右前)	—	y_4= 50000.8	＊ 0.1	D=3e 3	○	



試験項目		指示値 一表す量 A(mg)	分銅の器差 (協定値) B(mg)	器差(c) A+B(mg)	公差(D) ・基準等 (mg)	合否判定 ○ c≦D × c>D	検査方法、備考
③ 直線性	約 0% 0g		—	0.0	—	—	零を設定→荷重(50g)を載せる→指示値を読み取る→荷重を除く→零を確認し値を記録→零を設定・・・・以下(100g)、(150g)、(200g)の荷重で観測する。横軸に荷重、縦軸に測定値をとりプロットしたとき、理論上の直線からのずれが「偏り」。
	25 11 % 20 g	0.4 (零点変化 0.0 mg)	-0.058	0.342	D=3e 3	○	例1 410gの場合　50 100 150 200 250 300 350 / % 12 24 37 49 61 73 85
	50 28 % 50 g	0.8 (零点変化 0.0 mg)	-0.043	0.757	D=3e 3	○	例2 310gの場合　50 100 150 200 250 300 350 / % 16 32 48 65 81 97 -
	75 56 % 100 g	0.8 (零点変化 0.0 mg)	-0.03	0.77	D=3e 3	○	
	100 83 % 150 g	-0.5 (零点変化 0.0 mg)	-0.073	-0.573	D=3e 3	○	

④ 繰り返し性	1 回目	0.8 (零点変化 0.0 mg)	-0.043	0.757	D=3e 3	○	零を設定→荷重(例50g)を載せる→指示値を読み取る→荷重を除く→零を確認し値を記録→零を設定・・・・以上を3回以上繰り返す。
	2 回目	0.6 (零点変化 0.0 mg)	-0.043	0.557	D=3e 3	○	参考 : 特定計量器の場合
	3 回目	0.7 (零点変化 0.0 mg)	-0.043	0.657	D=3e 3	○	精度等級 Ⅰ級　0 ≦m≦ 50000 D= e　50000 <m≦ 200000 D=2e　200000 <m D=3e
	(4 回目)	0.6 (零点変化 0.0 mg)	-0.043	0.557	D=3e 3	○	精度等級 Ⅱ級　0 ≦m≦ 5000 D= e　5000 <m≦ 20000 D=2e　20000 <m≦ 100000 D=3e
	(5 回目)	0.6 (零点変化 0.0 mg)	-0.043	0.557	D=3e 3	○	②③④の判定基準は上表のとおり。
	(6 回目)	(零点変化 mg)			D=3e		(例)分銅 M= 2 g を使用したとき m=M/e を計算すると m=
	(7 回目)	(零点変化 mg)			D=3e		零点変化の判定基準は 3e
	(8 回目)	(零点変化 mg)			D=3e		
	(9 回目)	(零点変化 mg)			D=3e		
	(10 回目)	(零点変化 mg)			D=3e		
	使用分銅 50 g		標準偏差 σ= 0.0894		3σ= 0.268		

総合判定	合格・不合格	不合格の場合の処置 : (廃棄・修理・調整・清掃・環境改善・用途限定・)	計量士 印

この観測紙は、目量が 0.1mg 又は 0.01mg である電子天秤の自主検査用です。レンジ切り替えのある機種はそれぞれに作成する。
観測項目や公差、基準は一般的なものである。天秤の使用目的に応じて観測項目・方法及び社内管理基準を定める。
値の読み取りは、安定を表示(安全マーク表示など)後一定時間(**秒)後に読み取るようにする。

Calibration Results NO.3 Control Room

APPROVED: T. Era

Temp.

MODEL	CS1W-PTS56	MANUFACTURER	OMRON
CAL. SECTION	Testing group		
RANGE	0～660℃	TOLERANCE	±2℃
CALIBRATOR	ALTEK CALIBRATOR MODEL11-250JIS		

NAME	MODEL	CALIBRATION RESULTS(℃)			DATE OF CALIBRATION	INSPECTOR
		0	50	75		
F.O.	CS1W-PTS56	0.0	50.0	75.1	2012/8/24	T.Kimoto
F.W. High	CS1W-PTS56	0.0	50.0	75.0	2012/8/24	T.Kimoto
F.W. Low	CS1W-PTS56	0.0	50.0	75.0	2012/8/24	T.Kimoto
SCAV	CS1W-PTS56	0.0	50.0	75.1	2012/8/24	T.Kimoto
L.O.	CS1W-PTS56	0.0	50.0	75.0	2012/8/24	T.Kimoto

Press.

MODEL	CS1W-AD081-V1	MANUFACTURER	OMRON
CAL. SECTION	Testing group		
RANGE	0～0.6MPa, 0～1.5MPa	TOLERANCE	±0.02MPa
CALIBRATOR	NESS 799218		

NAME	MODEL	CALIBRATION RESULTS(℃)			DATE OF CALIBRATION	INSPECTOR
		0	0.2/0.5(*1)	0.4/1.0(*1)		
F.O. (*1)	CS1W-AD081-V1	0	0.50	1.00	2012/8/24	T.Kimoto
F.W. High	CS1W-AD081-V1	0	0.20	0.40	2012/8/24	T.Kimoto
F.W. Low	CS1W-AD081-V1	0	0.21	0.40	2012/8/24	T.Kimoto
L.O.	CS1W-AD081-V1	0	0.20	0.40	2012/8/24	T.Kimoto

T/C exh. gas outlet temp.

MODEL	Model:3114	MANUFACTURER	TSURUGA
CAL. SECTION	Testing Group		
RANGE	0～1000℃	TOLERANCE	±1%
CALIBRATOR	ALTEK CALIBRATOR MODEL22-K-1000		

NAME	MODEL	CALIBRATION RESULTS(℃)			DATE OF CALIBRATION	INSPECTOR
		0	150	300		
Exh. Gas	MODEL:3114	0	150	300	2012/8/24	T.Kimoto

Engine revolution counter

MODEL	H7EC-BM	MANUFACTURER	OMRON
CAL. SECTION	Testing Group		
RANGE	0～150rpm	TOLERANCE	±1%
CALIBRATOR	universal counter TC110		

NAME	MODEL	CALIBRATION RESULTS(rpm)			DATE OF CALIBRATION	INSPECTOR
		50	100	150		
Rev. counter	H7EC-BM	50.0	100.0	150.0	2012/8/24	T.Kimoto

Calibration Results of Measuring Equipments (1/2)

APPROVED: J. Era

Handy manometer

MODEL	PG-100	MANUFACTURER	COPAL ELECTRONICS
CAL. SECTION	Testing Group		
RANGE	0～0.4MPa	TOLERANCE	<2% (0.01MPa)
CALIBRATOR	NESS 3D		

NAME	No.	CALIBRATION RESULTS (MPa)			DATE OF CALIBRATION	INSPECTOR
		0.15	0.25	0.40		
SCAV. Press.	DE-HM1	0.150	0.250	0.400	2012/7/13	T. Hirota
	DE-HM2	0.150	0.250	0.400	2012/7/13	T. Hirota
	DE-HM3	0.150	0.250	0.400	2012/7/13	T. Hirota
	DE-HM4	0.150	0.250	0.400	2012/7/13	T. Hirota
	DE-HM5	0.150	0.250	0.400	2012/7/13	T. Hirota

Stop watch

MODEL	S031-4000 etc	MANUFACTURER	SEIKO
CAL. SECTION	test group		
---	---	TOLERANCE	<2 sec/hour
CALIBRATOR	time signal (telephone)		

NAME	No.	CALIBRATION RESULTS (min)			DATE OF CALIBRATION	INSPECTOR
		10	20	30		
Engine Rev. F.O. Tank	DE-ST1	10'00"04	20'00"10	30'00"12	2012/7/13	T. Hirota
	DE-ST2	10'00"06	20'00"03	30'00"17	2012/7/13	T. Hirota
	DE-ST3	10'00"02	20'00"05	30'00"03	2012/7/13	T. Hirota
	DE-ST4	10'00"05	20'00"08	30'00"10	2012/7/13	T. Hirota
	DE-ST5	10'00"07	20'00"07	30'00"08	2012/7/13	T. Hirota
	DE-ST6	10'00"04	20'00"08	30'00"14	2012/7/13	T. Hirota
	DE-ST7	10'00"05	20'00"08	30'00"05	2012/7/13	T. Hirota
	DE-ST8	10'00"02	20'00"06	30'00"09	2012/7/13	T. Hirota
	DE-ST9	10'00"04	20'00"05	30'00"03	2012/7/13	T. Hirota
	DE-ST10	10'00"07	20'00"04	30'00"12	2012/7/13	T. Hirota
	DE-ST11	10'00"04	20'00"10	30'00"16	2012/7/13	T. Hirota
	DE-ST12	10'00"04	20'00"05	30'00"06	2012/7/13	T. Hirota

Calibration Results of Measuring Equipments (2/2)

APPROVED: T. Era

T/C intake air temp.

MODEL	HA-100K	MANUFACTURER	ANRITSU
CAL. SECTION	Testing Group		
RANGE	-200～1200℃	TOLERANCE	<2℃
CALIBRATOR	ALTEK CALIBRATOR MODEL22-K-1000		

NAME	No.	CALIBRATION RESULTS(℃)			DATE OF CALIBRATION	INSPECTOR
		0	50	100		
Intake air	HA-100K-1	0.0	50.0	100.0	2012/7/13	T. Hirota
	HA-100K-2	0.0	50.0	100.0	2012/7/13	T. Hirota
	HA-100K-3	0.0	50.0	100.0	2012/7/13	T. Hirota
	HA-100K-4	0.0	50.0	100.0	2012/7/13	T. Hirota
	HA-100K-5	0.0	50.0	100.0	2012/7/13	T. Hirota

F. O. drain

MODEL	H5CR/H5CX	MANUFACTURER	OMRON
CAL. SECTION	Testing Group		
---	---	TOLERANCE	<2 sec /hour
CALIBRATOR	time signal(telephone)		

NAME	MODEL	CALIBRATION RESULTS(min)			DATE OF CALIBRATION	INSPECTOR
		10	20	30		
TIMER	DE-DR1	10'00"06	20'00"10	30'00"06	2012/7/13	T. Hirota
	DE-DR2	---	---	---	---	---
	DE-DR3	10'00"04	20'00"08	30'00"06	2012/7/13	T. Hirota
	DE-DR4	10'00"03	20'00"15	30'00"06	2012/7/13	T. Hirota
	DE-DR5	10'00"04	20'00"09	30'00"08	2012/7/13	T. Hirota
	DE-DR6	10"00"04	20'00"09	30'00"15	2012/7/13	T. Hirota
	DE-DR7	10'00"05	20'00"05	30'00"10	2012/7/13	T. Hirota
	DE-DR8	10'00"03	20'00"05	30'00"09	2012/7/13	T. Hirota
	DE-DR9	---	---	---	---	---

CALIBRATION RESULT OF BALANCER

TYPE: PL-LLC2 (No.3)

Date of calibration 2012/06/04

Result :

Next calibration 2012/12/03

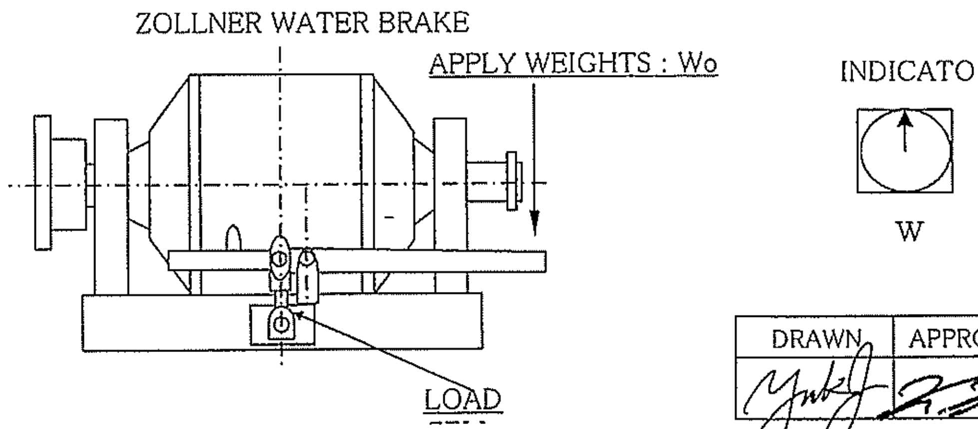
	STANDARD WEIGHT PUT ON BALANCER	READING OF BALANCER	DIFFERENCE 1 Wo-W1	DIFFERENCE 2 $\frac{Wo-W1}{Wo}$
	Wo (kg)	W1 (kg)	(kg)	(%)
1	0	0	0.0	0
2	200.03	200	0.030	0.01
3	400.95	401	-0.050	-0.01
4	601.92	602	-0.080	-0.01
5	803.11	803	0.110	0.01
6	1004.2	1004	0.200	0.02
7	1205.22	1205	0.220	0.02

TESTING SECTION : DRAWN H. Tochimoto APPROVED J. Era

RESULT OF CALIBRATION FOR WATER BRAKE

TYPE	PLACE	DATE	DATE OF VALIDITY
WB-7.5-0-10	NO. 4B TEST BED	Jul. 18, 2012	Oct. 17, 2012

	WEIGHT	THEORETICAL	INDICATOR	ERROR	ERROR	TOLERANCE	
	W0 kg	W1 kNm	W2 kNm	W1-W2 kNm	$\frac{W1-W2}{W1}$ %	W1-W2≦±42.0kNm (≦±1% of full scale)	
1	0	0	1	-1.00	0.00		
2	100	150	150	0.00	0.00		
3	200	300	300	0.00	0.00		
4	300	450	450	0.00	0.00		
5	400	600	600	0.00	0.00		
6	500	750	750	0.00	0.00		
7	600	900	900	0.00	0.00		
8	700	1050	1050	0.00	0.00		
9	800	1200	1200	0.00	0.00		
10	900	1350	1351	-1.00	-0.07		
11	1000	1500	1501	-1.00	-0.07		
12	1100	1650	1651	-1.00	-0.06		
13	1200	1800	1801	-1.00	-0.06		



DRAWN	APPROVED
[signature]	[signature]

CALIBRATION RECORD OF BAROMETER

Object	: Pressure gauge (Aneroid barometer)
Serial number	: 16373
Manufacturer	: OTA KEIKI SEISAKUSHO
Calibration method	: Compared with the standard barometer
Calibration condition	: Gauge pressure
Place of calibration	: MITSUI ENGINEERING & SHIPBUILDING CO., LTD. 1-1,Tama 3-chome,Tamano,Okayama 706-8651,Japan Diesel engine factory No.3 control room
Calibration date	: Apr.18,2012

Record

Indicated value of the standard barometer	Indicated value	Difference	Allowance (IMO Nox technical code)	Room temp.	Results
hPa	hPa	hPa	hPa	℃	
1015.9	1016.4	-0.5	±1	17.5	Good

Approved

Inspector

H. Tochimoto

MITSUI ENGINEERING & SHIPBUILDING CO.,LTD.
Diesel engine test group
Quality assurance department
Machinery factory

27/E

Enclosure 3

TEST RESULTS OF FUEL OIL

JOB No. 2H0160
DOC No. O-2207

DATE : 4 Oct 2012

Name of Sample		TE3P46 F.O.	(Analytical Method)
Density(15°C)	g/cm3	0.8355	JIS K 2249
Calorific Value L.	J/g	42820	JIS K 2279
Viscosity(50°C)	mm2/s	2.595	JIS K 2283
Flash Point(P.M)	°C	70	JIS K 2265
Water by Dist.	wt%	<0.05	JIS K 2275
Ash	wt%	<0.01	JIS K 2272
Sulphur	wt%	0.08	JIS K 2541
Carbon	wt%	86.0	JIS M 8813
Hydrogen	wt%	13.7	JIS M 8813
Nitrogen	wt%	<0.01	JIS M 8813
Oxygen	wt%	0.22	JIS M 8813
Con. Carbon Residue(10%)	wt%	0.39	JIS K 2270
Cetane Index		56.9	JIS K 2280

Notes : Date of Sampling : 26 Sep 2012

K. Kimura

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

Enclosure 3

1

TEST RESULTS OF FUEL OIL

JOB No. 2H0259
DOC No. O-2291

DATE : 21 Dec 2012

Name of Sample		TE3P46 F.O.	(Analytical Method)
Density(15°C)	g/cm3	0.8333	JIS K 2249
Calorific Value L.	J/g	42740	JIS K 2279
Viscosity(50°C)	mm2/s	2.666	JIS K 2283
Flash Point(P.M)	°C	72	JIS K 2265
Water by Dist.	wt%	<0.05	JIS K 2275
Ash	wt%	<0.01	JIS K 2272
Sulphur	wt%	0.07	JIS K 2541
Carbon	wt%	86.2	JIS M 8813
Hydrogen	wt%	13.5	JIS M 8813
Nitrogen	wt%	<0.01	JIS M 8813
Oxygen	wt%	0.23	JIS M 8813
Con. Carbon Residue(10%)	wt%	0.38	JIS K 2270
Cetane Index		58.7	JIS K 2280

Notes : Date of Sampling : 27 Sep 2012

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

TEST RESULTS OF FUEL OIL

JOB No. 2H0259
DOC No. O-2292

DATE : 21 Dec 2012

Name of Sample		TE3P46 F.O.	(Analytical Method)
Density(15°C)	g/cm3	0.8336	JIS K 2249
Calorific Value L.	J/g	42740	JIS K 2279
Viscosity(50°C)	mm2/s	2.648	JIS K 2283
Flash Point(P.M)	°C	71	JIS K 2265
Water by Dist.	wt%	<0.05	JIS K 2275
Ash	wt%	<0.01	JIS K 2272
Sulphur	wt%	0.07	JIS K 2541
Carbon	wt%	86.3	JIS M 8813
Hydrogen	wt%	13.5	JIS M 8813
Nitrogen	wt%	<0.01	JIS M 8813
Oxygen	wt%	0.13	JIS M 8813
Con. Carbon Residue(10%)	wt%	0.38	JIS K 2270
Cetane Index		58.5	JIS K 2280

Notes : Date of Sampling : 28 Sep 2012

K. Kemura

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

To:Mitsui Engineering & Shipbuilding Co., Ltd.

RESULTS OF CHEMICAL ANALYSIS

Entry date: 11 Dec 2012 JOB No. 2H0259
Report date: 11 Jan 2013 DOC No. O-2293

Name	TEST RESULTS OF LUBRICANT OIL		
Sample name	26 Sep 2012 Cylinder Oil		
Item	**Unit**	**Result**	**Method**
Acid number	mgKOH/g	0.5	JIS K2501
Basic number	mgKOH/g	70.2	JIS K2501
Density (15℃)	g/cm3	0.9346	JIS K2249
Insolubles(pentane)	wt%	<0.05	ASTM D893
Insolubles(toluene)	wt%	<0.05	ASTM D893
Sulphur	wt%	0.87	JIS K2541
Viscosity (40℃)	mm2/s	224.1	JIS K2283
Carbon	wt%	81.5	JIS M8813
Hydrogen	wt%	12.2	JIS M8813
Destilation curves		attached sheet	ASTM D2887

K. Kimura

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

Version 7,3,0,0 サンプル：17124340

Instrument 1 ASTM D 2887 1

Sample name	: 28251		
Acquired on	: 12/27/2012 5:03:13 PM	Vial	: 6
Processed on	: 12/28/2012 9:29:00 AM	Injection	: 1
Sample type	: Sample	Sample (g)	: 0.0000
Method name	: D2887CAF	Solvent (g)	: 0.0000
Operator	: SVC	ISTD (g)	: 0.0000
Sequence name	: C:\Chem32\1\DATA\2121227F\2121227F 2012-12-27 11-46-53\2121227F.S		

Data File : 2121227F\2121227F 2012-12-27 11-46-53\006F0601.D\

General Variables

Used Blank	2121227F\2121227F 2012-12-27 11-46-53\001F0103.D\
Used BP calibrant	2121227F\2121227F 2012-12-27 11-46-53\002F0201.D\
Used Start elution (min)	0.040
Used End elution (min)	19.813
Total area	1511287

BP Distribution table - Percent

Recovered mass%	BP °C	Recovered mass%	BP °C	Recovered mass%	BP °C	Recovered mass%	BP °C
IBP	289.8	26.0	469.4	52.0	497.4	78.0	519.4
1.0	327.8	27.0	471.0	53.0	498.2	79.0	520.4
2.0	350.8	28.0	472.6	54.0	499.0	80.0	521.4
3.0	366.0	29.0	474.0	55.0	499.8	81.0	522.2
4.0	375.6	30.0	475.4	56.0	500.6	82.0	523.2
5.0	385.0	31.0	476.6	57.0	501.4	83.0	524.2
6.0	392.8	32.0	478.0	58.0	502.2	84.0	525.2
7.0	400.2	33.0	479.2	59.0	503.0	85.0	526.2
8.0	406.4	34.0	480.4	60.0	504.0	86.0	527.2
9.0	411.4	35.0	481.6	61.0	504.8	87.0	528.2
10.0	417.0	36.0	482.6	62.0	505.6	88.0	529.2
11.0	422.2	37.0	483.8	63.0	506.4	89.0	530.6
12.0	427.0	38.0	484.8	64.0	507.0	90.0	531.6
13.0	431.8	39.0	485.6	65.0	507.8	91.0	532.8
14.0	436.0	40.0	486.8	66.0	509.0	92.0	533.8
15.0	439.6	41.0	487.8	67.0	509.6	93.0	535.0
16.0	443.6	42.0	488.6	68.0	510.4	94.0	536.4
17.0	447.0	43.0	489.6	69.0	511.2	95.0	537.6
18.0	450.4	44.0	490.4	70.0	512.2	96.0	538.8
19.0	453.4	45.0	491.4	71.0	513.0	97.0	540.4
20.0	456.2	46.0	492.2	72.0	513.8	98.0	541.6
21.0	459.2	47.0	493.2	73.0	514.8	99.0	543.2
22.0	461.4	48.0	494.0	74.0	515.6	FBP	544.0
23.0	463.6	49.0	494.8	75.0	516.8		
24.0	465.6	50.0	495.6	76.0	517.4		
25.0	467.4	51.0	496.4	77.0	518.6		

Version 7,3,0,0

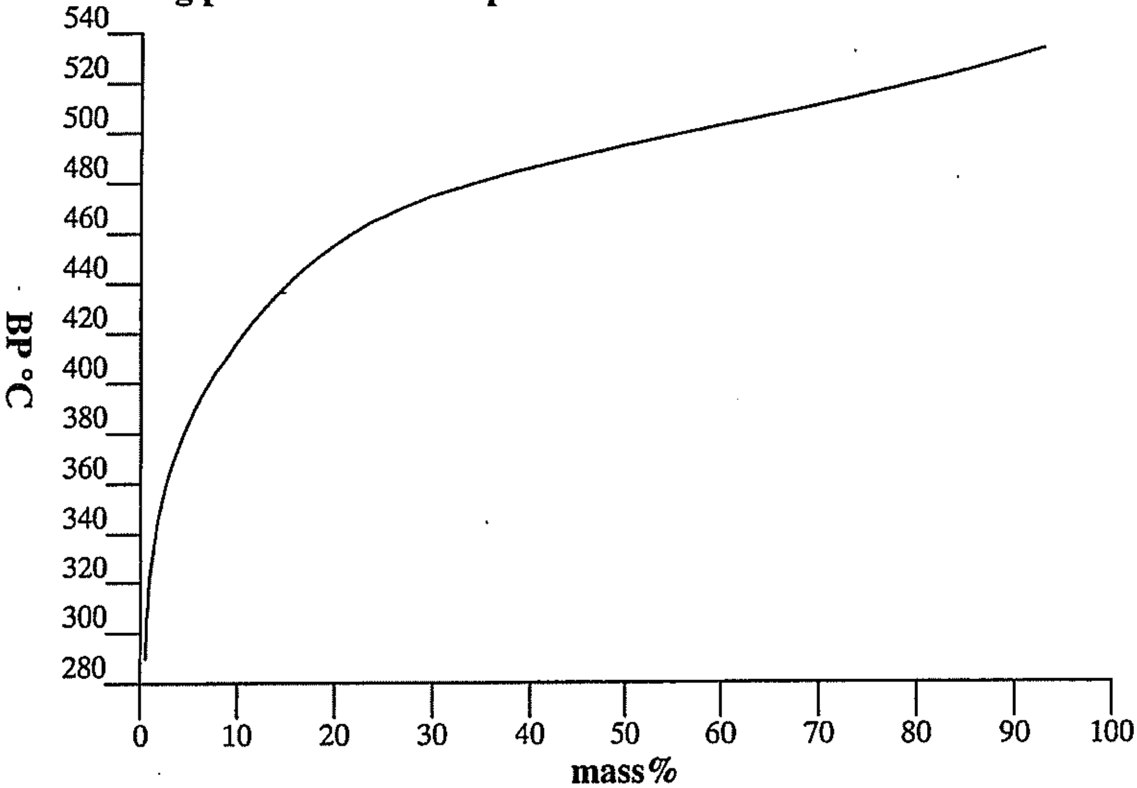
Instrument 1 ASTM D 2887 2

Sample name : 28251
Acquired on : 12/27/2012 5:03:13 PM Vial : 6
Processed on : 12/28/2012 9:29:00 AM Injection : 1
Data File : 2121227F\2121227F 2012-12-27 11-46-53\006F0601.D\

BP Distribution table - cut points

BP °C	Recovered mass%	Fraction mass%	BP °C	Recovered mass%	Fraction mass%	BP °C	Recovered mass%	Fraction mass%
36.0	0.0	0.0	316.0	0.7	0.2	458.0	20.7	3.1
69.0	0.0	0.0	330.0	1.1	0.4	466.0	24.2	3.5
98.0	0.0	0.0	344.0	1.7	0.5	474.0	29.1	4.9
126.0	0.0	0.0	356.0	2.3	0.6	481.0	34.7	5.6
151.0	0.1	0.0	369.0	3.3	1.0	489.0	42.4	7.7
174.0	0.1	0.0	380.0	4.4	1.1	496.0	50.4	8.0
196.0	0.1	0.0	391.0	5.7	1.3	503.0	59.0	8.6
216.0	0.2	0.0	402.0	7.3	1.6	509.0	66.3	7.3
235.0	0.2	0.1	412.0	9.1	1.8	516.0	74.4	8.1
254.0	0.4	0.1	422.0	11.0	1.9	522.0	80.7	6.4
271.0	0.4	0.1	431.0	12.9	1.9	528.0	86.8	6.1
287.0	0.5	0.1	440.0	15.1	2.2	534.0	92.2	5.4
302.0	0.6	0.1	449.0	17.6	2.6			

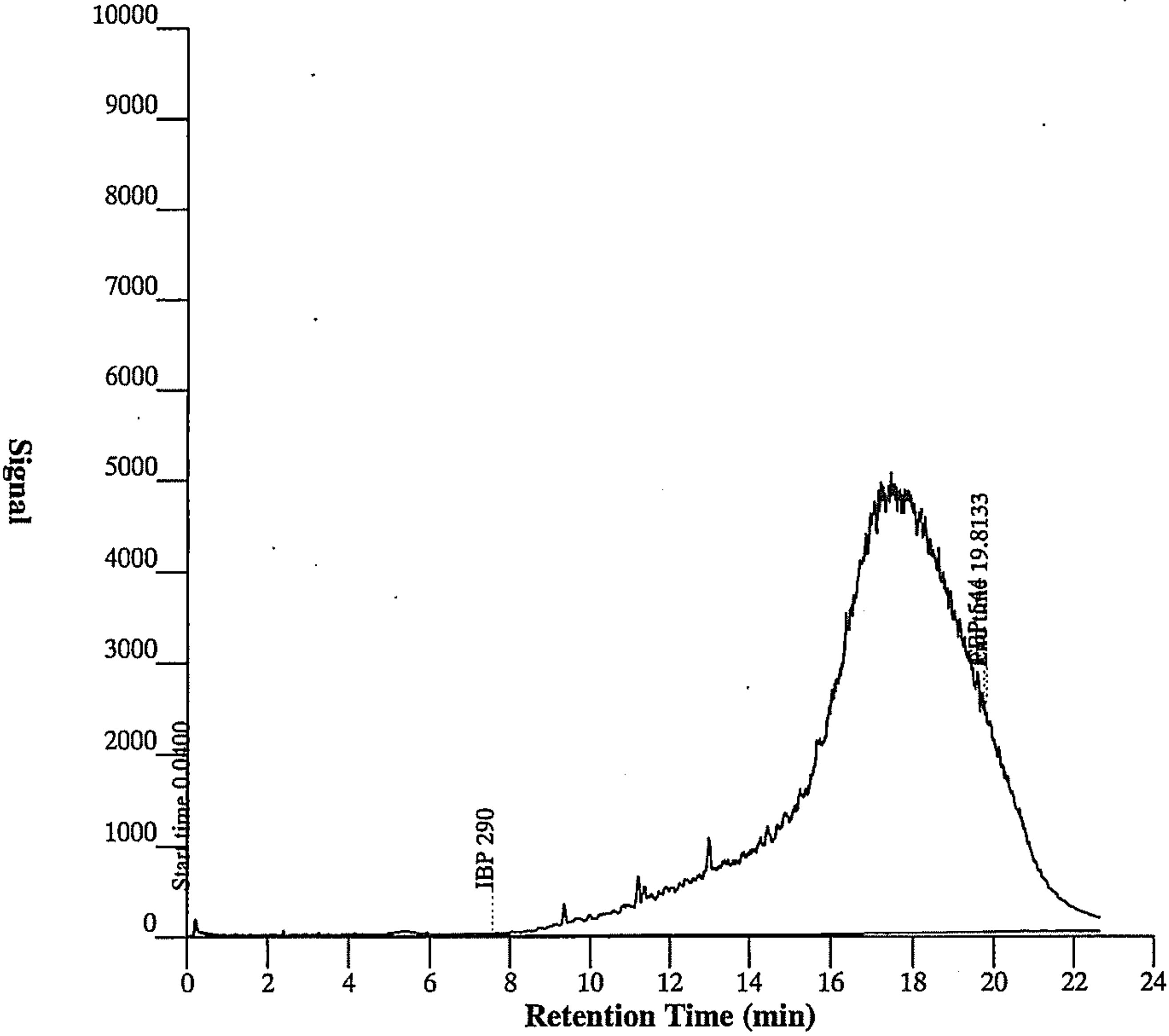
Boiling point distribution plot



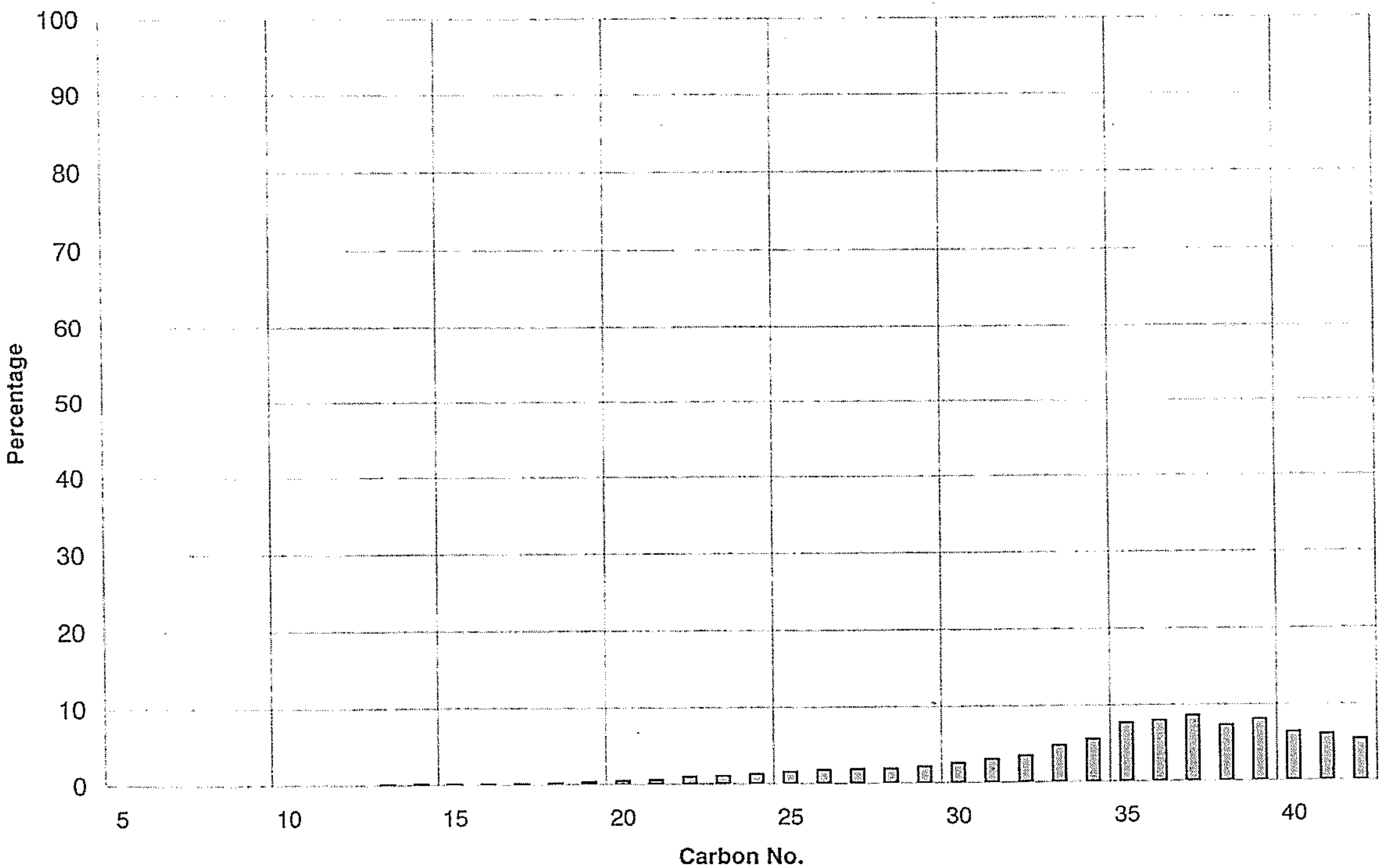
Version 7,3,0,0

Instrument 1 ASTM D 2887 · 3

Sample name	: 28251		
Acquired on	: 12/27/2012 5:03:13 PM	Vial	: 6
Processed on	: 12/28/2012 9:29:00 AM	Injection	: 1
Data File	: 2121227F\2121227F 2012-12-27 11-46-53\006F0601.D\		



DATE : 2012/12/28 SAMPLE : 28251 DATA : Simdis



DATE : 2012/12/28 SAMPLE : 28251 DATA : Simdis

Carbon No.	Temperature	Fraction		Carbon No.	Temperature	Fraction
5	36	0.0		24	391	1.3
6	69	0.0		25	402	1.6
7	98	0.0		26	412	1.8
8	126	0.0		27	422	1.9
9	151	0.0		28	431	1.9
10	174	0.0		29	440	2.2
11	196	0.0		30	449	2.6
12	216	0.0		31	458	3.1
13	235	0.1		32	466	3.5
14	254	0.1		33	474	4.9
15	271	0.1		34	481	5.6
16	287	0.1		35	489	7.7
17	302	0.1		36	496	8.0
18	316	0.2		37	503	8.6
19	330	0.4		38	509	7.3
20	344	0.5		39	516	8.1
21	356	0.6		40	522	6.4
22	369	1.0		41	528	6.1
23	380	1.1		42	534	5.4

9/E

Enclosure 4

/

Enclosure 4

TE3P46 Slide FV (Original C26)	Data Sheet No.	T01-1
Data Sheet of 10 % Load Test	Date 26-Sep-2012	Measured Time 8:15

Ambient Condition
Room Temp : 22.8 ℃ Barometric Press : 1017 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
42.2	424.6	1876	3.1	30	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.23	-	0.23	0.76	0.39	0.20	-
Temp (deg.C)	44		-	44	31	73	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		58.7	58.0	58.7	58.7	59.1	58.7	58.8		
Pcomp (bar)		40.2	40.2	40.2	40.0	40.0	40.4	40.3		
Pi (bar)		4.6	4.5	4.7	4.6	4.7	4.5	4.6		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.4		
	Pump Mark Index	43.0	43	43	43	43	43	43		
Exh. Gas Temp Cyl Outlet		206	204	210	206	209	202	205		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.5	46	46	46	47	47	47		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			0.32	0.32	
Temp. ℃	Air	In	42.4	42.4	
		Out	-	-	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air		
Press MPa	Temperature ℃	
0.014	36.1	
Exh. Gas Receive Press	0.010 MPa	
Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
194.1	194.6	194.4

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2450	26.9	0.04	229.0	213.9	0.13	44.0	48.0	-
No.1	2450	26.9	0.04	229.0	213.9	0.13	44.0	48.0	-
No.2									

F.O. Drain g/kWh 5.3 Thrust Temp. deg.C 46
C.O feed rate l/day.cyl 78.0

TE3P46	Slide FV (Original C26)	Data Sheet No.	T01-2
Data Sheet of	10 % Load Test	Date Measured Time	26-Sep-2012 9:15

Ambient Condition
Room Temp : 24.6 °C　Barometric Press : 1017 hPa　Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.2	424.6	1876	3.1	30	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.23	-	0.23	0.76	0.39	0.20	-
Temp (deg.C)	45		-	45	33	73	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		58.4	57.7	58.4	58.5	59.0	58.6	58.3		
Pcomp (bar)		40.1	40.1	40.0	39.9	39.9	40.2	40.2		
Pi (bar)		4.7	4.5	4.7	4.7	4.8	4.6	4.6		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	43.0	43	43	43	43	43	43		
Exh. Gas Temp Cyl Outlet		202	197	206	204	206	197	202		
C.F.W Temp Cyl. Outlet		75.7	75	75	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.8	46	47	47	47	47	47		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			0.32	0.32	
Temp. °C	Air	In	35.9	35.9	
		Out	-	-	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air		
Press MPa	Temperature °C	
0.013	36.3	
Exh. Gas Receive Press	0.009 MPa	
Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
194.0	194.5	194.2

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	2340	28.2	0.04	221.4	205.7	0.12	45.0	48.0	-
No.1	2340	28.2	0.04	221.4	205.7	0.12	45.0	48.0	-
No.2									

F.O. Drain g/kWh 5.4　　Thrust Temp. deg.C 46
C.O feed rate l/day.cyl 78.1

TE3P46	Slide FV (Original C26)	Data Sheet No.	T02-1
Data Sheet of	15 % Load Test	Date / Measured Time 10:15	26-Sep-2012

Ambient Condition
Room Temp : 24.8 °C Barometric Press : 1017 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	555.0	2813	3.9	34	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.23	–	0.23	0.76	0.39	0.21	–
Temp (deg.C)	45		–	45	34	72	26.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		64.2	63.5	63.8	64.3	64.8	64.5	64.2		
Pcomp (bar)		42.4	42.4	42.5	42.2	42.2	42.6	42.7		
Pi (bar)		5.9	5.8	6.0	5.9	6.0	5.8	5.8		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	48.2	48	48	48	49	48	48		
Exh. Gas Temp Cyl Outlet		245	243	249	246	247	242	244		
C.F.W Temp Cyl. Outlet		76.3	76	76	77	77	76	76		
P.C.O. Temp Cyl. Outlet		47.5	47	47	47	48	48	48		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	0.39	0.39	
Temp. °C	Air	In	41.4	41.4	
		Out	–	–	
	Water	In	26.9	26.9	
		Out	28	28	

Scavenging Air		
Press MPa	Temperature °C	
0.019	36	
Exh. Gas Receive Press	0.014 MPa	

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
189.5	190.0	189.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	3010	28.6	0.05	266.0	240.6	0.16	45.0	48.0	–
No.1	3010	28.6	0.05	266.0	240.6	0.16	45.0	48.0	–
No.2									

F.O. Drain g/kWh 3.7 Thrust Temp. deg.C 46
C.O feed rate l/day.cyl 91.2

TE3P46 Slide FV (Original C26)	Data Sheet No.	T02-2
Data Sheet of 15 % Load Test	Date 26-Sep-2012	Measured Time 11:15

Ambient Condition
Room Temp : 26.2 ℃ Barometric Press : 1016 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
48.4	554.6	2811	3.9	34	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.23	-	0.23	0.76	0.39	0.20	-
Temp (deg.C)	44		-	44	35	72	27	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		64.3	63.5	63.9	63.8	64.2	65.3	64.9		
Pcomp (bar)		42.4	42.4	42.4	42.2	42.2	42.6	42.6		
Pi (bar)		5.9	5.8	6.0	5.9	6.0	5.9	5.9		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	48.2	48	48	48	49	48	48		
Exh. Gas Temp Cyl Outlet		246	244	252	246	248	243	244		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.8	46	47	47	47	47	47		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	0.41	0.41	
Temp. ℃	Air	In	42.5	42.5	
		Out	-	-	
	Water	In	27	27	
		Out	28	28	

Scavenging Air	
Press MPa	Temperature ℃
0.020	36
Exh. Gas Receive Press	0.015 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
189.5	190.0	189.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	3050	28.7	0.05	268.4	244.3	0.16	44.0	48.0	-
No.1	3050	28.7	0.05	268.4	244.3	0.16	44.0	48.0	-
No.2									

F.O. Drain g/kWh 3.8 Thrust Temp. deg.C 46
C.O feed rate l/day.cyl 91.2

TE3P46	Slide FV (Original C26)	Data Sheet No.	T03-1

Data Sheet of 25 % Load Test — Date 26-Sep-2012, Measured Time 12:15

Ambient Condition
Room Temp : 25.6 ℃ Barometric Press : 1016 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
57.3	775.8	4655	5	42	―

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	-	0.23	0.75	0.39	0.20	-
Temp (deg.C)	45		-	45	35	72	27.1	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		77.9	77.1	77.3	78.3	78.0	78.5	78.2		
Pcomp (bar)		50.4	50.4	50.6	50.1	50.2	50.5	50.8		
Pi (bar)		8.2	8.1	8.3	8.2	8.3	8.2	8.1		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	58.5	58	58	58	59	59	59		
Exh. Gas Temp Cyl Outlet		287	281	292	294	286	281	285		
C.F.W Temp Cyl. Outlet		77.3	77	77	78	78	77	77		
P.C.O. Temp Cyl. Outlet		48.0	48	48	48	48	48	48		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			0.64	0.64	
Temp. ℃	Air	In	61.6	61.6	
		Out	-	-	
	Water	In	27.1	27.1	
		Out	29	29	

Scavenging Air

Press MPa	Temperature ℃
0.041	35.5
Exh. Gas Receive Press	0.031 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
187.8	188.3	187.9

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4570	31.6	0.10	311.7	270.3	0.37	45.0	52.0	-
No.1	4570	31.6	0.10	311.7	270.3	0.37	45.0	52.0	-
No.2									

F.O. Drain g/kWh 2.4 Thrust Temp. deg.C 46
C.O feed rate l/day.cyl 108.7

TE3P46	Slide FV (Original C26)	Data Sheet No.	T03-2
Data Sheet of	25 % Load Test	Date / Measured Time	26-Sep-2012 / 13:15

Ambient Condition

Room Temp : 25.6 ℃ Barometric Press : 1016 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
57.3	775.7	4655	5	41	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.23	-	0.23	0.76	0.39	0.20	-
Temp (deg.C)	44		-	44	34	72	27.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		78.2	77.7	77.1	78.4	79.1	78.3	78.4		
Pcomp (bar)		50.6	50.7	50.7	50.2	50.4	50.6	51.0		
Pi (bar)		8.2	8.2	8.3	8.2	8.3	8.2	8.1		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	58.5	58	58	58	59	59	59		
Exh. Gas Temp Cyl Outlet		288	284	294	294	287	282	287		
C.F.W Temp Cyl. Outlet		77.5	77	77	78	78	78	77		
P.C.O. Temp Cyl. Outlet		47.8	47	48	48	48	48	48		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	0.64	0.64	
Temp. ℃	Air	In	63.9	63.9	
		Out	-	-	
	Water	In	27.2	27.2	
		Out	29	29	

Scavenging Air	
Press MPa	Temperature ℃
0.041	35.7
Exh. Gas Receive Press	0.031 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
188.2	188.7	188.2

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4610	32.3	0.10	313.7	272.6	0.37	44.0	52.0	-
No.1	4610	32.3	0.10	313.7	272.6	0.37	44.0	52.0	-
No.2									

F.O. Drain g/kWh 2.3 Thrust Temp. deg.C 46

C.O feed rate l/day.cyl 108.7

TE3P46	Slide FV (Original C26)	Data Sheet No.	T04-1

Data Sheet of **50** % Load Test — Date 26-Sep-2012, Measured Time 14:15

Ambient Condition
Room Temp : 25.8 °C — Barometric Press : 1015 hPa — Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1237.3	9355	6.9	56	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.24	-	0.23	0.76	0.39	0.20	-
Temp (deg.C)	45		-	45	34	72	27.4	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		107.9	107.7	108.1	106.6	108.7	108.3	108.2		
Pcomp (bar)		79.3	79.4	79.9	78.7	78.9	79.0	79.9		
Pi (bar)		13.0	13.0	13.1	13.1	13.2	12.8	12.9		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	80.8	81	81	81	81	80	81		
Exh. Gas Temp Cyl Outlet		301	303	296	302	302	298	302		
C.F.W Temp Cyl. Outlet		79	79	79	79	79	79	79		
P.C.O. Temp Cyl. Outlet		50.0	50	50	50	50	50	50		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.08	1.08	
Temp. °C	Air	In	122.5	122.5	
		Out	-	-	
	Water	In	27.4	27.4	
		Out	34	34	

Scavenging Air

Press MPa	Temperature °C
0.120	31.8
Exh. Gas Receive Press	0.102 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
181.4	181.9	181.5

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	7600	31.1	0.25	347.7	255.9	1.33	45.0	56.0	-
No.1	7600	31.1	0.25	347.7	255.9	1.33	45.0	56.0	-
No.2									

F.O. Drain g/kWh 1.2 — Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 136.8

TE3P46	Slide FV (Original C26)	Data Sheet No.	T04-2
Data Sheet of	50 % Load Test	Date / Measured Time	26-Sep-2012 / 15:15

Ambient Condition
Room Temp : 26.4 °C   Barometric Press : 1015 hPa   Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
72.2	1238.2	9362	6.9	56	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	–	0.23	0.76	0.39	0.21	–
Temp (deg.C)	44		–	44	34	72	27.7	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	108.5	108.1	108.8	107.0	110.1	109.2	107.8		
Pcomp (bar)	79.7	79.9	80.5	78.9	79.2	79.4	80.4		
Pi (bar)	13.0	13.0	13.0	13.0	13.2	12.9	12.8		
Fuel Pump Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
Fuel Pump Pump Mark Index	81.0	81	80	81	82	81	81		
Exh. Gas Temp Cyl Outlet	301	304	298	300	300	299	303		
C.F.W Temp Cyl. Outlet	79	79	79	79	79	79	79		
P.C.O. Temp Cyl. Outlet	49.5	49	49	49	50	50	50		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	1.08	1.08	
Temp. °C	Air	In	125.2	125.2	
		Out	–	–	
	Water	In	27.7	27.7	
		Out	34	34	

Scavenging Air	
Press MPa	Temperature °C
0.122	32.3
Exh. Gas Receive Press	0.104 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
181.5	182.0	181.5

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min−1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	7620	31.2	0.25	348.0	255.5	1.31	44.0	56.0	–
No.1	7620	31.2	0.25	348.0	255.5	1.31	44.0	56.0	–
No.2									

F.O. Drain g/kWh 1.2   Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 137.1

TE3P46	Slide FV (Original C26)	Data Sheet No.	T05-1

Data Sheet of	75	% Load Test	Date 26-Sep-2012 Measured Time 16:45

Ambient Condition
Room Temp : 26.8 °C Barometric Press : 1015 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
82.7	1618.2	14014	8.3	71	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	–	0.23	0.75	0.39	0.21	–
Temp (deg.C)	45		–	45	34	72	27.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		134.2	133.7	134.4	132.9	134.3	135.3	134.6		
Pcomp (bar)		113.1	113.6	114.2	111.7	112.3	112.7	114.2		
Pi (bar)		16.9	17.1	17.2	16.7	16.8	16.8	16.7		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	100.3	100	101	100	101	100	100		
Exh. Gas Temp Cyl Outlet		319	320	321	321	316	316	322		
C.F.W Temp Cyl. Outlet		80	80	80	80	80	80	80		
P.C.O. Temp Cyl. Outlet		50.8	50	51	51	51	51	51		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.42	1.42	
Temp. °C	Air	In	173.4	173.4	
		Out	–	–	
	Water	In	27.9	27.9	
		Out	42	42	

Scavenging Air		
Press MPa	Temperature °C	
0.213	37.6	
Exh. Gas Receive Press	0.190 MPa	

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
178.7	179.2	178.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	9380	30.9	0.48	376.5	239.5	2.16	45.0	60.0	–
No.1	9380	30.9	0.48	376.5	239.5	2.16	45.0	60.0	–
No.2									

F.O. Drain g/kWh 0.8 Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 158.0

TE3P46 Slide FV (Original C26)	Data Sheet No.	T05-2
Data Sheet of 75 % Load Test	Date / Measured Time 17:45	26-Sep-2012

Ambient Condition
Room Temp : 26.8 °C   Barometric Press : 1015 hPa   Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
82.7	1618.5	14017	8.3	71	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	–	0.23	0.75	0.39	0.21	–
Temp (deg.C)	45		–	45	34	72	27.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		134.3	133.8	133.7	132.8	135.5	134.5	135.5		
Pcomp (bar)		113.2	113.8	114.1	112.0	112.6	112.5	114.1		
Pi (bar)		16.9	17.1	17.2	16.8	16.8	16.9	16.4		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	100.7	100	101	101	100	101	101		
Exh. Gas Temp Cyl Outlet		323	320	322	323	327	318	325		
C.F.W Temp Cyl. Outlet		80	80	80	80	80	80	80		
P.C.O. Temp Cyl. Outlet		50.8	50	51	51	51	51	51		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.42	1.42	
Temp. °C	Air	In	173.8	173.8	
		Out	–	–	
	Water	In	27.9	27.9	
		Out	42	42	

Scavenging Air	
Press MPa	Temperature °C
0.214	37.7
Exh. Gas Receive Press	0.191 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
179.2	179.7	179.2

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	9380	31.3	0.49	376.4	239.5	2.16	45.0	60.0	–
No.1	9380	31.3	0.49	376.4	239.5	2.16	45.0	60.0	–
No.2									

F.O. Drain g/kWh 0.7   Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 157.8

TE3P46	Slide FV (Original C26)	Data Sheet No.	T06-1

Data Sheet of 100 % Load Test — Date 26-Sep-2012, Measured Time 18:40

Ambient Condition
Room Temp : 27.0 °C — Barometric Press : 1015 hPa — Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
91.0	1961.6	18693	9.4	86	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	-	0.23	0.75	0.39	0.21	-
Temp (deg.C)	45		-	45	34	72	28.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		151.8	151.5	151.4	150.2	152.1	152.7	152.9		
Pcomp (bar)		142.7	143.8	143.5	140.8	141.8	142.5	143.9		
Pi (bar)		20.5	20.7	20.9	20.0	20.5	20.6	20.1		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	121.3	121	121	121	122	122	121		
Exh. Gas Temp Cyl Outlet		366	371	367	368	359	365	363		
C.F.W Temp Cyl. Outlet		82	82	82	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.5	53	53	53	54	54	54		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.57	1.57	
Temp. °C	Air	In	208.0	208	
		Out	-	-	
	Water	In	28.2	28.2	
		Out	48	48	

Scavenging Air

Press MPa	Temperature °C
0.292	43.4
Exh. Gas Receive Press	0.264 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
181.6	182.1	181.6

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	10540	31.3	0.69	432.8	263.2	3.14	45.0	62.0	-
No.1	10540	31.3	0.69	432.8	263.2	3.14	45.0	62.0	-
No.2									

F.O. Drain g/kWh 0.5 — Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 174.3

TE3P46	Slide FV (Original C26)	Data Sheet No.	T06-2

Data Sheet of	100	% Load Test	Date 26-Sep-2012 Measured Time 19:40

Ambient Condition
Room Temp : 26.0 °C Barometric Press : 1015 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
91.0	1961.4	18691	9.4	86	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.24	–	0.23	0.75	0.39	0.21	–
Temp (deg.C)	45		–	45	34	72	28.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		151.8	152.4	151.4	150.1	151.2	153.7	152.1		
Pcomp (bar)		142.2	143.4	143.2	140.1	141.6	141.9	142.9		
Pi (bar)		20.4	20.7	20.8	20.0	20.5	20.5	20.1		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	122.0	122	122	122	122	122	122		
Exh. Gas Temp Cyl Outlet		369	372	371	371	365	368	369		
C.F.W Temp Cyl. Outlet		82	82	82	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.2	53	53	53	53	54	53		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.57	1.57	
Temp. °C	Air	In	209.5	209.5	
		Out	–	–	
	Water	In	28.2	28.2	
		Out	48	48	

Scavenging Air		
Press MPa	Temperature °C	
0.293	44	
Exh. Gas Receive Press	0.265 MPa	

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
182.3	182.8	182.2

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	10560	32.2	0.69	433.1	263.9	3.14	45.0	62.0	–
No.1	10560	32.2	0.69	433.1	263.9	3.14	45.0	62.0	–
No.2									

F.O. Drain g/kWh 0.5 Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 174.7

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T07-1
Data Sheet of	10 % Load Test	Date Measured Time 10:30	27-Sep-2012

Ambient Condition
Room Temp : 24.8 °C   Barometric Press : 1015 hPa   Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
42.2	422.2	1866	3.1	27	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.26	–	0.25	0.75	0.42	0.20	–
Temp (deg.C)	44		–	44	33	73	26.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		57.4	57.3	57.1	57.7	57.6	57.3	57.1		
Pcomp (bar)		40.0	40.0	40.1	39.9	39.9	40.1	40.1		
Pi (bar)		4.6	4.6	4..7	4.6	4.6	4.5	4.6		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	38.0	38	38	38	38	38	38		
Exh. Gas Temp Cyl Outlet		211	210	217	211	210	210	210		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.0	46	46	46	46	46	46		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			0.32	0.32	
Temp. °C	Air	In	50.9	50.9	
		Out	–	–	
	Water	In	26.9	26.9	
		Out	28	28	

Scavenging Air

Press MPa	Temperature °C
0.014	37.3
Exh. Gas Receive Press	0.010 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
202.1	202.3	201.9

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	2440	29.7	0.06	236.0	221.6	0.12	44.0	48.0	–
No.1	2440	29.7	0.06	236.0	221.6	0.12	44.0	48.0	–
No.2									

F.O. Drain g/kWh 4.9   Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 80.7

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T07-2

Data Sheet of 10 % Load Test — Date 27-Sep-2012, Measured Time 11:30

Ambient Condition
Room Temp : 24.5 °C Barometric Press : 1015 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.2	423.0	1869	3.1	26	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.26	-	0.25	0.76	0.41	0.20	-
Temp (deg.C)	44		-	44	34	72	26.8	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	57.0	56.6	56.4	57.8	57.4	56.8	57.0		
Pcomp (bar)	39.8	39.8	39.8	39.7	39.6	39.9	39.9		
Pi (bar)	4.6	4.6	4.7	4.7	4.7	4.5	4.6		
Fuel Pump Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
Fuel Pump Pump Mark Index	38.0	38	38	38	38	38	38		
Exh. Gas Temp Cyl Outlet	207	203	211	207	206	204	208		
C.F.W Temp Cyl. Outlet	75	75	75	75	75	75	75		
P.C.O. Temp Cyl. Outlet	46.0	46	46	46	46	46	46		

Air Cooler

No.		Ave	1	2
Press. Drop kPa		0.32	0.32	
Temp. °C Air	In	36.8	36.8	
Temp. °C Air	Out	-	-	
Temp. °C Water	In	26.8	26.8	
Temp. °C Water	Out	28	28	

Scavenging Air

Press MPa	Temperature °C
0.013	36.8
Exh. Gas Receive Press	0.010 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
197.4	197.6	197.2

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	2340	30.6	0.05	222.9	208.2	0.12	44.0	48.0	-
No.1	2340	30.6	0.05	222.9	208.2	0.12	44.0	48.0	-
No.2									

F.O. Drain g/kWh 5 Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 81.1

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T08-1
Data Sheet of	15 % Load Test	Date / Measured Time	27-Sep-2012 / 12:30

Ambient Condition
Room Temp : 25.0 °C Barometric Press : 1014 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
48.4	555.0	2813	3.9	30	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.26	-	0.25	0.76	0.42	0.20	-
Temp (deg.C)	45		-	45	34	73	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		63.1	62.4	63.0	63.2	63.8	63.2	63.2		
Pcomp (bar)		42.3	42.3	42.4	42.1	42.1	42.4	42.6		
Pi (bar)		5.9	5.8	6.0	5..9	5.9	5.8	5.9		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	43.0	43	43	43	43	43	43		
Exh. Gas Temp Cyl Outlet		248	244	253	250	247	246	247		
C.F.W Temp Cyl. Outlet		76.3	76	76	77	77	76	76		
P.C.O. Temp Cyl. Outlet		47.0	47	47	47	47	47	47		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			0.40	0.40	
Temp. °C	Air	In	42.2	42.2	
		Out	-	-	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air	
Press MPa	Temperature °C
0.019	36.2
Exh. Gas Receive Press	0.014 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
192.8	193.0	192.6

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	2990	31.2	0.06	267.3	241.8	0.14	45.0	48.0	-
No.1	2990	31.2	0.06	267.3	241.8	0.14	45.0	48.0	-
No.2									

F.O. Drain g/kWh 3.3 Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 92.4

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T08-2

Data Sheet of 15 % Load Test — Date 27-Sep-2012, Measured Time 13:30

Ambient Condition
Room Temp : 56.6 °C — Barometric Press : 1013 hPa — Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	554.6	2811	3.9	30	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.26	-	0.25	0.76	0.42	0.21	-
Temp (deg.C)	45		-	45	34	73	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		63.5	63.1	63.3	64.2	63.8	63.6	63.2		
Pcomp (bar)		42.3	42.3	42.3	42.1	42.1	42.4	42.6		
Pi (bar)		6.0	5.8	6.1	6.1	6.0	6.0	5.9		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	43.0	43	43	43	43	43	43		
Exh. Gas Temp Cyl Outlet		249	246	255	251	248	247	247		
C.F.W Temp Cyl. Outlet		76.3	76	76	77	77	76	76		
P.C.O. Temp Cyl. Outlet		46.8	46	47	47	47	47	47		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			0.40	0.40	
Temp. °C	Air	In	43.5	43.5	
		Out	-	-	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air		
Press MPa	Temperature °C	
0.019	36.3	
Exh. Gas Receive Press	0.014 MPa	
Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
191.4	191.6	191.2

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	3030	31.7	0.06	271.0	246.5	0.14	45.0	48.0	-
No.1	3030	31.7	0.06	271.0	246.5	0.14	45.0	48.0	-
No.2									

F.O. Drain g/kWh 3.4 — Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 92.5

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T09-1

Data Sheet of	25	% Load Test	Date 27-Sep-2012 Measured Time 14:20

Ambient Condition
Room Temp : 26.2 °C   Barometric Press : 1013 hPa   Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
57.3	776.8	4661	5	38	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.25	-	0.25	0.76	0.42	0.21	-
Temp (deg.C)	45		-	45	34	72	27	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		75.1	75.0	74.2	75.3	75.3	75.6	75.2		
Pcomp (bar)		50.7	50.6	50.9	50.3	50.6	50.7	51.2		
Pi (bar)		8.1	8.1	8.2	8.1	8.1	8.1	8.1		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	54.2	54	54	54	55	54	54		
Exh. Gas Temp Cyl Outlet		289	285	292	289	286	289	290		
C.F.W Temp Cyl. Outlet		77	77	77	77	77	77	77		
P.C.O. Temp Cyl. Outlet		47.2	47	48	47	47	47	47		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	0.64	0.64	
Temp. °C	Air	In	62.8	62.8	
		Out	-	-	
	Water	In	27	27	
		Out	29	29	

Scavenging Air	
Press MPa	Temperature °C
0.041	35.6
Exh. Gas Receive Press	0.031 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
190.3	190.5	190.1

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	4580	31.5	0.10	314.6	273.0	0.36	45.0	50.0	-
No.1	4580	31.5	0.10	314.6	273.0	0.36	45.0	50.0	-
No.2									

F.O. Drain g/kWh 2.2   Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 110.0

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T09-2
Data Sheet of 25 % Load Test		Date 27-Sep-2012 Measured Time 15:20	

Ambient Condition
Room Temp : 26.4 ℃ Barometric Press : 1012 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
57.3	776.2	4658	5	39	—

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.25	0.25	-	0.25	0.76	0.42	0.21	-
Temp	(deg.C)	44		-	44	34	72	27	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		74.7	74.6	74.9	74.5	75.0	74.7	74.3		
Pcomp (bar)		50.5	50.4	50.9	50.1	50.3	50.4	51.0		
Pi (bar)		8.2	8.1	8.3	8.2	8.2	8.1	8.1		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	54.5	54	55	55	55	54	54		
Exh. Gas Temp Cyl Outlet		290	287	294	289	286	290	292		
C.F.W Temp Cyl. Outlet		77	77	77	77	77	77	77		
P.C.O. Temp Cyl. Outlet		47.5	47	47	47	48	48	48		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	0.64	0.64	
Temp. ℃	Air	In	64.7	64.7	
		Out	-	-	
	Water	In	27	27	
		Out	29	29	

Scavenging Air		
Press MPa	Temperature ℃	
0.041	35.8	
Exh. Gas Receive Press	0.032 MPa	

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
190.1	190.3	189.8

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4590	32.6	0.11	317.1	275.8	0.37	44.0	49.0	-
No.1	4590	32.6	0.11	317.1	275.8	0.37	44.0	49.0	-
No.2									

F.O. Drain g/kWh 2.2 Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 110.3

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T10-1
Data Sheet of	50 % Load Test	Date Measured Time 16:10	27-Sep-2012

Ambient Condition
Room Temp : 27.4 °C   Barometric Press : 1012 hPa   Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
72.2	1233.4	9325	6.9	54	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.26	0.26	-	0.25	0.76	0.42	0.21	-
Temp (deg.C)	45		-	45	35	72	27.6	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		106.7	106.3	106.9	106.3	107.8	106.2	106.6		
Pcomp (bar)		79.4	79.3	80.3	78.7	79.1	78.9	80.1		
Pi (bar)		13.0	13.0	13.1	13.0	13.1	12.9	12.9		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	76.8	77	76	77	78	77	76		
Exh. Gas Temp Cyl Outlet		303	308	302	298	299	298	310		
C.F.W Temp Cyl. Outlet		79	79	79	79	79	79	79		
P.C.O. Temp Cyl. Outlet		49.3	49	49	49	50	49	50		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	1.03	1.03	
Temp. °C	Air	In	123.4	123.4	
		Out	-	-	
	Water	In	27.6	27.6	
		Out	35	35	

Scavenging Air		
Press MPa	Temperature °C	
0.122	31.8	
Exh. Gas Receive Press	0.102 MPa	
Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
184.0	184.2	183.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	7630	31.3	0.25	351.6	259.9	1.32	45.0	56.0	-
No.1	7630	31.3	0.25	351.6	259.9	1.32	45.0	56.0	-
No.2									

F.O. Drain g/kWh 1.2   Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 139.2

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T10-2

Data Sheet of	50	% Load Test	Date: 27-Sep-2012	Measured Time: 17:10

Ambient Condition

Room Temp :	27.4 °C	Barometric Press :	1012 hPa	Humidity :	57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1232.3	9317	6.9	53	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.26	–	0.25	0.76	0.42	0.21	–
Temp (deg.C)	45		–	45	35	72	27.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		106.7	106.3	106.6	107.0	107.0	106.9	106.1		
Pcomp (bar)		79.9	79.8	80.6	79.2	79.6	79.4	80.6		
Pi (bar)		12.9	13.0	12.9	12.8	12.9	12.8	12.7		
Fuel Pump	Actuator Index	–	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	76.8	76	78	77	76	76	78		
Exh. Gas Temp Cyl Outlet		302	306	302	297	298	297	312		
C.F.W Temp Cyl. Outlet		79	79	79	79	79	79	79		
P.C.O. Temp Cyl. Outlet		49.2	49	49	49	49	49	50		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.06	1.06	
Temp. °C	Air	In	125.4	125.4	
		Out	–	–	
	Water	In	27.2	27.2	
		Out	35	35	

Scavenging Air

Press MPa	Temperature °C
0.121	31.8
Exh. Gas Receive Press	0.101 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
183.9	184.1	183.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	7630	31.2	0.26	351.8	259.0	1.35	45.0	56.0	–
No.1	7630	31.2	0.26	351.8	259.0	1.35	45.0	56.0	–
No.2									

F.O. Drain g/kWh 1.3
C.O feed rate l/day.cyl 139.4

Thrust Temp. deg.C 48

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T11-1
Data Sheet of 75 % Load Test		Date / Measured Time 17:50	27-Sep-2012

Ambient Condition
Room Temp : 26.5 °C Barometric Press : 1011 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
82.7	1616.7	14001	8.3	68	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.26	0.27	–	0.25	0.75	0.41	0.21	–
Temp (deg.C)	45		–	45	35	72	27.7	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		134.1	134.1	134.6	133.6	134.5	133.2	134.4		
Pcomp (bar)		113.2	113.8	114.0	112.1	112.5	112.3	114.3		
Pi (bar)		16.8	17.2	17.1	16.6	16.7	16.7	16.5		
Fuel Pump	Actuator Index	–	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	97.7	97	98	98	97	98	98		
Exh. Gas Temp Cyl Outlet		321	323	324	315	316	319	329		
C.F.W Temp Cyl. Outlet		80	80	80	80	80	80	80		
P.C.O. Temp Cyl. Outlet		50.8	50	51	51	51	51	51		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.37	1.37	
Temp. °C	Air	In	171.6	171.6	
		Out	–	–	
	Water	In	27.7	27.7	
		Out	41	41	

Scavenging Air	
Press MPa	Temperature °C
0.212	36.9
Exh. Gas Receive Press	0.187 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
179.8	180.0	179.5

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	9330	32.0	0.49	375.6	239.8	2.16	45.0	60.0	–
No.1	9330	32.0	0.49	375.6	239.8	2.16	45.0	60.0	–
No.2									

F.O. Drain g/kWh 0.7 Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 159.0

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T11-2
Data Sheet of	75 % Load Test	Date / Measured Time	27-Sep-2012 / 18:50

Ambient Condition

Room Temp : 26.5 °C — Barometric Press : 1011 hPa — Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
82.7	1618.1	14013	8.3	68	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.26	0.26	-	0.25	0.75	0.42	0.21	-
Temp (deg.C)	45		-	45	34	72	27.7	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		134.1	134.5	134.5	134.8	134.1	132.6	134.1		
Pcomp (bar)		113.7	114.2	114.5	112.5	113.0	113.0	114.9		
Pi (bar)		17.0	17.4	17.3	16.8	16.9	17.0	16.7		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	97.7	98	97	97	99	98	97		
Exh. Gas Temp Cyl Outlet		321	322	324	314	316	320	329		
C.F.W Temp Cyl. Outlet		80	80	80	80	80	80	80		
P.C.O. Temp Cyl. Outlet		50.8	50	51	51	51	51	51		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.42	1.42	
Temp. °C	Air	In	172.0	172	
		Out	-	-	
	Water	In	27.7	27.7	
		Out	41	41	

Scavenging Air	
Press MPa	Temperature °C
0.212	37.3
Exh. Gas Receive Press	0.189 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
180.2	180.4	179.9

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	9340	30.7	0.49	374.7	238.2	2.21	45.0	60.0	-
No.1	9340	30.7	0.49	374.7	238.2	2.21	45.0	60.0	-
No.2									

F.O. Drain g/kWh 0.7 — Thrust Temp. deg.C 48

C.O feed rate l/day.cyl 159.0

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T12-1
Data Sheet of	100 % Load Test	Date / Measured Time	27-Sep-2012 / 19:35

Ambient Condition
Room Temp : 26.2 ℃ Barometric Press : 1011 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
91.1	1961.6	18714	9.4	84	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.26	0.27	–	0.25	0.75	0.41	0.20	–
Temp	(deg.C)	46		–	46	33	72	28.1	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		150.6	151.2	150.6	150.3	151.3	151.0	149.0		
Pcomp (bar)		141.4	142.3	142.2	140.0	140.7	140.9	142.5		
Pi (bar)		20.6	21.0	21.0	20.2	20.5	20.6	20.2		
Fuel Pump	Actuator Index	–	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	119.5	119	119	120	120	120	119		
Exh. Gas Temp Cyl Outlet		367	373	368	362	360	369	367		
C.F.W Temp Cyl. Outlet		82	82	82	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.7	53	54	53	54	54	54		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.57	1.57	
Temp. ℃	Air	In	206.2	206.2	
		Out	–	–	
	Water	In	28.1	28.1	
		Out	48	48	

Scavenging Air

Press MPa	Temperature ℃
0.288	42.9
Exh. Gas Receive Press	0.261 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
181.6	181.8	181.3

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	10470	31.9	0.64	428.9	261.0	3.14	46.0	60.0	–
No.1	10470	31.9	0.64	428.9	261.0	3.14	46.0	60.0	–
No.2									

F.O. Drain g/kWh 0.5 Thrust Temp. deg.C 49
C.O feed rate l/day.cyl 175.8

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T12-2

Data Sheet of	100	% Load Test	Date	27-Sep-2012
			Measured Time	20:35

Ambient Condition

Room Temp : 25.8 °C　Barometric Press : 1011 hPa　Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.1	1962.0	18717	9.4	84	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.26	0.26	–	0.25	0.74	0.41	0.20	–
Temp (deg.C)	46		–	46	33	72	28.1	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		149.4	149.9	148.3	149.4	150.2	150.4	148.1		
Pcomp (bar)		141.3	142.3	142.2	139.6	140.6	141.0	142.2		
Pi (bar)		20.4	20.8	20.7	20.0	20.3	20.4	20.0		
Fuel Pump	Actuator Index	–	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	121.0	120	121	121	122	120	122		
Exh. Gas Temp Cyl Outlet		370	377	371	364	362	374	369		
C.F.W Temp Cyl. Outlet		82	82	82	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.5	53	53	53	54	54	54		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.57	1.57	
Temp. °C	Air	In	207.5	207.5	
		Out	–	–	
	Water	In	28.1	28.1	
		Out	48	48	

Scavenging Air

Press MPa	Temperature °C
0.289	43.6
Exh. Gas Receive Press	0.264 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
182.7	182.9	182.4

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	10510	31.5	0.69	430.1	262.1	3.29	46.0	62.0	–
No.1	10510	31.5	0.69	430.1	262.1	3.29	46.0	62.0	–
No.2									

F.O. Drain g/kWh 0.5　Thrust Temp. deg.C 49

C.O feed rate l/day.cyl 175.5

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T13-1

Data Sheet of	10	% Load Test	Date	28-Sep-2012
			Measured Time	9:00

Ambient Condition

Room Temp : 23.6 °C Barometric Press : 1011 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.1	422.7	1864	3.1	27	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	–	0.23	0.77	0.41	0.20	–
Temp (deg.C)	44		–	44	32	73	26.6	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		56.6	56.8	56.5	56.4	57.2	56.7	55.7		
Pcomp (bar)		39.9	39.9	40.0	39.8	39.8	40.1	40.0		
Pi (bar)		4.6	4.6	4.8	4.6	4.7	4.6	4.5		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	39.0	39	39	39	39	39	39		
Exh. Gas Temp Cyl Outlet		212	208	217	211	214	208	211		
C.F.W Temp Cyl. Outlet		75.7	75	75	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.2	46	46	46	46	46	47		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			0.32	0.32	
Temp. °C	Air	In	40.8	40.8	
		Out	–	–	
	Water	In	26.6	26.6	
		Out	28	28	

Scavenging Air

Press MPa	Temperature °C
0.014	36.3
Exh. Gas Receive Press	0.010 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
200.9	201.1	200.8

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	2400	29.0	0.04	228.8	213.9	0.09	44.0	48.0	–
No.1	2400	29.0	0.04	228.8	213.9	0.09	44.0	48.0	–
No.2									

F.O. Drain g/kWh 4.8 Thrust Temp. deg.C 47

C.O feed rate l/day.cyl 81.2

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T13-2
Data Sheet of	10 % Load Test	Date / Measured Time	28-Sep-2012 / 9:40

Ambient Condition

Room Temp :	23.6 ℃	Barometric Press :	1011 hPa	Humidity :	57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.2	423.4	1871	3.1	27	—

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.23	0.24	-	0.23	0.76	0.41	0.20	-
Temp	(deg.C)	44		-	44	33	72	26.6	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		56.7	56.7	56.8	56.5	57.5	56.8	56.1		
Pcomp (bar)		39.9	39.8	39.9	39.8	39.8	40.0	39.9		
Pi (bar)		4.7	4.6	4.8	4.6	4.8	4.6	4.6		
Fuel Pump	Actuator Index	-	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	39.3	39	40	39	40	39	39		
Exh. Gas Temp Cyl Outlet		212	211	216	211	214	207	211		
C.F.W Temp Cyl. Outlet		75	75	75	75	75	75	75		
P.C.O. Temp Cyl. Outlet		46.2	46	46	46	46	46	47		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.32	0.32	
Temp. ℃	Air	In	37.8	37.8	
		Out	-	-	
	Water	In	26.6	26.6	
		Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.013	36.2
Exh. Gas Receive Press	0.009 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
199.6	199.8	199.5

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2370	29.0	0.04	227.1	211.1	0.10	44.0	48.0	-
No.1	2370	29.0	0.04	227.1	211.1	0.10	44.0	48.0	-
No.2									

F.O. Drain g/kWh 4.8 Thrust Temp. deg.C 47

C.O feed rate l/day.cyl 80.5

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T14-1
Data Sheet of 15 % Load Test		Date / Measured Time	28-Sep-2012 / 10:35

Ambient Condition
Room Temp : 24.6 ℃   Barometric Press : 1011 hPa   Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	553.0	2803	3.9	31	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	-	0.23	0.77	0.41	0.20	-
Temp (deg.C)	45		-	45	33	72	26.6	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		62.2	62.1	62.4	62.5	62.8	62.1	61.4		
Pcomp (bar)		42.2	42.2	42.3	42.1	42.0	42.3	42.4		
Pi (bar)		5.8	5.7	6.0	5.8	5.9	5.8	5.8		
Fuel Pump	Actuator Index	-	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	44.0	44	44	44	44	44	44		
Exh. Gas Temp Cyl Outlet		252	247	258	253	253	249	250		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		47.0	47	47	47	47	47	47		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			0.41	0.41	
Temp. ℃	Air	In	42.6	42.6	
		Out	-	-	
	Water	In	26.6	26.6	
		Out	28	28	

Scavenging Air	
Press MPa	Temperature ℃
0.020	36
Exh. Gas Receive Press	0.015 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
194.4	194.6	194.3

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	3060	29.7	0.05	271.5	245.1	0.16	45.0	48.0	-
No.1	3060	29.7	0.05	271.5	245.1	0.16	45.0	48.0	-
No.2									

F.O. Drain g/kWh 3.2   Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 92.3

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T14-2

Data Sheet of	15	% Load Test	Date	28-Sep-2012
			Measured Time	11:15

Ambient Condition

Room Temp : 24.8 °C Barometric Press : 1010 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	553.4	2805	3.9	31	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	-	0.23	0.76	0.41	0.20	-
Temp (deg.C)	45		-	45	33	72	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		62.3	62.1	62.3	62.3	62.9	62.3	62.0		
Pcomp (bar)		42.4	42.4	42.5	42.2	42.1	42.5	42.6		
Pi (bar)		5.8	5.7	5.9	5.8	6.0	5.8	5.8		
Fuel Pump	Actuator Index	-	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	44.3	44	44	44	45	44	45		
Exh. Gas Temp Cyl Outlet		253	249	259	253	254	251	251		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.8	46	47	47	47	47	47		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			0.41	0.41	
Temp. °C	Air	In	43.8	43.8	
		Out	-	-	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air

Press MPa	Temperature °C
0.020	36.1
Exh. Gas Receive Press	0.015 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
194.1	194.3	193.9

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	3090	30.6	0.05	274.2	248.8	0.16	45.0	48.0	-
No.1	3090	30.6	0.05	274.2	248.8	0.16	45.0	48.0	-
No.2									

F.O. Drain g/kWh 3.4 Thrust Temp. deg.C 47

C.O feed rate l/day.cyl 92.4

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T15-1

Data Sheet of 25 % Load Test — Date 28-Sep-2012, Measured Time 12:20

Ambient Condition
Room Temp : 25.0 ℃ Barometric Press : 1009 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
57.3	776.1	4657	5	38	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	–	0.23	0.76	0.41	0.21	–
Temp (deg.C)	45		–	45	34	73	26.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		75.7	76.1	75.5	75.7	75.4	75.8	75.7		
Pcomp (bar)		51.0	51.1	51.2	50.7	50.8	50.9	51.4		
Pi (bar)		8.2	8.1	8.3	8.2	8.3	8.3	8.1		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
Fuel Pump	Pump Mark Index	54.7	55	55	55	54	54	55		
Exh. Gas Temp Cyl Outlet		292	285	299	294	293	290	293		
C.F.W Temp Cyl. Outlet		77	77	77	77	77	77	77		
P.C.O. Temp Cyl. Outlet		47.8	47	48	48	48	48	48		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			0.61	0.61	
Temp. ℃	Air	In	63.6	63.6	
Temp. ℃	Air	Out	–	–	
Temp. ℃	Water	In	26.9	26.9	
Temp. ℃	Water	Out	29	29	

Scavenging Air

Press MPa	Temperature ℃
0.045	35.7
Exh. Gas Receive Press	0.034 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
192.1	192.3	191.9

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4700	31.7	0.10	316.3	273.2	0.35	45.0	50.0	–
No.1	4700	31.7	0.10	316.3	273.2	0.35	45.0	50.0	–
No.2									

F.O. Drain g/kWh 2.2 Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 109.8

TE3P46 Conv. FV (313823-0 C11)	Data Sheet No.	T15-2
Data Sheet of 25 % Load Test	Date 28-Sep-2012	Measured Time 13:00

Ambient Condition
Room Temp : 25.2 °C Barometric Press : 1009 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
57.3	776.0	4656	5	38	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	-	0.23	0.76	0.41	0.20	-
Temp (deg.C)	45		-	45	33	72	27	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		75.5	75.7	75.3	75.5	75.7	75.4	75.4		
Pcomp (bar)		50.9	51.0	51.2	50.6	50.7	50.8	51.3		
Pi (bar)		8.2	8.1	8.4	8.2	8.3	8.2	8.1		
Fuel Pump	Actuator Index	-	3.3	2.5	3.4	3.4	3.0	1.9		
Fuel Pump	Pump Mark Index	55.0	55	55	55	55	55	55		
Exh. Gas Temp Cyl Outlet		293	286	299	295	294	291	295		
C.F.W Temp Cyl. Outlet		77	77	77	77	77	77	77		
P.C.O. Temp Cyl. Outlet		47.8	47	48	48	48	48	48		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			0.63	0.63	
Temp. °C	Air	In	65.5	65.5	
Temp. °C	Air	Out	-	-	
Temp. °C	Water	In	27	27	
Temp. °C	Water	Out	29	29	

Scavenging Air		
Press MPa	Temperature °C	
0.045	35.8	
Exh. Gas Receive Press	0.034 MPa	
Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
193.2	193.4	193.0

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	4740	31.4	0.10	317.6	275.0	0.37	45.0	50.0	-
No.1	4740	31.4	0.10	317.6	275.0	0.37	45.0	50.0	-
No.2									

F.O. Drain g/kWh 2.2 Thrust Temp. deg.C 47
C.O feed rate l/day.cyl 110.1

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T16-1

Data Sheet of **50** % Load Test — Date 28-Sep-2012, Measured Time 14:05

Ambient Condition
Room Temp : 26.2 °C — Barometric Press : 1008 hPa — Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1232.1	9316	6.9	54	----

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	–	0.24	0.76	0.41	0.22	–
Temp (deg.C)	45		–	45	34	72	27.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		107.0	107.4	106.6	106.8	107.3	107.2	106.4		
Pcomp (bar)		80.4	80.5	81.1	79.9	80.0	80.0	81.0		
Pi (bar)		12.8	12.8	12.9	12.8	12.9	12.8	12.7		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	77.0	77	77	77	77	77	77		
Exh. Gas Temp Cyl Outlet		306	303	308	304	308	301	310		
C.F.W Temp Cyl. Outlet		78	78	78	78	78	78	78		
P.C.O. Temp Cyl. Outlet		49.8	49	50	50	50	50	50		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.08	1.08	
Temp. °C	Air	In	125.0	125	
		Out	–	–	
	Water	In	27.2	27.2	
		Out	34	34	

Scavenging Air	
Press MPa	Temperature °C
0.124	31.7
Exh. Gas Receive Press	0.105 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
184.7	184.9	184.4

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	7700	31.8	0.27	351.7	257.2	1.37	45.0	56.0	–
No.1	7700	31.8	0.27	351.7	257.2	1.37	45.0	56.0	–
No.2									

F.O. Drain g/kWh 1.3 — Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 139.3

TE3P46 Conv. FV (313823-0 C11)	Data Sheet No.	T16-2
Data Sheet of 50 % Load Test	Date / Measured Time 14:45	28-Sep-2012

Ambient Condition
Room Temp : 26.8 ℃ Barometric Press : 1008 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1232.5	9319	6.9	54	——

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	-	0.23	0.76	0.41	0.20	-
Temp (deg.C)	45		-	45	34	72	27.3	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		107.3	107.7	106.3	106.7	107.3	107.7	107.9		
Pcomp (bar)		80.8	80.8	81.3	80.1	80.5	80.3	81.5		
Pi (bar)		13.0	12.9	13.0	12.9	13.1	13.1	13.0		
Fuel Pump	Actuator Index	-	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	77.5	77	78	78	78	77	77		
Exh. Gas Temp Cyl Outlet		307	303	307	308	308	302	311		
C.F.W Temp Cyl. Outlet		78.7	78	78	79	79	79	79		
P.C.O. Temp Cyl. Outlet		49.8	49	50	50	50	50	50		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.08	1.08	
Temp. ℃	Air	In	128.2	128.2	
		Out	-	-	
	Water	In	27.3	27.3	
		Out	35	35	

Scavenging Air		
Press MPa		Temperature ℃
0.125		31.8
Exh. Gas Receive Press		0.106 MPa
Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
184.9	185.1	184.6

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	7730	32.1	0.27	353.0	257.9	1.40	45.0	56.0	-
No.1	7730	32.1	0.27	353.0	257.9	1.40	45.0	56.0	-
No.2									

F.O. Drain g/kWh 1.3 Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 139.3

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T17-1

Data Sheet of **75** % Load Test — Date 28-Sep-2012, Measured Time 15:45

Ambient Condition
Room Temp : 27.5 °C Barometric Press : 1008 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
82.7	1617.8	14011	8.3	69	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	–	0.24	0.75	0.41	0.20	–
Temp (deg.C)	45		–	45	34	72	27.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		132.5	132.7	133.1	131.6	132.6	131.5	133.4		
Pcomp (bar)		113.2	113.2	114.1	112.2	112.5	112.5	114.4		
Pi (bar)		16.8	17.0	17.0	16.6	16.9	16.8	16.6		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	97.8	98	97	98	99	98	97		
Exh. Gas Temp Cyl Outlet		324	320	329	322	325	320	328		
C.F.W Temp Cyl. Outlet		79.7	79	79	80	80	80	80		
P.C.O. Temp Cyl. Outlet		51.0	51	51	51	51	51	51		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.37	1.37	
Temp. °C	Air	In	173.2	173.2	
		Out	–	–	
	Water	In	27.8	27.8	
		Out	42	42	

Scavenging Air

Press MPa	Temperature °C
0.214	37.4
Exh. Gas Receive Press	0.190 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
179.5	179.7	179.2

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	9380	31.8	0.49	378.1	241.2	2.16	45.0	60.0	–
No.1	9380	31.8	0.49	378.1	241.2	2.16	45.0	60.0	–
No.2									

F.O. Drain g/kWh 0.8 Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 159.8

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T17-2

Data Sheet of 75 % Load Test — Date 28-Sep-2012, Measured Time 16:25

Ambient Condition
Room Temp : 27.2 °C   Barometric Press : 1008 hPa   Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
82.7	1618.2	14014	8.3	69	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	-	0.24	0.75	0.41	0.20	-
Temp (deg.C)	45		-	45	34	72	27.9	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	132.3	132.7	132.5	131.0	132.8	132.6	132.4		
Pcomp (bar)	113.6	113.9	114.4	112.7	113.2	112.9	114.7		
Pi (bar)	16.8	17.1	17.0	16.5	16.9	16.8	16.6		
Fuel Pump Actuator Index	-	3.3	2.5	3.4	3.4	3.0	1.9		
Fuel Pump Pump Mark Index	98.8	98	99	99	100	99	98		
Exh. Gas Temp Cyl Outlet	327	321	332	325	328	323	332		
C.F.W Temp Cyl. Outlet	79.7	79	79	80	80	80	80		
P.C.O. Temp Cyl. Outlet	51.0	51	51	51	51	51	51		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.42	1.42	
Temp. °C	Air	In	175.8	175.8	
		Out	-	-	
	Water	In	27.9	27.9	
		Out	42	42	

Scavenging Air

Press MPa	Temperature °C
0.214	37.8
Exh. Gas Receive Press	0.190 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
180.7	180.9	180.3

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	9410	32.5	0.51	380.3	242.3	2.19	45.0	60.0	-
No.1	9410	32.5	0.51	380.3	242.3	2.19	45.0	60.0	-
No.2									

F.O. Drain g/kWh 0.7   Thrust Temp. deg.C 48
C.O feed rate l/day.cyl 160.0

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T18-1
Data Sheet of 100 % Load Test		Date / Measured Time	28-Sep-2012 / 17:25

Ambient Condition
Room Temp : 26.4 ℃ Barometric Press : 1008 hPa Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.0	1961.7	18694	9.4	85	—

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	-	0.24	0.75	0.41	0.20	-
Temp (deg.C)	45		-	45	35	72	28.1	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		149.6	151.0	149.7	149.1	149.3	149.2	149.2		
Pcomp (bar)		142.0	142.7	142.6	140.8	141.5	141.5	143.1		
Pi (bar)		20.5	20.9	20.8	20.2	20.6	20.6	20.1		
Fuel Pump	Actuator Index	-	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	119.8	119	120	120	120	120	120		
Exh. Gas Temp Cyl Outlet		374	371	377	376	371	373	374		
C.F.W Temp Cyl. Outlet		81.5	81	81	81	82	82	82		
P.C.O. Temp Cyl. Outlet		53.8	53	54	54	54	54	54		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.67	1.67	
Temp. ℃	Air	In	208.4	208.4	
		Out	-	-	
	Water	In	28.1	28.1	
		Out	48	48	

Scavenging Air	
Press MPa	Temperature ℃
0.292	42.9
Exh. Gas Receive Press	0.265 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
182.3	182.5	181.9

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	10550	32.3	0.69	433.8	264.2	3.31	45.0	60.0	-
No.1	10550	32.3	0.69	433.8	264.2	3.31	45.0	60.0	-
No.2									

F.O. Drain g/kWh 0.5 Thrust Temp. deg.C 49
C.O feed rate l/day.cyl 176.3

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T18-2

Data Sheet of	100	% Load Test	Date 28-Sep-2012	Measured Time 18:05

Ambient Condition

Room Temp : 26.8 °C   Barometric Press : 1008 hPa   Humidity : 57%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.0	1962.1	18698	9.4	85	―

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.24	–	0.23	0.75	0.41	0.20	–
Temp (deg.C)	45		–	45	34	73	28.1	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		149.5	150.0	149.1	149.1	149.3	150.0	149.5		
Pcomp (bar)		142.0	142.9	142.7	140.7	141.3	141.4	143.1		
Pi (bar)		20.4	20.8	20.6	20.1	20.4	20.5	20.0		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	120.2	120	120	120	120	121	120		
Exh. Gas Temp Cyl Outlet		377	376	380	378	373	375	378		
C.F.W Temp Cyl. Outlet		81.7	81	81	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.2	53	53	53	53	53	54		

Air Cooler					
No.			Ave	1	2
Press. Drop kPa			1.62	1.62	
Temp. °C	Air	In	210.8	210.8	
		Out	–	–	
	Water	In	28.1	28.1	
		Out	48	48	

Scavenging Air	
Press MPa	Temperature °C
0.292	43.8
Exh. Gas Receive Press	0.265 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
183.5	183.7	183.1

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	10600	33.0	0.69	433.8	266.5	3.33	45.0	60.0	–
No.1	10600	33.0	0.69	433.8	266.5	3.33	45.0	60.0	–
No.2									

F.O. Drain g/kWh 0.5   Thrust Temp. deg.C 49

C.O feed rate l/day.cyl 176.1

Enclosure 5

The Emission Measurement Results for Mitsui-MAN B&W 6S70MC-C

MES TESTING & RESEACH CENTER CO.,LTD
CHEMICAL ANALYSIS SECTION

Approved	Measure
森	窪田

Engine job No. : TE3P46
Issue : 2012/10/02

H-237
D-413-1

The Emission Results

LOAD(%)	DATE	TIME	NOx (ppm) 7M120806NOx	O2 (%) 7M120806O2	CO2 (%) 7M120806CO2	CO (ppm) 7M120806CO	THC (ppmC) 7M120806THC	Temp (℃) T120727	Hum (%) H120831	IMO-NOx (g/kWH)	KHDIES (MBD)
T01 - 1 10%	2012/09/26	08:21-08:22	900	17.22	2.60	15	35	22.8	57	22.68	1.001
T01 - 2 10%		09:34-09:35	916	17.21	2.66	18	32	24.6	49	22.55	0.995
T02 - 1 15%		10:22-10:23	1032	16.28	3.27	32	39	24.8	50	20.26	0.997
T02 - 2 15%		11:26-11:27	1016	16.36	3.25	37	40	26.2	50	20.08	1.000
T03 - 1 25%		12:22-12:23	994	15.65	3.70	150	43	25.6	56	17.11	1.005
T03 - 2 25%		13:21-13:22	1010	15.71	3.67	126	43	25.6	56	17.58	1.005
T04 - 1 50%		14:23-14:24	898	15.43	3.86	121	39	25.8	55	14.35	1.004
T04 - 2 50%		15:25-15:26	896	15.44	3.86	134	41	26.4	52	14.31	1.002
T05 - 1 75%		16:51-16:52	927	15.23	4.02	69	56	26.8	52	14.04	1.003
T05 - 2 75%		17:55-17:56	944	15.26	4.00	61	52	26.8	51	14.41	1.002
T06 - 1 100%		18:45-18:46	917	14.52	4.54	106	90	27.0	54	12.53	1.010
T06 - 2 100%		19:48-19:49	932	14.48	4.53	78	60	26.0	56	12.83	1.011
T07 - 1 10%	2012/09/27	10:38-10:39	871	17.15	2.65	58	370	24.8	54	22.27	1.001
T07 - 2 10%		11:38-11:39	879	17.13	2.69	54	367	24.5	59	21.51	1.005
T08 - 1 15%		12:37-12:38	985	16.19	3.33	53	359	25.0	53	19.14	1.001
T08 - 2 15%		13:39-13:40	999	16.22	3.32	53	361	25.6	51	19.32	0.999
T09 - 1 25%		14:27-14:28	923	15.69	3.70	73	339	26.2	45	16.09	0.993

Note

Enclosure 5

1

The Emission Measurement Results for Mitsui-MAN B&W 6S70MC-C

MES TESTING & RESEACH CENTER CO.,LTD
CHEMICAL ANALYSIS SECTION

Approved	Measure

Engine job No. : TE3P46
Issue : 2012/10/02

H-237
D-413-2

The Emission Results

LOAD(%)	DATE	TIME	NOx (ppm) 7M120806NOx	O2 (%) 7M120806O2	CO2 (%) 7M120806CO2	CO (ppm) 7M120806CO	THC (ppmC) 7M120806THC	Temp (℃) T120727	Hum (%) H120831	IMO-NOx (g/kWH)	KHDIES (MBD)
T09 - 2 25%	2012/09/27	15:30-15:31	924	15.70	3.71	76	343	26.4	46	15.94	0.995
T10 - 1 50%		16:16-16:17	840	15.41	3.91	60	295	27.4	40	13.35	0.992
T10 - 2 50%		17:19-17:20	847	15.45	3.90	64	289	27.4	42	13.49	0.992
T11 - 1 75%		17:56-17:57	954	15.19	4.05	68	297	26.5	47	14.33	0.996
T11 - 2 75%		19:05-19:06	943	15.14	4.05	62	290	26.2	49	14.20	0.998
T12 - 1 100%		19:40-19:41	1001	14.46	4.58	100	304	26.2	53	13.50	1.004
T12 - 2 100%		20:45-20:46	990	14.43	4.57	70	267	25.8	56	13.48	1.008
T13 - 1 10%	2012/09/28	09:08-09:09	781	17.07	2.72	170	352	23.6	61	19.17	1.005
T13 - 2 10%		09:47-09:48	768	17.10	2.67	163	371	23.6	61	19.06	1.006
T14 - 1 15%		10:40-10:41	854	16.27	3.27	247	359	24.6	60	16.95	1.007
T14 - 2 15%		11:21-11:22	862	16.30	3.25	260	367	24.8	58	17.17	1.005
T15 - 1 25%		12:25-12:26	821	15.76	3.61	482	302	25.0	53	14.56	1.000
T15 - 2 25%		13:07-13:08	819	15.70	3.65	498	284	25.2	56	14.47	1.003
T16 - 1 50%		14:11-14:12	777	15.45	3.86	216	273	26.2	49	12.52	0.998
T16 - 2 50%		14:52-14:53	771	15.49	3.84	221	278	26.8	46	12.49	0.996
T17 - 1 75%		15:52-15:53	918	15.22	4.04	89	271	27.5	44	13.80	0.995
T17 - 2 75%		16:30-16:31	902	15.21	4.05	91	265	27.2	45	13.62	0.995

Note

2

The Emission Measurement Results for Mitsui-MAN B&W 6S70MC-C

MES TESTING & RESEACH CENTER CO.,LTD
CHEMICAL ANALYSIS SECTION

Approved	Measure
大村	窪田

Engine job No. : TE3P46
Issue : 2012/10/02

H-237
D-413-3

The Emission Results

LOAD(%)	DATE	TIME	NOx (ppm) 7M120806NOx	O2 (%) 7M120806O2	CO2 (%) 7M120806CO2	CO (ppm) 7M120806CO	THC (ppmC) 7M120806THC	Temp (℃) T120727	Hum (%) H120831	IMO-NOx (g/kWH)	KHDIES (MBD)
T18 - 1 100%	2012/09/28	17:30-17:31	938	14.46	4.58	133	270	26.4	51	12.69	1.001
T18 - 2 100%		18:10-18:11	927	14.43	4.58	97	237	26.8	49	12.64	0.999

Note

ω

The Emission Measurement Results for Mitsui-MAN B&W 6S70MC-C7

MES TESTING & RESEACH CENTER CO.,LTD
CHEMICAL ANALYSIS SECTION

Approved	Measure
	松原

H-237
D-413-1

Engine No.: 6384

TE3P46 / 6S70MC-C7

TestNo.	DATE	TIME	Dust (mg/m^{3}N)	Bosch 1Bosch 1L			Bosch 3L		
				①	②	Ave.	①	②	Ave.
T01 (C26_10%)	2012/09/26	08:15-09:56	1.1	0.2	0.3	0.3	0.7	0.7	0.7
T02 (C26_15%)		10:20-11:53	10.8	0.4	0.4	0.4	1.1	1.1	1.1
T03 (C26_25%)		12:18-13:40	10.6	0.4	0.3	0.4	0.9	1.0	1.0
T04 (C26_50%)		14:18-16:03	13.3	0.1	0.1	0.1	0.2	0.2	0.2
T05 (C26_75%)		16:45-18:20	21.6	0.1	0.1	0.1	0.2	0.2	0.2
T06 (C26_100%)		18:41-20:39	30.8	0.2	0.1	0.2	0.2	0.2	0.2
T07 (C1_10%)	2012/09/27	10:32-11:56	1.7	0.3	0.3	0.3	0.8	0.9	0.9
T08 (C1_15%)		12:32-13:46	15.4	0.6	0.5	0.6	1.3	1.2	1.3
T09 (C1_25%)		14:23-15:39	8.8	0.3	0.3	0.3	0.8	0.8	0.8
T10 (C1_50%)		16:12-17:28	13.7	0.1	0.1	0.1	0.2	0.2	0.2
T11 (C1_75%)		17:53-19:14	28.0	0.1	0.1	0.1	0.2	0.2	0.2
T12 (C1_100%)		19:38-20:53	31.0	0.1	0.1	0.1	0.2	0.2	0.2
T13 (C11_10%)	2012/09/28	09:02-10:16	9.2	0.1	0.1	0.1	0.2	0.2	0.2
T14 (C11_15%)		10:36-11:52	9.8	0.1	0.1	0.1	0.1	0.2	0.2
T15 (C11_25%)		12:22-13:35	18.6	0.1	0.1	0.1	0.2	0.2	0.2
T16 (C11_50%)		14:05-15:19	27.0	0.1	0.1	0.1	0.1	0.1	0.1

Note

Bosch
1. Sampling Volume: 1 liter & 3 liter
2. Bosch No.: 0.0 (White) ～10.0 (Black)

Dust
Method ; JIS Z8808(EPA-17)

The Emission Measurement Results for Mitsui-MAN B&W 6S70MC-C7

MES TESTING & RESEACH CENTER CO.,LTD
CHEMICAL ANALYSIS SECTION

Approved	Measure
	松原

H-237
D-413-2

Engine No.: 6384

TE3P46 / 6S70MC-C7

TestNo.	DATE	TIME	Dust (mg/m^{3}N)	Bosch 1Bosch 1L			Bosch 3Bosch 3L		
				①	②	Ave.	①	②	Ave.
T17 (C11_75%)	2012/09/28	15:45-16:58	36.2	0.1	0.1	0.1	0.1	0.1	0.1
T18 (C11_100%)		17:25-18:38	37.1	0.1	0.1	0.1	0.1	0.2	0.2

Note

Bosch
1. Sampling Volume: 1 liter & 3 liter
2. Bosch No.: 0.0 (White) ～10.0 (Black)

Dust
Method ; JIS Z8808(EPA-17)

6

M	Slide F.V. C-26	Emission Results (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.	IMO E3 NOx 14.06g/kWh

Engine Type	6S70MC-C	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	2012/09/26	LCV	42.8MJ/kg	C (wt%)	86.0%	S (wt%)	0.08%
Layout power	18660kW	Density (15℃)	835.5kg/m3	H (wt%)	13.7%	N (wt%)	0.01%
Layout rpm	91.0min-1	Viscosity (50℃)	2.60cSt	H_2O (wt%)	0.05%	O (wt%)	0.22%

Test No. T06-1

Load	100%	Ambient press.	1015.0hPa	Ambient hum.	54.0%	Scav. Press.	0.394MPa abs.
Power	18693kW	Ambient (Dry bulb) temp.	27.0℃	Scav. Temp.	43.4℃	SFOC	181.6g/kWh
rpm	91.0rpm			Tsc.ref	37.0℃	T/C Suction air temp.	31.3℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	106ppm	-	101ppm	15.690	15.690	0.839
CO_2	Dry	4.54%	4.30%	4.30%	10553	10553	564.5
NO	Wet	-	-	917ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	917ppm	-	917ppm	237.7	235.0	**12.57**
O_2	Dry	14.52%	13.77%	13.77%	24540	24540	1313
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	90ppmC	-	90.0	7.0	7.0	0.4
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.948191	Hum. in air (Ha)	12.02g/kg	GEXHW (q_{mew})	161599	fc	2.465
GEXHW	161599	Hum. in Scav (Hsc)	12.02g/kg	KWEXH (k_{wr2})	0.948191	f_{fd}	-0.760
		Fuel Flow (qmf)	3395kg/h			C_{h2d}	0.003
		CO_2 in air	0.03%			k_{w2}	0.0190
Pmax	152.8barabs	KHDIES(Khd)(MBD)*)	1.011				

Test No. T06-2

Load	100%	Ambient press.	1015.0hPa	Ambient hum.	56.0%	Scav. Press.	0.395MPa abs.
Power	18691kW	Ambient (Dry bulb) temp.	26.0℃	Scav. Temp.	44.0℃	SFOC	182.3g/kWh
rpm	91.0rpm			Tsc.ref	37.0℃	T/C Suction air temp.	32.2℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	78ppm	-	74ppm	11.631	11.631	0.622
CO_2	Dry	4.53%	4.30%	4.30%	10608	10608	567.5
NO	Wet	-	-	932ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	932ppm	-	932ppm	242.9	240.5	**12.87**
O_2	Dry	14.48%	13.74%	13.74%	24653	24653	1319
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	60ppmC	-	60.0	4.7	4.7	0.3
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.948673	Hum. in air (Ha)	11.75g/kg	GEXHW (q_{mew})	162711	fc	2.456
GEXHW	162711	Hum. in Scav (Hsc)	11.75g/kg	KWEXH (k_{wr2})	0.948673	f_{fd}	-0.760
		Fuel Flow (qmf)	3407kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0185
Pmax	152.8barabs	KHDIES(Khd)(MBD)*)	1.010				

Test No. T05-1

Load	75%	Ambient press.	1015.0hPa	Ambient hum.	52.0%	Scav. Press.	0.315MPa abs.
Power	14014kW	Ambient (Dry bulb) temp.	26.8℃	Scav. Temp.	37.6℃	SFOC	178.7g/kWh
rpm	82.7rpm			Tsc.ref	32.0℃	T/C Suction air temp.	30.9℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	69ppm	-	66ppm	8.529	8.529	0.609
CO_2	Dry	4.02%	3.83%	3.83%	7803	7803	556.8
NO	Wet	-	-	927ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	927ppm	-	927ppm	197.8	197.3	**14.08**
O_2	Dry	15.23%	14.52%	14.52%	21495	21495	1534
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	56ppmC	-	56.0	3.6	3.6	0.3
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.953502	Hum. in air (Ha)	11.43g/kg	GEXHW (q_{mew})	134196	fc	2.178
GEXHW	134196	Hum. in Scav (Hsc)	11.43g/kg	KWEXH (k_{wr2})	0.953502	f_{fd}	-0.760
		Fuel Flow (qmf)	2504kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0181
Pmax	135.2barabs	KHDIES(Khd)(MBD)*)	1.003				

Test No. T05-2

Load	75%	Ambient press.	1015.0hPa	Ambient hum.	51.0%	Scav. Press.	0.316MPa abs.
Power	14017kW	Ambient (Dry bulb) temp.	26.8℃	Scav. Temp.	37.7℃	SFOC	179.2g/kWh
rpm	82.7rpm			Tsc.ref	32.0℃	T/C Suction air temp.	31.3℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	61ppm	-	58ppm	7.604	7.604	0.542
CO_2	Dry	4.00%	3.82%	3.82%	7830	7830	558.6
NO	Wet	-	-	944ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	944ppm	-	944ppm	202.8	202.5	**14.45**
O_2	Dry	15.26%	14.56%	14.56%	21720	21720	1550
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	52ppmC	-	52.0	3.4	3.4	0.2
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.953995	Hum. in air (Ha)	11.21g/kg	GEXHW (q_{mew})	135262	fc	2.166
GEXHW	135262	Hum. in Scav (Hsc)	11.21g/kg	KWEXH (k_{wr2})	0.953995	f_{fd}	-0.760
		Fuel Flow (qmf)	2512kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0177
Pmax	135.3barabs	KHDIES(Khd)(MBD)*)	1.002				

M	Slide F.V. C-26	**Emission Results** (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.	IMO E3 NOx 14.06g/kWh

Engine Type	**6S70MC-C**	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	**2012/09/26**	LCV	42.8MJ/kg	C (wt%)	86.0%	S (wt%)	0.08%
Layout power	**18660kW**	Density (15℃)	835.5kg/m3	H (wt%)	13.7%	N (wt%)	0.01%
Layout rpm	**91.0min-1**	Viscosity (50℃)	2.60cSt	H_2O (wt%)	0.05%	O (wt%)	0.22%

Test No. T04-1

Load	**50%**	Ambient press.	1015.0hPa	Ambient hum.	55.0%	Scav. Press.	0.222MPa abs.
Power	9355kW	Ambient (Dry bulb) temp.	25.8℃	Scav. Temp.	31.8℃	SFOC	181.4g/kWh
rpm	72.2rpm			Tsc.ref	28.0℃	T/C Suction air temp.	31.1℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	121ppm	-	116ppm	10.548	10.548	1.127
CO_2	Dry	3.86%	3.69%	3.69%	5284	5284	564.8
NO	Wet	-	-	898ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	898ppm	-	898ppm	135.1	134.6	**14.39**
O_2	Dry	15.43%	14.73%	14.73%	15358	15358	1642
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	39ppmC	-	39.0	1.8	1.8	0.2
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.954903	Hum. in air (Ha)	11.40g/kg	GEXHW (q_{mew})	94501	fc	2.093
GEXHW	94501	Hum. in Scav (Hsc)	11.40g/kg	KWEXH (k_{wr2})	0.954903	f_{fd}	-0.760
		Fuel Flow (qmf)	1697kg/h			C_{h2d}	0.004
		CO_2 in air	0.03%			k_{w2}	0.0180
Pmax	109.9barabs	KHDIES(Khd)(MBD)*)	1.004				

Test No. T04-2

Load	**50%**	Ambient press.	1015.0hPa	Ambient hum.	52.0%	Scav. Press.	0.224MPa abs.
Power	9362kW	Ambient (Dry bulb) temp.	26.4℃	Scav. Temp.	32.3℃	SFOC	181.5g/kWh
rpm	72.2rpm			Tsc.ref	28.0℃	T/C Suction air temp.	31.2℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	134ppm	-	128ppm	11.693	11.693	1.249
CO_2	Dry	3.86%	3.69%	3.69%	5290	5290	565.0
NO	Wet	-	-	896ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	896ppm	-	896ppm	134.6	134.4	**14.35**
O_2	Dry	15.44%	14.75%	14.75%	15384	15384	1643
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	41ppmC	-	41.0	1.9	1.9	0.2
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.955231	Hum. in air (Ha)	11.16g/kg	GEXHW (q_{mew})	94566	fc	2.094
GEXHW	94566	Hum. in Scav (Hsc)	11.16g/kg	KWEXH (k_{wr2})	0.955231	f_{fd}	-0.760
		Fuel Flow (qmf)	1699kg/h			C_{h2d}	0.004
		CO_2 in air	0.03%			k_{w2}	0.0176
Pmax	109.5barabs	KHDIES(Khd)(MBD)*)	1.002				

Test No. T03-1

Load	**25%**	Ambient press.	1016.0hPa	Ambient hum.	56.0%	Scav. Press.	0.143MPa abs.
Power	4655kW	Ambient (Dry bulb) temp.	25.6℃	Scav. Temp.	35.5℃	SFOC	187.8g/kWh
rpm	57.3rpm			Tsc.ref	28.0℃	T/C Suction air temp.	31.6℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	150ppm	-	143ppm	7.022	7.022	1.508
CO_2	Dry	3.70%	3.54%	3.54%	2720	2720	584.3
NO	Wet	-	-	994ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	994ppm	-	994ppm	80.3	79.9	**17.16**
O_2	Dry	15.65%	14.96%	14.96%	8365	8365	1797
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	43ppmC	-	43.0	1.0	1.0	0.2
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.956181	Hum. in air (Ha)	11.46g/kg	GEXHW (q_{mew})	50680	fc	2.007
GEXHW	50680	Hum. in Scav (Hsc)	11.46g/kg	KWEXH (k_{wr2})	0.956181	f_{fd}	-0.760
		Fuel Flow (qmf)	874kg/h			C_{h2d}	0.005
		CO_2 in air	0.03%			k_{w2}	0.0181
Pmax	78.9barabs	KHDIES(Khd)(MBD)*)	1.005				

Test No. T03-2

Load	**25%**	Ambient press.	1016.0hPa	Ambient hum.	56.0%	Scav. Press.	0.143MPa abs.
Power	4655kW	Ambient (Dry bulb) temp.	25.6℃	Scav. Temp.	35.5℃	SFOC	188.2g/kWh
rpm	57.3rpm			Tsc.ref	28.0℃	T/C Suction air temp.	32.3℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	126ppm	-	121ppm	5.963	5.963	1.281
CO_2	Dry	3.67%	3.51%	3.51%	2728	2728	585.9
NO	Wet	-	-	1010ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	1010ppm	-	1010ppm	82.4	82.1	**17.63**
O_2	Dry	15.71%	15.03%	15.03%	8489	8489	1824
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	43ppmC	-	43.0	1.1	1.1	0.2
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.956455	Hum. in air (Ha)	11.46g/kg	GEXHW (q_{mew})	51223	fc	1.990
GEXHW	51223	Hum. in Scav (Hsc)	11.46g/kg	KWEXH (k_{wr2})	0.956455	f_{fd}	-0.760
		Fuel Flow (qmf)	876kg/h			C_{h2d}	0.004
		CO_2 in air	0.03%			k_{w2}	0.0181
Pmax	79.2barabs	KHDIES(Khd)(MBD)*)	1.005				

8

M	Slide F.V. C-26	**Emission Results** (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.	**IMO E3 NOx 14.06g/kWh**

Engine Type	**6S70MC-C**	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	**2012/09/26**	LCV	42.8MJ/kg	C (wt%)	86.0%	S (wt%)	0.08%
Layout power	**18660kW**	Density (15℃)	835.5kg/m3	H (wt%)	13.7%	N (wt%)	0.01%
Layout rpm	**91.0min-1**	Viscosity (50℃)	2.60cSt	H_2O (wt%)	0.05%	O (wt%)	0.22%

Test No. **T01-1**

Load	**10%**	Ambient press.	1017.0hPa	Ambient hum.	57.0%	Scav. Press.	0.116MPa abs.
Power	1876kW	Ambient (Dry bulb) temp	22.8℃	Scav. Temp.	36.1℃	SFOC	194.1g/kWh
rpm	42.2rpm			Tsc.ref	33.0℃	T/C Suction air temp.	26.9℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	15ppm	-	15ppm	0.419	0.419	0.224
CO_2	Dry	2.60%	2.52%	2.52%	1141	1141	608.4
NO	Wet	-	-	900ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	900ppm	-	900ppm	42.7	42.7	**22.74**
O_2	Dry	17.22%	16.67%	16.67%	5497	5497	2930
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	35ppmC	-	35.0	0.5	0.5	0.3
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.968271	Hum. in air (Ha)	9.83g/kg	GEXHW (q_{mew})	29888	fc	1.401
GEXHW	29888	Hum. in Scav (Hsc)	9.83g/kg	KWEXH (k_{wr2})	0.968271	f_{fd}	-0.760
		Fuel Flow (qmf)	364kg/h			C_{h2d}	0.000
		CO_2 in air	0.03%			k_{w2}	0.0156
Pmax	59.7barabs	KHDIES(Khd)(MBD)*)	1.001				

Test No. **T01-2**

Load	**10%**	Ambient press.	1017.0hPa	Ambient hum.	49.0%	Scav. Press.	0.115MPa abs.
Power	1876kW	Ambient (Dry bulb) temp	24.6℃	Scav. Temp.	36.3℃	SFOC	194.0g/kWh
rpm	42.2rpm			Tsc.ref	33.0℃	T/C Suction air temp.	28.2℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	15ppm	-	15ppm	0.419	0.419	0.223
CO_2	Dry	2.60%	2.52%	2.52%	1141	1141	608.3
NO	Wet	-	-	900ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	900ppm	-	900ppm	42.4	42.6	**22.72**
O_2	Dry	17.22%	16.68%	16.68%	5495	5495	2929
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	35ppmC	-	35.0	0.5	0.5	0.3
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.968883	Hum. in air (Ha)	9.41g/kg	GEXHW (q_{mew})	29861	fc	1.401
GEXHW	29861	Hum. in Scav (Hsc)	9.41g/kg	KWEXH (k_{wr2})	0.968883	f_{fd}	-0.760
		Fuel Flow (qmf)	364kg/h			C_{h2d}	0.000
		CO_2 in air	0.03%			k_{w2}	0.0149
Pmax	59.4barabs	KHDIES(Khd)(MBD)*)	0.996				

Test No. **T02-1**

Load	**15%**	Ambient press.	1017.0hPa	Ambient hum.	50.0%	Scav. Press.	0.121MPa abs.
Power	2813kW	Ambient (Dry bulb) temp.	24.8℃	Scav. Temp.	36.0℃	SFOC	189.5g/kWh
rpm	48.4rpm			Tsc.ref	33.0℃	T/C Suction air temp.	28.6℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	32ppm	-	31ppm	1.039	1.039	0.369
CO_2	Dry	3.27%	3.15%	3.15%	1667	1667	592.5
NO	Wet	-	-	1032ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	1032ppm	-	1032ppm	57.0	57.1	**20.31**
O_2	Dry	16.28%	15.67%	15.67%	6034	6034	2145
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	39ppmC	-	39.0	0.7	0.7	0.2
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.962488	Hum. in air (Ha)	9.72g/kg	GEXHW (q_{mew})	34910	fc	1.767
GEXHW	34910	Hum. in Scav (Hsc)	9.72g/kg	KWEXH (k_{wr2})	0.962488	f_{fd}	-0.760
		Fuel Flow (qmf)	533kg/h			C_{h2d}	0.001
		CO_2 in air	0.03%			k_{w2}	0.0154
Pmax	65.2barabs	KHDIES(Khd)(MBD)*)	0.997				

Test No. **T02-2**

Load	**15%**	Ambient press.	1016.0hPa	Ambient hum.	50.0%	Scav. Press.	0.122MPa abs.
Power	2811kW	Ambient (Dry bulb) temp.	26.2℃	Scav. Temp.	36.0℃	SFOC	189.5g/kWh
rpm	48.4rpm			Tsc.ref	33.0℃	T/C Suction air temp.	28.7℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	32ppm	-	31ppm	1.037	1.037	0.369
CO_2	Dry	3.27%	3.14%	3.14%	1665	1665	592.3
NO	Wet	-	-	1032ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	1032ppm	-	1032ppm	57.1	57.1	**20.33**
O_2	Dry	16.28%	15.65%	15.65%	6027	6027	2144
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	39ppmC	-	39.0	0.7	0.7	0.2
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.961246	Hum. in air (Ha)	10.59g/kg	GEXHW (q_{mew})	34914	fc	1.767
GEXHW	34914	Hum. in Scav (Hsc)	10.59g/kg	KWEXH (k_{wr2})	0.961246	f_{fd}	-0.760
		Fuel Flow (qmf)	533kg/h			C_{h2d}	0.001
		CO_2 in air	0.03%			k_{w2}	0.0167
Pmax	65.3barabs	KHDIES(Khd)(MBD)*)	0.999				

***) B&W's Khd correction factor**

M	Conventional F.V. C-I	Emission Results (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.	IMO E3 NOx 14.09g/kWh

Engine Type	6S70MC-C	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	2013/09/27	LCV	42.8MJ/kg	C (wt%)	86.2%	S (wt%)	0.07%
Layout power	18660kW	Density (15℃)	0.8kg/m3	H (wt%)	13.5%	N (wt%)	0.01%
Layout rpm	91.0min-1	Viscosity (50℃)	2.67cSt	H_2O (wt%)	0.05%	O (wt%)	0.23%

Test No.	T12-1						
Load	100%	Ambient press.	1011.0hPa	Ambient hum.	53.0%	Scav. Press.	0.389MPa abs.
Power	18714kW	Ambient (Dry bulb) temp	26.2℃	Scav. Temp.	42.9℃	SFOC	181.6g/kWh
rpm	91.1rpm			Tsc.ref	37.0℃	T/C Suction air temp.	31.9℃
	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	100ppm	-	95ppm	14.665	14.665	0.784
CO_2	Dry	4.58%	4.35%	4.35%	10548	10548	563.6
NO	Wet	-	-	1001ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	1001ppm	-	1001ppm	255.0	253.8	**13.56**
O_2	Dry	14.46%	13.73%	13.73%	24213	24213	1294
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	304ppmC	-	304.0	23.3	23.3	1.2
PM	-	-	-	-	-	-	-
Calculation				**C-balance**			
KWEXH	0.949565	Hum. in air (Ha)	11.29g/kg	GEXHW (q_{mew})	159875	fc	2.499
GEXHW	159875	Hum. in Scav (Hsc)	11.29g/kg	KWEXH (k_{wr2})	0.949565	f_{fd}	-0.749
		Fuel Flow (qmf)	3398kg/h			C_{h2d}	0.003
		CO_2 in air	0.03%			k_{w2}	0.0178
Pmax	151.6barabs	KHDIES(Khd)(MBD)*)	1.005				

Test No.	T12-2						
Load	100%	Ambient press.	1011.0hPa	Ambient hum.	56.0%	Scav. Press.	0.390MPa abs.
Power	18717kW	Ambient (Dry bulb) temp.	25.8℃	Scav. Temp.	43.6℃	SFOC	182.7g/kWh
rpm	91.1rpm			Tsc.ref	37.0℃	T/C Suction air temp.	31.5℃
	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	70ppm	-	66ppm	10.365	10.365	0.554
CO_2	Dry	4.57%	4.34%	4.34%	10627	10627	567.8
NO	Wet	-	-	990ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	990ppm	-	990ppm	255.9	253.6	**13.55**
O_2	Dry	14.43%	13.70%	13.70%	24397	24397	1303
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	267ppmC	-	267.0	20.7	20.7	1.1
PM	-	-	-	-	-	-	-
Calculation				**C-balance**			
KWEXH	0.949154	Hum. in air (Ha)	11.66g/kg	GEXHW (q_{mew})	161496	fc	2.489
GEXHW	161496	Hum. in Scav (Hsc)	11.66g/kg	KWEXH (k_{wr2})	0.949154	f_{fd}	-0.749
		Fuel Flow (qmf)	3420kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0184
Pmax	150.4barabs	KHDIES(Khd)(MBD)*)	1.009				

Test No.	T11-1						
Load	75%	Ambient press.	1011.0hPa	Ambient hum.	47.0%	Scav. Press.	0.313MPa abs.
Power	14001kW	Ambient (Dry bulb) temp	26.5℃	Scav. Temp.	36.9℃	SFOC	179.8g/kWh
rpm	82.7rpm			Tsc.ref	32.0℃	T/C Suction air temp.	32.0℃
	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	68ppm	-	65ppm	8.363	8.363	0.597
CO_2	Dry	4.05%	3.87%	3.87%	7822	7822	558.7
NO	Wet	-	-	954ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	954ppm	-	954ppm	200.8	201.6	**14.40**
O_2	Dry	15.19%	14.52%	14.52%	21330	21330	1523
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	297ppmC	-	297.0	19.0	19.0	1.4
PM	-	-	-	-	-	-	-
Calculation				**C-balance**			
KWEXH	0.955647	Hum. in air (Ha)	10.17g/kg	GEXHW (q_{mew})	133219	fc	2.208
GEXHW	133219	Hum. in Scav (Hsc)	10.17g/kg	KWEXH (k_{wr2})	0.955647	f_{fd}	-0.749
		Fuel Flow (qmf)	2517kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0161
Pmax	135.1barabs	KHDIES(Khd)(MBD)*)	0.996				

Test No.	T11-2						
Load	75%	Ambient press.	1011.0hPa	Ambient hum.	49.0%	Scav. Press.	0.313MPa abs.
Power	14013kW	Ambient (Dry bulb) temp.	26.2℃	Scav. Temp.	37.3℃	SFOC	180.2g/kWh
rpm	82.7rpm			Tsc.ref	32.0℃	T/C Suction air temp.	30.7℃
	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	62ppm	-	59ppm	7.650	7.650	0.546
CO_2	Dry	4.05%	3.87%	3.87%	7847	7847	560.0
NO	Wet	-	-	943ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	943ppm	-	943ppm	199.6	200.0	**14.27**
O_2	Dry	15.14%	14.46%	14.46%	21330	21330	1522
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	290ppmC	-	290.0	18.6	18.6	1.3
PM	-	-	-	-	-	-	-
Calculation				**C-balance**			
KWEXH	0.955294	Hum. in air (Ha)	10.42g/kg	GEXHW (q_{mew})	133705	fc	2.207
GEXHW	133705	Hum. in Scav (Hsc)	10.42g/kg	KWEXH (k_{wr2})	0.955294	f_{fd}	-0.749
		Fuel Flow (qmf)	2525kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0165
Pmax	135.1barabs	KHDIES(Khd)(MBD)*)	0.998				

M	Conventional F.V. C-1 **Emission Results** (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.	**IMO E3 NOx 14.09g/kWh**

Engine Type	**6S70MC-C**	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	**2013/09/27**	LCV	42.8MJ/kg	C (wt%)	86.2%	S (wt%)	0.07%
Layout power	**18660kW**	Density (15℃)	0.8kg/m3	H (wt%)	13.5%	N (wt%)	0.01%
Layout rpm	**91.0min-1**	Viscosity (50℃)	2.67cSt	H_2O (wt%)	0.05%	O (wt%)	0.23%

Test No.	**T10-1**						
Load	**50%**	Ambient press.	1012.0hPa	Ambient hum.	40.0%	Scav. Press.	0.223MPa abs.
Power	9325kW	Ambient (Dry bulb) temp	27.4℃	Scav. Temp.	31.8℃	SFOC	184.0g/kWh
rpm	72.2rpm			Tsc.ref	28.0℃	T/C Suction air temp.	31.3℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	60ppm	-	58ppm	5.213	5.213	0.559
CO_2	Dry	3.91%	3.75%	3.75%	5335	5335	572.1
NO	Wet	-	-	840ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	840ppm	-	840ppm	123.8	125.0	**13.41**
O_2	Dry	15.41%	14.77%	14.77%	15288	15288	1639
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	295ppmC	-	295.0	13.3	13.3	1.4
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.958368	Hum. in air (Ha)	9.10g/kg	GEXHW (q_{mew})	93851	fc	2.131
GEXHW	93851	Hum. in Scav (Hsc)	9.10g/kg	KWEXH (k_{wr2})	0.958368	f_{fd}	-0.749
		Fuel Flow (qmf)	1716kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0144
Pmax	107.7barabs	KHDIES(Khd)(MBD)*)	0.990				

Test No.	**T10-2**						
Load	**50%**	Ambient press.	1012.0hPa	Ambient hum.	42.0%	Scav. Press.	0.222MPa abs.
Power	9317kW	Ambient (Dry bulb) temp	27.4℃	Scav. Temp.	31.8℃	SFOC	183.9g/kWh
rpm	72.2rpm			Tsc.ref	28.0℃	T/C Suction air temp.	31.2℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	64ppm	-	61ppm	5.566	5.566	0.597
CO_2	Dry	3.90%	3.74%	3.74%	5326	5326	571.7
NO	Wet	-	-	847ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	847ppm	-	847ppm	125.3	126.3	**13.55**
O_2	Dry	15.45%	14.80%	14.80%	15342	15342	1647
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	289ppmC	-	289.0	13.0	13.0	1.4
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.957790	Hum. in air (Ha)	9.57g/kg	GEXHW (q_{mew})	93999	fc	2.126
GEXHW	93999	Hum. in Scav (Hsc)	9.57g/kg	KWEXH (k_{wr2})	0.957790	f_{fd}	-0.749
		Fuel Flow (qmf)	1713kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0151
Pmax	107.7barabs	KHDIES(Khd)(MBD)*)	0.992				

Test No.	**T09-1**						
Load	**25%**	Ambient press.	1013.0hPa	Ambient hum.	45.0%	Scav. Press.	0.142MPa abs.
Power	4661kW	Ambient (Dry bulb) temp.	26.2℃	Scav. Temp.	35.6℃	SFOC	190.3g/kWh
rpm	57.3rpm			Tsc.ref	28.0℃	T/C Suction air temp.	31.5℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	73ppm	-	70ppm	3.458	3.458	0.742
CO_2	Dry	3.70%	3.55%	3.55%	2753	2753	590.6
NO	Wet	-	-	923ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	923ppm	-	923ppm	74.4	74.8	**16.05**
O_2	Dry	15.69%	15.06%	15.06%	8487	8487	1821
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	339ppmC	-	339.0	8.3	8.3	1.8
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.959528	Hum. in air (Ha)	9.54g/kg	GEXHW (q_{mew})	51110	fc	2.020
GEXHW	51110	Hum. in Scav (Hsc)	9.54g/kg	KWEXH (k_{wr2})	0.959528	f_{fd}	-0.749
		Fuel Flow (qmf)	887kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0151
Pmax	76.1barabs	KHDIES(Khd)(MBD)*)	0.994				

Test No.	**T09-2**						
Load	**25%**	Ambient press.	1012.0hPa	Ambient hum.	46.0%	Scav. Press.	0.142MPa abs.
Power	4658kW	Ambient (Dry bulb) temp	26.4℃	Scav. Temp.	35.8℃	SFOC	190.1g/kWh
rpm	57.3rpm			Tsc.ref	28.0℃	T/C Suction air temp.	32.6℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	76ppm	-	73ppm	3.583	3.583	0.769
CO_2	Dry	3.71%	3.56%	3.56%	2747	2747	589.7
NO	Wet	-	-	924ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	924ppm	-	924ppm	74.2	74.6	**16.01**
O_2	Dry	15.70%	15.06%	15.06%	8452	8452	1815
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	343ppmC	-	343.0	8.4	8.4	1.8
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.958956	Hum. in air (Ha)	9.88g/kg	GEXHW (q_{mew})	50898	fc	2.026
GEXHW	50898	Hum. in Scav (Hsc)	9.88g/kg	KWEXH (k_{wr2})	0.958956	f_{fd}	-0.749
		Fuel Flow (qmf)	885kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0156
Pmax	75.7barabs	KHDIES(Khd)(MBD)*)	0.995				

M	Conventional F.V. C-1 **Emission Results** (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.	**IMO E3 NOx 14.09g/kWh**

Engine Type	**6S70MC-C**	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	**2013/09/27**	LCV	42.8MJ/kg	C (wt%)	86.2%	S (wt%)	0.07%
Layout power	**18660kW**	Density (15℃)	0.8kg/m3	H (wt%)	13.5%	N (wt%)	0.01%
Layout rpm	**91.0min-1**	Viscosity (50℃)	2.67cSt	H_2O (wt%)	0.05%	O (wt%)	0.23%

Test No.	**T07-1**						
Load	**10%**	Ambient press.	1015.0hPa	Ambient hum.	54.0%	Scav. Press.	0.116MPa abs.
Power	1866kW	Ambient (Dry bulb) temp.	24.8℃	Scav. Temp.	37.3℃	SFOC	202.1g/kWh
rpm	42.2rpm			Tsc.ref	33.0℃	T/C Suction air temp.	29.7℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	58ppm	-	56ppm	1.627	1.627	0.872
CO_2	Dry	2.65%	2.56%	2.56%	1167	1167	625.5
NO	Wet	-	-	871ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	871ppm	-	871ppm	41.5	41.5	**22.22**
O_2	Dry	17.15%	16.59%	16.59%	5492	5492	2943
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	370ppmC	-	370.0	5.3	5.3	2.9
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.967184	Hum. in air (Ha)	10.53g/kg	GEXHW (q_{mew})	30020	fc	1.450
GEXHW	30020	Hum. in Scav (Hsc)	10.53g/kg	KWEXH (k_{wr2})	0.967184	f_{fd}	-0.749
		Fuel Flow (qmf)	377kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0167
Pmax	59.7barabs	KHDIES(Khd)(MBD)*)	1.001				

Test No.	**T07-2**						
Load	**10%**	Ambient press.	1015.0hPa	Ambient hum.	59.0%	Scav. Press.	0.115MPa abs.
Power	1869kW	Ambient (Dry bulb) temp.	24.5℃	Scav. Temp.	36.8℃	SFOC	197.4g/kWh
rpm	42.2rpm			Tsc.ref	33.0℃	T/C Suction air temp.	30.6℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	54ppm	-	52ppm	1.460	1.460	0.781
CO_2	Dry	2.69%	2.60%	2.60%	1142	1142	610.9
NO	Wet	-	-	879ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	879ppm	-	879ppm	40.6	40.4	**21.61**
O_2	Dry	17.13%	16.54%	16.54%	5287	5287	2829
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	367ppmC	-	367.0	5.1	5.1	2.7
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.965700	Hum. in air (Ha)	11.32g/kg	GEXHW (q_{mew})	28975	fc	1.471
GEXHW	28975	Hum. in Scav (Hsc)	11.32g/kg	KWEXH (k_{wr2})	0.965700	f_{fd}	-0.749
		Fuel Flow (qmf)	369kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0179
Pmax	58.0barabs	KHDIES(Khd)(MBD)*)	1.005				

Test No.	**T08-1**						
Load	**15%**	Ambient press.	1014.0hPa	Ambient hum.	53.0%	Scav. Press.	0.120MPa abs.
Power	2813kW	Ambient (Dry bulb) temp.	25.0℃	Scav. Temp.	36.2℃	SFOC	192.8g/kWh
rpm	48.4rpm			Tsc.ref	33.0℃	T/C Suction air temp.	31.2℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	53ppm	-	51ppm	1.704	1.704	0.606
CO_2	Dry	3.33%	3.20%	3.20%	1682	1682	597.8
NO	Wet	-	-	985ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	985ppm	-	985ppm	54.1	54.1	**19.23**
O_2	Dry	16.19%	15.56%	15.56%	5944	5944	2113
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	359ppmC	-	359.0	6.0	6.0	2.1
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.961383	Hum. in air (Ha)	10.47g/kg	GEXHW (q_{mew})	34624	fc	1.819
GEXHW	34624	Hum. in Scav (Hsc)	10.47g/kg	KWEXH (k_{wr2})	0.961383	f_{fd}	-0.749
		Fuel Flow (qmf)	542kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0166
Pmax	64.1barabs	KHDIES(Khd)(MBD)*)	1.000				

Test No.	**T08-2**						
Load	**15%**	Ambient press.	1013.0hPa	Ambient hum.	51.0%	Scav. Press.	0.120MPa abs.
Power	2811kW	Ambient (Dry bulb) temp.	25.6℃	Scav. Temp.	36.3℃	SFOC	191.4g/kWh
rpm	48.4rpm			Tsc.ref	33.0℃	T/C Suction air temp.	31.7℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	53ppm	-	51ppm	1.696	1.696	0.603
CO_2	Dry	3.32%	3.19%	3.19%	1668	1668	593.4
NO	Wet	-	-	999ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	999ppm	-	999ppm	54.5	54.6	**19.41**
O_2	Dry	16.22%	15.60%	15.60%	5925	5925	2108
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	361ppmC	-	361.0	6.0	6.0	2.1
PM	-	-	-	-	-	-	-

Calculation				**C-balance**			
KWEXH	0.961504	Hum. in air (Ha)	10.45g/kg	GEXHW (q_{mew})	34445	fc	1.814
GEXHW	34445	Hum. in Scav (Hsc)	10.45g/kg	KWEXH (k_{wr2})	0.961504	f_{fd}	-0.749
		Fuel Flow (qmf)	538kg/h			C_{h2d}	0.002
		CO_2 in air	0.03%			k_{w2}	0.0165
Pmax	64.5barabs	KHDIES(Khd)(MBD)*)	0.999				

***) B&W's Khd correction factor**

M	Conventional F.V. C-11	Emission Results (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.				IMO E3 NOx 13.36g/kWh	
Engine Type	6S70MC-C	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	2013/09/28	LCV	42.8MJ/kg	C (wt%)	86.3%	S (wt%)	0.07%
Layout power	18660kW	Density (15℃)	0.8kg/m3	H (wt%)	13.5%	N (wt%)	0.01%
Layout rpm	91.0min-1	Viscosity (50℃)	2.65cSt	H_2O (wt%)	0.05%	O (wt%)	0.13%
Test No.	**T18-1**						
Load	100%	Ambient press.	1008.0hPa	Ambient hum.	51.0%	Scav. Press.	0.393MPa abs.
Power	18694kW	Ambient (Dry bulb) temp.	26.4℃	Scav. Temp.	42.9℃	SFOC	182.3g/kWh
rpm	91.0rpm			Tsc,ref	37.0℃	T/C Suction air temp.	32.3℃
	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	133ppm	-	126ppm	19.586	19.586	1.048
CO_2	Dry	4.58%	4.35%	4.35%	10592	10592	566.6
NO	Wet	-	-	938ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	938ppm	-	938ppm	239.1	238.7	**12.77**
O_2	Dry	14.46%	13.74%	13.74%	24314	24314	1301
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	270ppmC	-	270.0	20.8	20.8	1.1
PM	-	-	-	-	-	-	-
Calculation				**C-balance**			
KWEXH	0.949988	Hum. in air (Ha)	11.02g/kg	GEXHW (q_{mew})	160471	fc	2.498
GEXHW	160471	Hum. in Scav (Hsc)	11.02g/kg	KWEXH (k_{wr2})	0.949988	f_{fd}	-0.750
		Fuel Flow (qmf)	3408kg/h			C_{h2d}	0.004
		CO_2 in air	0.03%			k_{w2}	0.0174
Pmax	150.6barabs	KHDIES(Khd)(MBD)*)	1.002				
Test No.	**T18-2**						
Load	100%	Ambient press.	1008.0hPa	Ambient hum.	49.0%	Scav. Press.	0.393MPa abs.
Power	18698kW	Ambient (Dry bulb) temp.	26.8℃	Scav. Temp.	43.8℃	SFOC	183.5g/kWh
rpm	91.0rpm			Tsc,ref	37.0℃	T/C Suction air temp.	33.0℃
	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	97ppm	-	92ppm	14.404	14.404	0.770
CO_2	Dry	4.58%	4.35%	4.35%	10681	10681	571.2
NO	Wet	-	-	927ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	927ppm	-	927ppm	237.7	237.8	**12.72**
O_2	Dry	14.43%	13.71%	13.71%	24467	24467	1309
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	237ppmC	-	237.0	18.4	18.4	1.0
PM	-	-	-	-	-	-	-
Calculation				**C-balance**			
KWEXH	0.950265	Hum. in air (Ha)	10.84g/kg	GEXHW (q_{mew})	161772	fc	2.495
GEXHW	161772	Hum. in Scav (Hsc)	10.84g/kg	KWEXH (k_{wr2})	0.950265	f_{fd}	-0.750
		Fuel Flow (qmf)	3431kg/h			C_{h2d}	0.003
		CO_2 in air	0.03%			k_{w2}	0.0171
Pmax	150.5barabs	KHDIES(Khd)(MBD)*)	0.999				
Test No.	**T17-1**						
Load	75%	Ambient press.	1008.0hPa	Ambient hum.	44.0%	Scav. Press.	0.315MPa abs.
Power	14011kW	Ambient (Dry bulb) temp.	27.5℃	Scav. Temp.	37.4℃	SFOC	179.5g/kWh
rpm	82.7rpm			Tsc,ref	32.0℃	T/C Suction air temp.	31.8℃
	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	89ppm	-	85ppm	10.977	10.977	0.783
CO_2	Dry	4.04%	3.86%	3.86%	7825	7825	558.5
NO	Wet	-	-	918ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	918ppm	-	918ppm	193.4	194.5	**13.88**
O_2	Dry	15.22%	14.55%	14.55%	21434	21434	1530
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	271ppmC	-	271.0	17.3	17.3	1.2
PM	-	-	-	-	-	-	-
Calculation				**C-balance**			
KWEXH	0.955843	Hum. in air (Ha)	10.13g/kg	GEXHW (q_{mew})	133576	fc	2.202
GEXHW	133576	Hum. in Scav (Hsc)	10.13g/kg	KWEXH (k_{wr2})	0.955843	f_{fd}	-0.750
		Fuel Flow (qmf)	2515kg/h			C_{h2d}	0.003
		CO_2 in air	0.03%			k_{w2}	0.0160
Pmax	133.5barabs	KHDIES(Khd)(MBD)*)	0.994				
Test No.	**T17-2**						
Load	75%	Ambient press.	1008.0hPa	Ambient hum.	45.0%	Scav. Press.	0.315MPa abs.
Power	14014kW	Ambient (Dry bulb) temp.	27.2℃	Scav. Temp.	37.8℃	SFOC	180.7g/kWh
rpm	82.7rpm			Tsc,ref	32.0℃	T/C Suction air temp.	32.5℃
	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	91ppm	-	87ppm	11.274	11.274	0.804
CO_2	Dry	4.05%	3.87%	3.87%	7880	7880	562.3
NO	Wet	-	-	902ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	902ppm	-	902ppm	191.0	192.0	**13.70**
O_2	Dry	15.21%	14.54%	14.54%	21516	21516	1535
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	265ppmC	-	265.0	17.0	17.0	1.2
PM	-	-	-	-	-	-	-
Calculation				**C-balance**			
KWEXH	0.955685	Hum. in air (Ha)	10.18g/kg	GEXHW (q_{mew})	134198	fc	2.207
GEXHW	134198	Hum. in Scav (Hsc)	10.18g/kg	KWEXH (k_{wr2})	0.955685	f_{fd}	-0.750
		Fuel Flow (qmf)	2532kg/h			C_{h2d}	0.003
		CO_2 in air	0.03%			k_{w2}	0.0161
Pmax	133.3barabs	KHDIES(Khd)(MBD)*)	0.995				

M	Conventional F.V. C-11	Emission Results (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.	IMO E3 NOx 13.36g/kWh

Engine Type	6S70MC-C	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	2013/09/28	LCV	42.8MJ/kg	C (wt%)	86.3%	S (wt%)	0.07%
Layout power	18660kW	Density (15℃)	0.8kg/m3	H (wt%)	13.5%	N (wt%)	0.01%
Layout rpm	91.0min-1	Viscosity (50℃)	2.65cSt	H_2O (wt%)	0.05%	O (wt%)	0.13%

Test No.	T16-1						
Load	50%	Ambient press.	1008.0hPa	Ambient hum.	49.0%	Scav. Press.	0.225MPa abs.
Power	9316kW	Ambient (Dry bulb) temp	26.2℃	Scav. Temp.	31.7℃	SFOC	184.7g/kWh
rpm	72.2rpm			Tsc.ref	28.0℃	T/C Suction air temp.	31.8℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	216ppm	-	207ppm	19.009	19.009	2.040
CO_2	Dry	3.86%	3.69%	3.69%	5335	5335	572.6
NO	Wet	-	-	777ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	777ppm	-	777ppm	117.1	117.3	12.59
O_2	Dry	15.45%	14.78%	14.78%	15525	15525	1667
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	273ppmC	-	273.0	12.5	12.5	1.3
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.956841	Hum. in air (Ha)	10.46g/kg	GEXHW (q_{mew})	95212	fc	2.111
GEXHW	95212	Hum. in Scav (Hsc)	10.46g/kg	KWEXH (k_{wr2})	0.956841	f_{fd}	-0.750
		Fuel Flow (qmf)	1721kg/h			C_{h2d}	0.007
		CO_2 in air	0.03%			k_{w2}	0.0165
Pmax	108.0barabs	KHDIES(Khd)(MBD)*)	0.998				

Test No.	T16-2						
Load	50%	Ambient press.	1008.0hPa	Ambient hum.	46.0%	Scav. Press.	0.226MPa abs.
Power	9319kW	Ambient (Dry bulb) temp.	26.8℃	Scav. Temp.	31.8℃	SFOC	184.9g/kWh
rpm	72.2rpm			Tsc.ref	28.0℃	T/C Suction air temp.	32.1℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	221ppm	-	212ppm	19.575	19.575	2.101
CO_2	Dry	3.84%	3.68%	3.68%	5341	5341	573.2
NO	Wet	-	-	771ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	771ppm	-	771ppm	116.6	117.1	12.57
O_2	Dry	15.49%	14.83%	14.83%	15666	15666	1681
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	278ppmC	-	278.0	12.8	12.8	1.4
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.957424	Hum. in air (Ha)	10.16g/kg	GEXHW (q_{mew})	95771	fc	2.101
GEXHW	95771	Hum. in Scav (Hsc)	10.16g/kg	KWEXH (k_{wr2})	0.957424	f_{fd}	-0.750
		Fuel Flow (qmf)	1723kg/h			C_{h2d}	0.007
		CO_2 in air	0.03%			k_{w2}	0.0161
Pmax	108.3barabs	KHDIES(Khd)(MBD)*)	0.996				

Test No.	T15-1						
Load	25%	Ambient press.	1009.0hPa	Ambient hum.	53.0%	Scav. Press.	0.146MPa abs.
Power	4657kW	Ambient (Dry bulb) temp.	25.0℃	Scav. Temp.	35.7℃	SFOC	192.1g/kWh
rpm	57.3rpm			Tsc.ref	28.0℃	T/C Suction air temp.	31.7℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	482ppm	-	462ppm	23.384	23.384	5.021
CO_2	Dry	3.61%	3.46%	3.46%	2750	2750	590.6
NO	Wet	-	-	821ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	821ppm	-	821ppm	68.2	68.2	14.65
O_2	Dry	15.76%	15.11%	15.11%	8730	8730	1875
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	302ppmC	-	302.0	7.6	7.6	1.6
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.958725	Hum. in air (Ha)	10.52g/kg	GEXHW (q_{mew})	52385	fc	1.991
GEXHW	52385	Hum. in Scav (Hsc)	10.52g/kg	KWEXH (k_{wr2})	0.958725	f_{fd}	-0.750
		Fuel Flow (qmf)	895kg/h			C_{h2d}	0.015
		CO_2 in air	0.03%			k_{w2}	0.0166
Pmax	76.7barabs	KHDIES(Khd)(MBD)*)	1.000				

Test No.	T15-2						
Load	25%	Ambient press.	1009.0hPa	Ambient hum.	56.0%	Scav. Press.	0.146MPa abs.
Power	4656kW	Ambient (Dry bulb) temp.	25.2℃	Scav. Temp.	35.8℃	SFOC	193.2g/kWh
rpm	57.3rpm			Tsc.ref	28.0℃	T/C Suction air temp.	35.8℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	498ppm	-	477ppm	24.024	24.024	5.160
CO_2	Dry	3.65%	3.49%	3.49%	2765	2765	593.9
NO	Wet	-	-	819ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	819ppm	-	819ppm	68.0	67.8	14.55
O_2	Dry	15.70%	15.03%	15.03%	8648	8648	1857
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	284ppmC	-	284.0	7.1	7.1	1.5
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.957316	Hum. in air (Ha)	11.26g/kg	GEXHW (q_{mew})	52165	fc	2.013
GEXHW	52165	Hum. in Scav (Hsc)	11.26g/kg	KWEXH (k_{wr2})	0.957316	f_{fd}	-0.750
		Fuel Flow (qmf)	900kg/h			C_{h2d}	0.016
		CO_2 in air	0.03%			k_{w2}	0.0178
Pmax	76.5barabs	KHDIES(Khd)(MBD)*)	1.004				

14/E

M	Conventional F.V. C-11	Emission Results (IMOCALC-M Sheet for NTC2008) Mitsui Engineering & Shipbuilding Co., Ltd.	IMO E3 NOx 13.36g/kWh

Engine Type	6S70MC-C	Fuel Type	M.D.O	Fuel Oil Brand	LSA by NIPPON OIL CORPORATION		
Date	2013/09/28	LCV	42.8MJ/kg	C (wt%)	86.3%	S (wt%)	0.07%
Layout power	18660kW	Density (15℃)	0.8kg/m3	H (wt%)	13.5%	N (wt%)	0.01%
Layout rpm	91.0min-1	Viscosity (50℃)	2.65cSt	H_2O (wt%)	0.05%	O (wt%)	0.13%

Test No. T13-1

Load	10%	Ambient press.	1011.0hPa	Ambient hum.	61.0%	Scav. Press.	0.115MPa abs.
Power	1864kW	Ambient (Dry bulb) temp.	23.6℃	Scav. Temp.	36.3℃	SFOC	200.9g/kWh
rpm	42.1rpm			Tsc.ref	33.0℃	T/C Suction air temp.	29.0℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	170ppm	-	164ppm	4.602	4.602	2.469
CO_2	Dry	2.72%	2.63%	2.63%	1156	1156	620.4
NO	Wet	-	-	781ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	781ppm	-	781ppm	36.1	35.9	19.28
O_2	Dry	17.07%	16.48%	16.48%	5277	5277	2831
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	352ppmC	-	352.0	4.9	4.9	2.6
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.965704	Hum. in air (Ha)	11.12g/kg	GEXHW (q_{mew})	29020	fc	1.493
GEXHW	29020	Hum. in Scav (Hsc)	11.12g/kg	KWEXH (k_{wr2})	0.965704	f_{fd}	-0.750
		Fuel Flow (qmf)	374kg/h			C_{h2d}	0.005
		CO_2 in air	0.03%			k_{w2}	0.0176
Pmax	57.6barabs	KHDIES(Khd)(MBD)*)	1.005				

Test No. T13-2

Load	10%	Ambient press.	1011.0hPa	Ambient hum.	61.0%	Scav. Press.	0.114MPa abs.
Power	1871kW	Ambient (Dry bulb) temp.	23.6℃	Scav. Temp.	36.2℃	SFOC	199.6g/kWh
rpm	42.2rpm			Tsc.ref	33.0℃	T/C Suction air temp.	29.0℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	163ppm	-	157ppm	4.480	4.480	2.395
CO_2	Dry	2.67%	2.58%	2.58%	1152	1152	616.0
NO	Wet	-	-	768ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	768ppm	-	768ppm	36.1	35.9	19.17
O_2	Dry	17.10%	16.52%	16.52%	5367	5367	2868
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	371ppmC	-	371.0	5.2	5.2	2.8
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.966143	Hum. in air (Ha)	11.12g/kg	GEXHW (q_{mew})	29450	fc	1.467
GEXHW	29450	Hum. in Scav (Hsc)	11.12g/kg	KWEXH (k_{wr2})	0.966143	f_{fd}	-0.750
		Fuel Flow (qmf)	373kg/h			C_{h2d}	0.005
		CO_2 in air	0.03%			k_{w2}	0.0176
Pmax	57.7barabs	KHDIES(Khd)(MBD)*)	1.005				

Test No. T14-1

Load	15%	Ambient press.	1011.0hPa	Ambient hum.	60.0%	Scav. Press.	0.121MPa abs.
Power	2803kW	Ambient (Dry bulb) temp.	24.6℃	Scav. Temp.	36.0℃	SFOC	194.4g/kWh
rpm	48.4rpm			Tsc.ref	33.0℃	T/C Suction air temp.	29.7℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	247ppm	-	237ppm	8.083	8.083	2.884
CO_2	Dry	3.27%	3.14%	3.14%	1681	1681	599.6
NO	Wet	-	-	854ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	854ppm	-	854ppm	48.1	47.8	17.05
O_2	Dry	16.27%	15.62%	15.62%	6080	6080	2169
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	359ppmC	-	359.0	6.1	6.1	2.2
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.960182	Hum. in air (Ha)	11.63g/kg	GEXHW (q_{mew})	35283	fc	1.797
GEXHW	35283	Hum. in Scav (Hsc)	11.63g/kg	KWEXH (k_{wr2})	0.960182	f_{fd}	-0.750
		Fuel Flow (qmf)	545kg/h			C_{h2d}	0.008
		CO_2 in air	0.03%			k_{w2}	0.0184
Pmax	63.2barabs	KHDIES(Khd)(MBD)*)	1.006				

Test No. T14-2

Load	15%	Ambient press.	1010.0hPa	Ambient hum.	58.0%	Scav. Press.	0.121MPa abs.
Power	2805kW	Ambient (Dry bulb) temp	24.8℃	Scav. Temp.	36.1℃	SFOC	194.1g/kWh
rpm	48.4rpm			Tsc.ref	33.0℃	T/C Suction air temp.	30.6℃

	Dry/Wet	Measured	Wet (Calculated)	Wet (Measured)	kg/h (with Khd)	kg/h	g/kWh
CO	Dry	260ppm	-	250ppm	8.549	8.549	3.048
CO_2	Dry	3.25%	3.12%	3.12%	1678	1678	598.3
NO	Wet	-	-	862ppm	-	-	-
NO_2	Wet	-	-	0ppm	-	-	-
NOx	Wet	862ppm	-	862ppm	48.7	48.4	17.27
O_2	Dry	16.30%	15.66%	15.66%	6120	6120	2182
SO_2	-	-	-	-	-	-	-
N_2	-	-	-	-	-	-	-
H_2O	-	-	-	-	-	-	-
HC	Wet	367ppmC	-	367.0	6.2	6.2	2.2
PM	-	-	-	-	-	-	-

Calculation				C-balance			
KWEXH	0.960705	Hum. in air (Ha)	11.38g/kg	GEXHW (q_{mew})	35431	fc	1.787
GEXHW	35431	Hum. in Scav (Hsc)	11.38g/kg	KWEXH (k_{wr2})	0.960705	f_{fd}	-0.750
		Fuel Flow (qmf)	544kg/h			C_{h2d}	0.008
		CO_2 in air	0.03%			k_{w2}	0.0180
Pmax	63.3barabs	KHDIES(Khd)(MBD)*)	1.005				

*) B&W's Khd correction factor

Attachment 2 – MAN Diesel & Turbo A/S Report

Particulate Measurements for Fuel-Valve Tests
On
6S70MC-C7 at Mitsui, Tamano, Japan

MAN Diesel & Turbo A/S – R&D Dept. LDF4

March 2013

Particulate Measurements

for Fuel-Valve Tests

on

6S70MC-C7 at Mitsui, Tamano

March 2013

MAN Diesel & Turbo A/S – R&D Dept. LDF4

Table of Contents

1. SUMMARY

The fuel-valve test was performed on a 6S70MC-C engine at Mitsui, Tamano Works, from 26-28 September 2012. The fuel valves tested were a conventional fuel valve (C3 type), a low-NOx nozzle (type C11), and a slide valve of type C26. The purpose of the fuel-valve test was to investigate the benefit of using slide valves in relation to NOx and particulate emissions with special focus on the benefit at low loads (<25%).

This report deals with the particulate measurements performed according to ISO 8178. The main conclusions are stated below:

- Slide valve emits less particulate matter by mass at low load compared with the conventional C3 and C11 fuel valves. At low load, slide valve emits up to 50% less particulates than C3 and C11 fuel valves and up to 65% less for cylinder-lubrication-corrected particulate-emission results.
- The chemical analysed particulate matter for all tests performed is dominated by organic matter. The particulate matter consists of 72-89% of organic matter by mass.
- The Organic fraction of particulate matter is determined to originate from the cylinder lube oil. Gas-Chromatography (GC) analysis shows that 90 wt% of the particulate soluble-organic fraction originate from the cylinder lube oil.
- At 75% engine load the particulate emission for all 3 fuel valves is considered to be around 4 times higher compared with equivalent engines and fuel types. This is considered to be due to high running-in cylinder lubrication dosing.
- The high lube-oil organic fraction makes it very difficult to perform detailed particulate measurements on production engines on test bed.

2. INTRODUCTION

MAN Diesel & Turbo (MDT) has in the past participated in several projects with port and government authorities, when additional experiences from MAN B&W engines were asked for in relation to environmental issues. Especially, if additional knowledge could be obtained, MDT will participate in a supervising position, but MDT would usually refrain from standard work, which can be performed cheaper by commercial players. Also, as MDT has no test-bed facilities for production engines, usually reference is given to one of our licencees. Therefore, as MDT was approached in this project, Mitsui Engineering & Shipbuilding Co. Ltd., Tamano Works was asked to participate utilizing a production engine on test bed and standard emission equipment.

In 2008, the Port of Los Angeles (POLA) and the Port of Long Beach (POLB), along with several other funding partners, including the United States Environmental Protection Agency (USEPA) and the California Air Resources Board (CARB), participated in a demonstration of the use of slide-valve retrofit, plus fuel-water emulsion, on an APL container vessel calling at the ports.

MDT has in early publications indicated that slide valves in general have produced reductions of 30% NOx emissions and 25% DPM (Diesel Particulate Matter) emissions, when the technology is optimized in new engines. However, the results from the 2008 slide-valve retrofit demonstration were inconclusive, and indicated that the use of slide valves as a retrofit technology may not provide the same emission reductions as originally anticipated. In addition to the APL data, data provided by the manufacturer also indicates that the potential benefits from slide valves could be eroded as engine load is reduced.

Ships complying with the vessel-speed reduction (VSR) program generally have main engine loads below 25%, which is the lowest load point used in the standard ISO 8178 E3/E2 test cycle. Due to the high participation levels of vessels complying with the VSR program and in discussions with MDT, it was identified that there have been very limited low-load engine tests for slide-valve emission reductions conducted specifically on large slow-speed, two-stroke propulsion engines below 25% load and, therefore, there is not enough data to determine whether the slide-valve benefit is appropriate at these lower loads. The benefit is currently being applied in the emissions inventories for all main engine loads.

POLA and POLB (the ports) are interested in an emissions test to determine what, if any, benefit there is from MDT slide valves compared with conventional fuel valves, specifically at lower engine loads (below 25%), in support of the San Pedro Bay Ports (SPBP) Clean Air Action Plan (CAAP) ocean-going vessel measure number 6 (OGV6) and to improve the annual emissions inventories. Slide-valve retrofits are applicable as an emissions reductions strategy for Tier 0 and Tier I vessels. New Tier II vessels already incorporate slide valves and therefore no additional reduction is applicable to their use.

Slide valve is considered to reduce the amount of waste products and give better combustion properties in the engine. The elimination of the fuel-nozzle sac volume also saves fuel. Unburned fuel will expand out from the sac volume during the late expansion stroke into the combustion chamber and cause fouling of piston liners and exhaust system. The spray pattern of the fuel is further optimised and therefore leads to an improved combustion process. The result is less deposit throughout the gas ways and a reduction in overall emissions, such as HC, NOx and particulate matter. The visible smoke level is also considered to be greatly reduced as a result of the improved combustion.

3. ENGINE INFORMATION AND SET UP

3.1 Engine information

Table 1 lists important engine data. And in Appendix 1 - 6S70MC-C technical file IMO components – important IMO components are listed from the 'parent' engine.

Engine type	6S70MC-C7
Engine Serial Number	6384
IMO no.	9641895
Mark and Hull No.	S-8127
Layout (MCR)	18660 (kW), 91.0 (rpm)
	Bore: 70 cm, Stroke: 280 cm Stroke-to-bore ratio: 4 : 1 MEP: 20 bar
Turbocharger	TCA88-20030
Air cooler	Direct sea-water cooling
Maximum pressure (MCR)	150 barabs

Table 1 – Engine Data

3.2 Fuel-valve data

Table 2 specifies the fuel valves for the engine test.

Conventional fuel valve (C3)	3137901-2
Conventional fuel valve (C11)	3138323-0
Slide fuel valve (SV)	1767890-6

Table 2 – Fuel-valve specification

3.3 Exhaust-gas system and sampling position

Gaseous and particulate emissions were measured after the turbocharger. The sample-point position and mounting of the dilution tunnel for particulate measurement according to ISO 8178 are specified in Appendix 2 - Specification for mounting MDT Dilution tunnel.

3.4 Fuel- and lube-oil specification

Table 3 and Table 4 specify the most important properties of the fuel oil and lube oil used. Copies of the fuel analysis certificates are included in Appendix 3 - Fuel-oil analysis and Appendix 4 - Lube-oil analysis.

	Fuel oil	-	Method
Certificate no.	O-2291	-	-
Quality class	FO	-	-
Date of Sampling	27.09.2012	-	-
Density (at 15 deg.C)	833.3	kg/m3	JIS K 2249
Heat of Combustion, Net.	42747	kJ/kg	JIS K 2279
Viscosity (at 50°C)	2.666	mm2/s	JIS K 2283
Sulphur content	0.07	% mass	JIS K 2541
Nitrogen	<0.01	% mass	JIS K 8813
Carbon	86.2	% mass	JIS K 8813
Hydrogen	13.3	% mass	JIS K 8813
Oxygen	0,23	% mass	JIS K 8813
Water by Dist.	<0.05	% mass	JIS K 2275
Ash	<0.01	% mass	JIS K 2272
Con. Carbon Residue (10%)	0.38	% mass	JIS K 2270
Flash point (P.M)	72	°C	JIS K 2265
Cetane index	58.7	-	JIS K 2280

Table 3 – Fuel-oil properties (Appendix 3 - Fuel-oil analysis**)**

	Lube oil	-	Method
Certificate no.	O-2293	-	-
Quality class	LO	-	-
Date of Sampling	26.09.2012	-	-
Density (at 15 deg.C)	934.6	kg/m3	JIS K 2249
Viscosity (at 40°C)	224.1	mm2/s	JIS K 2283
Sulphur content	0.87	% mass	JIS K 2541
Carbon	81.5	% mass	JIS K 8813
Hydrogen	12.2	% mass	JIS K 8813
Acid no.	0.5	mgKOH/g	JIS K 2501
Base no.	70.2	mgKOH/g	JIS K 2501
Insolubles (Pentane)	<0.05	% mass	ASTM D893
Insolubles (Toluene)	<0.05	% mass	ASTM D893

Table 4 – Cylinder lube-oil properties (Appendix 4 - Lube-oil analysis**)**

4. EMISSION EQUIPMENT AND MEASUREMENT PROCEDURES

4.1 Exhaust-gas analyzers, sampling system and calibration gasses

Table 5 specifies the exhaust-gas analyzer used to measure CO_2 concentrations in the diluted and undiluted exhaust gas. There has also been performed CO_2 back-ground measurement from the compressed dilution air. Prior to measurement campaign the analyzer has been linearized in agreement with IMO - NOx Technical Code 2008. Specification is given in Appendix 5 - LinCheck - sn.N1-PD-0056 - 2012.07.16.

Component	Manufacturer	Model	Device ID.	Measuring range (DSR)
CO_2 (high)	Siemens AG	Ultramat 23	34	0-10 %
CO_2 (low)	Siemens AG	Ultramat 23	34	0-0.5 %

Table 5 – Gas analyzer

The calibration gasses used are specified in Table 6. The certificates are specified in Appendix 6 - Calibration gas certificates.

Component (s)	Concentration	Cylinder no.	Expiration date	Supplier
CO_2, High	8.713 %	GT-93980	2013-08-21	Takachiho chemical industrial CO.
CO_2,Low	0.4742 %	NOX-02074	2013-08-22	
N_2	<3 ppm H_2O <0.5 ppm C_nH_m <2 ppm O_2	NA	NA	

Table 6 – Calibration gasses

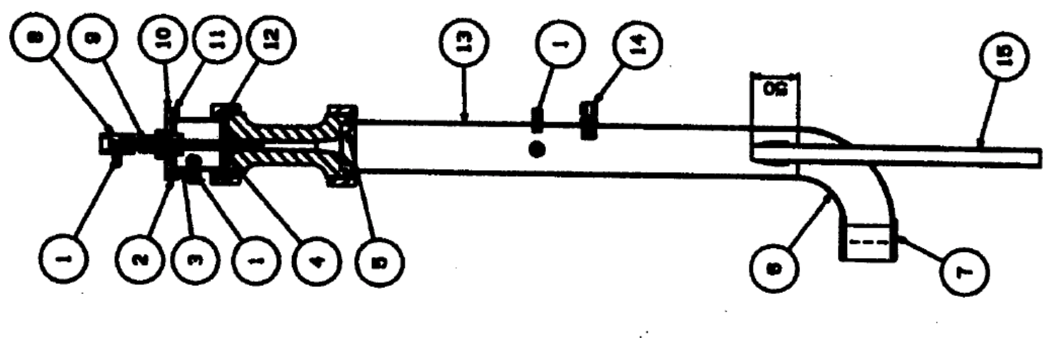
Table 7 specifies the gas meters used to measure the flow through the particle filters. The calibration of the gas meters are specified in Appendix 7 - MDT gas-meter calibration.

Device I.D.	Manufacturer	Model	Calibration I.D.	Measuring range (DSR)
Volumen måler NR1	ICA	AC-5M	20121025-VMNR1	0-5 m3/h
Volumen måler NR2	ICA	AC-5M	20121025-VMNR2	0-5 m3/h

Table 7 – Gas meters

4.2 Dilution tunnel

Particulates are measured by the partial-flow dilution method, using a MAN B&W custom-made mini-dilution tunnel. The system is described in details in Reference [1]. The main dimensions and the conditions for the tunnel are given in Table 8.



Length transfer line – mm	300
Temperature transfer line – deg.C	300
Internal diameter transfer line – ømm	6
Inlet temperature dilution air – deg.C	25
Ventura diameter – ømm	9.5
Needle tube – outer diameter	8
Needle tube – inner diameter	3
Dilution-tunnel mixing length – mm	430
Internal dilution-tunnel diameter – ømm	50
Dilution-tunnel temperature (mixing section) – deg. C	41-49
Filter type (Teflon coated borosilicate glass fibers)	Pallflex TX40HI20WW
Filter type (Quartz for chemical analysis)	GL-quartz filters
Filter diameter – mm	47
Gas-meter temperature – deg.C	25-40
Dilution ratio	17-20

Table 8 – Mini-dilution tunnel for particulate measurements

4.3 Sampling probes

The MDT sample probe is a straight closed-ended multi-hole probe used for gas as well as particulate sampling in the exhaust channel after the turbocharger. The sample probes O.D is 8 mm and have 5x3 holes of 1 mm, Reference [2]. The length is 1265 and 1150 mm respectively for particle and gaseous emissions.

4.4 Measurement procedures

Emission measurements are performed following standard MAN B&W procedures for test-bed measurements, as described in the MAN B&W Emission measurement procedures [2]. The procedures follow closely ISO 8178-4 [3].

4.5 Chemical filter analysis

The chemical analysis of the particulates where performed by Germanischer Lloyd SE. The table below summarizes the chemical analysis conducted:

Analysis for:	Symbol:	Method:
Elemental Carbon	EC	Thermo Gravimetric Analysis (VDI 2465 Part 2)
Organic Matter	OM	Thermo Gravimetric Analysis (VDI 2465 Part 2)
Sulphate	SO4	Ion chromatography system (Dionex DX 500)
Ash + Remaining	AR	The remaining of particle-filter load after analysis (no analysis for Ash alone)

The analysis is described in more details in Appendix 8 - Chemical analysis by Germanischer Lloyd SE.

5. TEST PROGRAM AND CONDITIONS

The test program is described in Appendix 9 - MES Plan for NOx measurement on test bed. An overview is given in Table 9.

Test no.	-	Fuel valve	load	date
T01	1	SV	10%	2012-09-26
T01	2	SV		
T02	1	SV	15%	
T02	2	SV		
T03	1	SV	25%	
T03	2	SV		
T04	1	SV	50%	
T04	2	SV		
T05	1	SV	75%	
T05	2	SV		
T06	1	SV	100%	
T06	2	SV		
T07	1	C3	10%	2012-09-27
T07	2	C3		
T08	1	C3	15%	
T08	2	C3		
T09	1	C3	25%	
T09	2	C3		
T10	1	C3	50%	
T10	2	C3		
T11	1	C3	75%	
T11	2	C3		
T12	1	C3	100%	
T12	2	C3		
T13	1	C11	10%	2012-09-28
T13	2	C11		
T14	1	C11	15%	
T14	2	C11		
T15	1	C11	25%	
T15	2	C11		
T16	1	C11	50%	
T16	2	C11		
T17	1	C11	75%	
T17	2	C11		
T18	1	C11	100%	
T18	2	C11		

Table 9 – Test program overview

6. RESULTS

6.1 Directly measured emission data

Gaseous emissions are measured after the turbocharger by Mitsui (MES). The results are specified in Appendix 10 - The Emission measurement results for Mitsui-MAN B&W 6S70MC-C.

6.2 Performance data

Engine performance measurements are performed by MES. The results are specified in Appendix 11 - MES Performance data results for Mitsui-MAN B&W 6S70MC-C.

6.3 Particulate measurement

Data sheets for the particulate measurements are included in Appendix 12 - MDT ISO 8178 particulate measurement data sheets. In-stack particulate measurements according to EPA17 where performed by MES and is not included in this report.

The results of the particulate measurements are presented in Figure 1 below.

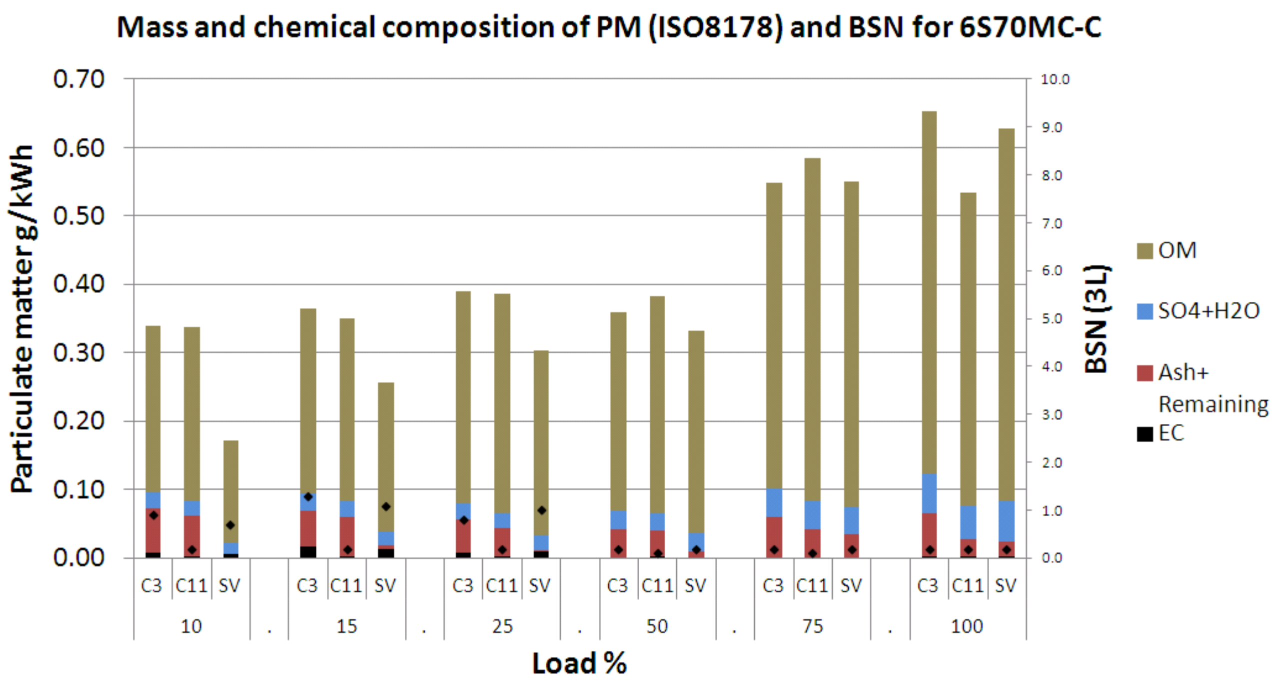


Figure 1 – Comparison of particulate emissions for different fuel valves.

At low load (<25% load) SV emits less particulates than C3 and C11. Between 10% and 25% engine load SV emits 50 to 20% less particulate than C3 and C11. Particle matter for all tests performed is dominated by organic matter (OM). The particle matter consists of 72-89% of OM (see Table 10).

Load%	FV	EC	SO4+H2O	OM	Ash+ Remaining	PM total	BOSCH (3L)
10	C3	0.009	0.023	0.245	0.064	0.340	0.9
	C11	0.002*	0.021	0.254	0.060	0.338	0.2
	SV	0.005	0.018	0.150	0.000	0.173	0.7
15	C3	0.017	0.025	0.271	0.052	0.365	1.3
	C11	0.002*	0.022	0.267	0.059	0.350	0.2
	SV	0.014	0.021	0.218	0.004	0.257	1.1
25	C3	0.007	0.024	0.310	0.049	0.390	0.8
	C11	0.002*	0.022	0.321	0.042	0.386	0.2
	SV	0.009	0.020	0.271	0.003	0.303	1
50	C3	0.001*	0.026	0.291	0.041	0.359	0.2
	C11	0.001*	0.026	0.317	0.038	0.383	0.1
	SV	0.001*	0.027	0.296	0.008	0.332	0.2
75	C3	0.001*	0.041	0.447	0.059	0.548	0.2
	C11	0.001*	0.041	0.501	0.041	0.585	0.1
	SV	0.001*	0.040	0.477	0.033	0.551	0.2
100	C3	0.001*	0.057	0.531	0.064	0.654	0.2
	C11	0.002*	0.048	0.458	0.027	0.534	0.2
	SV	0.001*	0.060	0.544	0.023	0.628	0.2

Table 10 – PM chemical species in g/kWh, *EC below detection limit calculated based on detection limit value of 0.016 mg/filter.

Elemental carbon (EC) is low for all 3 FVs and only detectable for SV and C3 at 50% engine load and below. The EC emission correlates with BSN (Bosch Smoke Number) for all analyses above EC detection limit.

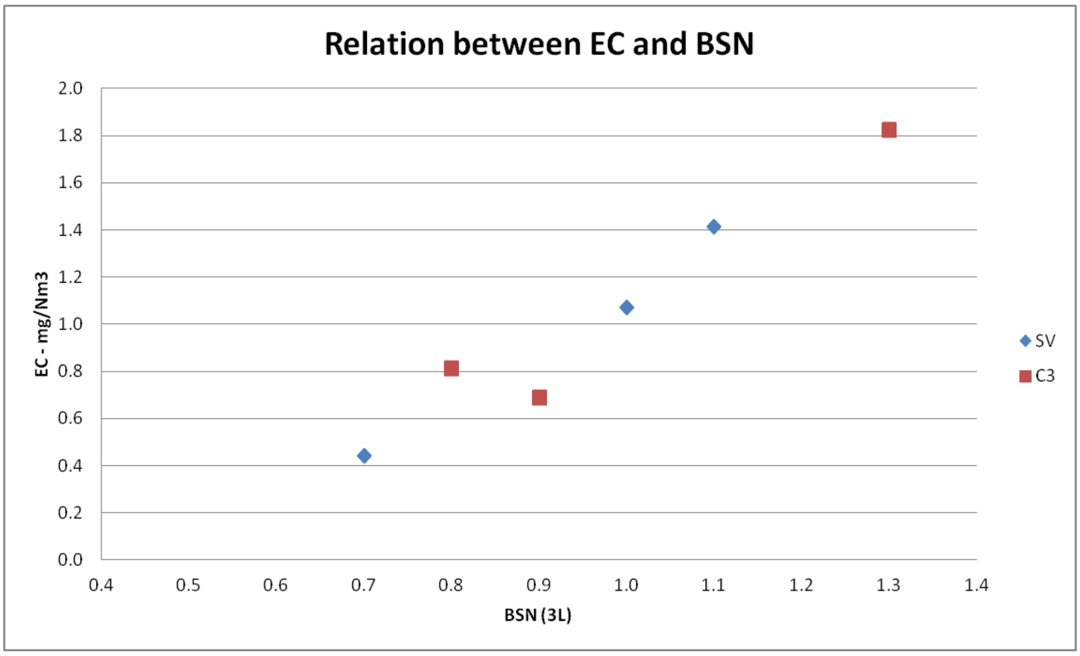


Figure 2 – Particulate EC in relation to BSN

At MCR the C11 FV emits less particulates compared with the other FVs.

The particulate emission level is generally high compared with other MDT 2-stroke engines running on low-sulphur fuel oil. The cylinder lubrication on test bed where higher than expected and this condition can explain why higher particulate emissions in general are seen. It can also explain why the OM fraction is dominant. These matters will be discussed further in the next section of this report.

7. DISCUSSION

7.1 Comparison of particle emission with other engine types and fuels

Figure 3 shows the particle emissions for the 75% load point compared with other engine and fuel types at the same load point.

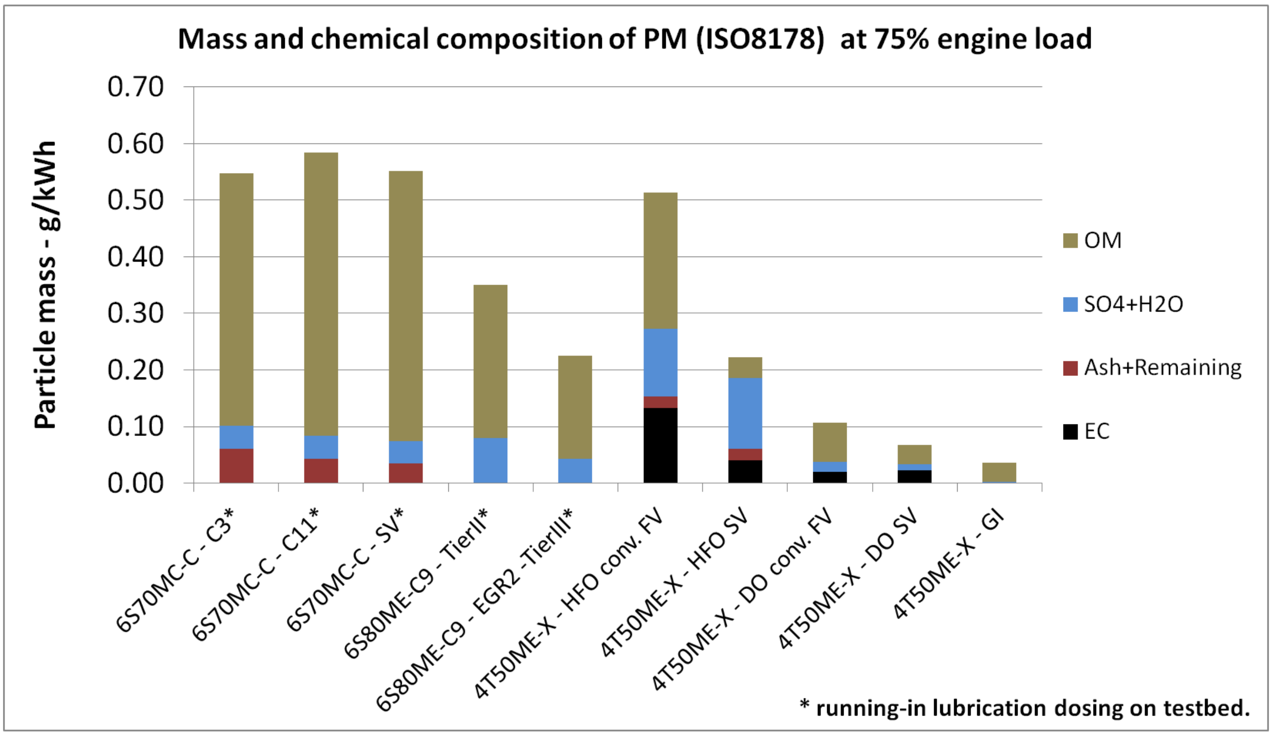


Figure 3 – Comparison of particulate emission with other engine types and fuels.

If the particulate emission from 6S70MC-C engines is compared with an equivalent fuel type (4T50ME-X – DO conv. FV, fuel sulphur 0.05 wt%,) the particulate emission is 4 times as high by mass. If the OM fraction is compared, the 6S70MC-C engine emits 6 times more OM than an engine with comparable fuel type. The particulate emission level is of the same magnitude of heavy fuel oil (fuel sulphur 2 wt%) with conventional FV. It is expected that the fraction of organic matter is a little higher for MC than ME engines due to the ME engines possibility of better fuel-injection tuning. This however, can not explain why the particulate emission level is comparable with HFO particulate emission.

7.2 Lubrication

It is known that the cylinder lubrication contribute to the particulate emission. Unburned cylinder oil can be torn of the cylinder liner and a small fraction will end up on the particulate filters due to the scavenging process.

The lubrication dosing is controlled by the MDT alpha lubricator. The cylinder lubrication is normally set according to the Sulphur content of the fuel (Figure 4).

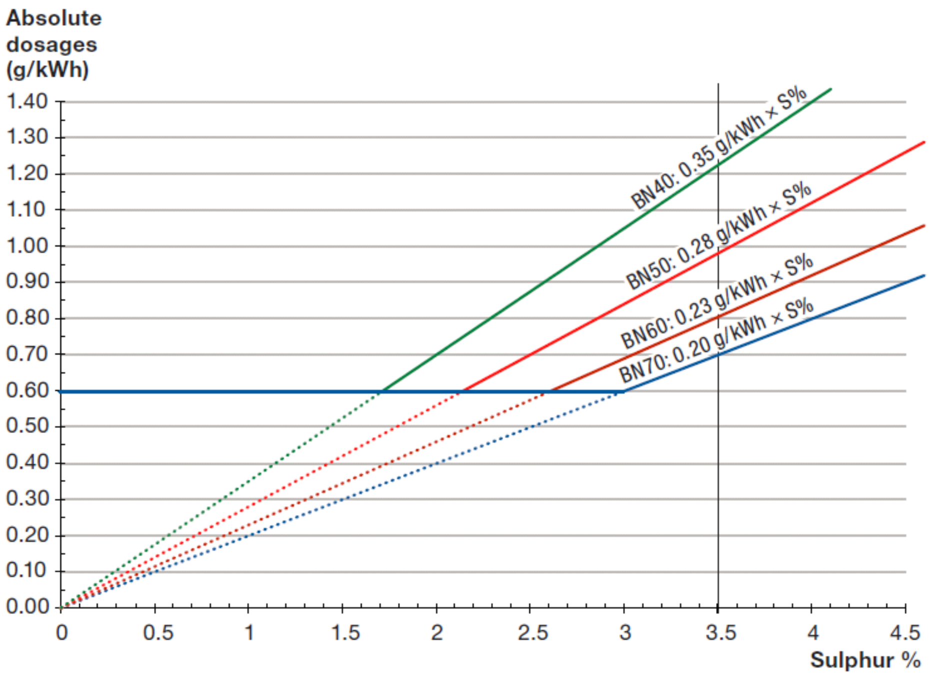


Figure 4 – Recommended cylinder lubrication according to SL09-507 (MDT service letter)

On test bed however, the cylinder-lubrication dosing is set higher in order to run-in the engine cylinder liners. On 6S70MC-C the cylinder lube-oil dosing was set to 2.1 g/kWh at MCR and the part-load dosing was proportional with fuel index.

7.3 Gas-chromatography analysis

In order to quantify the lube-oil related OM an additional analysis of particle filters by GC analysis (Gas-chromatography analysis) was initiated. The test where performed by Technical Univ. of Denmark, the Dep. of Mechanical Engineering. The method is described in Appendix 13 - SOF gas-chromatography analysis by DTU-MEK. The table below shows good correlation between particulate OM analyzed by Thermo-Gravimetric Analysis (TGA) and extracted soluble-organic fraction (SOF). The deviation between OM by TGA and SOF is less than 2 percent.

test:	1	2	3	4
TGA - Germanischer Lloyd SE	89.3	89.2	86.5	86.6
SOF - DTU-MEK	89.6	89.6	87.9	88.2

Table 11 – Comparison of measured organic matter by Thermo-Gravimetric Analysis (TGA) and extracted soluble-organic fraction (SOF), unit percent by mass.

Figure 5 below shows chromatogram from the GC analysis of particulates derived for SOF extraction.

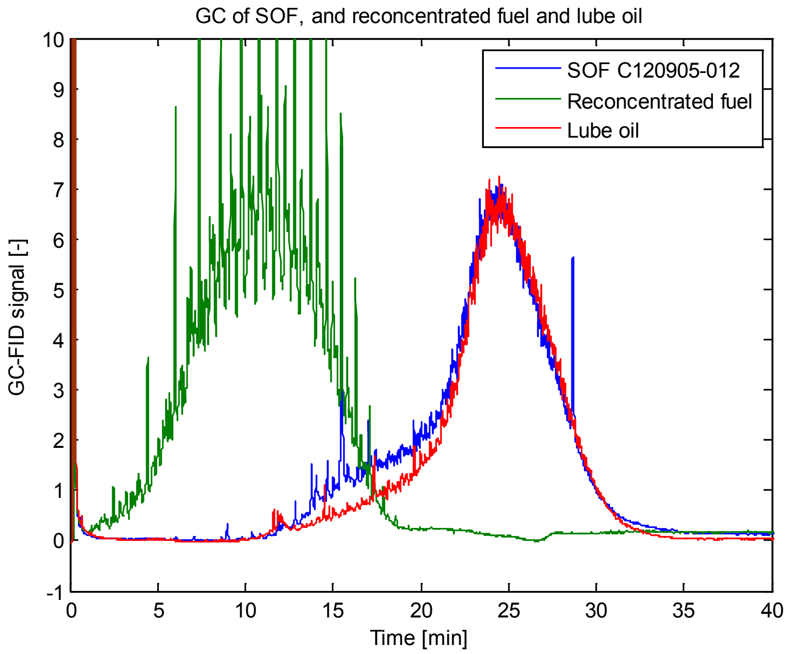


Figure 5 – Chromatogram of fuel oil, lube oil and PM-SOF

From the GC chromatogram it is obvious that the PM-SOF resemble the cylinder lube oil rather than the fuel oil. Based on the GC analysis the fraction of fuel-related OM was found to be between 12.1-9.4 percent by mass. Based on these results the conclusion is that the particulate fraction of OM originates primarily from the cylinder lube oil and constitutes around 90% by mass of the total fraction of OM.

If the results were corrected not to include cylinder-oil-related OM the particulate emission would be reduced according to Figure 6 below (assumed OM reduction of 90%).

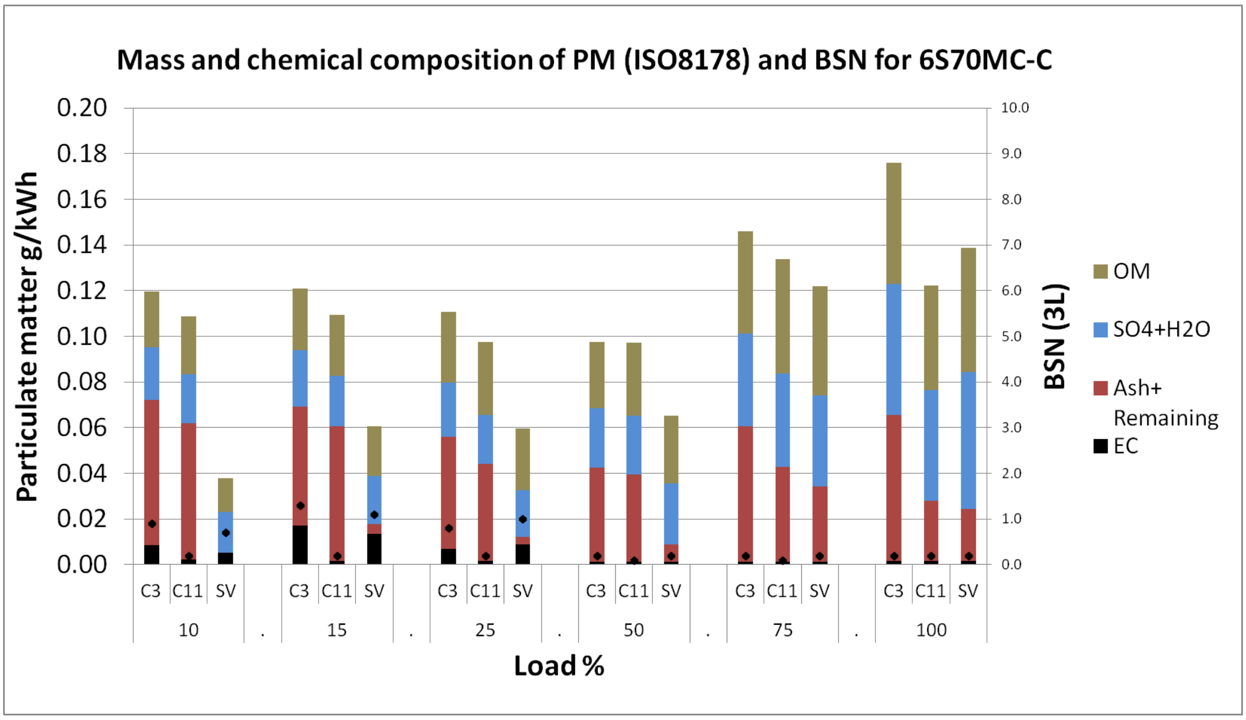


Figure 6 – Particulate corrected not to include lubrication originated OM

Cylinder lube-oil-related OM cannot be directly correlated to cylinder lube-oil dosing. MDT has not yet established a correction factor that can account for deviation in lube-oil dosing with satisfactory results. It is therefore considered to be more appropriate to give the results based on GC analysis without any cylinder lube-oil contribution, rather than make estimation of cylinder lube-oil OM contribution that are inconclusive and in worst case incorrect.

The results presented in Figure 6 correspond better with the results for other engine types presented in Figure 3. The low content of ash+remaining (AR) for SV compared with C3 and C11 FVs, may suggest that that the AR originate from the fuel rather that the lube oil. If AR originated from the cylinder lube-oil FV type, it is expected to have no influence on the AR content of particulate. The low AR content for SV also indicates that the particulate OM is condensate rather than AR containing cylinder lube-oil droplets that have been ripped off the cylinder liner. The lube oil might have been evaporated or partly combusted in the cylinder and after the turbocharger condensed to particulate OM in the exhaust-gas funnel or dilution tunnel. The corrected results also imply that the benefit of SV is also valid for part load (75% engine load). The reduction of PM by mass for SV compared with C3 and C11 is 65% at 10% load and approximately 10% at 75% engine load.

7.4 Discussion summary

The focus of the discussion has primarily been on the cylinder-oil related particulate emission.

There has been no evidence of correlation between lubrication dosing and particulate emission for older engines prior to year 1999. In the GESA report [4] no increase in particulate Organics by doubling the lubrication dosing was observed. In the study by Linda Gratz [5] there was no indication that an increased lubrication dosing contributed to higher particulate emissions.

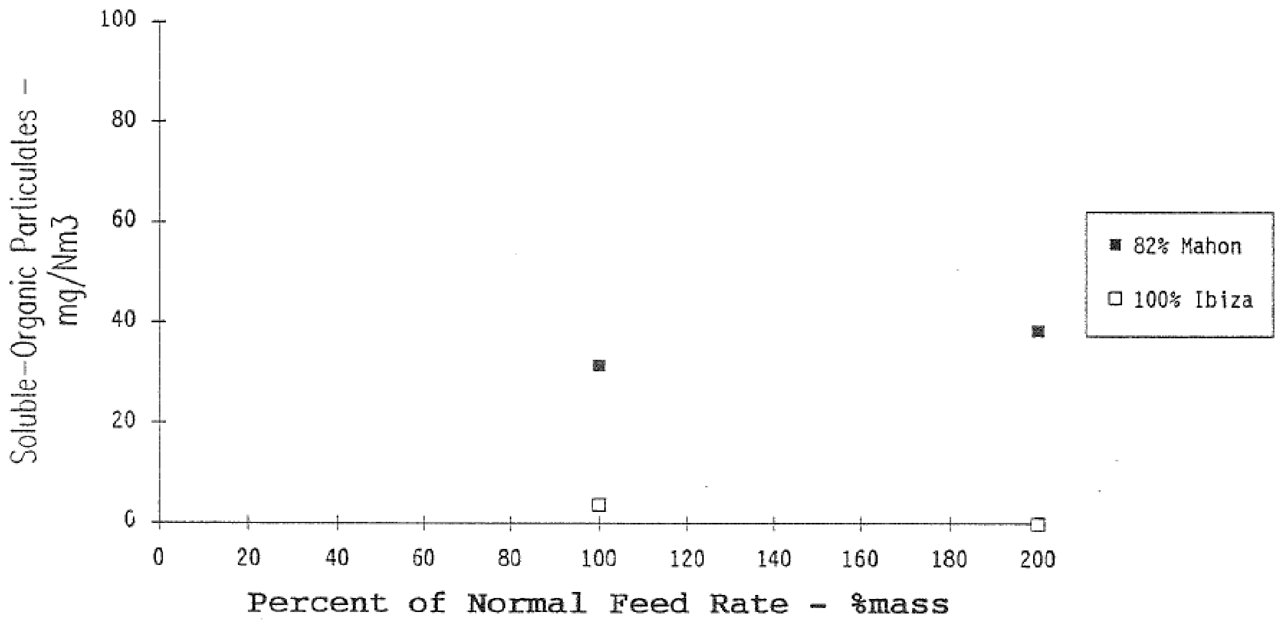


Figure 7 – GESA – 10L67GB-S and 10K67GSCA-S, Mahon and Ibiza 1992, 82% engine load.

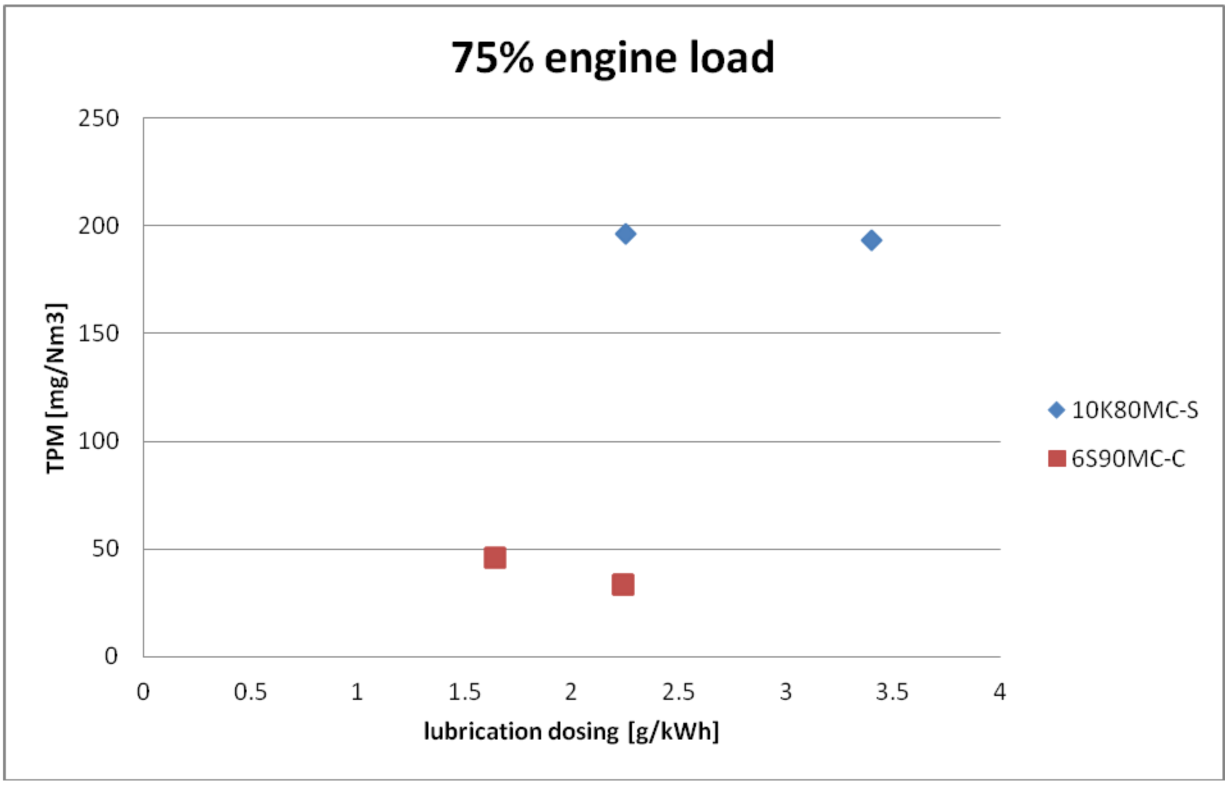


Figure 8 – The contribution of Lubricating Oil to Total Diesel Particulate emissions, Linda Gratz & Jesper Schramm, 10K80MC-S, 6S90MC-C 1999.

The alpha lubricator was first introduced and tested on a large-bore engine in Korea on a 12K90MC engine in September 1999. One of the features of the alpha lubricator system is to inject the cylinder lubrication oil directly into the ring pack for every 4,5,6 etc. revolutions. By doing so, there is a risk that cylinder oil is trapped in the ring packs and will be blown out in the exhaust-gas system. For older lubrication systems the cylinder oil is introduced to the liner above the piston. This feature might prevent the blow-out of cylinder oil from the ring pack and might be the explanation why an increase in lubrication dosing doesn’t influence the particulate mass in case of engine prior to 1999. It must be stated this is only a theory.

The data for older engines, therefore, doesn’t give a reason to establish correlations between cylinder-oil lubrication and particulate emission. A new attempt to correlate cylinder-oil lubrication to particulate mass needs to be established. This is, however, not straight forward and many parameters will affect the results.

To make particulate measurements on test bed with decreased cylinder-lubrication dosing after engine running-in are not really feasible due to the Licencees delivery schedule. The alternative is to make particulate measurements in service. But the conditions on board makes measurement much harder than on test bed and will require more resources. This will add to the uncertainties of the particulate measurement and make comparison between particulate measurements more difficult. However, it will make the particulate measurements more realistic.

REFERENCES

[1] 'MAN B&W Diesel A/S Custom made mini-dilution tunnel, version DT-4', MAN B&W Diesel A/S, R&D Dept. 2431, Oct. 2002
[2] 'Emission Measurement Procedures for IMO Certification of MAN B&W Two-Stroke Engines on Test Bed,' MAN B&W Diesel A/S, R&D Dept. 2431, Nov. 1998
[3] ISO 8178-1: Reciprocating internal combustion engines – Exhaust-gas measurement, Part1: Test-bed measurement of gaseous and particulate emissions (ISO, 2006)
[4] GESA - 10L67GB-S and 10K67GSCA-S, Mahon and Ibiza 1992
[5] The contribution of Lubricating Oil to Diesel Particulate emissions, Linda Gratz & Jesper Schramm, 10K80MC-S, 6S90MC-C 1999.

APPENDICES

Appendix 1 - 6S70MC-C technical file IMO components
Appendix 2 - Specification for mounting MDT Dilution tunnel
Appendix 3 - Fuel-oil analysis
Appendix 4 - Lube-oil analysis
Appendix 5 - LinCheck - sn.N1-PD-0056 - 2012.07.16
Appendix 6 - Calibration gas certificates
Appendix 7 - MDT gas-meter calibration
Appendix 8 - Chemical analysis by Germanischer Lloyd SE
Appendix 9 - MES Plan for NOx measurement on test bed
Appendix 10 - The Emission measurement results for Mitsui-MAN B&W 6S70MC-C
Appendix 11 - MES Performance data results for Mitsui-MAN B&W 6S70MC-C
Appendix 12 - MDT ISO 8178 particulate measurement data sheets
Appendix 13 - SOF gas-chromatography analysis by DTU-MEK

Appendix 1 - 6S70MC-C technical file IMO components

Particulars of the engine

Two-stroke, uni-flow scavenged, turbo-charged, charge-air cooled, in-line, cross-head, water cooled, open-chamber, direct-injection diesel engine, with pump-line-nozzle fuel injection for each cylinder, and for operation on heavy fuel oil.

1 Name and address of manufacturer **Mitsui Engineering & Shipbuilding Co., Ltd.**
1-1, Tama 3-chome, Tamano, Okayama 706-8651, Japan

2 Place of engine build **Same**

3 Date of engine build **April, 2010**

4 Place of pre-certification survey **as above**

5 Date of pre-certification survey **16 April, 2010**

6 Engine type **6S70MC-C**
Number of cyl **6** *Bore (mm)* **700** *Stroke (mm)* **2800**
Cooling system **Direct Sea Water Cooling**

7 Engine number **5881**

8 Plant spec. number **0909215-2**

9 If applicable, the engine is: ***an Individual engine*** ***a Parent engine*** **X** ***a Member engine***
of the following engine Group: **S70MC-C NOx Group 10**
On-board survey code version **survey-S70MC-C NOx Group 10-v4-1(5881).xls**

10 Test cycle(s) (see chapter 3 of the Technical Code) **E3**

11 Rated MCR Power (kW) and Speed (r/min) **18660 kW at 91 r/min**

12 Nominal engine MCR Power (kW) and Speed ((r/min) **18660 kW at 91 r/min**

13 Layout MEP (bar) / max. cylinder pressure (barabs) **19 bar / 151 barabs**

14 Engine approval number **NK Approval no.**

15 Specification(s) of test fuel (and/or Certification no. of fuel sample analysis) **Certificate no. : TE3J95FO**

16 NOx reducing device designated approval number (if installed) **Not applicable**

17 Applicable NOx Emission Limit (g/kWh) (regulation 13 of Annex VI) **17.0**

18 Parent Engine's actual NOx Emission Value (g/kWh) **16.3**

19 NOx Emission at maximum allowed tolerances (g/kWh) **16.9**

1 Engine information

1.1 'NOx' Components *(Standard engine setup plus listing of allowed inter-changeable components)* [1]

	Component	Specification	Original ID	Alternative ID (MAN B&W IMO ID)
Combustion chamber*)	Cylinder liner	ID 700 mm	5019	3136898-2
	Piston crown		6006	3136824-0
	Cylinder cover		4017	3135579-0
Fuel injection equipment (FIE)*)	Fuel pump plunger	OD 73mm	2007	1767947-2
	Fuel pump barrel	ID 73mm	3007	1767946-0
	Fuel nozzle	S70MC-C C26	1034	1767890-6
	Fuel cam	Template : 1E-04754	1E-04752	3135014-6
Turbocharger*)	Turbocharger make [2]	MITSUI-MAN	TCA88-20030	
	Number of turbochargers	1		
	Compressor Turbine		IMO-2666 IMO-2061	
	Diffuser Nozzle ring		IMO-1670 IMO-3565	
Other	Exhaust cam	Template : 1E-04755	1E-04753	3135039-8
	Scavenge air cooler [3] *)	KAWASAKI	BBBB50S-M1	
	Governor [3]	MSR	BMS2000III	
	Auxiliary Blower [3] *)	OSAKA BLOWER MFG., LTD	TBMS7538	

[1-8] *Notes or comments are found in Section 1.4*

**) For engine components see also details in Appendix A*

1.2 Settings *(engine matching at test bed)* [4]

	Parameter	Value	Range
Engine layout *)	Maximum continuous rating (MCR) - kW	18660	-
	Rated speed at MCR - min^{-1}	91	-
	Mean effective pressure at MCR (MEP) - bar	19.0	-
	Maximum pressure (Pmax) at MCR - barabs ***)	151	+3
Performance set-up *)	Compression ratio (shims) -mm [4]	4	-
	Fuel pump shims - mm (if applicable)	N/A	-
	Fuel pump orifice - Ømm (if applicable)	5.5	-
	Fuel valve opening/closing pressure - bar	350	+30 / -30
	Fuel cam lead angle - deg. CA (b.TDC) **)	10.4	-
	Fuel cam lead lift - mm [4] **)	17.4±1	-
	Exhaust cam lead angle - deg. CA (b.BDC) [4] **)	-4.1±1°	-
	Exhaust by-pass (orifice diameter) - Ømm (if applicable)	N/A	-
	Variable injection timing	With (Fixed)	-

**) For technical data see also details in Appendix A*
***) Average for all cylinder units*
****) Adjusted to ISO ambient conditions*

1.3 Operating values *(varying with engine matching, atmospheric conditions and fuel type)*

	Parameter	Reference Value [5] (at ISO ambient conditions)				Tolerance [6]			
	Power - %	100	75	50	25	100	75	50	25
Engine parameters [7]	Scavenging air pressure - barabs	3.7	3.0	2.1	1.4	N/A			
	Scavenging air temperature [8] - deg.C	37	32	28	33	+6	+3	+3	+3
	Compression pressure - barabs	131	104	75	48	N/A			
	Cylinder maximum pressure [8] - barabs	151	134	107	79	+3	+3	+3	+3
	Exhaust gas pressure [8] (back pressure) - mmWC	300	179	86	25	max. 450	max. 340	max. 225	max. 115
Atmospheric conditions (ISO ambient conditions)	Atmospheric pressure - hPa	1000							
	Ambient temperature - deg.C	25							
	Humidity - rel.%	30							
	Scavenging-air cooler sea-water inlet temperature - deg.C	25							

1.3.2 Operating values (each cylinder)

(varying with engine matching, atmospheric conditions and fuel type)

	ave	No.1	No.2	No.3	No.4	No.5	No.6
Fuel cam lead angle -deg. b.TDC	10.4	10.2	10.4	10.4	10.2	10.6	10.5
Top lift -mm	17.4	17.1	17.4	17.4	17.1	17.8	17.6
VIT index at 75%	4.3	5.0	4.0	4.5	5.0	3.5	3.5
Fuel lead [9] at 75% -mm	4.9	5.3	4.6	5.1	5.3	4.5	4.3
VIT index at MCO	4.3	5.0	4.0	4.5	5.0	3.5	3.5
Fuel lead [9] at MCO -mm	4.9	5.3	4.6	5.1	5.3	4.5	4.3
Exh. cam lead angle - deg. b.BDC	-4.1	-4.2	-4.0	-3.9	-4.2	-4.2	-4.2

*) b.TDC: Before Top Dead Center

**) b.BDC: Before Bottom Dead Center

Appendix 2 - Specification for mounting MDT Dilution tunnel

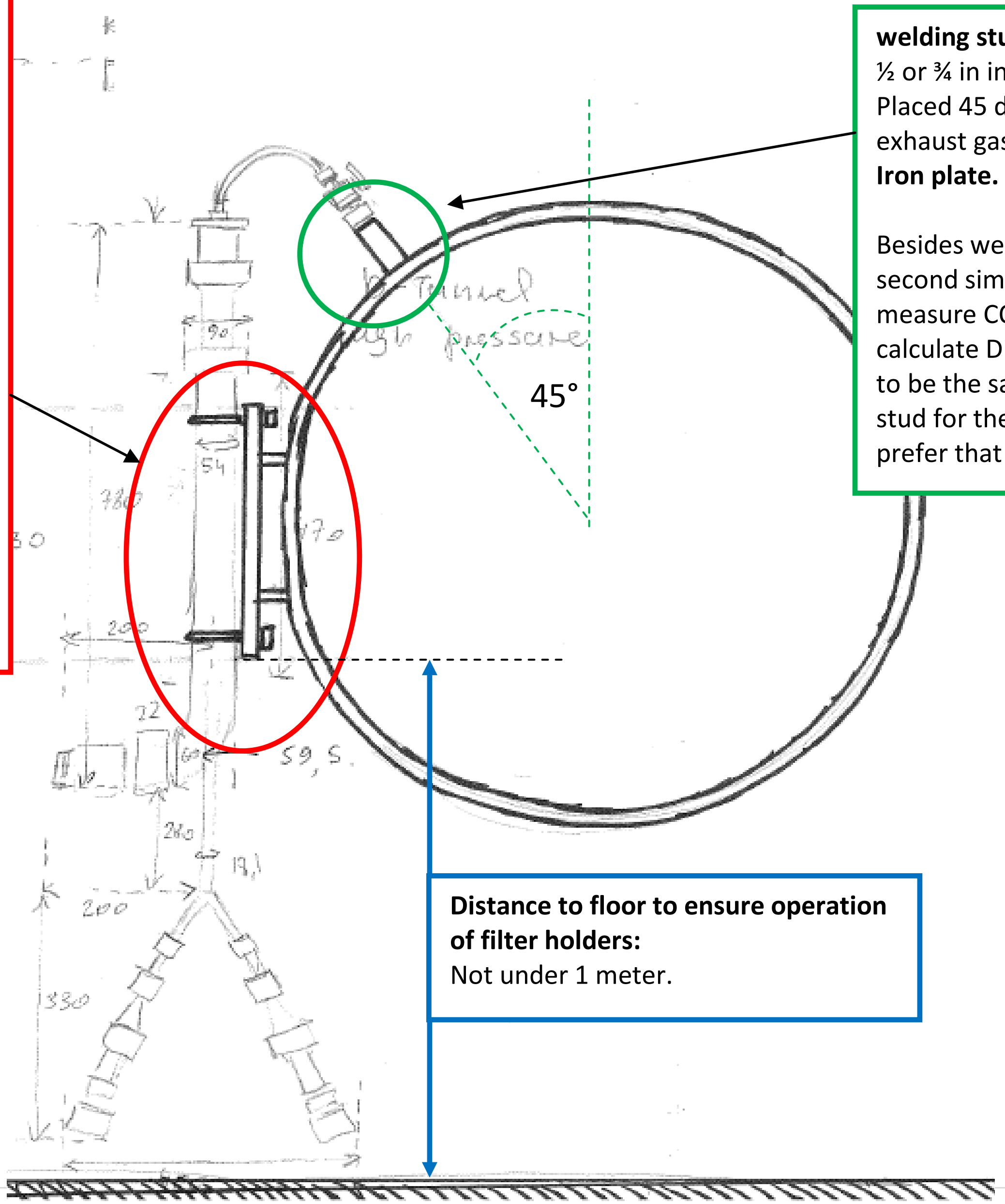
Specification for Mounting MDT Dilution tunnel for PM ISO8187 measurements – Mitsui Tamano September 2012 – 6S70MC-C7

DT Iron plate:
Iron plate for mounting Dillutiontunnel(DT).
W/H: 100x300mm and 10 to 8mm tightness. Must be welded on exhaust gas funnel 2 places to ensure stability.
4 wholes must be drilled with a diameter of 12mm, see drawing on page 2 below.

I will bring to hangers with nuts that fit the holes in the plate.

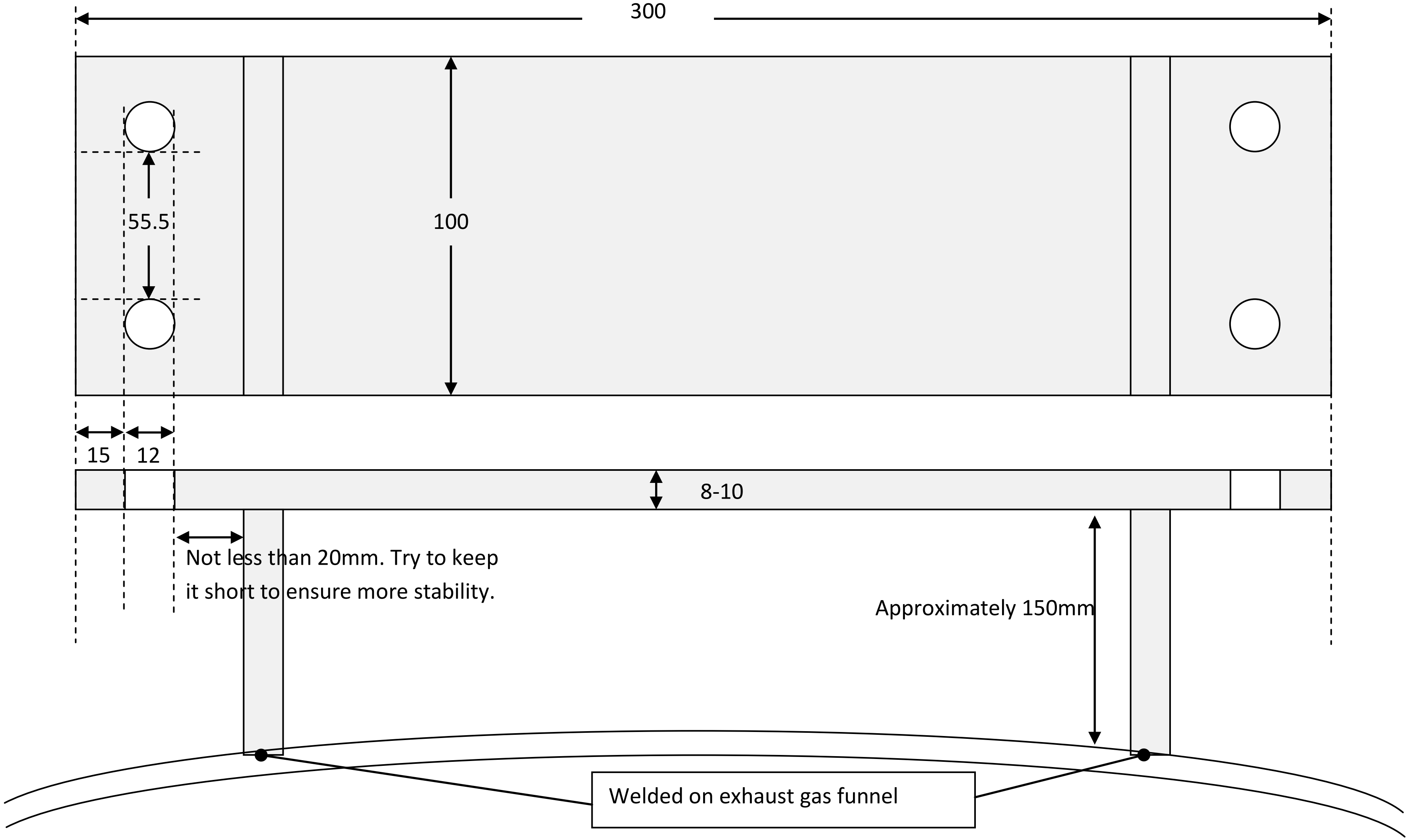
welding studs:
½ or ¾ in internal tread.
Placed 45 degree down from top of exhaust gas funnel just over the **DT Iron plate.**

Besides welding stud for PM probe a second similar stud is needed for measure CO2 in the exhaust to calculate Dilution ratio (It doesn't have to be the same angle as the welding stud for the particle probe, but we will prefer that it is not hanging down).



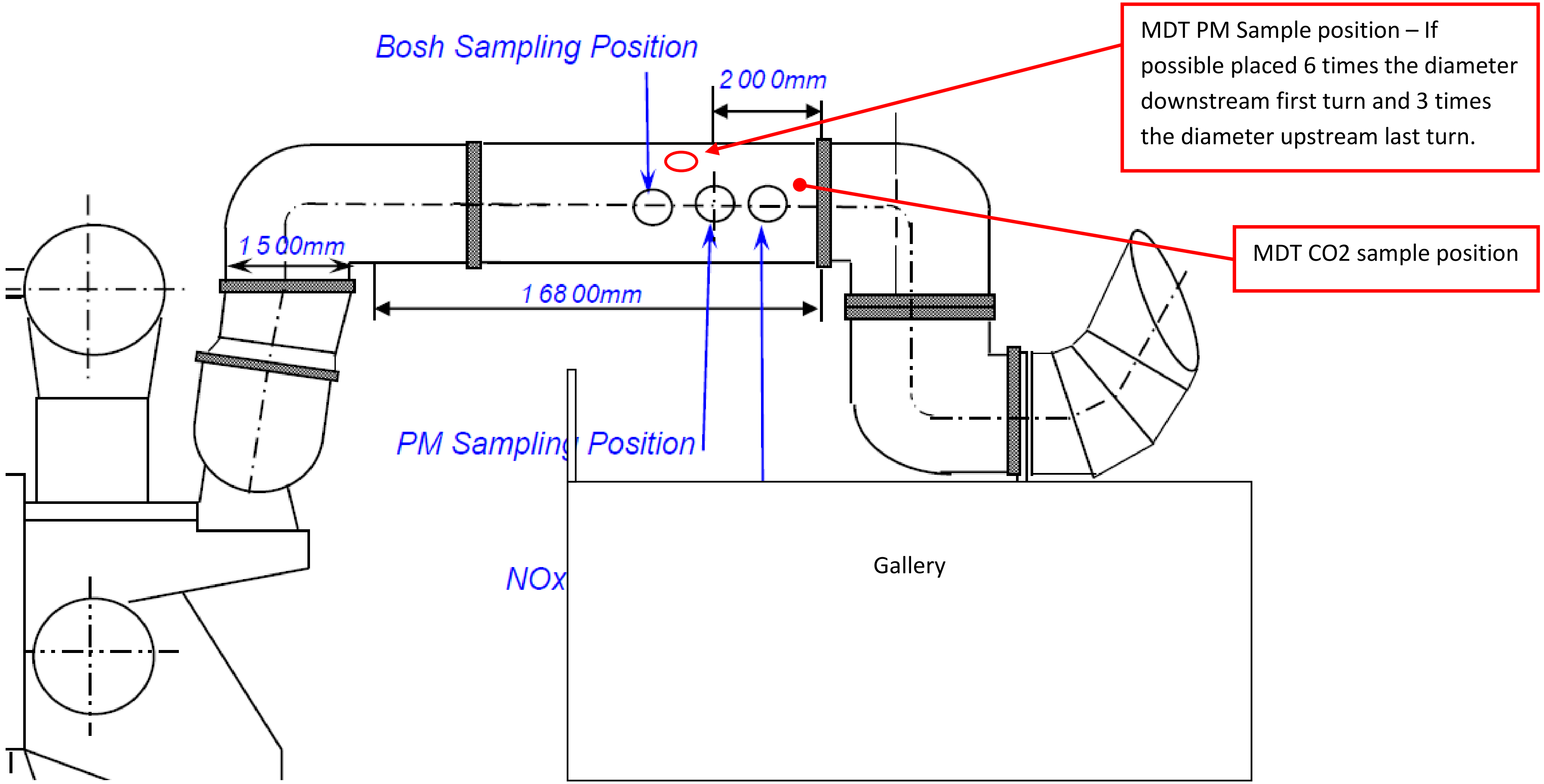
Distance to floor to ensure operation of filter holders:
Not under 1 meter.

DT Iron plate (measures in mm):



Sampling position for MDT probes and Dilution tunnel:

Because the Dilution tunnel will be mounted on the exhaust gas funnel, we need to have the sample position for the particle probe on the gallery so we can change the filters easily. If the welding studs for our particle probe and CO2 probe are placed close to each other we will prefer to have the particle placed upstream the CO2 probe.



Appendix 3 - Fuel-oil analysis

TEST RESULTS OF FUEL OIL

JOB No. 2H0259
DOC No. O-2291

DATE : 21 Dec 2012

Name of Sample		TE3P46 F.O.	(Analytical Method)
Density(15°C)	g/cm3	0.8333	JIS K 2249
Calorific Value L.	J/g	42740	JIS K 2279
Viscosity(50°C)	mm2/s	2.666	JIS K 2283
Flash Point(P.M)	°C	72	JIS K 2265
Water by Dist.	wt%	<0.05	JIS K 2275
Ash	wt%	<0.01	JIS K 2272
Sulphur	wt%	0.07	JIS K 2541
Carbon	wt%	86.2	JIS M 8813
Hydrogen	wt%	13.5	JIS M 8813
Nitrogen	wt%	<0.01	JIS M 8813
Oxygen	wt%	0.23	JIS M 8813
Con. Carbon Residue(10%)	wt%	0.38	JIS K 2270
Cetane Index		58.7	JIS K 2280

Notes : Date of Sampling : 27 Sep 2012

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

TEST RESULTS OF FUEL OIL

JOB No. 2H0259
DOC No. O-2291

DATE : 21 Dec 2012

Name of Sample		TE3P46 F.O.	(Analytical Method)
Density(15°C)	g/cm3	0.8333	JIS K 2249
Calorific Value L.	cal/g	10210	JIS K 2279
Viscosity(50°C)	mm2/s	2.666	JIS K 2283
Flash Point(P.M)	°C	72	JIS K 2265
Water by Dist.	wt%	<0.05	JIS K 2275
Ash	wt%	<0.01	JIS K 2272
Sulphur	wt%	0.07	JIS K 2541
Carbon	wt%	86.2	JIS M 8813
Hydrogen	wt%	13.5	JIS M 8813
Nitrogen	wt%	<0.01	JIS M 8813
Oxygen	wt%	0.23	JIS M 8813
Con. Carbon Residue(10%)	wt%	0.38	JIS K 2270
Cetane Index		58.7	JIS K 2280

Notes : Date of Sampling : 27 Sep 2012

K. Kimura

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

TEST RESULTS OF FUEL OIL

JOB No. 2H0259
DOC No. O-2292

DATE : 21 Dec 2012

Name of Sample		TE3P46 F.O.	(Analytical Method)
Density(15°C)	g/cm3	0.8336	JIS K 2249
Calorific Value L.	J/g	42740	JIS K 2279
Viscosity(50°C)	mm2/s	2.648	JIS K 2283
Flash Point(P.M)	°C	71	JIS K 2265
Water by Dist.	wt%	<0.05	JIS K 2275
Ash	wt%	<0.01	JIS K 2272
Sulphur	wt%	0.07	JIS K 2541
Carbon	wt%	86.3	JIS M 8813
Hydrogen	wt%	13.5	JIS M 8813
Nitrogen	wt%	<0.01	JIS M 8813
Oxygen	wt%	0.13	JIS M 8813
Con. Carbon Residue(10%)	wt%	0.38	JIS K 2270
Cetane Index		58.5	JIS K 2280

Notes : Date of Sampling : 28 Sep 2012

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

TEST RESULTS OF FUEL OIL

JOB No. 2H0259
DOC No. O-2292

DATE : 21 Dec 2012

Name of Sample		TE3P46 F.O.	(Analytical Method)
Density(15°C)	g/cm3	0.8336	JIS K 2249
Calorific Value L.	cal/g	10210	JIS K 2279
Viscosity(50°C)	mm2/s	2.648	JIS K 2283
Flash Point(P.M)	°C	71	JIS K 2265
Water by Dist.	wt%	<0.05	JIS K 2275
Ash	wt%	<0.01	JIS K 2272
Sulphur	wt%	0.07	JIS K 2541
Carbon	wt%	86.3	JIS M 8813
Hydrogen	wt%	13.5	JIS M 8813
Nitrogen	wt%	<0.01	JIS M 8813
Oxygen	wt%	0.13	JIS M 8813
Con. Carbon Residue(10%)	wt%	0.38	JIS K 2270
Cetane Index		58.5	JIS K 2280

Notes : Date of Sampling : 28 Sep 2012

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

Appendix 4 - Lube-oil analysis

To:Mitsui Engineering & Shipbuilding Co., Ltd.

RESULTS OF CHEMICAL ANALYSIS

Entry date: 11 Dec 2012 JOB No. 2H0259

Report date: 21 Dec 2012 DOC No. O-2293

Name	TEST RESULTS OF LUBRICANT OIL		
Sample name	26 Sep 2012 Cylinder Oil		
Item	Unit	Result	Method
Acid number	mgKOH/g	0.5	JIS K2501
Basic number	mgKOH/g	70.2	JIS K2501
Density (15℃)	g/cm3	0.9346	JIS K2249
Insolubles(pentane)	wt%	<0.05	ASTM D893
Insolubles(toluene)	wt%	<0.05	ASTM D893
Sulphur	wt%	0.87	JIS K2541
Viscosity (40℃)	mm2/s	224.1	JIS K2283
Carbon	wt%	81.5	JIS M8813
Hydrogen	wt%	12.2	JIS M8813

K. Kimura

CHIEF OF CHEMICAL ANALYSIS SECTION
TAMANO TESTING DEPARTMENT
MES TESTING RESEARCH CENTER CO.,LTD.

Appendix 5 - LinCheck - sn.N1-PD-0056 - 2012.07.16

Calibration of MAN B&W exhaust gas analyzer

Udfyld de gule celler!

Serial no.	N1-PD-0056
Date	2011-03-20

Analyzer specifications

Model	Ultramat 23		
Manufacture	Siemens AG		
Calibration curve for component	CO_2,high		
Detector type	NDIR		
Measuring range (full scale)	10 %		(Indicate % or ppm)

Span gas data

Gas type	CO_2	in	Purified Nitrogen
Concentration	8.98	%	
Certificate no./ Bottle no.	K-137038HG		
Expiration date	2012-08-19		
Supplier	Yara		

Zero gas data

Specification (purity)	99.999%
Expiration date	
Supplier	

Establishment af calibration curve

1. deg polynomia
2. deg polynomia (selected)

Gas divider %	Nominal	ured value (% or	Cal curve	Error % of read	Error % of f s
0	0	0.01	0.0		-0.3%
10	0.898	0.9	0.9	-0.5%	0.0%
20	1.796	1.79	1.8	1.0%	0.2%
30	2.694	2.69	2.7	1.1%	0.3%
40	3.592	3.62	3.6	0.4%	0.1%
50	4.49	4.52	4.5	0.6%	0.3%
60	5.388	5.48	5.4	-0.4%	-0.2%
70	6.286	6.4	6.3	-0.4%	-0.3%
80	7.184	7.34	7.2	-0.7%	-0.5%
90	8.082	8.21	8.1	-0.1%	-0.1%
100	8.98	9.07	8.9	0.5%	0.5%
Calibrator:				Max 2%	Max 0.3%

2 deg. Polynom	A	B	C
A×X2+B×X+C	-0.000167207	0.9846	0.01669151

Comments:

Signature:	JAPE/LDF4	**Date:**	2012-07-16

Note: The calibration is performed according to the specifications in Annex VI to MARPOL 73/78 (Technical code on control of emission of nitrogen oxides from marine diesel engines).

Calibration of MAN B&W exhaust gas analyzer

Udfyld de gule celler!

Serial no.	N1-PD-0056
Date	2012-07-16

Analyzer specifications

Model	Ultramat 23	
Manufacture	Siemens AG	
Calibration curve for component	CO2	
Detector type	NDIR	
Measuring range (full scale)	0.5 %	(Indicate % or ppm)

Span gas data

Gas type	CO2	in	Purified Nitrogen
Concentration	0.358	%	
Certificate no./ Bottle no.	NK541432		
Expiration date	2013-05-20		
Supplier	Yara		

Zero gas data

Specification (purity)	99.999%
Expiration date	
Supplier	

◉ 1. deg polynomia
○ 2. deg polynomia

Establishment af calibration curve

Gas divider %	**Nominal**	**ured value (% or**	Cal curve	**Error % of read**	**Error % of f s**
0	0	0.001	0.0		-0.1%
10	0.0358	0.037	0.0	-1.0%	-0.1%
20	0.0716	0.073	0.1	-0.1%	0.0%
30	0.1074	0.109	0.1	0.2%	0.0%
40	0.1432	0.145	0.1	0.4%	0.1%
50	0.179	0.181	0.2	0.5%	0.2%
60	0.2148	0.218	0.2	0.1%	0.0%
70	0.2506	0.254	0.3	0.2%	0.1%
80	0.2864	0.291	0.3	-0.1%	-0.1%
90	0.3222	0.327	0.3	0.0%	0.0%
100	0.358	0.364	0.4	-0.2%	-0.1%
8.98x0.44	0.395	0.396	0.4	1.2%	0.9%
8.98x0.5	0.449	0.451	0.4	1.0%	0.9%
Calibrator:				Max 2%	Max 0.3%

1 deg. Polynom	**A**	**B**	**C**
B×X+C	**0**	**0.9865**	**-0.0003558**

Comments: Ekstra calibration points with 8.98% spangas (see CO2high for spec.)

Signature: JAPE/LDF4 **Date:** 2012-07-16

Note: The calibration is performed according to the specifications in Annex VI to MARPOL 73/78 (Technical code on control of emission of nitrogen oxides from marine diesel engines).

Appendix 6 - Calibration gas certificates

Certificate of Analysis

2012/9/25

No.12207090101e

TAKACHIHO CHEMICAL INDUSTRIAL CO., LTD.
1557 Tsuruma, Machida-shi, Tokyo 194-0004 Japan
Phone : 81-042-796-5501 Fax : 81-042-796-2717

MAN Diesl &Turbo Japan Ltd.

Commercial name	Cylinder Number
GAS MIXTURE	GT 93980

Method of analysis	INFRA-RED METHOD, CHEMILUMINESCENT METHOD

Cylinder type, Material	47L(Manganese Steel)		
Filling amount	4700L		
Date of filling	2012/ 8/ 8		
Date of analysis	2012/ 8/21		
Room temperature	20℃		
Storage temperature	0℃ ～ 35℃		
Shipping terms	Free cylinder rental for 1 year		
Memo			

Gas Name	Analysis Result	Spec
Carbon monoxide	459.4 ppm	450 ppm
Nitric oxide	2216 ppm	2250 ppm
Carbon dioxide	8.713 %	9 %
Nitrogen	Balance	

Signature		
S. Mukasa		

Certificate of Analysis

2012/9/25

No.12207083201e

TAKACHIHO CHEMICAL INDUSTRIAL CO., LTD.
1557 Tsuruma, Machida-shi, Tokyo 194-0004 Japan
Phone : 81-042-796-5501 Fax : 81-042-796-2717

MAN Diesl &Turbo Japan Ltd.

Commercial name	Cylinder Number
GAS MIXTURE	NOX 02074

Method of analysis	CHEMILUMINESCENT METHOD, INFRA-RED METHOD

Cylinder type, Material	47L(Manganese Steel)		
Filling amount	11.8MPa		
Date of filling	2012/ 7/31		
Date of analysis	2012/ 8/22		
Room temperature	20℃		
Storage temperature	0℃ ∽ 35℃		
Shipping terms	Free cylinder rental for 1 year		
Memo			

Gas Name	Analysis Result	Spec
Nitric oxide	431.2 ppm	400 ppm
Carbon dioxide	0.4742 %	0.45 %
Nitrogen	Balance	

Signature		
S. Mukasa		

Appendix 7 - MDT gas-meter calibration

MAN Diesel & Turbo

Volumemeter Calibration

Date of calibration: 25-10-2012 **Calibration I.D.:** 20121025-VMNR1

Reference Object:		**Object:**	
Type:	Gallus2000	Type:	IGA AC-5M
Se. No.:	57403422006	Se. No.:	2724282006
Name:	DT filter 3	Name:	Volumen måler NR1
Certificat no.:	9.8-10768		

Test conditions:

Medium:	Air
Ambient pressure:	1000.00
Ambient Temperature:	22.00

Test results:

Reference Object:

Flow	Error
m3/h	%
1.40	2.08
3.00	1.45
4.00	1.92
0.00	0.00

Object:

Flow	Error	Pressure	Temperature:
m3/h	%	mbar	C
3.91	0.91	12.40	22.00
2.23	-0.81	4.70	22.00
2.36	-0.20	5.80	22.00
0.00	0.00	0.00	0.00

Linear Coralation (Error% = flow*a+b):

	a	b
Reference Objekt:	-0.0924	2.0755
Objekt:	0.3875	-1.4914

Volumen Correction formula:

$$V_{coor} = V_{meas}\left(\left(\frac{a_1 V_{meas} + b_1}{100} + 1\right)\left(\frac{a_2 V_{meas} + b_2}{100} + 1\right)\right)^{-1}$$

Date of calibration: 25-10-2012

Performed by: JAPE/LDF4

Jacob B. [illegible]

Signature

date: 25 /10 -2012

MAN Diesel & Turbo

Volumemeter Calibration

Date of calibration:	25-10-2012	**Calibration I.D.:**	20121025-VMNR2
Reference Object:		**Object:**	
Type:	Gallus2000	Type:	IGA AC-5M
Se. No.:	57403422006	Se. No.:	2724292006
Name:	DT filter 3	Name:	Volumen måler NR2
Certificat no.:	9.8-10768		

Test conditions:

Medium:	Air
Ambient pressure:	1000.00
Ambient Temperature:	22.00

Test results:

Reference Object:		Object:			
Flow	Error	Flow	Error	Pressure	Temperature:
m3/h	%	m3/h	%	mbar	C
1.40	2.08	3.97	0.14	13.30	22.00
3.00	1.45	2.24	-0.27	5.40	22.00
4.00	1.92	2.59	-0.93	6.60	22.00
0.00	0.00	0.00	0.00	0.00	0.00

Linear Coralation (Error% = flow*a+b):

	a	b
Reference Objekt:	-0.0924	2.0755
Objekt:	0.3875	-1.4914

Volumen Correction formula:

$$V_{coor} = V_{meas}\left(\left(\frac{a_1 V_{meas} + b_1}{100} + 1\right)\left(\frac{a_2 V_{meas} + b_2}{100} + 1\right)\right)^{-1}$$

Date of calibration: 25-10-2012
Performed by: JAPE/LDF4

Jacob B. [illegible]

Signature

date: 14 / 11 -20 12

ilac-MRA DANAK CAL Reg. nr. 9 CIPM MRA

FORCE TECHNOLOGY

Kalibreringscertifikat

Task nr.:	112-29587.001
Certifikat nr.:	9.8-10768
Certifikat dato.:	03-08-2012
Side.	1 af 3
Bilag.	-

OBJEKT:

Prøveemne:	Bælggasmåler
Størrelse:	Gallus 2000 G4
Nr. - år:	5740342-2006
ID. Nr:	-
Fabrikat:	Flonidan
Tællervisning ved modtagelse (m^3):	-
Tællervisning efter kalibrering (m^3):	-

REKVIRENT: MAN Diesel & Turbo A/S Ordre nr.: 4200105668
Teglholmsgade 35
2450 København SV

Att.: Jannik B. Pedersen

PRØVNINGSBETINGELSER:

Prøvemetode/medie: Gennemstrømning med atmosfærisk luft.

MiddelBarometerstand: 1012,9 mbar
Omgivelsestemperatur: 20 ± 1°C

PRØVNINGSOMFANG: Kalibrering ved belastningerne 1.4, 3 og 4 m^3/h.

KALIBRERING iht.: FORCE instruktion nr. 9.08.01.B01 version 1

KALIBRERINGSRESULTAT: Resultater: se side 2.
Teknisk vurdering: Ingen bemærkninger

Måleren er konditioneret 500 l. ved Qmax inden kalibrering.

SPORBARHED: Prøveanlæg: FORCE nr. C01-001
Se side 3.

KALIBRERINGSDATO: 02-08-2012

Laboratorium for
Gas/luft volumenmålere:

Ansvarlig underskriftsberettiget — Opgaven udført af

Kurt Rasmussen — **Kurt Rasmussen**

FORCE Technology, Division for kalibrering og Måleteknik, Navervej 1 6600 Vejen tlf: 76961600
Dansk nationalt referencelaboratorium for volumengasmåling

Vol_master-Rev.105

Task nr.	:	112-29587.001
Certifikat nr.	:	9.8-10768
Kalibreringsdato	:	02-08-2012
Side	:	2 af 3

RESULTATBLAD

Volumengasmålere

Målerdata.:

Måler nr.	: 5740342	Qmax.	:	6,0 m^3/h.
Målertype.	: Bælggasmåler	Qmin.	:	0,040 m^3/h.
Størrelse.	: Gallus 2000 G4			

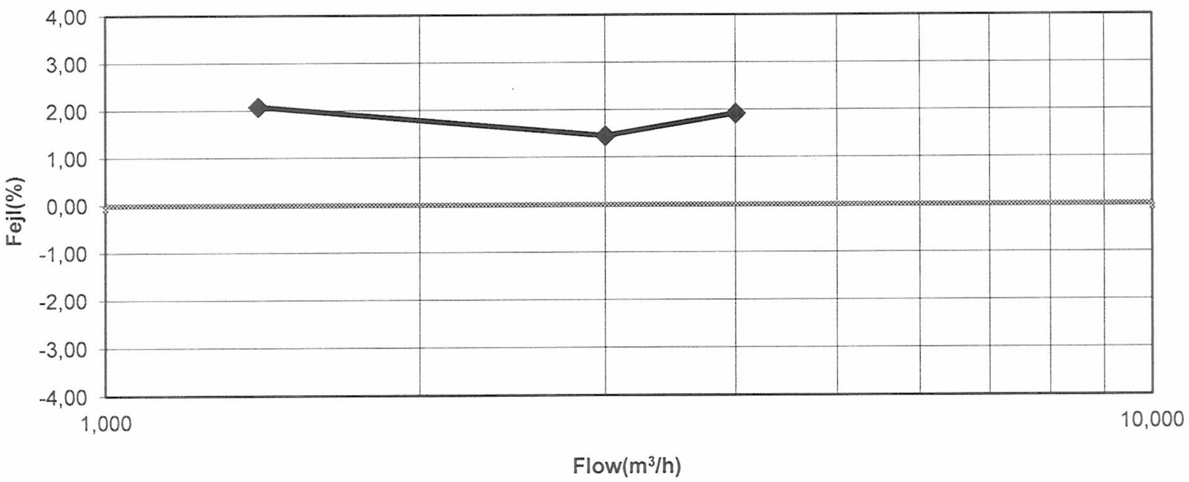
Kalibreringsresultat.:

Belastning %	Flow m^3/h.	Fejl %	Trykfald mbar	Temperatur. °C
23	1,40	2,08	0,4	20,2
50	3,00	1,45	0,7	20,2
67	4,00	1,92	1,0	20,2

Fejlen er relateret til trykket før måler.

Fejl = (Vist volumen - Virkelig volumen) / Virkelig volumen * 100 %

Fejlkurve



Målepunkter er forbundet med rette linier ilac-MRA DANAK CAL Reg. nr. 9 CIPM MRA

FORCE TECHNOLOGY

Kalibreringscertifikat

Task nr.:	112-29587.001
Certifikat nr.:	9.8-10768
Certifikat dato.:	03-08-2012
Side.	1 af 3
Bilag.	-

OBJEKT:

Prøveemne:	Bælggasmåler
Størrelse:	Gallus 2000 G4
Nr. - år:	5740342-2006
ID. Nr:	-
Fabrikat:	Flonidan
Tællervisning ved modtagelse (m^3):	-
Tællervisning efter kalibrering (m^3):	-

REKVIRENT:

MAN Diesel & Turbo A/S
Teglholmsgade 35
2450 København SV

Ordre nr.: 4200105668

Att.: Jannik B. Pedersen

PRØVNINGSBETINGELSER:

Prøvemetode/medie:	Gennemstrømning med atmosfærisk luft.
MiddelBarometerstand:	1012,9 mbar
Omgivelsestemperatur:	20 ± 1°C

PRØVNINGSOMFANG: Kalibrering ved belastningerne 1.4, 3 og 4 m^3/h.

KALIBRERING iht.: FORCE instruktion nr. 9.08.01.B01 version 1

KALIBRERINGSRESULTAT:

Resultater: se side 2.
Teknisk vurdering: Ingen bemærkninger

Måleren er konditioneret 500 l. ved Qmax inden kalibrering.

SPORBARHED:

Prøveanlæg: FORCE nr. C01-001
Se side 3.

KALIBRERINGSDATO: 02-08-2012

Laboratorium for
Gas/luft volumenmålere:

Ansvarlig underskriftsberettiget

Kurt Rasmussen

Opgaven udført af

Kurt Rasmussen

FORCE Technology, Division for kalibrering og Måleteknik, Navervej 1 6600 Vejen tlf: 76961600
Dansk nationalt referencelaboratorium for volumengasmåling

Task nr. : 112-29587.001
Certifikat nr. : 9.8-10768
Kalibreringsdato : 02-08-2012

RESULTATBLAD

Volumengasmålere

Målerdata.:

Måler nr.	: 5740342	Qmax. :	6,0 m^3/h.
Målertype.	: Bælggasmåler	Qmin. :	0,040 m^3/h.
Størrelse.	: Gallus 2000 G4		

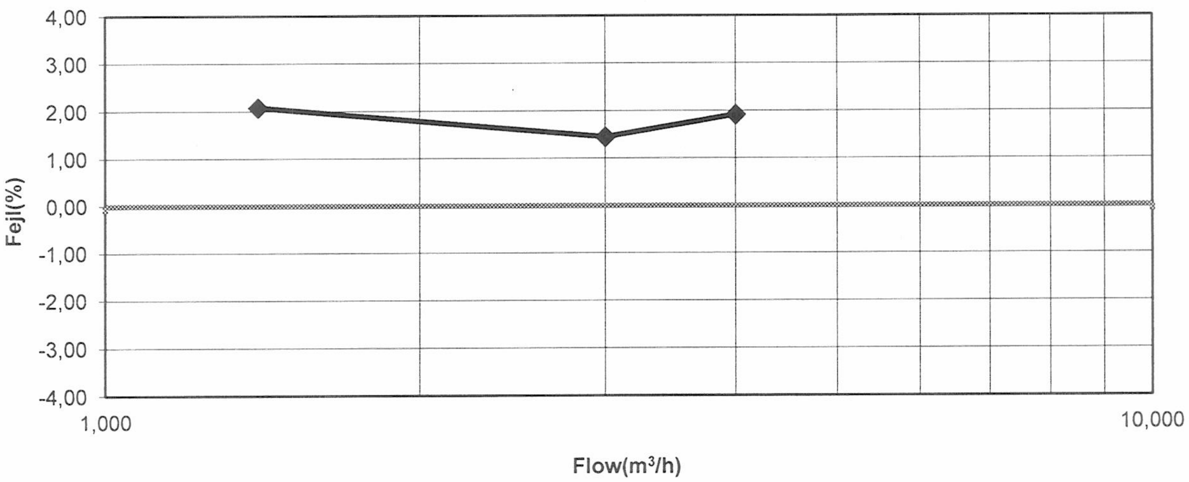
Kalibreringsresultat.:

Belastning %	Flow m^3/h.	Fejl %	Trykfald mbar	Temperatur. °C
23	1,40	2,08	0,4	20,2
50	3,00	1,45	0,7	20,2
67	4,00	1,92	1,0	20,2

Fejlen er relateret til trykket før måler.

Fejl = (Vist volumen - Virkelig volumen) / Virkelig volumen * 100 %

Fejlkurve



Målepunkter er forbundet med rette linier

Task nr.	:	112-29587.001
Certifikat nr.	:	9.8-10768
Kalibreringsdato	:	02-08-2012
Side.	:	3 af 3

LABORATORIETS KONTROLUDSTYR

De med x mærkede arbejdsnormaler er anvendt til kalibreringen

	Arbejdsnormaler:	FORCE nr.	Sporbarhed.	Kalibreret.	Certifikat nr.
	Anlæg: FORCE nr. C01-001.				
x	Vådgasmåler 0-3 m^3/h.	A03-010	NMI*	05-11-2008	9.8-6995
x	Vådgasmåler 0.15-17 m^3/h.	A03-011	NMI*	05-11-2008	9.8-6996
	Anlæg: FORCE nr. C02-001.				
	Rotormeter 1-8 m^3/h.	A03-003	NMI*	01-05-2012	9.8-10666
	Rotormeter 4-40 m^3/h.	A03-002	NMI*	27-04-2012	9.8-10667
	Rotormeter 40-400 m^3/h.	A03-001	NMI*	26-04-2012	9.8-10668
	Anlæg: FORCE nr. C02-002.				
	Rotormeter 5-100m^3/h.	A03-005	NMI*	29-11-2010	9.8-9053
	Turbinemåler 60-400 m^3/h.	A03-004	NMI*	29-11-2010	9.8-9089
	Turbinemåler 100-1000 m^3/h.	A03-012	NMI*	29-11-2010	9.8-9103
	Anlæg: FORCE nr. C02-003.				
	Rotormeter 10-100m^3/h.	A03-009	NMI*	08-03-2012	9.8-10428
	Turbinemåler 80-400 m^3/h.	A03-008	NMI*	08-03-2012	9.8-10427
	Turbinemåler 200-1000 m^3/h.	A03-007	NMI*	09-03-2012	9.8-10426
	Turbinemåler 800-4000 m^3/h.	A03-006	NMI*	09-03-2012	9.8-10425

Øvrigt udstyr.

x	Temperaturmålere	A70-xxx	kalibreres
x	Trykmålere	A80-xxx	i h.t FORCE
x	Barometer	A75-xxx	instruktion

Laboratoriets måleevne:

Kombineret måleusikkerhed (for K = 2, svarende til en dækningssandsynlighed på 95%):

for flow < 1 m3/h.	Ua = ± 0.24% relativ, ± 0,08% (aflæsning måler)
for flow = 1 - 17 m3/h.	Ua = ± 0.22% relativ, ± 0,03% (aflæsning måler)

Kombineret måleusikkerhed er fastlagt i overensstemmelse med EA-4/02.
* NMI, Holland via FORCE Technology´s nationale referencelaboratorium i Vejen.

Appendix 8 - Chemical analysis by Germanischer Lloyd SE

Particulate Mass (PM)

The filters were conditioned in the weighing chamber for approx. 24h and then weighed. The gross weight mass of the filters were recorded and the tare weight subtracted.
According to ISO 8178-1 the temperature of the chamber in which the particulate filters were conditioned and weighed was within 22 °C ± 3 °C. The humidity was maintained to a dewpoint of 9.5 °C ± 3 °C and a relative humidity of 45 % ± 8 %. The analytical balance (Sartorius SE2-F) used to determine the masses of the filters

Elemental Carbon (EC) and Organic Carbon (OC)
Elemental carbon (EC) and organic carbon (OC) were determined with a thermal carbon analyser. The measurement method is described in VDI 2465 Part 2.
The elemental and organic carbon is analysed from quartz fibre filter plates.
The analysis method consisted of a multi-step combustion method for organic (OC) and elemental (EC) carbon. The analysis method exploits the higher thermal stability of elemental carbon in comparison with that of organic carbon compounds. The organic compounds were vaporizing in an inert gas stream whereas the solid elemental carbon cannot be converted to the gas phase. In the next step the elemental carbon (EC) is converted to the gas phase by combustion in an oxygen stream. An oxidation catalyst between the temperature-programmed pyrolysis oven and the CO_2 detector converts the carbon compounds from the sample into CO_2. The CO_2 concentration in the test gas is determined continuously using a nondispersive

Organic Material (OM)
The organic material (OM) was calculated from the organic carbon by multiplication with the factor 1.2 (OM = 1

Sulphate

chromatography system.
As reference for sulphate an ion standard in aqueous solution was used.

Water associated with sulphate
The water associated with sulphate could be calculated by multiplication of the sulphate concentration with the

Germanischer Lloyd SE
Dept. Environmental Certification (CL-T-SC)
Testing Laboratory "Analysetechnik"
Dipl.-Ing. Claus Kurok
Brooktorkai 18
D-20457 Hamburg/Germany
Phone1: +49 (0)40 36 149 - 4837
Phone2: +49 (0)40 36 149 - 5791
Fax.: +49 (0)40 36 149 - 7321
Mobile: +49 173 6155413
E-Mail: claus.kurok@gl-group.com
Internet: http://www.gl-group.com

.2 x OC).

factor 0.8 (Water = 0.8 x SO_4).

Appendix 9 - MES Plan for NOx measurement on test bed

Mitsui-MAN B&W

IMO3P46PNM

Plan for NOx measurement on test bed

Engine Manufacturer	Model Number	Engine Serial Number	Test Cycle(S)	Rated Power(kW) Rated Speed(rpm)	Class
Mitsui Engineering & Shipbuilding CO.,Ltd	6S70MC-C	6384	E3	18660(kW) 91.0(rpm)	NK

Content

2012.09.12

MITSUI ENGINEERING &
SHIPBUILDING CO.,LTD
TAMANO WORKS
Diesel Design Department

1. Test Schedule

Place: Diesel Assembly Factory
Mitsui Engineering & Shipbuilding Co.,Ltd
1-1,Tama 3-chome,Tamano,Okayama

Test cycle: E3 test-cycle

Date: 9/26-28

Load	Time	REMARK
	08:00-08:30	Zero/Span Check and Leak Check
10%	08:30-10:30	Emission + PM + Bosh Measurement
15%	10:30-12:30	Emission + PM + Bosh Measurement
25%	12:30-14:30	Emission + PM + Bosh Measurement
50%	14:30-16:30	Emission + PM + Bosh Measurement
75%	16:30-18:30	Emission + PM + Bosh Measurement
100%	18:30-20:30	Emission + PM + Bosh Measurement
	20:30-21:00	Zero/Span Check and Leak Check

* This schedule is guidanace only. Time schedule is changed depend on the actual measuring time.

2. Engine Setting

2.1 Exhaust gas system and sampling position

Figure 1 show a schematic of the test bed exhaust system indicating approximate dimensions and distance to the exhaust gas sampling position.

2.2 Sampling probe(s)

Figure 2 shows the sampling probe for emission measurment.

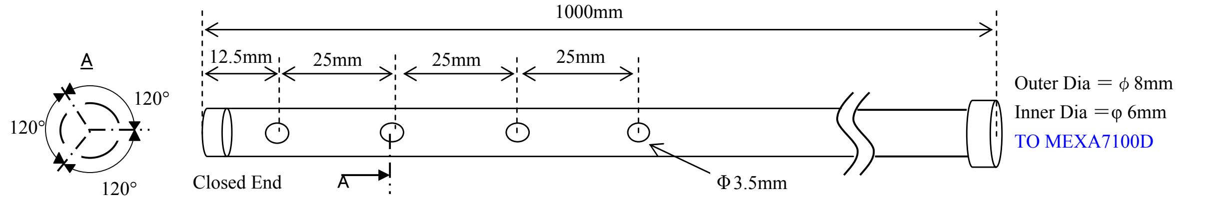


Fig.2 Sampling Probe

3. Test cell specification
3.1 Emission Equipment

Table3.1 shows the specifications for all the exhaust analyzers which will be used on test bed.
Table3.2 shows the specifications for the calibration gasses during the shop test.
Fig.3 shows the flow diagram of the measuring system.
All the calibration results are to be attached in "Supporting Document".

Table 3.1 Specification for analyzers

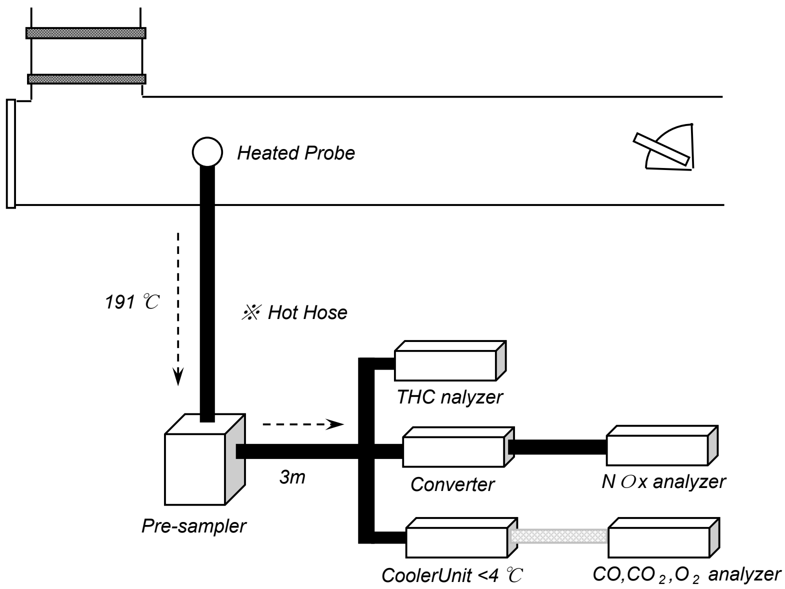
Comp.	Manu facturer	Model	Serial No.	Method	Dry/Wet	Measuring range	Date of calibration
NOx	HORIBA	MEXA7100D	4454745001	HCLD	Wet	2500ppm	2012.08.06
O_2	HORIBA	MEXA7100D	4454745001	PMD	Dry	25%	2012.08.06
CO	HORIBA	MEXA7100D	4454745001	NDIR	Dry	1000ppm	2012.08.06
CO_2	HORIBA	MEXA7100D	4454745001	NDIR	Dry	10%	2012.08.06
THC	HORIBA	MEXA7100D	4454745001	HFID	Wet	1000ppmC	2012.08.06
PM	SHINAGAWA	DC-2	10946	GD	-	-	-
		Ng17-B	170253		-	-	-

Note:
All the calibration results is to be submit to the surveyor at the shop test.
Warming up time for the analyzers will be kept more than 2 hours.

Table 3.2 Specification for the calibration gasses

Comp.	Conc.	Cylinder No.	Order No.	Expiration
Zero gas	≧99.99% N2	GS66905	11211072001	2012.12.07
	-% Zero Air	GT8261	12201077301	2013.02.08
NO span gas	2330ppm in N2	1J10141	11211061501	2012.11.30
CO span gas	936ppm in N2	GUA73102	12201077001	2013.02.14
CO_2 span gas	9.29% in N2	1J66949	12204015801	2013.05.01
O_2 span gas	23.33% in N2	1FK-65693	12202037901	2013.03.21
THC span gas	944ppmC in Air	2BIS54746	12201077101	2013.02.22

Note:
The certification for all calibration gases will be submitted to the surveyor at the shop test.



※TC1 (m)	15
※TC2 (m)	-
※TC3 (m)	-

Fig.3 Flow diagram of measuring system

3.2 Test-Cell equipment

Table 3.3 Measurement equipment

	Manufacturer	Model	Measurement ranges	Calibration	
				Deviation	Date
Speed	OMRON	H7EC-BM	0～150rpm	≦ 2% of Reading value	2012.08.24
Torque	TOKYO	WB-3.0-0-4	0～1264.2kNm	≦ 1% of Max. value	-
Power, if applicable	N/A	-	-	-	-
Fuel flow	YAMATO	PL-LLC2(No.3)	0～1205kg	≦ 2% of Max. value	2012.06.04
Air flow	N/A	-	-	-	-
Exhaust flow	N/A	-	-	-	-
Temperature					
Coolant	M-system	FRS-3A-K	0～75℃	≦2℃	2012.08.24
Lubricant	M-system	FRS-3A-K	0～75℃	≦2℃	2012.08.24
Exhaust gas	TSURUGA	3114	0～300℃	≦2℃	2012.08.24
Inlet air	ANRITSU	HA-100K	0～100℃	≦2℃	2012.08.24
Scavenging air	M-system	FRS-3A-K	0～75℃	≦2℃	2012.08.24
Fuel	M-system	FRS-3A-K	0～75℃	≦2℃	2012.08.24
Pressure					
Cylinder	MAN Diesel & Turbo	Off-line PMI system	0～200bar	≦2% of Reading value	-
Exhaust gas	N/A (Pressure drop)	-	-	≦0.2kPa	2012.08.24
Inlet manifold	COPAL ELECTRONICS	PG-100	0～0.4MPa	≦0.3kPa	-
Atmospheric	OTA KEIKI SEISAKUSYO	Aneroid barometar	930～1070hPa	≦0.1kPa	2012.06.11
Humidity					
Intake air (Wet)	YOSHINO	14629	0～50℃	≦2℃	2012.08.24
Intake air (Dry)	YOSHINO	985039	0～50℃	≦2℃	2012.08.24

Note:
All the calibration for the test cell equipments shall be carried out periodically in accordance with IMO NOx technical code.If the calibration date in Tabel 3.3 does not fulfill the IMO requirement,the calibration will be carried out before the measurement.The revised Table3.3 shall be attached"Supporting Document".

3.3 Measured performance parameters

Fig.4-1 shows our standard performance measurement sheet for each test condition.

3.4 Measured performance parameters

Fig.4-2 shows our standard emission measurement sheet.

4. Fuel specification

Table 4.1 shows the components of chemical elemental analysis for fuel oil.A sample of fuel oil is to be taken at the shop test. Fig. 5 shows the sampling position of Fuel oil sample in the test bed.

Table 4.1 Fuel elemental analysis

Carbon		% mass	Hydrogen		% mass
Nitrogen		% mass	Sulphur		% mass
Water		% mass	Oxygen		% mass

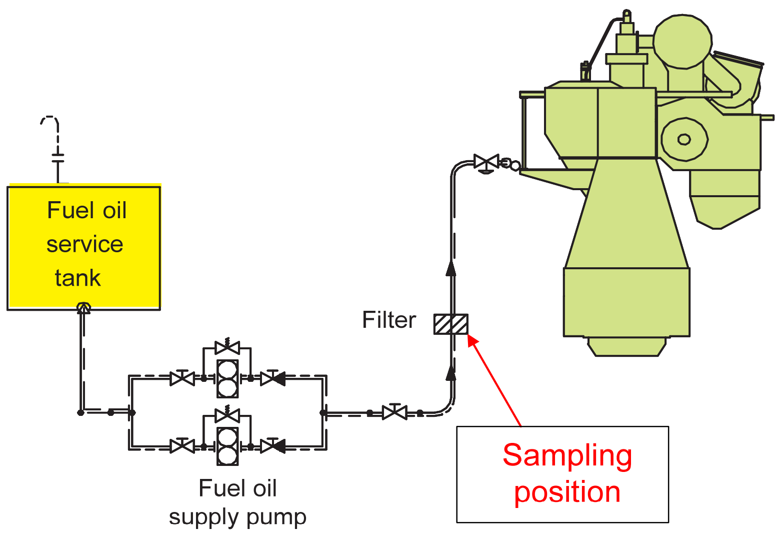


Fig. 5 Fuel oil sampling position

5. Humidity and Suction air temperature

Fig. 6 shows the location of hygrometer and suction air temperature sensor in the test bed.

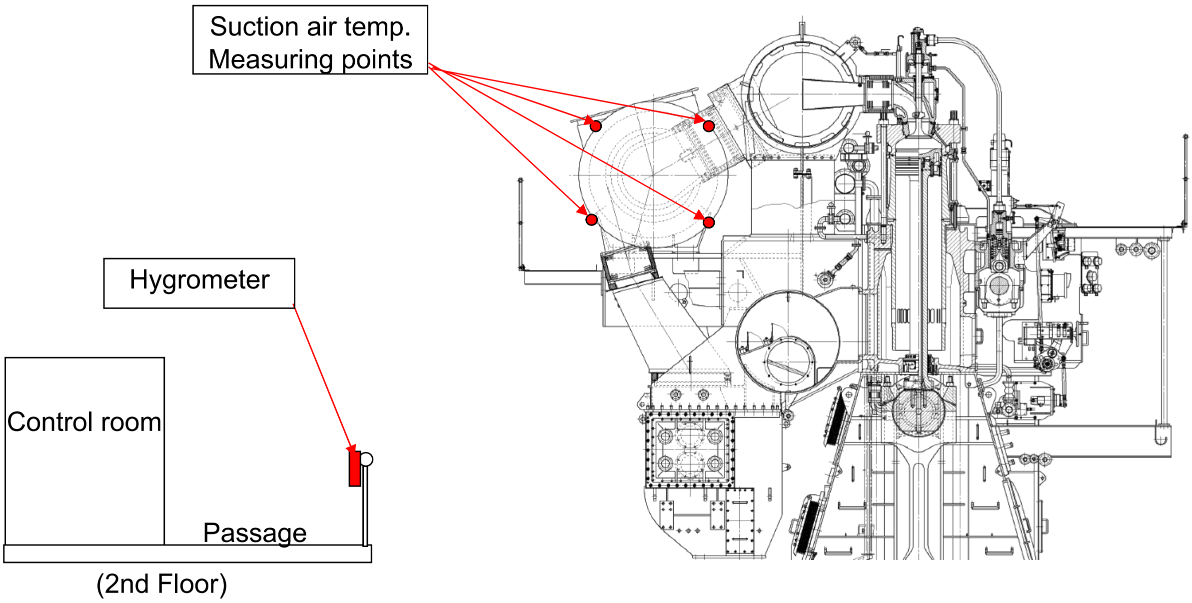


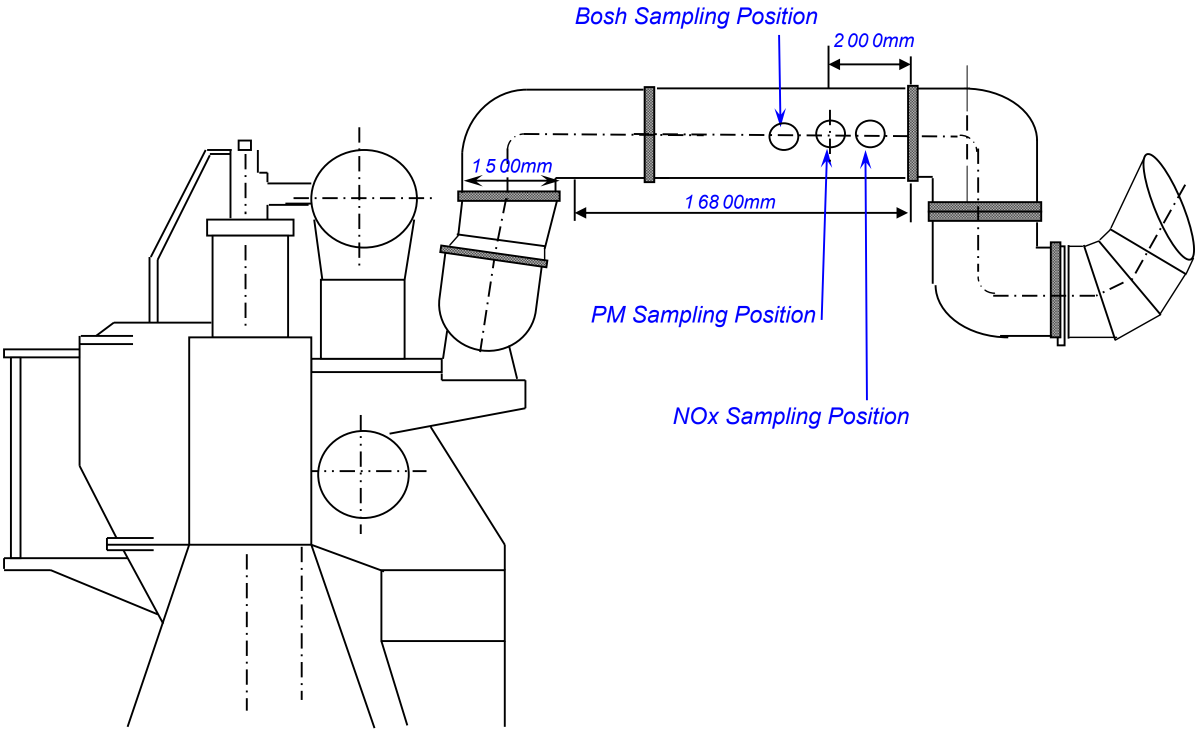
Fig. 6 Location of hygrometer and suction air temperature sensors

6. Reference values of performance parameters

Table 6 shows the Reference parameters for the engine performance.

	Parameter	Reference Value				Tolerance	
	Load - %	100	75	50	25	100	75 - 25
Engine parameters	Cylinder maximum pressure -	151	*)	*)	*)	+3	+3
	Compression pressure - barabs	*)	*)	*)	*)	N/A	N/A
	Scavenging-air cooler coolant inlet temperature - deg.C	25				N/A	N/A
	Scavenging air temperature - deg.C	37	32	28	33	+6	+3
	Pressure drop of suction air filter -kPa	*)	*)	*)	*)	±0.3	±0.3
	Exhaust gas pressure (Back pressure) -kPa	2.94	1.75	0.84	0.25	±0.65	±0.65

*) These reference values will be decided based on the shop test results on the engine before the Pre-certification survey.



Test Bed No.	3A
Engine Job No.	3P46
Engine Type	6S70MC-C
Engine No.	6384

Fig.1 Sampling Position

Data Sheet of % Load Test	Data Sheet No.	
	Date :	
	Measurement Time :	
Ambient Condition	Room Temp. ℃	Barometric Press. : hPa

Engine Speed	W/B Weight	OutPut(kW)	Handle Position	Governor Position	Speed Set Air Press.
rpm	kg	kW			MPa

Inlet	Main Lub. Oil	Piston Coolig Oil	CamShaft Lub. Oil	T/C Lub. Oil	Fuel Oil	Cooling Fresh Water	Charge Air Coolant	Actuator Pilot Air
Press. MPa								
Temp. ℃								

Cylinder No.		Ave.	1	2	3	4	5	6	7	8	9	10	11	12
Pmax. bar														
Pcomp. bar														
Fuel Pump	Actuator Index	---												
	Pump Mark Index													
Exh. Gas Temp. Cyl. Outlet ℃														
C.F.W. Temp. Cyl. Outlet ℃														
P.C.O. Temp. Cyl. Outlet ℃														

Air Cooler					
No.			1		
Press. Drop (kPa)					
Temp. (℃)	Air	In			
		Out			
	Water	In			
		Out			

Scavenging Air	
Pressure (MPa)	Temperature (℃)
Exh. Gas Receiver Pressure	MPa

Specific Fuel Oil Consumption (SFOC) (g/kW/Hr)	
*1 Mesured Value	LCV Corrected to 42700 kJ/kg

Turbo Charger		Speed (rpm)	Intake Air		Exhaust Gas			Lub.Oil Temp.		F.W.Temp.
			Temp. (℃)	Filter Press. Drop (kPa)	Inlet Temp. (℃)	Outlet Temp. (℃)	Back Press. (kPa)	Inlet (℃)	Outlet (℃)	Outlet (℃)
T/C	No. 1									

Note: *1 Marked SFOC is Corrected by F.O. Drain

Thrust Brg.Seg. Temp. : ℃

F.O. Drain : g/kW/Hr

Fig.4-1 Performance measurement data sheet

The Emission Measurement Results

Date						
Test No.						
Engine load	%					
Time						
Ambient pressure	hPa					
Ambient temp. (Dry)	℃					
Ambient temp. (Wet)	℃					
Relative Humidity	%					
Humidity in air	g/kg					
T/C suction air temp.	℃					
NOx (Wet)	ppm					
O2 (Dry)	%					
CO2	%					
CO	ppm					
THC	ppmC					
KHDIES						
KWEXH						
NOx flow rate	kg/h					
O2 flow rate	kg/h					
CO2 flow rate	kg/h					
CO flow rate	kg/h					
THC flow rate	kg/h					
NOx emission	g/kWh					

Fig.4-2 Emission measurement data sheet

Appendix 10 - The Emission measurement results for Mitsui-MAN B&W 6S70MC-C

The Emission Measurement Results for Mitsui-MAN B&W 6S70MC-C

MES TESTING & RESEACH CENTER CO.,LTD
CHEMICAL ANALYSIS SECTION

Approved	Measure

Engine job No.：TE3P46
Issue：2012/10/02

H-237
D-413-2

The Emission Results

LOAD(%)	DATE	TIME	NOx (ppm) 7M120806NOx	O2 (%) 7M120806O2	CO2 (%) 7M120806CO2	CO (ppm) 7M120806CO	THC (ppmC) 7M120806THC	Temp (℃) T120727	Hum (%) H120831	IMO-NOx (g/kWH)	KHDIES (MBD)
T01 - 1 10%	2012/09/26	8:21-8:22	900	17.22	2.60	15	35	22.8	57	22.68	1.001
T01 - 2 10%		9:34-9:35	916	17.21	2.66	18	32	24.6	49	22.55	0.995
T02 - 1 15%		10:22-10:23	1032	16.28	3.27	32	39	24.8	50	20.26	0.997
T02 - 2 15%		11:26-11:27	1016	16.36	3.25	37	40	26.2	50	20.08	1.000
T03 - 1 25%		12:22-12:23	994	15.65	3.70	150	43	25.6	56	17.11	1.005
T03 - 2 25%		13:21-13:22	1010	15.71	3.67	126	43	25.6	56	17.58	1.005
T04 - 1 50%		14:23-14:24	898	15.43	3.86	121	39	25.8	55	14.35	1.004
T04 - 2 50%		15:25-15:26	896	15.44	3.86	134	41	26.4	52	14.31	1.002
T05 - 1 75%		16:51-16:52	927	15.23	4.02	69	56	26.8	52	14.04	1.003
T05 - 2 75%		17:55-17:56	944	15.26	4.00	61	52	26.8	51	14.41	1.002
T06 - 1 100%		18:45-18:46	917	14.52	4.54	106	90	27.0	54	12.53	1.010
T06 - 2 100%		19:48-19:49	932	14.48	4.53	78	60	26.0	56	12.83	1.011
T07 - 1 10%	2012/09/27	10:38-10:39	871	17.15	2.65	58	370	24.8	54	22.27	1.001
T07 - 2 10%		11:38-11:39	879	17.13	2.69	54	367	24.5	59	21.51	1.005
T08 - 1 15%		12:37-12:38	985	16.19	3.33	53	359	25.0	53	19.14	1.001
T08 - 2 15%		13:39-13:40	999	16.22	3.32	53	361	25.6	51	19.32	0.999
T09 - 1 25%		14:27-14:28	923	15.69	3.70	73	339	26.2	45	16.09	0.993

Note

The Emission Measurement Results for Mitsui-MAN B&W 6S70MC-C

MES TESTING & RESEACH CENTER CO.,LTD

CHEMICAL ANALYSIS SECTION

Approved	Measure

Engine job No.:TE3P46 H-237

Issue:2012/10/02 D-413-7

The Emission Results

LOAD(%)	DATE	TIME	NOx (ppm) 7M120806NOx	O2 (%) 7M120806O2	CO2 (%) 7M120806CO2	CO (ppm) 7M120806CO	THC (ppmC) 7M120806THC	Temp (℃) T120727	Hum (%) H120831	IMO-NOx (g/kWH)	KHDIES (MBD)
T09 - 2 25%	2012/09/27	15:30-15:31	924	15.70	3.71	76	343	26.4	46	15.94	0.995
T10 - 1 50%		16:16-16:17	840	15.41	3.91	60	295	27.4	40	13.35	0.992
T10 - 2 50%		17:19-17:20	847	15.45	3.90	64	289	27.4	42	13.49	0.992
T11 - 1 75%		17:56-17:57	954	15.19	4.05	68	297	26.5	47	14.33	0.996
T11 - 2 75%		19:05-19:06	943	15.14	4.05	62	290	26.2	49	14.20	0.998
T12 - 1 100%		19:40-19:41	1001	14.46	4.58	100	304	26.2	53	13.50	1.004
T12 - 2 100%		20:45-20:46	990	14.43	4.57	70	267	25.8	56	13.48	1.008
T13 - 1 10%	2012/09/28	9:08-9:09	781	17.07	2.72	170	352	23.6	61	19.17	1.005
T13 - 2 10%		9:47-9:48	768	17.10	2.67	163	371	23.6	61	19.06	1.006
T14 - 1 15%		10:40-10:41	854	16.27	3.27	247	359	24.6	60	16.95	1.007
T14 - 2 15%		11:21-11:22	862	16.30	3.25	260	367	24.8	58	17.17	1.005
T15 - 1 25%		12:25-12:26	821	15.76	3.61	482	302	25.0	53	14.56	1.000
T15 - 2 25%		13:07-13:08	819	15.70	3.65	498	284	25.2	56	14.47	1.003
T16 - 1 50%		14:11-14:12	777	15.45	3.86	216	273	26.2	49	12.52	0.998
T16 - 2 50%		14:52-14:53	771	15.49	3.84	221	278	26.8	46	12.49	0.996
T17 - 1 75%		15:52-15:53	918	15.22	4.04	89	271	27.5	44	13.80	0.995
T17 - 2 75%		16:30-16:31	902	15.21	4.05	91	265	27.2	45	13.62	0.995

Note Turbocharger 1

The Emission Measurement Results for Mitsui-MAN B&W 6S70MC-C

MES TESTING & RESEACH CENTER CO.,LTD
CHEMICAL ANALYSIS SECTION

Approved	Measure

Engine job No.:TE3P46
Issue:2012/10/02

H-237
D-413-10

The Emission Results

LOAD(%)	DATE	TIME	NOx (ppm) 7M120806NOx	O2 (%) 7M120806O2	CO2 (%) 7M120806CO2	CO (ppm) 7M120806CO	THC (ppmC) 7M120806THC	Temp (℃) T120727	Hum (%) H120831	IMO-NOx (g/kWH)	KHDIES (MBD)
T18 - 1 100%	2012/09/28	17:30-17:31	938	14.46	4.58	133	270	26.4	51	12.69	1.001
T18 - 2 100%		18:10-18:11	927	14.43	4.58	97	237	26.8	49	12.64	0.999

Note Turbocharger 1

Appendix 11 - MES Performance data results for Mitsui-MAN B&W 6S70MC-C

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T07-1
Data Sheet of 10 % Load Test		Date / Measured Time	27-Sep-2012 / 10:30

Ambient Condition

Room Temp : 24.8 ℃ Barometric Press : 1015 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.2	422.2	1866	3.1	27	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.26	-	0.25	0.75	0.42	0.20	-
Temp (deg.C)	44		-	44	33	73	26.9	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	57.4	57.3	57.1	57.7	57.6	57.3	57.1		
Pcomp (bar)	40.0	40.0	40.1	39.9	39.9	40.1	40.1		
Fuel Pump Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
Fuel Pump Pump Mark Index	38.0	38	38	38	38	38	38		
Exh. Gas Temp Cyl Outlet	211	210	217	211	210	210	210		
C.F.W Temp Cyl. Outlet	76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet	46.0	46	46	46	46	46	46		

Air Cooler		Ave	1	2
No.		Ave	1	2
Press. Drop kPa		0.32	0.32	
Temp. °C Air	In	50.9	50.9	
	Out	-	-	
Temp. °C Water	In	26.9	26.9	
	Out	28	28	

Scavenging Air	
Press MPa	Temperature ℃
0.014	37.3
Exh. Gas Receive Press	0.010 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
202.1	202.9	202.5

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2440	29.7	0.06	236.0	221.6	0.12	44.0	48.0	-
No.1	2440	29.7	0.06	236.0	221.6	0.12	44.0	48.0	-
No.2									

F.O. Drain g/kWh 4.9
C.O feed rate l/day.cyl 80.70
Thrust Temp. 47

Pc/Ps 35.51
Pmax-Pcomp 17.4

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	4.6	4..7	4.6	4.6	4.5	4.6	4.58
Pc/Ps	35.5	35.6	35.4	35.4	35.6	35.6	35.51

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T07-2

Data Sheet of	10	% Load Test	Date 27-Sep-2012, Measured Time 11:30

Ambient Condition

Room Temp : 24.5 ℃ Barometric Press : 1015 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.2	423.0	1869	3.1	26	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.26	-	0.25	0.76	0.41	0.20	-
Temp (deg.C)	44		-	44	34	72	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		57.0	56.6	56.4	57.8	57.4	56.8	57.0		
Pcomp (bar)		39.8	39.8	39.8	39.7	39.6	39.9	39.9		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	38.0	38	38	38	38	38	38		
Exh. Gas Temp Cyl Outlet		207	203	211	207	206	204	208		
C.F.W Temp Cyl. Outlet		75	75	75	75	75	75	75		
P.C.O. Temp Cyl. Outlet		46.0	46	46	46	46	46	46		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			0.32	0.32	
Temp. °C	Air	In	36.8	36.8	
		Out	-	-	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.013	36.8
Exh. Gas Receive Press	0.010 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
197.4	198.2	197.8

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2340	30.6	0.05	222.9	208.2	0.12	44.0	48.0	-
No.1	2340	30.6	0.05	222.9	208.2	0.12	44.0	48.0	-
No.2									

F.O. Drain g/kWh 5
C.O feed rate l/day.cyl 81.10
Thrust Temp. 47

Pc/Ps 35.65
Pmax-Pcomp 17.2

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	4.6	4.7	4.7	4.7	4.5	4.6	4.63
Pc/Ps	35.6	35.6	35.6	35.5	35.7	35.7	35.65

TE3P46 Conv. FV (3137901-2 C1)	Data Sheet No.	T08-1

Data Sheet of **15** % Load Test — Date **27-Sep-2012**, Measured Time **12:30**

Ambient Condition
Room Temp : **25.0** ℃ Barometric Press : **1014 hPa** Humidity : **51%**

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	555.0	2813	3.9	30	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.26	-	0.25	0.76	0.42	0.20	-
Temp (deg.C)	45		-	45	34	73	26.8	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	63.1	62.4	63.0	63.2	63.8	63.2	63.2		
Pcomp (bar)	42.3	42.3	42.4	42.1	42.1	42.4	42.6		
Fuel Pump Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
Fuel Pump Pump Mark Index	43.0	43	43	43	43	43	43		
Exh. Gas Temp Cyl Outlet	248	244	253	250	247	246	247		
C.F.W Temp Cyl. Outlet	76.3	76	76	77	77	76	76		
P.C.O. Temp Cyl. Outlet	47.0	47	47	47	47	47	47		

Air Cooler

No.		Ave	1	2
Press. Drop kPa		0.40	0.40	
Temp. °C Air	In	42.2	42.2	
	Out	-	-	
Temp. °C Water	In	26.8	26.8	
	Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.019	36.2
Exh. Gas Receive Press	0.014 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
192.8	193.6	193.2

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2990	31.2	0.06	267.3	241.8	0.14	45.0	48.0	-
No.1	2990	31.2	0.06	267.3	241.8	0.14	45.0	48.0	-
No.2									

F.O. Drain g/kWh **3.3**
C.O feed rate l/day.cyl **92.40**
Thrust Temp. **47**
Pc/Ps **35.98**
Pmax-Pcomp **20.8**

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	5.8	6	5..9	5.9	5.8	5.9	5.88
Pc/Ps	36.0	36.1	35.8	35.8	36.1	36.2	35.98

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T08-2

Data Sheet of	15	% Load Test	Date	27-Sep-2012
			Measured Time	13:30

Ambient Condition

Room Temp :	56.6	℃	Barometric Press :	1013 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	554.6	2811	3.9	30	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.25	0.26	-	0.25	0.76	0.42	0.21	-
Temp	(deg.C)	45		-	45	34	73	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		63.5	63.1	63.3	64.2	63.8	63.6	63.2		
Pcomp (bar)		42.3	42.3	42.3	42.1	42.1	42.4	42.6		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	43.0	43	43	43	43	43	43		
Exh. Gas Temp Cyl Outlet		249	246	255	251	248	247	247		
C.F.W Temp Cyl. Outlet		76.3	76	76	77	77	76	76		
P.C.O. Temp Cyl. Outlet		46.8	46	47	47	47	47	47		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	0.40	0.40	
Temp. ℃	Air	In	43.5	43.5	
		Out	-	-	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air		
Press MPa		Temperature ℃
0.019		36.3
Exh. Gas Receive Press		0.014 MPa
Specific Fuel Oil Consumption		g/kWh
Measured Value	LCV corrected	ISO Corrected
191.4	192.2	191.8

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	3030	31.7	0.06	271.0	246.5	0.14	45.0	48.0	-
No.1	3030	31.7	0.06	271.0	246.5	0.14	45.0	48.0	-
No.2									

F.O. Drain	g/kWh	3.4		
C.O feed rate	l/day.cyl	92.50		
Thrust Temp.		47	Pc/Ps	36
			Pmax-Pcomp	21.2

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	5.8	6.1	6.1	6	6	5.9	5.98
Pc/Ps	36.0	36.0	35.8	35.8	36.1	36.3	36.00

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T09-1

Data Sheet of	25	% Load Test	Date 27-Sep-2012 Measured Time 14:20

Ambient Condition

Room Temp :	26.2 ℃	Barometric Press :	1013 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
57.3	776.8	4661	5	38	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.25	0.25	–	0.25	0.76	0.42	0.21	–
Temp (deg.C)	45		–	45	34	72	27	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	75.1	75.0	74.2	75.3	75.3	75.6	75.2		
Pcomp (bar)	50.7	50.6	50.9	50.3	50.6	50.7	51.2		
Fuel Pump Actuator Index	–	4.4	3.4	4.8	5.0	4.4	2.9		
Fuel Pump Pump Mark Index	54.2	54	54	54	55	54	54		
Exh. Gas Temp Cyl Outlet	289	285	292	289	286	289	290		
C.F.W Temp Cyl. Outlet	77	77	77	77	77	77	77		
P.C.O. Temp Cyl. Outlet	47.2	47	48	47	47	47	47		

Air Cooler

No.		Ave	1	2
Press. Drop kPa		0.64	0.64	
Temp. ℃ Air	In	62.8	62.8	
Temp. ℃ Air	Out	–	–	
Temp. ℃ Water	In	27	27	
Temp. ℃ Water	Out	29	29	

Scavenging Air

Press MPa	Temperature ℃
0.041	35.6
Exh. Gas Receive Press	0.031 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
190.3	191.1	190.7

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4580	31.5	0.10	314.6	273.0	0.36	45.0	50.0	–
No.1	4580	31.5	0.10	314.6	273.0	0.36	45.0	50.0	–
No.2									

F.O. Drain g/kWh	2.2		
C.O feed rate l/day.cyl	110.00		
Thrust Temp.	47	Pc/Ps	36.34
		Pmax-Pcomp	24.4

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	8.1	8.2	8.1	8.1	8.1	8.1	8.12
Pc/Ps	36.3	36.5	36.1	36.3	36.3	36.7	36.34

TE3P46 Conv. FV (3137901-2 C1)	Data Sheet No.	T09-2

Data Sheet of	25	% Load Test	Date	27-Sep-2012
			Measured Time	15:20

Ambient Condition

Room Temp :	26.4 ℃	Barometric Press :	1012 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
57.3	776.2	4658	5	39	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.25	0.25	-	0.25	0.76	0.42	0.21	-
Temp	(deg.C)	44		-	44	34	72	27	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		74.7	74.6	74.9	74.5	75.0	74.7	74.3		
Pcomp (bar)		50.5	50.4	50.9	50.1	50.3	50.4	51.0		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	54.5	54	55	55	55	54	54		
Exh. Gas Temp Cyl Outlet		290	287	294	289	286	290	292		
C.F.W Temp Cyl. Outlet		77	77	77	77	77	77	77		
P.C.O. Temp Cyl. Outlet		47.5	47	47	47	48	48	48		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.64	0.64	
Temp. ℃	Air	In	64.7	64.7	
		Out	-	-	
	Water	In	27	27	
		Out	29	29	

Scavenging Air

Press MPa	Temperature ℃
0.041	35.8
Exh. Gas Receive Press	0.032 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
190.1	190.9	190.4

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4590	32.6	0.11	317.1	275.8	0.37	44.0	49.0	-
No.1	4590	32.6	0.11	317.1	275.8	0.37	44.0	49.0	-
No.2									

F.O. Drain	g/kWh	2.2
C.O feed rate	l/day.cyl	110.30
Thrust Temp.		47

Pc/Ps	36.23
Pmax-Pcomp	24.2

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	8.1	8.3	8.2	8.2	8.1	8.1	8.17
Pc/Ps	36.2	36.5	35.9	36.1	36.2	36.6	36.23

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T10-1

Data Sheet of	50	% Load Test	Date / Measured Time	27-Sep-2012 / 16:10

Ambient Condition

Room Temp :	27.4 ℃	Barometric Press :	1012 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1233.4	9325	6.9	54	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.26	0.26	-	0.25	0.76	0.42	0.21	-
Temp	(deg.C)	45		-	45	35	72	27.6	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		106.7	106.3	106.9	106.3	107.8	106.2	106.6		
Pcomp (bar)		79.4	79.3	80.3	78.7	79.1	78.9	80.1		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	76.8	77	76	77	78	77	76		
Exh. Gas Temp Cyl Outlet		303	308	302	298	299	298	310		
C.F.W Temp Cyl. Outlet		79	79	79	79	79	79	79		
P.C.O. Temp Cyl. Outlet		49.3	49	49	49	50	49	50		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.03	1.03	
Temp. °C	Air	In	123.4	123.4	
		Out	-	-	
	Water	In	27.6	27.6	
		Out	35	35	

Scavenging Air

Press MPa	Temperature ℃
0.122	31.8
Exh. Gas Receive Press	0.102 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
184.0	184.7	184.2

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	7630	31.3	0.25	351.6	259.9	1.32	45.0	56.0	-
No.1	7630	31.3	0.25	351.6	259.9	1.32	45.0	56.0	-
No.2									

F.O. Drain g/kWh 1.2
C.O feed rate l/day.cyl 139.20
Thrust Temp. 48

Pc/Ps 36.03
Pmax-Pcomp 27.3

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	13	13.1	13	13.1	12.9	12.9	13.00
Pc/Ps	36.0	36.4	35.7	35.9	35.8	36.3	36.03

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T10-2

Data Sheet of	50	% Load Test	Date	27-Sep-2012
			Measured Time	17:10

Ambient Condition

Room Temp : 27.4 ℃ Barometric Press : 1012 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1232.3	9317	6.9	53	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.25	0.26	-	0.25	0.76	0.42	0.21	-
Temp	(deg.C)	45		-	45	35	72	27.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		106.7	106.3	106.6	107.0	107.0	106.9	106.1		
Pcomp (bar)		79.9	79.8	80.6	79.2	79.6	79.4	80.6		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	76.8	76	78	77	76	76	78		
Exh. Gas Temp Cyl Outlet		302	306	302	297	298	297	312		
C.F.W Temp Cyl. Outlet		79	79	79	79	79	79	79		
P.C.O. Temp Cyl. Outlet		49.2	49	49	49	49	49	50		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	1.06	1.06	
Temp. °C	Air	In	125.4	125.4	
		Out	-	-	
	Water	In	27.2	27.2	
		Out	35	35	

Scavenging Air	
Press MPa	Temperature ℃
0.121	31.8
Exh. Gas Receive Press	0.101 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
183.9	184.6	184.2

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	7630	31.2	0.26	351.8	259.0	1.35	45.0	56.0	-
No.1	7630	31.2	0.26	351.8	259.0	1.35	45.0	56.0	-
No.2									

F.O. Drain g/kWh 1.3

C.O feed rate l/day.cyl 139.40

Thrust Temp. 48

Pc/Ps 36.41

Pmax-Pcomp 26.8

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	13	12.9	12.8	12.9	12.8	12.7	12.85
Pc/Ps	36.4	36.7	36.1	36.3	36.2	36.7	36.41

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T11-1

Data Sheet of	75	% Load Test	Date 27-Sep-2012 Measured Time 17:50

Ambient Condition

Room Temp : 26.5 ℃ Barometric Press : 1011 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
82.7	1616.7	14001	8.3	68	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.26	0.27	–	0.25	0.75	0.41	0.21	–
Temp	(deg.C)	45		–	45	35	72	27.7	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		134.1	134.1	134.6	133.6	134.5	133.2	134.4		
Pcomp (bar)		113.2	113.8	114.0	112.1	112.5	112.3	114.3		
Fuel Pump	Actuator Index	–	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	97.7	97	98	98	97	98	98		
Exh. Gas Temp Cyl Outlet		321	323	324	315	316	319	329		
C.F.W Temp Cyl. Outlet		80	80	80	80	80	80	80		
P.C.O. Temp Cyl. Outlet		50.8	50	51	51	51	51	51		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.37	1.37	
Temp. °C	Air	In	171.6	171.6	
		Out	–	–	
	Water	In	27.7	27.7	
		Out	41	41	

Scavenging Air

Press MPa	Temperature ℃
0.212	36.9
Exh. Gas Receive Press	0.187 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
179.8	180.5	180.0

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	9330	32.0	0.49	375.6	239.8	2.16	45.0	60.0	–
No.1	9330	32.0	0.49	375.6	239.8	2.16	45.0	60.0	–
No.2									

F.O. Drain g/kWh 0.7
C.O feed rate l/day.cyl 159.00
Thrust Temp. 48

Pc/Ps 36.48
Pmax−Pcomp 20.9

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	17.2	17.1	16.6	16.7	16.7	16.5	16.80
Pc/Ps	36.7	36.7	36.1	36.3	36.2	36.8	36.48

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T11-2

Data Sheet of **75** % Load Test — Date **27-Sep-2012**, Measured Time **18:50**

Ambient Condition
Room Temp : **26.5** ℃ Barometric Press : **1011 hPa** Humidity : **51%**

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
82.7	1618.1	14013	8.3	68	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.26	0.26	-	0.25	0.75	0.42	0.21	-
Temp	(deg.C)	45		-	45	34	72	27.7	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		134.1	134.5	134.5	134.8	134.1	132.6	134.1		
Pcomp (bar)		113.7	114.2	114.5	112.5	113.0	113.0	114.9		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	97.7	98	97	97	99	98	97		
Exh. Gas Temp Cyl Outlet		321	322	324	314	316	320	329		
C.F.W Temp Cyl. Outlet		80	80	80	80	80	80	80		
P.C.O. Temp Cyl. Outlet		50.8	50	51	51	51	51	51		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.42	1.42	
Temp. ℃	Air	In	172.0	172	
		Out	-	-	
	Water	In	27.7	27.7	
		Out	41	41	

Scavenging Air

Press MPa	Temperature ℃
0.212	37.3

Exh. Gas Receive Press 0.189 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
180.2	180.9	180.4

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	9340	30.7	0.49	374.7	238.2	2.21	45.0	60.0	-
No.1	9340	30.7	0.49	374.7	238.2	2.21	45.0	60.0	-
No.2									

F.O. Drain g/kWh 0.7
C.O feed rate l/day.cyl 159.00
Thrust Temp. 48

Pc/Ps 36.64
Pmax-Pcomp 20.4

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	17.4	17.3	16.8	16.9	17	16.7	17.02
Pc/Ps	36.8	36.9	36.3	36.4	36.4	37.0	36.64

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T12-1

Data Sheet of 100 % Load Test — Date 27-Sep-2012, Measured Time 19:35

Ambient Condition
Room Temp : 26.2 ℃ Barometric Press : 1011 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.1	1961.6	18714	9.4	84	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.26	0.27	–	0.25	0.75	0.41	0.20	–
Temp (deg.C)	46		–	46	33	72	28.1	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	150.6	151.2	150.6	150.3	151.3	151.0	149.0		
Pcomp (bar)	141.4	142.3	142.2	140.0	140.7	140.9	142.5		
Fuel Pump Actuator Index	–	4.4	3.4	4.8	5.0	4.4	2.9		
Fuel Pump Pump Mark Index	119.5	119	119	120	120	120	119		
Exh. Gas Temp Cyl Outlet	367	373	368	362	360	369	367		
C.F.W Temp Cyl. Outlet	82	82	82	82	82	82	82		
P.C.O. Temp Cyl. Outlet	53.7	53	54	53	54	54	54		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.57	1.57	
Temp. °C	Air	In	206.2	206.2	
		Out	–	–	
	Water	In	28.1	28.1	
		Out	48	48	

Scavenging Air

Press MPa	Temperature ℃
0.288	42.9
Exh. Gas Receive Press	0.261 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
181.6	182.3	181.7

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	10470	31.9	0.64	428.9	261.0	3.14	46.0	60.0	–
No.1	10470	31.9	0.64	428.9	261.0	3.14	46.0	60.0	–
No.2									

F.O. Drain g/kWh 0.5
C.O feed rate l/day.cyl 175.80
Thrust Temp. 49

Pc/Ps 36.6
Pmax−Pcomp 9.2

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	21	21	20.2	20.5	20.6	20.2	20.58
Pc/Ps	36.8	36.8	36.2	36.4	36.5	36.9	36.60

TE3P46	Conv. FV (3137901-2 C1)	Data Sheet No.	T12-2

Data Sheet of	100	% Load Test	Date Measured Time	27-Sep-2012 20:35

Ambient Condition

Room Temp : 25.8 ℃ Barometric Press : 1011 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.1	1962.0	18717	9.4	84	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.26	0.26	-	0.25	0.74	0.41	0.20	-
Temp (deg.C)	46		-	46	33	72	28.1	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		149.4	149.9	148.3	149.4	150.2	150.4	148.1		
Pcomp (bar)		141.3	142.3	142.2	139.6	140.6	141.0	142.2		
Fuel Pump	Actuator Index	-	4.4	3.4	4.8	5.0	4.4	2.9		
	Pump Mark Index	121.0	120	121	121	122	120	122		
Exh. Gas Temp Cyl Outlet		370	377	371	364	362	374	369		
C.F.W Temp Cyl. Outlet		82	82	82	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.5	53	53	53	54	54	54		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.57	1.57	
Temp. ℃	Air	In	207.5	207.5	
		Out	-	-	
	Water	In	28.1	28.1	
		Out	48	48	

Scavenging Air

Press MPa	Temperature ℃
0.289	43.6
Exh. Gas Receive Press	0.264 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
182.7	183.4	182.9

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	10510	31.5	0.69	430.1	262.1	3.29	46.0	62.0	-
No.1	10510	31.5	0.69	430.1	262.1	3.29	46.0	62.0	-
No.2									

F.O. Drain g/kWh 0.5

C.O feed rate l/day.cyl 175.50

Thrust Temp. 49

Pc/Ps 36.48

Pmax-Pcomp 8.1

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	20.8	20.7	20	20.3	20.4	20	20.37
Pc/Ps	36.7	36.7	36.0	36.3	36.4	36.7	36.48

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T13-1

Data Sheet of	10	% Load Test	Date	28-Sep-2012
			Measured Time	9:00

Ambient Condition

Room Temp :	23.6 ℃	Barometric Press :	1011 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.1	422.7	1864	3.1	27	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	–	0.23	0.77	0.41	0.20	–
Temp (deg.C)	44		–	44	32	73	26.6	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		56.6	56.8	56.5	56.4	57.2	56.7	55.7		
Pcomp (bar)		39.9	39.9	40.0	39.8	39.8	40.1	40.0		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	39.0	39	39	39	39	39	39		
Exh. Gas Temp Cyl Outlet		212	208	217	211	214	208	211		
C.F.W Temp Cyl. Outlet		75.7	75	75	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.2	46	46	46	46	46	47		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.32	0.32	
Temp. °C	Air	In	40.8	40.8	
		Out	–	–	
	Water	In	26.6	26.6	
		Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.014	36.3
Exh. Gas Receive Press	0.010 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
200.9	201.7	201.4

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2400	29.0	0.04	228.8	213.9	0.09	44.0	48.0	–
No.1	2400	29.0	0.04	228.8	213.9	0.09	44.0	48.0	–
No.2									

F.O. Drain g/kWh	4.8		
C.O feed rate l/day.cyl	81.20		
Thrust Temp.	47	Pc/Ps	35.54
		Pmax-Pcomp	16.7

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	4.6	4.8	4.6	4.7	4.6	4.5	4.63
Pc/Ps	35.5	35.6	35.5	35.5	35.7	35.6	35.54

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T13-2

Data Sheet of	10 % Load Test	Date	28-Sep-2012
		Measured Time	9:40

Ambient Condition

Room Temp : 23.6 ℃ Barometric Press : 1011 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.2	423.4	1871	3.1	27	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	-	0.23	0.76	0.41	0.20	-
Temp (deg.C)	44		-	44	33	72	26.6	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	56.7	56.7	56.8	56.5	57.5	56.8	56.1		
Pcomp (bar)	39.9	39.8	39.9	39.8	39.8	40.0	39.9		
Fuel Pump Actuator Index	-	3.3	2.5	3.4	3.4	3.0	1.9		
Fuel Pump Pump Mark Index	39.3	39	40	39	40	39	39		
Exh. Gas Temp Cyl Outlet	212	211	216	211	214	207	211		
C.F.W Temp Cyl. Outlet	75	75	75	75	75	75	75		
P.C.O. Temp Cyl. Outlet	46.2	46	46	46	46	46	47		

Air Cooler

No.		Ave	1	2
Press. Drop kPa		0.32	0.32	
Temp. °C Air	In	37.8	37.8	
	Out	-	-	
Temp. °C Water	In	26.6	26.6	
	Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.013	36.2
Exh. Gas Receive Press	0.009 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
199.6	200.4	200.1

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2370	29.0	0.04	227.1	211.1	0.10	44.0	48.0	-
No.1	2370	29.0	0.04	227.1	211.1	0.10	44.0	48.0	-
No.2									

F.O. Drain g/kWh	4.8		
C.O feed rate l/day.cyl	80.50		
Thrust Temp.	47	Pc/Ps	35.86
		Pmax-Pcomp	16.8

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	4.6	4.8	4.6	4.8	4.6	4.6	4.67
Pc/Ps	35.8	35.9	35.8	35.8	35.9	35.9	35.86

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T14-1

Data Sheet of	15	% Load Test	Date	28-Sep-2012
			Measured Time	10:35

Ambient Condition

Room Temp :	24.6 ℃	Barometric Press :	1011 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	553.0	2803	3.9	31	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.23	0.24	–	0.23	0.77	0.41	0.20	–
Temp	(deg.C)	45		–	45	33	72	26.6	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		62.2	62.1	62.4	62.5	62.8	62.1	61.4		
Pcomp (bar)		42.2	42.2	42.3	42.1	42.0	42.3	42.4		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	44.0	44	44	44	44	44	44		
Exh. Gas Temp Cyl Outlet		252	247	258	253	253	249	250		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		47.0	47	47	47	47	47	47		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.41	0.41	
Temp. ℃	Air	In	42.6	42.6	
		Out	–	–	
	Water	In	26.6	26.6	
		Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.020	36
Exh. Gas Receive Press	0.015 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
194.4	195.2	194.9

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	3060	29.7	0.05	271.5	245.1	0.16	45.0	48.0	–
No.1	3060	29.7	0.05	271.5	245.1	0.16	45.0	48.0	–
No.2									

F.O. Drain g/kWh 3.2
C.O feed rate l/day.cyl 92.30
Thrust Temp. 47

Pc/Ps 35.68
Pmax-Pcomp 20

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	5.7	6	5.8	5.9	5.8	5.8	5.83
Pc/Ps	35.7	35.8	35.6	35.5	35.8	35.8	35.68

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T14-2

Data Sheet of	15	% Load Test	Date	28-Sep-2012
			Measured Time	11:15

Ambient Condition

Room Temp :	24.8 ℃	Barometric Press :	1010 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	553.4	2805	3.9	31	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	–	0.23	0.76	0.41	0.20	–
Temp (deg.C)	45		–	45	33	72	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		62.3	62.1	62.3	62.3	62.9	62.3	62.0		
Pcomp (bar)		42.4	42.4	42.5	42.2	42.1	42.5	42.6		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	44.3	44	44	44	45	44	45		
Exh. Gas Temp Cyl Outlet		253	249	259	253	254	251	251		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.8	46	47	47	47	47	47		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			0.41	0.41	
Temp. °C	Air	In	43.8	43.8	
		Out	–	–	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.020	36.1
Exh. Gas Receive Press	0.015 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
194.1	194.9	194.5

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	3090	30.6	0.05	274.2	248.8	0.16	45.0	48.0	–
No.1	3090	30.6	0.05	274.2	248.8	0.16	45.0	48.0	–
No.2									

F.O. Drain g/kWh	3.4		
C.O feed rate l/day.cyl	92.40		
Thrust Temp.	47	Pc/Ps	35.88
		Pmax-Pcomp	19.9

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	5.7	5.9	5.8	6	5.8	5.8	5.83
Pc/Ps	35.9	36.0	35.7	35.6	36.0	36.0	35.88

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T15-1

Data Sheet of	25	% Load Test	Date Measured Time 12:20	28-Sep-2012

Ambient Condition

Room Temp :	25.0 ℃	Barometric Press :	1009 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
57.3	776.1	4657	5	38	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	−	0.23	0.76	0.41	0.21	−
Temp (deg.C)	45		−	45	34	73	26.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		75.7	76.1	75.5	75.7	75.4	75.8	75.7		
Pcomp (bar)		51.0	51.1	51.2	50.7	50.8	50.9	51.4		
Fuel Pump	Actuator Index	−	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	54.7	55	55	55	54	54	55		
Exh. Gas Temp Cyl Outlet		292	285	299	294	293	290	293		
C.F.W Temp Cyl. Outlet		77	77	77	77	77	77	77		
P.C.O. Temp Cyl. Outlet		47.8	47	48	48	48	48	48		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.61	0.61	
Temp. °C	Air	In	63.6	63.6	
		Out	−	−	
	Water	In	26.9	26.9	
		Out	29	29	

Scavenging Air

Press MPa	Temperature ℃
0.045	35.7
Exh. Gas Receive Press	0.034 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
192.1	192.9	192.5

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4700	31.7	0.10	316.3	273.2	0.35	45.0	50.0	−
No.1	4700	31.7	0.10	316.3	273.2	0.35	45.0	50.0	−
No.2									

F.O. Drain g/kWh	2.2		
C.O feed rate l/day.cyl	109.80		
Thrust Temp.	47	Pc/Ps	35.65
		Pmax-Pcomp	24.7

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	8.1	8.3	8.2	8.3	8.3	8.1	8.22
Pc/Ps	35.7	35.8	35.4	35.5	35.6	35.9	35.65

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T15-2

Data Sheet of	25	% Load Test	Date 28-Sep-2012 Measured Time 13:00

Ambient Condition

Room Temp :	25.2 ℃	Barometric Press :	1009 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
57.3	776.0	4656	5	38	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.24	–	0.23	0.76	0.41	0.20	–
Temp (deg.C)	45		–	45	33	72	27	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		75.5	75.7	75.3	75.5	75.7	75.4	75.4		
Pcomp (bar)		50.9	51.0	51.2	50.6	50.7	50.8	51.3		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	55.0	55	55	55	55	55	55		
Exh. Gas Temp Cyl Outlet		293	286	299	295	294	291	295		
C.F.W Temp Cyl. Outlet		77	77	77	77	77	77	77		
P.C.O. Temp Cyl. Outlet		47.8	47	48	48	48	48	48		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	0.63	0.63	
Temp. °C	Air	In	65.5	65.5	
		Out	–	–	
	Water	In	27	27	
		Out	29	29	

Scavenging Air	
Press MPa	Temperature ℃
0.045	35.8
Exh. Gas Receive Press	0.034 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
193.2	194.0	193.6

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4740	31.4	0.10	317.6	275.0	0.37	45.0	50.0	–
No.1	4740	31.4	0.10	317.6	275.0	0.37	45.0	50.0	–
No.2									

F.O. Drain g/kWh	2.2		
C.O feed rate l/day.cyl	110.10		
Thrust Temp.	47	Pc/Ps	35.58
		Pmax-Pcomp	24.6

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	8.1	8.4	8.2	8.3	8.2	8.1	8.22
Pc/Ps	35.6	35.8	35.4	35.4	35.5	35.9	35.58

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T16-1

Data Sheet of	50	% Load Test	Date	28-Sep-2012
			Measured Time	14:05

Ambient Condition

Room Temp :	26.2 ℃	Barometric Press :	1008 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
72.2	1232.1	9316	6.9	54	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	–	0.24	0.76	0.41	0.22	–
Temp (deg.C)	45		–	45	34	72	27.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		107.0	107.4	106.6	106.8	107.3	107.2	106.4		
Pcomp (bar)		80.4	80.5	81.1	79.9	80.0	80.0	81.0		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	77.0	77	77	77	77	77	77		
Exh. Gas Temp Cyl Outlet		306	303	308	304	308	301	310		
C.F.W Temp Cyl. Outlet		78	78	78	78	78	78	78		
P.C.O. Temp Cyl. Outlet		49.8	49	50	50	50	50	50		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.08	1.08	
Temp. °C	Air	In	125.0	125	
		Out	–	–	
	Water	In	27.2	27.2	
		Out	34	34	

Scavenging Air

Press MPa	Temperature ℃
0.124	31.7
Exh. Gas Receive Press	0.105 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
184.7	185.4	184.9

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	7700	31.8	0.27	351.7	257.2	1.37	45.0	56.0	–
No.1	7700	31.8	0.27	351.7	257.2	1.37	45.0	56.0	–
No.2									

F.O. Drain g/kWh	1.3		
C.O feed rate l/day.cyl	139.30		
Thrust Temp.	48	Pc/Ps	36.21
		Pmax-Pcomp	26.6

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	12.8	12.9	12.8	12.9	12.8	12.7	12.82
Pc/Ps	36.3	36.5	36.0	36.0	36.0	36.5	36.21

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T16-2

Data Sheet of	50 % Load Test	Date	28-Sep-2012
		Measured Time	14:45

Ambient Condition

Room Temp : 26.8 ℃ Barometric Press : 1008 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1232.5	9319	6.9	54	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	−	0.23	0.76	0.41	0.20	−
Temp (deg.C)	45		−	45	34	72	27.3	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	107.3	107.7	106.3	106.7	107.3	107.7	107.9		
Pcomp (bar)	80.8	80.8	81.3	80.1	80.5	80.3	81.5		
Fuel Pump Actuator Index	−	3.3	2.5	3.4	3.4	3.0	1.9		
Fuel Pump Pump Mark Index	77.5	77	78	78	78	77	77		
Exh. Gas Temp Cyl Outlet	307	303	307	308	308	302	311		
C.F.W Temp Cyl. Outlet	78.7	78	78	79	79	79	79		
P.C.O. Temp Cyl. Outlet	49.8	49	50	50	50	50	50		

Air Cooler

No.		Ave	1	2
Press. Drop	kPa	1.08	1.08	
Temp. °C Air	In	128.2	128.2	
Temp. °C Air	Out	−	−	
Temp. °C Water	In	27.3	27.3	
Temp. °C Water	Out	35	35	

Scavenging Air

Press MPa	Temperature ℃
0.125	31.8
Exh. Gas Receive Press	0.106 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
184.9	185.6	185.1

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	7730	32.1	0.27	353.0	257.9	1.40	45.0	56.0	−
No.1	7730	32.1	0.27	353.0	257.9	1.40	45.0	56.0	−
No.2									

F.O. Drain	g/kWh	1.3		
C.O feed rate	l/day.cyl	139.30		
Thrust Temp.		48	Pc/Ps	36.23
			Pmax−Pcomp	26.5

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	12.9	13	12.9	13.1	13.1	13	13.00
Pc/Ps	36.2	36.5	35.9	36.1	36.0	36.5	36.23

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T17-1

Data Sheet of	75	% Load Test	Date	28-Sep-2012
			Measured Time	15:45

Ambient Condition

Room Temp :	27.5 ℃	Barometric Press :	1008 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
82.7	1617.8	14011	8.3	69	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.24	0.25	–	0.24	0.75	0.41	0.20	–
Temp	(deg.C)	45		–	45	34	72	27.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		132.5	132.7	133.1	131.6	132.6	131.5	133.4		
Pcomp (bar)		113.2	113.2	114.1	112.2	112.5	112.5	114.4		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	97.8	98	97	98	99	98	97		
Exh. Gas Temp Cyl Outlet		324	320	329	322	325	320	328		
C.F.W Temp Cyl. Outlet		79.7	79	79	80	80	80	80		
P.C.O. Temp Cyl. Outlet		51.0	51	51	51	51	51	51		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	1.37	1.37	
Temp. ℃	Air	In	173.2	173.2	
		Out	–	–	
	Water	In	27.8	27.8	
		Out	42	42	

Scavenging Air	
Press MPa	Temperature ℃
0.214	37.4
Exh. Gas Receive Press	0.190 MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
179.5	180.2	179.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	9380	31.8	0.49	378.1	241.2	2.16	45.0	60.0	–
No.1	9380	31.8	0.49	378.1	241.2	2.16	45.0	60.0	–
No.2									

F.O. Drain	g/kWh	0.8
C.O feed rate	l/day.cyl	159.80
Thrust Temp.		48

Pc/Ps	36.28
Pmax-Pcomp	19.3

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	17	17	16.6	16.9	16.8	16.6	16.82
Pc/Ps	36.3	36.6	36.0	36.1	36.1	36.7	36.28

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T17-2

Data Sheet of	75	% Load Test	Date 28-Sep-2012 Measured Time 16:25

Ambient Condition
Room Temp : 27.2 ℃ Barometric Press : 1008 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Governor Position	Speed Set Air Press
82.7	1618.2	14014	8.3	69	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.24	0.25	–	0.24	0.75	0.41	0.20	–
Temp	(deg.C)	45		–	45	34	72	27.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		132.3	132.7	132.5	131.0	132.8	132.6	132.4		
Pcomp (bar)		113.6	113.9	114.4	112.7	113.2	112.9	114.7		
Fuel Pump	Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	98.8	98	99	99	100	99	98		
Exh. Gas Temp Cyl Outlet		327	321	332	325	328	323	332		
C.F.W Temp Cyl. Outlet		79.7	79	79	80	80	80	80		
P.C.O. Temp Cyl. Outlet		51.0	51	51	51	51	51	51		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.42	1.42	
Temp. ℃	Air	In	175.8	175.8	
		Out	–	–	
	Water	In	27.9	27.9	
		Out	42	42	

Scavenging Air

Press MPa	Temperature ℃
0.214	37.8
Exh. Gas Receive Press	0.190 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
180.7	181.4	180.8

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	9410	32.5	0.51	380.3	242.3	2.19	45.0	60.0	–
No.1	9410	32.5	0.51	380.3	242.3	2.19	45.0	60.0	–
No.2									

F.O. Drain g/kWh 0.7
C.O feed rate l/day.cyl 160.00
Thrust Temp. 48

Pc/Ps 36.41
Pmax-Pcomp 18.7

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	17.1	17	16.5	16.9	16.8	16.6	16.82
Pc/Ps	36.5	36.7	36.1	36.3	36.2	36.8	36.41

TE3P46 Conv. FV (313823-0 C11)	Data Sheet No.	T18-1

Data Sheet of	100	% Load Test	Date	28-Sep-2012
			Measured Time	17:25

Ambient Condition

Room Temp :	26.4 ℃	Barometric Press :	1008 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.0	1961.7	18694	9.4	85	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	–	0.24	0.75	0.41	0.20	–
Temp (deg.C)	45		–	45	35	72	28.1	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	149.6	151.0	149.7	149.1	149.3	149.2	149.2		
Pcomp (bar)	142.0	142.7	142.6	140.8	141.5	141.5	143.1		
Fuel Pump Actuator Index	–	3.3	2.5	3.4	3.4	3.0	1.9		
Fuel Pump Pump Mark Index	119.8	119	120	120	120	120	120		
Exh. Gas Temp Cyl Outlet	374	371	377	376	371	373	374		
C.F.W Temp Cyl. Outlet	81.5	81	81	81	82	82	82		
P.C.O. Temp Cyl. Outlet	53.8	53	54	54	54	54	54		

Air Cooler

No.		Ave	1	2
Press. Drop kPa		1.67	1.67	
Temp. °C Air	In	208.4	208.4	
Temp. °C Air	Out	–	–	
Temp. °C Water	In	28.1	28.1	
Temp. °C Water	Out	48	48	

Scavenging Air

Press MPa	Temperature ℃
0.292	42.9
Exh. Gas Receive Press	0.265 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
182.3	183.0	182.4

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	10550	32.3	0.69	433.8	264.2	3.31	45.0	60.0	–
No.1	10550	32.3	0.69	433.8	264.2	3.31	45.0	60.0	–
No.2									

F.O. Drain g/kWh	0.5		
C.O feed rate l/day.cyl	176.30		
Thrust Temp.	49	Pc/Ps	36.41
		Pmax-Pcomp	7.6

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	20.9	20.8	20.2	20.6	20.6	20.1	20.53
Pc/Ps	36.6	36.6	36.1	36.3	36.3	36.7	36.41

TE3P46	Conv. FV (313823-0 C11)	Data Sheet No.	T18-2

Data Sheet of	100	% Load Test	Date	28-Sep-2012
			Measured Time	18:05

Ambient Condition

Room Temp :	26.8 ℃	Barometric Press :	1008 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.0	1962.1	18698	9.4	85	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.24	0.24	−	0.23	0.75	0.41	0.20	−
Temp	(deg.C)	45		−	45	34	73	28.1	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		149.5	150.0	149.1	149.1	149.3	150.0	149.5		
Pcomp (bar)		142.0	142.9	142.7	140.7	141.3	141.4	143.1		
Fuel Pump	Actuator Index	−	3.3	2.5	3.4	3.4	3.0	1.9		
	Pump Mark Index	120.2	120	120	120	120	121	120		
Exh. Gas Temp Cyl Outlet		377	376	380	378	373	375	378		
C.F.W Temp Cyl. Outlet		81.7	81	81	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.2	53	53	53	53	53	54		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.62	1.62	
Temp. ℃	Air	In	210.8	210.8	
		Out	−	−	
	Water	In	28.1	28.1	
		Out	48	48	

Scavenging Air

Press MPa	Temperature ℃
0.292	43.8
Exh. Gas Receive Press	0.265 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
183.5	184.2	183.6

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	10600	33.0	0.69	433.8	266.5	3.33	45.0	60.0	−
No.1	10600	33.0	0.69	433.8	266.5	3.33	45.0	60.0	−
No.2									

F.O. Drain	g/kWh	0.5		
C.O feed rate	l/day.cyl	176.10		
Thrust Temp.		49	Pc/Ps	36.41
			Pmax-Pcomp	7.5

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	20.8	20.6	20.1	20.4	20.5	20	20.40
Pc/Ps	36.6	36.6	36.1	36.2	36.3	36.7	36.41

TE3P46	Slide FV (Original C26)	Data Sheet No.	T01-1

Data Sheet of 10 % Load Test — Date 26-Sep-2012, Measured Time 8:15

Ambient Condition
Room Temp : 22.8 ℃ — Barometric Press : 1017 hPa — Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.2	424.6	1876	3.1	30	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.23	0.23	-	0.23	0.76	0.39	0.20	-
Temp	(deg.C)	44		-	44	31	73	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		58.7	58.0	58.7	58.7	59.1	58.7	58.8		
Pcomp (bar)		40.2	40.2	40.2	40.0	40.0	40.4	40.3		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.4		
	Pump Mark Index	43.0	43	43	43	43	43	43		
Exh. Gas Temp Cyl Outlet		206	204	210	206	209	202	205		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.5	46	46	46	47	47	47		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.32	0.32	
Temp. °C	Air	In	42.4	42.4	
		Out	-	-	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.014	36.1
Exh. Gas Receive Press	0.010 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
194.1	194.9	194.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2450	26.9	0.04	229.0	213.9	0.13	44.0	48.0	-
No.1	2450	26.9	0.04	229.0	213.9	0.13	44.0	48.0	-
No.2									

F.O. Drain g/kWh 5.3
C.O feed rate l/day.cyl 78.00
Thrust Temp. 46
Pc/Ps 35.62
Pmax-Pcomp 18.5

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	4.5	4.7	4.6	4.7	4.5	4.6	4.60
Pc/Ps	35.6	35.6	35.5	35.5	35.8	35.7	35.62

TE3P46	Slide FV (Original C26)	Data Sheet No.	T01-2

Data Sheet of 10 % Load Test — Date 26-Sep-2012, Measured Time 9:15

Ambient Condition
Room Temp : 24.6 ℃ — Barometric Press : 1017 hPa — Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
42.2	424.6	1876	3.1	30	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.23	0.23	–	0.23	0.76	0.39	0.20	–
Temp	(deg.C)	45		–	45	33	73	26.8	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		58.4	57.7	58.4	58.5	59.0	58.6	58.3		
Pcomp (bar)		40.1	40.1	40.0	39.9	39.9	40.2	40.2		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	43.0	43	43	43	43	43	43		
Exh. Gas Temp Cyl Outlet		202	197	206	204	206	197	202		
C.F.W Temp Cyl. Outlet		75.7	75	75	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.8	46	47	47	47	47	47		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.32	0.32	
Temp. °C	Air	In	35.9	35.9	
		Out	–	–	
	Water	In	26.8	26.8	
		Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.013	36.3
Exh. Gas Receive Press	0.009 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
194.0	194.8	194.5

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	2340	28.2	0.04	221.4	205.7	0.12	45.0	48.0	–
No.1	2340	28.2	0.04	221.4	205.7	0.12	45.0	48.0	–
No.2									

F.O. Drain g/kWh 5.4
C.O feed rate l/day.cyl 78.10
Thrust Temp. 46

Pc/Ps 35.85
Pmax−Pcomp 18.3

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	4.5	4.7	4.7	4.8	4.6	4.6	4.65
Pc/Ps	35.8	35.8	35.7	35.7	35.9	35.9	35.85

TE3P46	Slide FV (Original C26)	Data Sheet No.	T02-1

Data Sheet of	15	% Load Test	Date	26-Sep-2012
			Measured Time	10:15

Ambient Condition

Room Temp :	24.8 ℃	Barometric Press :	1017 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	555.0	2813	3.9	34	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.23	–	0.23	0.76	0.39	0.21	–
Temp (deg.C)	45		–	45	34	72	26.9	

Cylinder No.	Ave.	1	2	3	4	5	6	7	8
Pmax (bar)	64.2	63.5	63.8	64.3	64.8	64.5	64.2		
Pcomp (bar)	42.4	42.4	42.5	42.2	42.2	42.6	42.7		
Fuel Pump Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
Fuel Pump Pump Mark Index	48.2	48	48	48	49	48	48		
Exh. Gas Temp Cyl Outlet	245	243	249	246	247	242	244		
C.F.W Temp Cyl. Outlet	76.3	76	76	77	77	76	76		
P.C.O. Temp Cyl. Outlet	47.5	47	47	47	48	48	48		

Air Cooler

No.		Ave	1	2
Press. Drop kPa		0.39	0.39	
Temp. ℃ Air	In	41.4	41.4	
	Out	–	–	
Temp. ℃ Water	In	26.9	26.9	
	Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.019	36
Exh. Gas Receive Press	0.014 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
189.5	190.3	190.0

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	3010	28.6	0.05	266.0	240.6	0.16	45.0	48.0	–
No.1	3010	28.6	0.05	266.0	240.6	0.16	45.0	48.0	–
No.2									

F.O. Drain g/kWh 3.7
C.O feed rate l/day.cyl 91.20
Thrust Temp. 46

Pc/Ps 35.97
Pmax-Pcomp 21.8

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	5.8	6	5.9	6	5.8	5.8	5.88
Pc/Ps	36.0	36.1	35.8	35.8	36.1	36.2	35.97

TE3P46	Slide FV (Original C26)	Data Sheet No.	T02-2

Data Sheet of	15	% Load Test	Date / Measured Time	26-Sep-2012 / 11:15

Ambient Condition

Room Temp :	26.2 ℃	Barometric Press :	1016 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
48.4	554.6	2811	3.9	34	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.23	0.23	–	0.23	0.76	0.39	0.20	–
Temp (deg.C)	44		–	44	35	72	27	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		64.3	63.5	63.9	63.8	64.2	65.3	64.9		
Pcomp (bar)		42.4	42.4	42.4	42.2	42.2	42.6	42.6		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	48.2	48	48	48	49	48	48		
Exh. Gas Temp Cyl Outlet		246	244	252	246	248	243	244		
C.F.W Temp Cyl. Outlet		76	76	76	76	76	76	76		
P.C.O. Temp Cyl. Outlet		46.8	46	47	47	47	47	47		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			0.41	0.41	
Temp. °C	Air	In	42.5	42.5	
		Out	–	–	
	Water	In	27	27	
		Out	28	28	

Scavenging Air

Press MPa	Temperature ℃
0.020	36
Exh. Gas Receive Press	0.015 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
189.5	190.3	190.0

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	3050	28.7	0.05	268.4	244.3	0.16	44.0	48.0	–
No.1	3050	28.7	0.05	268.4	244.3	0.16	44.0	48.0	–
No.2									

F.O. Drain g/kWh	3.8		
C.O feed rate l/day.cyl	91.20		
Thrust Temp.	46	Pc/Ps	35.7
		Pmax-Pcomp	21.9

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	5.8	6	5.9	6	5.9	5.9	5.92
Pc/Ps	35.7	35.7	35.5	35.5	35.9	35.9	35.70

TE3P46	Slide FV (Original C26)	Data Sheet No.	T03-1

Data Sheet of	25 % Load Test	Date	26-Sep-2012
		Measured Time	12:15

Ambient Condition

Room Temp :	25.6 ℃	Barometric Press :	1016 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
57.3	775.8	4655	5	42	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.23	0.24	–	0.23	0.75	0.39	0.20	–
Temp	(deg.C)	45		–	45	35	72	27.1	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		77.9	77.1	77.3	78.3	78.0	78.5	78.2		
Pcomp (bar)		50.4	50.4	50.6	50.1	50.2	50.5	50.8		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	58.5	58	58	58	59	59	59		
Exh. Gas Temp Cyl Outlet		287	281	292	294	286	281	285		
C.F.W Temp Cyl. Outlet		77.3	77	77	78	78	77	77		
P.C.O. Temp Cyl. Outlet		48.0	48	48	48	48	48	48		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.64	0.64	
Temp. °C	Air	In	61.6	61.6	
		Out	–	–	
	Water	In	27.1	27.1	
		Out	29	29	

Scavenging Air

Press MPa	Temperature ℃
0.041	35.5
Exh. Gas Receive Press	0.031 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
187.8	188.5	188.1

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4570	31.6	0.10	311.7	270.3	0.37	45.0	52.0	–
No.1	4570	31.6	0.10	311.7	270.3	0.37	45.0	52.0	–
No.2									

F.O. Drain g/kWh	2.4		
C.O feed rate l/day.cyl	108.70		
Thrust Temp.	46	Pc/Ps	36.06
		Pmax−Pcomp	27.5

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	8.1	8.3	8.2	8.3	8.2	8.1	8.20
Pc/Ps	36.1	36.2	35.8	35.9	36.1	36.3	36.06

TE3P46	Slide FV (Original C26)	Data Sheet No.	T03-2

Data Sheet of	25	% Load Test	Date	26-Sep-2012
			Measured Time	13:15

Ambient Condition

Room Temp :	25.6 ℃	Barometric Press :	1016 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
57.3	775.7	4655	5	41	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.23	0.23	-	0.23	0.76	0.39	0.20	-
Temp	(deg.C)	44		-	44	34	72	27.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		78.2	77.7	77.1	78.4	79.1	78.3	78.4		
Pcomp (bar)		50.6	50.7	50.7	50.2	50.4	50.6	51.0		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	58.5	58	58	58	59	59	59		
Exh. Gas Temp Cyl Outlet		288	284	294	294	287	282	287		
C.F.W Temp Cyl. Outlet		77.5	77	77	78	78	78	77		
P.C.O. Temp Cyl. Outlet		47.8	47	48	48	48	48	48		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	0.64	0.64	
Temp. ℃	Air	In	63.9	63.9	
		Out	-	-	
	Water	In	27.2	27.2	
		Out	29	29	

Scavenging Air

Press MPa	Temperature ℃
0.041	35.7
Exh. Gas Receive Press	0.031 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
188.2	188.9	188.4

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	4610	32.3	0.10	313.7	272.6	0.37	44.0	52.0	-
No.1	4610	32.3	0.10	313.7	272.6	0.37	44.0	52.0	-
No.2									

F.O. Drain g/kWh	2.3		
C.O feed rate l/day.cyl	108.70		
Thrust Temp.	46	Pc/Ps	36.2
		Pmax-Pcomp	27.6

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	8.2	8.3	8.2	8.3	8.2	8.1	8.22
Pc/Ps	36.3	36.3	35.9	36.1	36.2	36.5	36.20

TE3P46	Slide FV (Original C26)	Data Sheet No.	T04-1

Data Sheet of	50 % Load Test	Date	26-Sep-2012
		Measured Time	14:15

Ambient Condition

Room Temp :	25.8 °C	Barometric Press :	1015 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1237.3	9355	6.9	56	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.24	0.24	–	0.23	0.76	0.39	0.20	–
Temp	(deg.C)	45		–	45	34	72	27.4	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		107.9	107.7	108.1	106.6	108.7	108.3	108.2		
Pcomp (bar)		79.3	79.4	79.9	78.7	78.9	79.0	79.9		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	80.8	81	81	81	81	80	81		
Exh. Gas Temp Cyl Outlet		301	303	296	302	302	298	302		
C.F.W Temp Cyl. Outlet		79	79	79	79	79	79	79		
P.C.O. Temp Cyl. Outlet		50.0	50	50	50	50	50	50		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.08	1.08	
Temp. °C	Air	In	122.5	122.5	
		Out	–	–	
	Water	In	27.4	27.4	
		Out	34	34	

Scavenging Air

Press MPa	Temperature °C
0.120	31.8
Exh. Gas Receive Press	0.102 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
181.4	182.1	181.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	7600	31.1	0.25	347.7	255.9	1.33	45.0	56.0	–
No.1	7600	31.1	0.25	347.7	255.9	1.33	45.0	56.0	–
No.2									

F.O. Drain g/kWh	1.2		
C.O feed rate l/day.cyl	136.80		
Thrust Temp.	47	Pc/Ps	36.26
		Pmax-Pcomp	28.6

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	13	13.1	13.1	13.2	12.8	12.9	13.02
Pc/Ps	36.3	36.5	36.0	36.1	36.1	36.5	36.26

TE3P46	Slide FV (Original C26)	Data Sheet No.	T04-2

Data Sheet of	50	% Load Test	Date Measured Time	26-Sep-2012 15:15

Ambient Condition

Room Temp : 26.4 ℃ Barometric Press : 1015 hPa Humidity : 51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
72.2	1238.2	9362	6.9	56	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.23	0.24	–	0.23	0.76	0.39	0.21	–
Temp	(deg.C)	44		–	44	34	72	27.7	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		108.5	108.1	108.8	107.0	110.1	109.2	107.8		
Pcomp (bar)		79.7	79.9	80.5	78.9	79.2	79.4	80.4		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	81.0	81	80	81	82	81	81		
Exh. Gas Temp Cyl Outlet		301	304	298	300	300	299	303		
C.F.W Temp Cyl. Outlet		79	79	79	79	79	79	79		
P.C.O. Temp Cyl. Outlet		49.5	49	49	49	50	50	50		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.08	1.08	
Temp. °C	Air	In	125.2	125.2	
		Out	–	–	
	Water	In	27.7	27.7	
		Out	34	34	

Scavenging Air

Press MPa	Temperature ℃
0.122	32.3
Exh. Gas Receive Press	0.104 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
181.5	182.2	181.7

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	7620	31.2	0.25	348.0	255.5	1.31	44.0	56.0	–
No.1	7620	31.2	0.25	348.0	255.5	1.31	44.0	56.0	–
No.2									

F.O. Drain g/kWh 1.2

C.O feed rate l/day.cyl 137.10

Thrust Temp. 47

Pc/Ps 36.11

Pmax−Pcomp 28.8

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	13	13	13	13.2	12.9	12.8	12.98
Pc/Ps	36.2	36.5	35.8	35.9	36.0	36.4	36.11

TE3P46	Slide FV (Original C26)	Data Sheet No.	T05-1

Data Sheet of	75	% Load Test	Date / Measured Time	26-Sep-2012 / 16:45

Ambient Condition

Room Temp :	26.8 °C	Barometric Press :	1015 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
82.7	1618.2	14014	8.3	71	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.24	0.25	-	0.23	0.75	0.39	0.21	-
Temp	(deg.C)	45		-	45	34	72	27.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		134.2	133.7	134.4	132.9	134.3	135.3	134.6		
Pcomp (bar)		113.1	113.6	114.2	111.7	112.3	112.7	114.2		
Fuel Pump	Actuator Index	-	5.4	4.5	5.4	6.0	5.5	4.5		
Fuel Pump	Pump Mark Index	100.3	100	101	100	101	100	100		
Exh. Gas Temp Cyl Outlet		319	320	321	321	316	316	322		
C.F.W Temp Cyl. Outlet		80	80	80	80	80	80	80		
P.C.O. Temp Cyl. Outlet		50.8	50	51	51	51	51	51		

Air Cooler					
No.			Ave	1	2
Press. Drop		kPa	1.42	1.42	
Temp. °C	Air	In	173.4	173.4	
Temp. °C	Air	Out	-	-	
Temp. °C	Water	In	27.9	27.9	
Temp. °C	Water	Out	42	42	

Scavenging Air		
Press MPa	Temperature °C	
0.213	37.6	
Exh. Gas Receive Press	0.190	MPa

Specific Fuel Oil Consumption g/kWh		
Measured Value	LCV corrected	ISO Corrected
178.7	179.4	178.9

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min-1	°C	kPa	°C	°C	kPa	°C	°C	°C
Ave	9380	30.9	0.48	376.5	239.5	2.16	45.0	60.0	-
No.1	9380	30.9	0.48	376.5	239.5	2.16	45.0	60.0	-
No.2									

F.O. Drain g/kWh 0.8
C.O feed rate l/day.cyl 158.00
Thrust Temp. 48
Pc/Ps 36.28
Pmax-Pcomp 21.1

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	17.1	17.2	16.7	16.8	16.8	16.7	16.88
Pc/Ps	36.4	36.6	35.8	36.0	36.2	36.6	36.28

TE3P46	Slide FV (Original C26)	Data Sheet No.	T05-2

Data Sheet of	75	% Load Test	Date 26-Sep-2012 Measured Time 17:45

Ambient Condition

Room Temp :	26.8 ℃	Barometric Press :	1015 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
82.7	1618.5	14017	8.3	71	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.24	0.25	–	0.23	0.75	0.39	0.21	–
Temp	(deg.C)	45		–	45	34	72	27.9	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		134.3	133.8	133.7	132.8	135.5	134.5	135.5		
Pcomp (bar)		113.2	113.8	114.1	112.0	112.6	112.5	114.1		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	100.7	100	101	101	100	101	101		
Exh. Gas Temp Cyl Outlet		323	320	322	323	327	318	325		
C.F.W Temp Cyl. Outlet		80	80	80	80	80	80	80		
P.C.O. Temp Cyl. Outlet		50.8	50	51	51	51	51	51		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.42	1.42	
Temp. ℃	Air	In	173.8	173.8	
		Out	–	–	
	Water	In	27.9	27.9	
		Out	42	42	

Scavenging Air

Press MPa	Temperature ℃
0.214	37.7
Exh. Gas Receive Press	0.191 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
179.2	179.9	179.4

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	9380	31.3	0.49	376.4	239.5	2.16	45.0	60.0	–
No.1	9380	31.3	0.49	376.4	239.5	2.16	45.0	60.0	–
No.2									

F.O. Drain g/kWh 0.7
C.O feed rate l/day.cyl 157.80
Thrust Temp. 48

Pc/Ps 36.2
Pmax−Pcomp 21.1

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	17.1	17.2	16.8	16.8	16.9	16.4	16.87
Pc/Ps	36.4	36.5	35.8	36.0	36.0	36.5	36.20

TE3P46 Slide FV (Original C26)	Data Sheet No.	T06-1

Data Sheet of 100 % Load Test	Date	26-Sep-2012
	Measured Time	18:40

Ambient Condition

Room Temp :	27.0 ℃	Barometric Press :	1015 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.0	1961.6	18693	9.4	86	---

Inlet	Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press MPa	0.24	0.25	–	0.23	0.75	0.39	0.21	–
Temp (deg.C)	45		–	45	34	72	28.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		151.8	151.5	151.4	150.2	152.1	152.7	152.9		
Pcomp (bar)		142.7	143.8	143.5	140.8	141.8	142.5	143.9		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	121.3	121	121	121	122	122	121		
Exh. Gas Temp Cyl Outlet		366	371	367	368	359	365	363		
C.F.W Temp Cyl. Outlet		82	82	82	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.5	53	53	53	54	54	54		

Air Cooler

No.			Ave	1	2
Press. Drop kPa			1.57	1.57	
Temp. °C	Air	In	208.0	208	
		Out	–	–	
	Water	In	28.2	28.2	
		Out	48	48	

Scavenging Air

Press MPa	Temperature ℃
0.292	43.4
Exh. Gas Receive Press	0.264 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
181.6	182.3	181.8

Turbocharger	Speed	Intake Air Temp	Intake Air Filter Press. Drop	Exh. Gas Inlet Temp	Exh. Gas Outlet Temp	Exh. Gas Back Press	Lub. Oil Temp Inlet	Lub. Oil Temp Outlet	F.W. Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	10540	31.3	0.69	432.8	263.2	3.14	45.0	62.0	–
No.1	10540	31.3	0.69	432.8	263.2	3.14	45.0	62.0	–
No.2									

F.O. Drain g/kWh 0.5
C.O feed rate l/day.cyl 174.30
Thrust Temp. 48

Pc/Ps 36.52
Pmax−Pcomp 9.1

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	20.7	20.9	20	20.5	20.6	20.1	20.47
Pc/Ps	36.8	36.7	36.0	36.3	36.5	36.8	36.52

TE3P46 Slide FV (Original C26)	Data Sheet No.	T06-2

Data Sheet of	100	% Load Test	Date	26-Sep-2012
			Measured Time	19:40

Ambient Condition

Room Temp :	26.0 ℃	Barometric Press :	1015 hPa	Humidity :	51%

Engine Speed min^{-1}	W/B Weight kNm	Output kW	Handle Position	Govornor Position	Speed Set Air Press
91.0	1961.4	18691	9.4	86	---

Inlet		Main Lub. Oil	P.C.O	Cam L.O.	T/C Lub Oil	Fuel Oil	Cooling F. W.	Charge Air Coolant	Actuator Pilot Air
Press	MPa	0.24	0.24	–	0.23	0.75	0.39	0.21	–
Temp	(deg.C)	45		–	45	34	72	28.2	

Cylinder No.		Ave.	1	2	3	4	5	6	7	8
Pmax (bar)		151.8	152.4	151.4	150.1	151.2	153.7	152.1		
Pcomp (bar)		142.2	143.4	143.2	140.1	141.6	141.9	142.9		
Fuel Pump	Actuator Index	–	5.4	4.5	5.4	6.0	5.5	4.5		
	Pump Mark Index	122.0	122	122	122	122	122	122		
Exh. Gas Temp Cyl Outlet		369	372	371	371	365	368	369		
C.F.W Temp Cyl. Outlet		82	82	82	82	82	82	82		
P.C.O. Temp Cyl. Outlet		53.2	53	53	53	53	54	53		

Air Cooler

No.			Ave	1	2
Press. Drop		kPa	1.57	1.57	
Temp. °C	Air	In	209.5	209.5	
		Out	–	–	
	Water	In	28.2	28.2	
		Out	48	48	

Scavenging Air

Press MPa	Temperature ℃
0.293	44
Exh. Gas Receive Press	0.265 MPa

Specific Fuel Oil Consumption g/kWh

Measured Value	LCV corrected	ISO Corrected
182.3	183.0	182.4

Turbocharger	Speed	Intake Air		Exh. Gas			Lub. Oil Temp		F.W.
		Temp	Filter Press. Drop	Inlet Temp	Outlet Temp	Back Press	Inlet	Outlet	Outlet
	min−1	℃	kPa	℃	℃	kPa	℃	℃	℃
Ave	10560	32.2	0.69	433.1	263.9	3.14	45.0	62.0	–
No.1	10560	32.2	0.69	433.1	263.9	3.14	45.0	62.0	–
No.2									

F.O. Drain g/kWh	0.5		
C.O feed rate l/day.cyl	174.70		
Thrust Temp.	48	Pc/Ps	36.3
		Pmax−Pcomp	9.6

Cylinder No.	No.1	No.2	No.3	No.4	No.5	No.6	Ave.
Pi	20.7	20.8	20	20.5	20.5	20.1	20.43
Pc/Ps	36.6	36.6	35.8	36.2	36.2	36.5	36.30

Appendix 12 - MDT ISO 8178 particulate measurement data sheets

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	13.71	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	13.48	mg/NORMAL CUBIC METER		
						Average	13.60			
TEST NO:	**T01**		DATE	26-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	10					
TUNNEL ID :		DT1								
BAROMETER mbar:		1017								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		C120905-003		C120905-004						
Type:		Pallflex WW								
Weight after:		88.03		87.76						
Weight before:		86.66		86.39						
Particulates (mg):		*1.37*		*1.37*						
Gasmeter, after:		693.569		712.011		**Average BSN:**			at 10 stroke	
Gasmeter, before:		691.428		709.848						
Gas volume:		2.141	Cub. met.	2.163						
Corr. gas volume:		*1.761*	Cub. met.	*1.782*						
		1.741		1.771						
TEMPERATURES:					**PRESSURES:**					
Exhaust					DIL. AIR				1.8	
Transfer		266			DIL. TUN. UPSTREAM				0.9	
Upstream		27			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		41			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	25.6	26.6	27.6	28.6					26.8
filter	D-press	99.5	102.7	105.5	109.6					102
Right	Temp	26.6	26.7	26.7	26.7					26.4
filter	D-press	99.2	102.3	105.6	109					102
SAMPLE	MIN		10	20	29	30				
TIME	SEK	30			30	13				
										Max time:
TIME	SEK	30	600	1200	1770	1813	0	0	0	1813
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
2.60	0.187	0.04	17.4							
COMMENTS:		DT1								
Left filter										
MELLEM		30	570	600	570	43	0	0	0	

REGNING		49.75	101.1	104.1	107.55	54.8	0	0	0	
FOR		1492.5	57627	62460	61303.5	2356.4	0	0	0	102.172863
MIDLING		25.6	26.1	27.1	28.1	14.3	0	0	0	
		768	14877	16260	16017	614.9	0	0	0	26.771594
Right filter										
MELLEM		30	570	600	570	43	0	0	0	
REGNING		49.6	100.75	103.95	107.3	54.5	0	0	0	
FOR		1488	57427.5	62370	61161	2343.5	0	0	0	101.924986
MIDLING		26.6	26.65	26.7	26.7	13.35	0	0	0	
		798	15190.5	16020	15219	574.05	0	0	0	26.3659956

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	13.36	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	13.48	mg/NORMAL CUBIC METER		
						Average	13.42			
TEST NO:	**T01**		DATE	26-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	10					
TUNNEL	ID :	DT1								
BAROMETER mbar:		1017								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30332		GL-30333						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		1.4190		1.3633						
Gasmeter, after:		695.765		714.092		**Average BSN:**			at 10 stroke	
Gasmeter, before:		693.569		712.011						
Gas volume:		2.196	Cub. met.	2.081						
Corr. gas volume:		*1.871*	Cub. met.	*1.783*						
		1.851		1.772						
TEMPERATURES:					**PRESSURES:**					
Exhaust		196.3			DIL. AIR				1.8	
Transfer		267			DIL. TUN. UPSTREAM				0.9	
Upstream		27			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		41			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	28.8	29	29.2						24.1
filter	D-press	93.1	93.9	95.7						78
Right	Temp	26.6	26.5	26.4						22.0
filter	D-press	93.3	99.8	95.2						79
SAMPLE	MIN		10	20	30					
TIME	SEK	30			20					
										Max time:
TIME	SEK	30	600	1200	1820	0	0	0	0	1820
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
2.65	0.188	0.04	17.6							
COMMENTS:		DT1								
Left filter										
MELLEM		30	570	600	620	0	0	0	0	

REGNING		46.55	93.5	94.8	47.85	0	0	0	0	
FOR		1396.5	53295	56880	29667	0	0	0	0	77.60357143
MIDLING		28.8	28.9	29.1	14.6	0	0	0	0	
		864	16473	17460	9052	0	0	0	0	24.09285714
Right filter										
MELLEM		30	570	600	620	0	0	0	0	
REGNING		46.65	96.55	97.5	47.6	0	0	0	0	
FOR		1399.5	55033.5	58500	29512	0	0	0	0	79.36538462
MIDLING		26.6	26.55	26.45	13.2	0	0	0	0	
		798	15133.5	15870	8184	0	0	0	0	21.97005495

DATASHEET: PARTICULATE MEASUREMENTS			**PART-CONCENTRATION**		2013-01-02
ver 950425			Left	26.91	mg/NORMAL CUBIC METER
TEST PURPOSE:	**SV**		Right	26.76	mg/NORMAL CUBIC METER
			Average	26.84	
TEST NO:	**T02**	DATE	26-09-2012		
PLANT/VESSEL:	6S70MC-C7	Load:	15		
TUNNEL ID :	DT1				
BAROMETER mbar:	1017				
FUEL:	DF				

PARTICULATE MEASUREMENTS

	Left:		Right:
Filter no:	C120905-005		C120905-006
Type:	Pallflex WW		
Weight after:	87.14		#N/A
Weight before:	84.56		#N/A
Particulates (mg):	*2.57*		*2.59*
Gasmeter, after:	697.887		716.228
Gasmeter, before:	695.765		714.092
Gas volume:	2.122	Cub. met.	2.136
Corr. gas volume:	*1.733*	Cub. met.	*1.757*

Average BSN:		at 10 stroke

TEMPERATURES:	
Exhaust	229
Transfer	264
Upstream	29
Downstream	42

PRESSURES:	
DIL. AIR	1.8
DIL. TUN. UPSTREAM	0.8
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	28.4	28.4	28.6	28.9					28.0
filter	D-press	98.3	103.7	111	119.1					105
Right	Temp	26.7	26.7	26.7	26.4					26.1
filter	D-press	98	103.2	110	119.1					104
SAMPLE	MIN		10	20	29	30				
TIME	SEK	30				13				
										Max time:
TIME	SEK	30	600	1200	1740	1813	0	0	0	1813

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.28	0.218	0.04	18.1

COMMENTS:

Left filter								
MELLEM	30	570	600	540	73	0	0	0

REGNING		49.15	101	107.35	115.05	59.55	0	0	0	
FOR		1474.5	57570	64410	62127	4347.15	0	0	0	104.7593216
MIDLING		28.4	28.4	28.5	28.75	14.45	0	0	0	
		852	16188	17100	15525	1054.85	0	0	0	27.9756481
Right filter										
MELLEM		30	570	600	540	73	0	0	0	
REGNING		49	100.6	106.6	114.55	59.55	0	0	0	
FOR		1470	57342	63960	61857	4347.15	0	0	0	104.2339493
MIDLING		26.7	26.7	26.7	26.55	13.2	0	0	0	
		801	15219	16020	14337	963.6	0	0	0	26.11174848

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	27.13	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	26.66	mg/NORMAL CUBIC METER		
						Average	26.89			
TEST NO:	**T02**		DATE	26-09-2012						
				.						
PLANT/VESSEL:		6S70MC-C7		Load:	15					
TUNNEL ID :		DT1								
BAROMETER mbar:		1016								
FUEL:	DF									

PARTICULATE MEASUREMENTS									
		Left:		**Right:**					
Filter no:		GL-30336		GL-30337					
Type:		Pallflex WW							
Weight after:		#N/A		#N/A					
Weight before:		#N/A		#N/A					
Particulates (mg):		2.5823		2.6627					
Gasmeter, after:		700.000		718.422		**Average BSN:**			at 10 stroke
Gasmeter, before:		697.887		716.228					
Gas volume:		2.113	Cub. met.	2.194					
Corr. gas volume:		*1.733*	Cub. met.	*1.818*					

TEMPERATURES:					**PRESSURES:**				
Exhaust		231			DIL. AIR				1.8
Transfer		264			DIL. TUN. UPSTREAM				0.8
Upstream		30			DIL. TUN. DOWN STREAM (Valve open)				
Downstream		44			DIL. TUN. DOWN STREAM (Valve closed)				

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	29	29.1	29.6	30					29.1
filter	D-press	95.8	98.7	99.2	99.9					97
Right	Temp	26.6	26.5	26.4	26.6					26.2
filter	D-press	94.8	98	98.8	99					96
SAMPLE	MIN		10	20	30	30				
TIME	SEK	30	5	20	10	53				
										Max time:
TIME	SEK	30	605	1220	1810	1853	0	0	0	1853

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.26	0.217	0.04	18.2

COMMENTS:

Left filter									
MELLEM		30	575	615	590	43	0	0	0

REGNING		47.9	97.25	98.95	99.55	49.95	0	0	0	
FOR		1437	55918.75	60854.25	58734.5	2147.85	0	0	0	96.64994603
MIDLING		29	29.05	29.35	29.8	15	0	0	0	
		870	16703.75	18050.25	17582	645	0	0	0	29.06152186
Right filter										
MELLEM		30	575	615	590	43	0	0	0	
REGNING		47.4	96.4	98.4	98.9	49.5	0	0	0	
FOR		1422	55430	60516	58351	2128.5	0	0	0	95.97814355
MIDLING		26.6	26.55	26.45	26.5	13.3	0	0	0	
		798	15266.25	16266.75	15635	571.9	0	0	0	26.19422558

DATASHEET: PARTICULATE MEASUREMENTS					**PART-CONCENTRATION**				2013-01-02
ver 950425					Left	36.34	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**			Right	36.10	mg/NORMAL CUBIC METER		
					Average	36.22			
TEST NO:	**T03**		DATE	26-09-2012					
PLANT/VESSEL:		6S70MC-C7		Load:	25				
TUNNEL ID :		DT1							
BAROMETER mbar:		1016							
FUEL:	DF								

PARTICULATE MEASUREMENTS

		Left:		**Right:**	
Filter no:		C120905-007		C120905-008	
Type:		Pallflex WW			
Weight after:		#N/A		#N/A	
Weight before:		#N/A		#N/A	
Particulates (mg):		*3.45*		*3.48*	
Gasmeter, after:		702.168		720.605	
Gasmeter, before:		700.000		718.422	
Gas volume:		2.168	Cub. met.	2.183	
Corr. gas volume:		*1.765*	Cub. met.	*1.792*	

Average BSN:		at 10 stroke

TEMPERATURES:		
Exhaust		260
Transfer		266
Upstream		31
Downstream		45

PRESSURES:	
DIL. AIR	1.8
DIL. TUN. UPSTREAM	0.8
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	31.8	30.9	26.6	26.9					28.5
filter	D-press	98.9	103.7	110	121					105
Right	Temp	26.4	26.7	26.6	26.6					26.2
filter	D-press	99	103.3	109.1	119.9					105
SAMPLE	MIN		10	20	29	30				
TIME	SEK	30	10		52	53				
										Max time:
TIME	SEK	30	610	1200	1792	1853	0	0	0	1853

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.67	0.235	0.04	18.6

COMMENTS:

Left filter								
MELLEM	30	580	590	592	61	0	0	0

REGNING		49.45	101.3	106.85	115.5	60.5	0	0	0	
FOR		1483.5	58754	63041.5	68376	3690.5	0	0	0	105.4212089
MIDLING		31.8	31.35	28.75	26.75	13.45	0	0	0	
		954	18183	16962.5	15836	820.45	0	0	0	28.47056125
Right filter										
MELLEM		30	580	590	592	61	0	0	0	
REGNING		49.5	101.15	106.2	114.5	59.95	0	0	0	
FOR		1485	58667	62658	67784	3656.95	0	0	0	104.8305181
MIDLING		26.4	26.55	26.65	26.6	13.3	0	0	0	
		792	15399	15723.5	15747.2	811.3	0	0	0	26.1592013

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	35.85	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	36.03	mg/NORMAL CUBIC METER		
						Average	35.94			
TEST NO:	**T03**		DATE	26-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	25					
TUNNEL	ID :	DT1								
BAROMETER mbar:		1016								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30338		GL-30339						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		3.3163		3.2486						
Gasmeter, after:		704.314		722.711		**Average BSN:**			at 10 stroke	
Gasmeter, before:		702.168		720.605						
Gas volume:		2.146	Cub. met.	2.106						
Corr. gas volume:		*1.743*	Cub. met.	*1.699*						

TEMPERATURES:				**PRESSURES:**				
Exhaust				DIL. AIR				1.7
Transfer		268		DIL. TUN. UPSTREAM				0.85
Upstream		32		DIL. TUN. DOWN STREAM (Valve open)				
Downstream		46		DIL. TUN. DOWN STREAM (Valve closed)				

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	26.9	34	34.4						31.0
filter	D-press	102	103	104.6						100
Right	Temp	26.8	37.2	39.2						33.3
filter	D-press	99.9	103.1	104.3						99
SAMPLE	MIN		20	29	30					
TIME	SEK	50	12	30	35					
										Max time:
TIME	SEK	50	1212	1770	1835	0	0	0	0	1835

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.68	0.233	0.04	18.8

COMMENTS:

Left filter								
MELLEM	50	1162	558	65	0	0	0	0

REGNING		51	102.5	103.8	52.3	0	0	0	0	
FOR		2550	119105	57920.4	3399.5	0	0	0	0	99.71384196
MIDLING		26.9	30.45	34.2	17.2	0	0	0	0	
		1345	35382.9	19083.6	1118	0	0	0	0	31.02425068
Right filter										
MELLEM		50	1162	558	65	0	0	0	0	
REGNING		49.95	101.5	103.7	52.15	0	0	0	0	
FOR		2497.5	117943	57864.6	3389.75	0	0	0	0	99.01626703
MIDLING		26.8	32	38.2	19.6	0	0	0	0	
		1340	37184	21315.6	1274	0	0	0	0	33.30441417

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	42.61	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	42.72	mg/NORMAL CUBIC METER		
						Average	42.67			
TEST NO:	**T04**		DATE	26-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	50					
TUNNEL ID :		DT1								
BAROMETER mbar:		1015								
FUEL:	DF									

PARTICULATE MEASUREMENTS

	Left:		**Right:**	
Filter no:	C120905-009		C120905-010	
Type:	Pallflex WW			
Weight after:	#N/A		#N/A	
Weight before:	#N/A		#N/A	
Particulates (mg):	*3.88*		*3.87*	
Gasmeter, after:	707.845		726.166	
Gasmeter, before:	705.735		724.047	
Gas volume:	2.110	Cub. met.	2.119	
Corr. gas volume:	*1.700*	Cub. met.	*1.692*	

Average BSN:			at 10 stroke

TEMPERATURES:	
Exhaust	
Transfer	267
Upstream	33
Downstream	47

PRESSURES:	
DIL. AIR	
DIL. TUN. UPSTREAM	
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	33.3	34.5	32.8	32.5					32.9
filter	D-press	97.9	102.2	105.7	110					100
Right	Temp	36.7	36.7	36.4	36					35.9
filter	D-press	97.6	101.3	105.5	109					100
SAMPLE	MIN	1	10	20	29	30				
TIME	SEK	10	4	6	20	14				
										Max time:
TIME	SEK	70	604	1206	1760	1814	0	0	0	1814

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.84	0.244	0.04	18.7

COMMENTS:

Left filter								
MELLEM	70	534	602	554	54	0	0	0

REGNING		48.95	100.05	103.95	107.85	55	0	0	0	
FOR		3426.5	53426.7	62577.9	59748.9	2970	0	0	0	100.4134509
MIDLING		33.3	33.9	33.65	32.65	16.25	0	0	0	
		2331	18102.6	20257.3	18088.1	877.5	0	0	0	32.88671444
Right filter										
MELLEM		70	534	602	554	54	0	0	0	
REGNING		48.8	99.45	103.4	107.25	54.5	0	0	0	
FOR		3416	53106.3	62246.8	59416.5	2943	0	0	0	99.85038589
MIDLING		36.7	36.7	36.55	36.2	18	0	0	0	
		2569	19597.8	22003.1	20054.8	972	0	0	0	35.94084895

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	44.47	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	44.30	mg/NORMAL CUBIC METER		
						Average	44.39			
TEST NO:	**T04**		DATE	26-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	50					
TUNNEL ID :		DT1								
BAROMETER mbar:		1015								
FUEL:	DF									

PARTICULATE MEASUREMENTS

		Left:		**Right:**					
Filter no:		GL-30340		GL-30341					
Type:		Pallflex WW							
Weight after:		#N/A		#N/A					
Weight before:		#N/A		#N/A					
Particulates (mg):		4.1693		4.1602					
Gasmeter, after:		709.989		728.332		**Average BSN:**			at 10 stroke
Gasmeter, before:		707.845		726.166					
Gas volume:		2.144	Cub. met.	2.166					
Corr. gas volume:		*1.732*	Cub. met.	*1.735*					

TEMPERATURES:				**PRESSURES:**		
Exhaust				DIL. AIR		1.6
Transfer		266		DIL. TUN. UPSTREAM		0.8
Upstream		33		DIL. TUN. DOWN STREAM (Valve open)		
Downstream		48		DIL. TUN. DOWN STREAM (Valve closed)		

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	32.8	34.9	34.6	34.7					33.9
filter	D-press	97.4	98.4	99.4	99.7					95
Right	Temp	35.8	37.3	37.4	37.6					36.6
filter	D-press	97.1	98.5	99	99.7					95
SAMPLE	MIN	1	9	21	30	30				
TIME	SEK	27	45	28	2	52				
										Max time:
TIME	SEK	87	585	1288	1802	1852	0	0	0	1852

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.83	0.245	0.04	18.5

COMMENTS:

Left filter									
MELLEM		87	498	703	514	50	0	0	0

REGNING		48.7	97.9	98.9	99.55	49.85	0	0	0	
FOR		4236.9	48754.2	69526.7	51168.7	2492.5	0	0	0	95.12904968
MIDLING		32.8	33.85	34.75	34.65	17.35	0	0	0	
		2853.6	16857.3	24429.25	17810.1	867.5	0	0	0	33.91887149
Right filter										
MELLEM		87	498	703	514	50	0	0	0	
REGNING		48.55	97.8	98.75	99.35	49.85	0	0	0	
FOR		4223.85	48704.4	69421.25	51065.9	2492.5	0	0	0	94.98266739
MIDLING		35.8	36.55	37.35	37.5	18.8	0	0	0	
		3114.6	18201.9	26257.05	19275	940	0	0	0	36.60288877

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	74.93	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	74.70	mg/NORMAL CUBIC METER		
						Average	74.81			
TEST NO:	**T05**		DATE	26-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	75					
TUNNEL ID :		DT1								
BAROMETER mbar:		1015								
FUEL:	DF									

PARTICULATE MEASUREMENTS

	Left:		**Right:**			
Filter no:	C120905-011		C120905-012			
Type:	Pallflex WW					
Weight after:	#N/A		#N/A			
Weight before:	#N/A		#N/A			
Particulates (mg):	*6.62*		*6.98*			
Gasmeter, after:	711.954		730.419	**Average BSN:**		at 10 stroke
Gasmeter, before:	709.989		728.332			
Gas volume:	1.965	Cub. met.	2.087			
Corr. gas volume:	*1.629*	Cub. met.	*1.723*			

TEMPERATURES:		**PRESSURES:**	
Exhaust		DIL. AIR	1.8
Transfer	264	DIL. TUN. UPSTREAM	0.8
Upstream	34	DIL. TUN. DOWN STREAM (Valve open)	
Downstream	48	DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left filter	Temp	30.8	34.1	35						28.5
	D-press	102.3	104.5	108.4						88
Right filter	Temp	31.4	35.8	37.5						29.9
	D-press	101.5	103.5	107.7						87
SAMPLE	MIN		9	19	29					
TIME	SEK	50	42	54						
										Max time:
TIME	SEK	50	582	1194	1740	0	0	0	0	1740

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
4.02	0.256	0.04	18.4

COMMENTS:

Left filter								
MELLEM	50	532	612	546	0	0	0	0

REGNING		51.15	103.4	106.45	54.2	0	0	0	0	
FOR		2557.5	55008.8	65147.4	29593.2	0	0	0	0	87.53270115
MIDLING		30.8	32.45	34.55	17.5	0	0	0	0	
		1540	17263.4	21144.6	9555	0	0	0	0	28.45
Right filter										
MELLEM		50	532	612	546	0	0	0	0	
REGNING		50.75	102.5	105.6	53.85	0	0	0	0	
FOR		2537.5	54530	64627.2	29402.1	0	0	0	0	86.83724138
MIDLING		31.4	33.6	36.65	18.75	0	0	0	0	
		1570	17875.2	22429.8	10237.5	0	0	0	0	29.94971264

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	72.41	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	72.77	mg/NORMAL CUBIC METER		
						Average	72.59			
TEST NO:	**T05**		DATE	26-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	75					
TUNNEL ID :		DT1								
BAROMETER mbar:		1015								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30342		GL-30343						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		7.4165		7.3390						
Gasmeter, after:		714.276		732.723		**Average BSN:**			at 10 stroke	
Gasmeter, before:		711.954		730.419						
Gas volume:		2.322	Cub. met.	2.304						
Corr. gas volume:		*1.860*	Cub. met.	*1.831*						
TEMPERATURES:					**PRESSURES:**					
Exhaust					DIL. AIR				1.8	
Transfer		268			DIL. TUN. UPSTREAM				0.6	
Upstream		34			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		48			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	36	36.7	36.5	36.8					36.2
filter	D-press	96.8	99	100	101.5					96
Right	Temp	38.4	39.2	39.1	39.7					38.8
filter	D-press	96.3	97.6	100.1	100.8					95
SAMPLE	MIN	1	9	20	32	33				
TIME	SEK	46	52	37	46	22				
										Max time:
TIME	SEK	106	592	1237	1966	2002	0	0	0	2002
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
4.00	0.258	0.04	18.2							
COMMENTS:										
Left filter										
MELLEM		106	486	645	729	36	0	0	0	

REGNING		48.4	97.9	99.5	100.75	50.75	0	0	0	
FOR		5130.4	47579.4	64177.5	73446.75	1827	0	0	0	95.98454046
MIDLING		36	36.35	36.6	36.65	18.4	0	0	0	
		3816	17666.1	23607	26717.85	662.4	0	0	0	36.19847652
Right filter										
MELLEM		106	486	645	729	36	0	0	0	
REGNING		48.15	96.95	98.85	100.45	50.4	0	0	0	
FOR		5103.9	47117.7	63758.25	73228.05	1814.4	0	0	0	95.41573427
MIDLING		38.4	38.8	39.15	39.4	19.85	0	0	0	
		4070.4	18856.8	25251.75	28722.6	714.6	0	0	0	38.76930569

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	94.70	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**SV**				Right	94.21	mg/NORMAL CUBIC METER		
						Average	94.46			
TEST NO:	**T06**		DATE	26-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	100					
TUNNEL ID :		DT1								
BAROMETER mbar:		1015								
FUEL:	DF									

PARTICULATE MEASUREMENTS

		Left:		**Right:**			
Filter no:		C120905-013		C120905-014			
Type:		Pallflex WW					
Weight after:		#N/A		#N/A			
Weight before:		#N/A		#N/A			
Particulates (mg):		*9.06*		*9.32*			
Gasmeter, after:		716.520		735.054	**Average BSN:**		at 10 stroke
Gasmeter, before:		714.277		732.723			
Gas volume:		2.243	Cub. met.	2.331			
Corr. gas volume:		*1.783*	Cub. met.	*1.844*			

TEMPERATURES:			**PRESSURES:**		
Exhaust			DIL. AIR		1.5
Transfer		265	DIL. TUN. UPSTREAM		0.5
Upstream		34	DIL. TUN. DOWN STREAM (Valve open)		
Downstream		49	DIL. TUN. DOWN STREAM (Valve closed)		

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	33.1	35.4	36.4	37.2					34.5
filter	D-press	101.6	108.3	115	125					108
Right	Temp	33.1	37.4	38.9	39.5					36.3
filter	D-press	100.5	107.1	114.5	123.9					107
SAMPLE	MIN		10	19	30	32				
TIME	SEK	43	1	51	37	49				
										Max time:
TIME	SEK	43	601	1191	1837	1969	0	0	0	1969

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
4.53	0.281	0.04	18.6

COMMENTS:

Left filter								
MELLEM	43	558	590	646	132	0	0	0

REGNING		50.8	104.95	111.65	120	62.5	0	0	0	
FOR		2184.4	58562.1	65873.5	77520	8250	0	0	0	107.866938
MIDLING		33.1	34.25	35.9	36.8	18.6	0	0	0	
		1423.3	19111.5	21181	23772.8	2455.2	0	0	0	34.5067547
Right filter										
MELLEM		43	558	590	646	132	0	0	0	
REGNING		50.25	103.8	110.8	119.2	61.95	0	0	0	
FOR		2160.75	57920.4	65372	77003.2	8177.4	0	0	0	106.974987
MIDLING		33.1	35.25	38.15	39.2	19.75	0	0	0	
		1423.3	19669.5	22508.5	25323.2	2607	0	0	0	36.3288471

DATASHEET: PARTICULATE MEASUREMENTS					**PART-CONCENTRATION**			2013-01-02
ver 950425					Left	76.10	mg/NORMAL CUBIC METER	
TEST PURPOSE:	**SV**				Right	76.74	mg/NORMAL CUBIC METER	
					Average	76.42		
TEST NO:	**T06**	DATE	26-09-2012					
PLANT/VESSEL:	6S70MC-C7	Load:	100					
TUNNEL ID :	DT1							
BAROMETER mbar:	1015							
FUEL:	DF							

PARTICULATE MEASUREMENTS

	Left:		Right:
Filter no:	GL-30344		GL-30345
Type:	Pallflex WW		
Weight after:	#N/A		#N/A
Weight before:	#N/A		#N/A
Particulates (mg):	6.7594		6.7818
Gasmeter, after:	718.615		737.154
Gasmeter, before:	716.520		735.054
Gas volume:	2.095	Cub. met.	2.100
Corr. gas volume:	*1.676*	Cub. met.	*1.667*

Average BSN:		at 10 stroke

TEMPERATURES:	
Exhaust	
Transfer	266
Upstream	35
Downstream	49

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.5
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	34.8	36.1	36.8	36.2					35.7
filter	D-press	97.6	101.7	102	103.1					99
Right	Temp	37.6	38.6	39.2	38.9					38.2
filter	D-press	97.9	100.7	101	102.4					98
SAMPLE	MIN		10	19	29	30				
TIME	SEK	41	43	17	38	22				
										Max time:
TIME	SEK	41	643	1157	1778	1822	0	0	0	1822

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
4.53	0.278	0.04	18.9

COMMENTS:

Left filter								
MELLEM	41	602	514	621	44	0	0	0

REGNING		48.8	99.65	101.85	102.55	51.55	0	0	0	
FOR		2000.8	59989.3	52350.9	63683.55	2268.2	0	0	0	98.9532108
MIDLING		34.8	35.45	36.45	36.5	18.1	0	0	0	
		1426.8	21340.9	18735.3	22666.5	796.4	0	0	0	35.6563666
Right filter										
MELLEM		41	602	514	621	44	0	0	0	
REGNING		48.95	99.3	100.85	101.7	51.2	0	0	0	
FOR		2006.95	59778.6	51836.9	63155.7	2252.8	0	0	0	98.2606751
MIDLING		37.6	38.1	38.9	39.05	19.45	0	0	0	
		1541.6	22936.2	19994.6	24250.05	855.8	0	0	0	38.187843

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	27.45	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C3**				Right	27.56	mg/NORMAL CUBIC METER		
						Average	27.50			
TEST NO:	**T07**		DATE	27-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	10					
TUNNEL ID :		DT1								
BAROMETER mbar:		1015								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		C120905-015		C120905-016						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		*2.65*		*2.70*						
Gasmeter, after:		722.295		740.868		**Average BSN:**			at 10 stroke	
Gasmeter, before:		720.096		738.616						
Gas volume:		2.199	Cub. met.	2.252						
Corr. gas volume:		*1.768*	Cub. met.	*1.794*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		184			DIL. AIR				1.5	
Transfer		267			DIL. TUN. UPSTREAM				0.6	
Upstream		30			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		44			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	35.6	35	34.5	35					34.5
filter	D-press	94.9	99.6	104.1	108.5					98
Right	Temp	38.6	38	38	38.1					37.6
filter	D-press	94.2	99	103.2	108					97
SAMPLE	MIN	1	9	20	29	30				
TIME	SEK	50	55	23	46	33				
										Max time:
TIME	SEK	110	595	1223	1786	1833	0	0	0	1833
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
2.65	0.182	0.04	18.3							
COMMENTS:		Åbent for tidligt, tid ned af trappe filter exponeret dog uden pumpe, rettet gasmetermåling ca. 20L.								
Left filter										
MELLEM		110	485	628	563	47	0	0	0	

REGNING		47.45	97.25	101.85	106.3	54.25	0	0	0	
FOR		5219.5	47166.25	63961.8	59846.9	2549.75	0	0	0	97.5145663
MIDLING		35.6	35.3	34.75	34.75	17.5	0	0	0	
		3916	17120.5	21823	19564.25	822.5	0	0	0	34.504228
Right filter										
MELLEM		110	485	628	563	47	0	0	0	
REGNING		47.1	96.6	101.1	105.6	54	0	0	0	
FOR		5181	46851	63490.8	59452.8	2538	0	0	0	96.8432079
MIDLING		38.6	38.3	38	38.05	19.05	0	0	0	
		4246	18575.5	23864	21422.15	895.35	0	0	0	37.6448445

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	27.81	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C3**				Right	28.71	mg/NORMAL CUBIC METER		
						Average	28.26			
TEST NO:	**T07**		DATE	27-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	10					
TUNNEL	ID :	DT1								
BAROMETER mbar:		1015								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30346		GL-30347						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		2.4982		2.5486						
Gasmeter, after:		724.340		742.912		**Average BSN:**			at 10 stroke	
Gasmeter, before:		722.295		740.868						
Gas volume:		2.045	Cub. met.	2.044						
Corr. gas volume:		*1.662*	Cub. met.	*1.642*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		177			DIL. AIR				1.5	
Transfer		265			DIL. TUN. UPSTREAM				0.6	
Upstream		28			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		41			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	33.5	33.7	33.8	33.8					33.2
filter	D-press	92.6	94.4	94.4	95					91
Right	Temp	36.4	37.2	38.2	37.8					36.9
filter	D-press	92.7	93.1	94.5	94.7					91
SAMPLE	MIN		10	19	28	29				
TIME	SEK	47	11	58	41	37				
										Max time:
TIME	SEK	47	611	1198	1721	1777	0	0	0	1777
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
2.69	0.183	0.04	18.5							
COMMENTS:		DT1								
Left filter										
MELLEM		47	564	587	523	56	0	0	0	

REGNING		46.3	93.5	94.4	94.7	47.5	0	0	0	
FOR		2176.1	52734	55412.8	49528.1	2660	0	0	0	91.45244795
MIDLING		33.5	33.6	33.75	33.8	16.9	0	0	0	
		1574.5	18950.4	19811.25	17677.4	946.4	0	0	0	33.1794879
Right filter										
MELLEM		47	564	587	523	56	0	0	0	
REGNING		46.35	92.9	93.8	94.6	47.35	0	0	0	
FOR		2178.45	52395.6	55060.6	49475.8	2651.6	0	0	0	91.03097918
MIDLING		36.4	36.8	37.7	38	18.9	0	0	0	
		1710.8	20755.2	22129.9	19874	1058.4	0	0	0	36.87580191

DATASHEET: PARTICULATE MEASUREMENTS

ver 950425

PART-CONCENTRATION			2013-01-02
Left	38.26	mg/NORMAL CUBIC METER	
Right	38.85	mg/NORMAL CUBIC METER	
Average	38.55		

TEST PURPOSE: **C3**

TEST NO: **T08** DATE 27-09-2012

PLANT/VESSEL: 6S70MC-C7 Load: 15

TUNNEL ID : DT1

BAROMETER mbar: 1014

FUEL: DF

PARTICULATE MEASUREMENTS

	Left:		**Right:**
Filter no:	C120905-019		C120905-020
Type:	Pallflex WW		
Weight after:	#N/A		#N/A
Weight before:	#N/A		#N/A
Particulates (mg):	*3.35*		*3.27*
Gasmeter, after:	728.164		746.706
Gasmeter, before:	726.100		744.703
Gas volume:	2.064	Cub. met.	2.003
Corr. gas volume:	*1.658*	Cub. met.	*1.594*

Average BSN: at 10 stroke

TEMPERATURES:	
Exhaust	207
Transfer	266
Upstream	29
Downstream	42

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	30.7	35.8	33.5	34.7					33.0
filter	D-press	94.8	101.3	108.6	122.6					102
Right	Temp	34.5	36.6	37.9	38.8					36.0
filter	D-press	94.7	101.1	108	122.8					102
SAMPLE	MIN		10	19	28	29				
TIME	SEK	47	10	22	3	43				
										Max time:
TIME	SEK	47	610	1162	1683	1783	0	0	0	1783

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.34	0.214	0.04	18.9

COMMENTS:

Left filter								
MELLEM	47	563	552	521	100	0	0	0

REGNING		47.4	98.05	104.95	115.6	61.3	0	0	0	
FOR		2227.8	55202.15	57932.4	60227.6	6130	0	0	0	101.9180875
MIDLING		30.7	33.25	34.65	34.1	17.35	0	0	0	
		1442.9	18719.75	19126.8	17766.1	1735	0	0	0	32.9728267
Right filter										
MELLEM		47	563	552	521	100	0	0	0	
REGNING		47.35	97.9	104.55	115.4	61.4	0	0	0	
FOR		2225.45	55117.7	57711.6	60123.4	6140	0	0	0	101.692737
MIDLING		34.5	35.55	37.25	38.35	19.4	0	0	0	
		1621.5	20014.65	20562	19980.35	1940	0	0	0	35.96102075

DATASHEET: PARTICULATE MEASUREMENTS			**PART-CONCENTRATION**		2013-01-02
ver 950425			Left	37.64	mg/NORMAL CUBIC METER
TEST PURPOSE:	**C3**		Right	38.40	mg/NORMAL CUBIC METER
			Average	38.02	
TEST NO: **T08**		DATE	27-09-2012		
PLANT/VESSEL:	6S70MC-C7	Load:	15		
TUNNEL ID :	DT1				
BAROMETER mbar:	1014				
FUEL:	DF				

PARTICULATE MEASUREMENTS

	Left:		Right:
Filter no:	GL-30348		GL-30349
Type:	Pallflex WW		
Weight after:	#N/A		#N/A
Weight before:	#N/A		#N/A
Particulates (mg):	3.3026		3.3496
Gasmeter, after:	730.208		748.765
Gasmeter, before:	728.164		746.706
Gas volume:	2.044	Cub. met.	2.059
Corr. gas volume:	*1.653*	Cub. met.	*1.643*

Average BSN:		at 10 stroke

TEMPERATURES:	
Exhaust	208
Transfer	266
Upstream	30
Downstream	43

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	32.6	34.4	35.3	35.3					34.2
filter	D-press	91.9	94	94.9	96					92
Right	Temp	37.3	38.7	39.6	39.6					38.5
filter	D-press	91.1	93.3	94	95.9					92
SAMPLE	MIN		9	19	29	30				
TIME	SEK	38	46	32	34	15				
										Max time:
TIME	SEK	38	586	1172	1774	1815	0	0	0	1815

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.33	0.215	0.04	18.8

COMMENTS:

Left filter								
MELLEM	38	548	586	602	41	0	0	0

REGNING		45.95	92.95	94.45	95.45	48	0	0	0	
FOR		1746.1	50936.6	55347.7	57460.9	1968	0	0	0	92.26407713
MIDLING		32.6	33.5	34.85	35.3	17.65	0	0	0	
		1238.8	18358	20422.1	21250.6	723.65	0	0	0	34.15600551
Right filter										
MELLEM		38	548	586	602	41	0	0	0	
REGNING		45.55	92.2	93.65	94.95	47.95	0	0	0	
FOR		1730.9	50525.6	54878.9	57159.9	1965.95	0	0	0	91.60399449
MIDLING		37.3	38	39.15	39.6	19.8	0	0	0	
		1417.4	20824	22941.9	23839.2	811.8	0	0	0	38.47619835

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	45.82	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C3**				Right	46.60	mg/NORMAL CUBIC METER		
						Average	46.21			
TEST NO:	**T09**		DATE	27-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	25					
TUNNEL ID :		DT1								
BAROMETER mbar:		1013								
FUEL:	DF									

PARTICULATE MEASUREMENTS

		Left:		**Right:**				
Filter no:		C120905-021		C120905-022				
Type:		Pallflex WW						
Weight after:		#N/A		#N/A				
Weight before:		#N/A		#N/A				
Particulates (mg):		*4.02*		*4.05*				
Gasmeter, after:		732.290		750.852		**Average BSN:**		at 10 stroke
Gasmeter, before:		730.208		748.765				
Gas volume:		2.082	Cub. met.	2.087				
Corr. gas volume:		*1.677*	Cub. met.	*1.661*				

TEMPERATURES:				**PRESSURES:**				
Exhaust		232		DIL. AIR				1.5
Transfer		264		DIL. TUN. UPSTREAM				0.6
Upstream		32		DIL. TUN. DOWN STREAM (Valve open)				
Downstream		45		DIL. TUN. DOWN STREAM (Valve closed)				

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	30.1	32.9	33.6	35.5					32.4
filter	D-press	95.9	99.6	105	114.2					100
Right	Temp	33.3	36.5	38	40.2					36.4
filter	D-press	95.6	98.1	104.5	113.3					99
SAMPLE	MIN		9	19	29	30				
TIME	SEK	45	43	33	17	31				
										Max time:
TIME	SEK	45	583	1173	1757	1831	0	0	0	1831

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.71	0.232	0.04	19.1

COMMENTS:

Left filter								
MELLEM	45	538	590	584	74	0	0	0

REGNING		47.95	97.75	102.3	109.6	57.1	0	0	0	
FOR		2157.75	52589.5	60357	64006.4	4225.4	0	0	0	100.1289186
MIDLING		30.1	31.5	33.25	34.55	17.75	0	0	0	
		1354.5	16947	19617.5	20177.2	1313.5	0	0	0	32.44658656
Right filter										
MELLEM		45	538	590	584	74	0	0	0	
REGNING		47.8	96.85	101.3	108.9	56.65	0	0	0	
FOR		2151	52105.3	59767	63597.6	4192.1	0	0	0	99.29710541
MIDLING		33.3	34.9	37.25	39.1	20.1	0	0	0	
		1498.5	18776.2	21977.5	22834.4	1487.4	0	0	0	36.35936647

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	48.21	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C3**				Right	49.28	mg/NORMAL CUBIC METER		
						Average	48.75			
TEST NO:	**T09**		DATE	27-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	25					
TUNNEL ID :		DT1								
BAROMETER mbar:		1012								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30350		GL-30351						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		4.3398		4.3064						
Gasmeter, after:		734.447		752.975		**Average BSN:**			at 10 stroke	
Gasmeter, before:		732.290		750.852						
Gas volume:		2.157	Cub. met.	2.123						
Corr. gas volume:		*1.732*	Cub. met.	*1.682*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		236			DIL. AIR				1.5	
Transfer		267			DIL. TUN. UPSTREAM				0.6	
Upstream		31			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		46			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	34.7	35.9	36.4	35.9					35.5
filter	D-press	92.6	94.4	96.7	96.8					93
Right	Temp	40.2	40.2	40.5	40.3					39.9
filter	D-press	92.2	94.2	95.8	97					92
SAMPLE	MIN	1	9	19	30	31				
TIME	SEK	3	40	51	47	27				
										Max time:
TIME	SEK	63	580	1191	1847	1887	0	0	0	1887
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
3.73	0.232	0.04	19.2							
COMMENTS:										
Left filter										
MELLEM		63	517	611	656	40	0	0	0	

REGNING		46.3	93.5	95.55	96.75	48.4	0	0	0	
FOR		2916.9	48339.5	58381.05	63468	1936	0	0	0	92.76176471
MIDLING		34.7	35.3	36.15	36.15	17.95	0	0	0	
		2186.1	18250.1	22087.65	23714.4	718	0	0	0	35.48290938
Right filter										
MELLEM		63	517	611	656	40	0	0	0	
REGNING		46.1	93.2	95	96.4	48.5	0	0	0	
FOR		2904.3	48184.4	58045	63238.4	1940	0	0	0	92.37525172
MIDLING		40.2	40.2	40.35	40.4	20.15	0	0	0	
		2532.6	20783.4	24653.85	26502.4	806	0	0	0	39.89308426

DATASHEET: PARTICULATE MEASUREMENTS

ver 950425

TEST PURPOSE:	**C3**		
TEST NO:	**T10**	DATE	27-09-2012
PLANT/VESSEL:	6S70MC-C7	Load:	50
TUNNEL ID :	DT1		
BAROMETER mbar:	1012		
FUEL:	DF		

PART-CONCENTRATION		2013-01-02
Left	46.27	mg/NORMAL CUBIC METER
Right	46.53	mg/NORMAL CUBIC METER
Average	46.40	

PARTICULATE MEASUREMENTS

	Left:		**Right:**
Filter no:	C120905-023		C120905-024
Type:	Pallflex WW		
Weight after:	#N/A		#N/A
Weight before:	#N/A		#N/A
Particulates (mg):	*4.02*		*4.08*
Gasmeter, after:	736.478		755.049
Gasmeter, before:	734.447		752.975
Gas volume:	2.031	Cub. met.	2.074
Corr. gas volume:	*1.624*	Cub. met.	*1.639*

Average BSN:		at 10 stroke

TEMPERATURES:	
Exhaust	213
Transfer	265
Upstream	34
Downstream	48

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	33.5	35.5	37	38.1					35.6
filter	D-press	96.8	97.6	99.3	102.3					96
Right	Temp	36.6	39.2	41.9	41.8					39.6
filter	D-press	95.8	96.8	98.5	101.9					95
SAMPLE	MIN		9	19	29	30				
TIME	SEK	56	25	16	17	5				
										Max time:
TIME	SEK	56	565	1156	1757	1805	0	0	0	1805

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.87	0.245	0.04	18.7

COMMENTS:

Left filter								
MELLEM	56	509	591	601	48	0	0	0

REGNING		48.4	97.2	98.45	100.8	51.15	0	0	0	
FOR		2710.4	49474.8	58183.95	60580.8	2455.2	0	0	0	96.06933518
MIDLING		33.5	34.5	36.25	37.55	19.05	0	0	0	
		1876	17560.5	21423.75	22567.55	914.4	0	0	0	35.6466482
Right filter										
MELLEM		56	509	591	601	48	0	0	0	
REGNING		47.9	96.3	97.65	100.2	50.95	0	0	0	
FOR		2682.4	49016.7	57711.15	60220.2	2445.6	0	0	0	95.33299169
MIDLING		36.6	37.9	40.55	41.85	20.9	0	0	0	
		2049.6	19291.1	23965.05	25151.85	1003.2	0	0	0	39.59047091

DATASHEET: PARTICULATE MEASUREMENTS		**PART-CONCENTRATION**			2013-01-02
ver 950425		Left	49.79	mg/NORMAL CUBIC METER	
TEST PURPOSE:	**C3**	Right	50.84	mg/NORMAL CUBIC METER	
		Average	50.32		
TEST NO: T10	DATE 27-09-2012				
PLANT/VESSEL:	6S70MC-C7	Load: 50			
TUNNEL ID :	DT1				
BAROMETER mbar:	1012				
FUEL:	DF				

PARTICULATE MEASUREMENTS

	Left:		Right:
Filter no:	GL-30352		GL-30353
Type:	Pallflex WW		
Weight after:	#N/A		#N/A
Weight before:	#N/A		#N/A
Particulates (mg):	4.3941		4.3701
Gasmeter, after:	738.564		757.094
Gasmeter, before:	736.478		755.049
Gas volume:	2.086	Cub. met.	2.045
Corr. gas volume:	*1.665*	Cub. met.	*1.621*

Average BSN:		at 10 stroke

TEMPERATURES:	
Exhaust	218
Transfer	266
Upstream	35
Downstream	49

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	38.2	38.1	38.3	38.5					37.8
filter	D-press	92.8	94.2	95.6	96.3					92
Right	Temp	41.2	40	40.2	40.9					40.0
filter	D-press	92.3	93.9	95	96.1					91
SAMPLE	MIN	1	9	19	29	30				
TIME	SEK	24	24	28	52	34				
										Max time:
TIME	SEK	84	564	1168	1792	1834	0	0	0	1834

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.86	0.243	0.04	18.9

COMMENTS:

Left filter								
MELLEM	84	480	604	624	42	0	0	0

REGNING		46.4	93.5	94.9	95.95	48.15	0	0	0	
FOR		3897.6	44880	57319.6	59872.8	2022.3	0	0	0	91.59885496
MIDLING		38.2	38.15	38.2	38.4	19.25	0	0	0	
		3208.8	18312	23072.8	23961.6	808.5	0	0	0	37.82099237
Right filter										
MELLEM		84	480	604	624	42	0	0	0	
REGNING		46.15	93.1	94.45	95.55	48.05	0	0	0	
FOR		3876.6	44688	57047.8	59623.2	2018.1	0	0	0	91.19612868
MIDLING		41.2	40.6	40.1	40.55	20.45	0	0	0	
		3460.8	19488	24220.4	25303.2	858.9	0	0	0	39.98435115

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	74.94	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C3**				Right	74.86	mg/NORMAL CUBIC METER		
						Average	74.90			
TEST NO:	**T11**		DATE	27-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	75					
TUNNEL ID :		DT1								
BAROMETER mbar:		1011								
FUEL:	DF									

PARTICULATE MEASUREMENTS

		Left:		**Right:**
Filter no:		C120905-025		C120905-026
Type:		Pallflex WW		
Weight after:		#N/A		#N/A
Weight before:		#N/A		#N/A
Particulates (mg):		*6.54*		*6.65*
Gasmeter, after:		740.624		759.186
Gasmeter, before:		738.564		757.094
Gas volume:		2.060	Cub. met.	2.092
Corr. gas volume:		*1.639*	Cub. met.	*1.668*

Average BSN: at 10 stroke

TEMPERATURES:		
Exhaust		187
Transfer		264
Upstream		34
Downstream		48

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	34.4	36.8	37.6	37.7					36.2
filter	D-press	96.2	98.7	102.4	107.5					98
Right	Temp	33.3	36.5	37.7	36.2					35.7
filter	D-press	95.5	98.3	101.6	106.9					98
SAMPLE	MIN		10	19	29	30				
TIME	SEK	52	37	24	32	26				
										Max time:
TIME	SEK	52	637	1164	1772	1826	0	0	0	1826

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
4.05	0.253	0.04	18.8

COMMENTS:

Left filter								
MELLEM	52	585	527	608	54	0	0	0

REGNING		48.1	97.45	100.55	104.95	53.75	0	0	0	
FOR		2501.2	57008.25	52989.85	63809.6	2902.5	0	0	0	98.14424973
MIDLING		34.4	35.6	37.2	37.65	18.85	0	0	0	
		1788.8	20826	19604.4	22891.2	1017.9	0	0	0	36.21484118
Right filter										
MELLEM		52	585	527	608	54	0	0	0	
REGNING		47.75	96.9	99.95	104.25	53.45	0	0	0	
FOR		2483	56686.5	52673.65	63384	2886.3	0	0	0	97.54296276
MIDLING		33.3	34.9	37.1	36.95	18.1	0	0	0	
		1731.6	20416.5	19551.7	22465.6	977.4	0	0	0	35.67513691

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	79.42	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C3**				Right	78.63	mg/NORMAL CUBIC METER		
						Average	79.03			
TEST NO:	**T11**		DATE	27-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	75					
TUNNEL ID :		DT1								
BAROMETER mbar:		1011								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30354		GL-30355						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		7.0254		6.8426						
Gasmeter, after:		742.695		761.218		**Average BSN:**			at 10 stroke	
Gasmeter, before:		740.624		759.186						
Gas volume:		2.071	Cub. met.	2.032						
Corr. gas volume:		*1.653*	Cub. met.	*1.626*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		195			DIL. AIR				1.5	
Transfer		267			DIL. TUN. UPSTREAM				0.6	
Upstream		34			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		48			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	35.8	37.1	37.9	37.3					36.7
filter	D-press	91.7	95.5	96.4	98.2					94
Right	Temp	35.1	36.6	38.1	34.6					36.0
filter	D-press	91.9	94.5	96.1	97.7					93
SAMPLE	MIN		9	19	29	30				
TIME	SEK	30	30	36	27	13				
										Max time:
TIME	SEK	30	570	1176	1767	1813	0	0	0	1813
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
4.03	0.254	0.04	18.7							
COMMENTS:										
Left filter										
MELLEM		30	540	606	591	46	0	0	0	

REGNING		45.85	93.6	95.95	97.3	49.1	0	0	0	
FOR		1375.5	50544	58145.7	57504.3	2258.6	0	0	0	93.6724214
MIDLING		35.8	36.45	37.5	37.6	18.65	0	0	0	
		1074	19683	22725	22221.6	857.9	0	0	0	36.71345836
Right filter										
MELLEM		30	540	606	591	46	0	0	0	
REGNING		45.95	93.2	95.3	96.9	48.85	0	0	0	
FOR		1378.5	50328	57751.8	57267.9	2247.1	0	0	0	93.20093767
MIDLING		35.1	35.85	37.35	36.35	17.3	0	0	0	
		1053	19359	22634.1	21482.85	795.8	0	0	0	36.03130171

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	100.15	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C3**				Right	99.20	mg/NORMAL CUBIC METER		
						Average	99.68			
TEST NO:	**T12**		DATE	27-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	100					
TUNNEL ID :		DT1								
BAROMETER mbar:		1011								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		C120905-027		C120905-028						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		*8.53*		*8.46*						
Gasmeter, after:		744.767		763.282		**Average BSN:**			at 10 stroke	
Gasmeter, before:		742.695		761.218						
Gas volume:		2.072	Cub. met.	2.064						
Corr. gas volume:		*1.642*	Cub. met.	*1.644*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		240			DIL. AIR				1.5	
Transfer		266			DIL. TUN. UPSTREAM				0.6	
Upstream		34			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		49			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	33.4	35.7	36.5	37					35.3
filter	D-press	97.6	102.6	110.2	118.3					105
Right	Temp	32.2	34	35.6	35.2					34.0
filter	D-press	96.8	102	109.5	117.4					104
SAMPLE	MIN		9	19	29	30				
TIME	SEK	40	23	25	30	23				
										Max time:
TIME	SEK	40	563	1165	1770	1823	0	0	0	1823
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
4.57	0.275	0.04	19.3							
COMMENTS:										
Left filter										
MELLEM		40	523	602	605	53	0	0	0	

REGNING		48.8	100.1	106.4	114.25	59.15	0	0	0	
FOR		1952	52352.3	64052.8	69121.25	3134.95	0	0	0	104.56023
MIDLING		33.4	34.55	36.1	36.75	18.5	0	0	0	
		1336	18069.65	21732.2	22233.75	980.5	0	0	0	35.3001097
Right filter										
MELLEM		40	523	602	605	53	0	0	0	
REGNING		48.4	99.4	105.75	113.45	58.7	0	0	0	
FOR		1936	51986.2	63661.5	68637.25	3111.1	0	0	0	103.857405
MIDLING		32.2	33.1	34.8	35.4	17.6	0	0	0	
		1288	17311.3	20949.6	21417	932.8	0	0	0	33.9543061

DATASHEET: PARTICULATE MEASUREMENTS				**PART-CONCENTRATION**		2013-01-02
ver 950425				Left	82.30	mg/NORMAL CUBIC METER
TEST PURPOSE:	**C3**			Right	81.48	mg/NORMAL CUBIC METER
				Average	81.89	
TEST NO: T12		DATE	27-09-2012			
PLANT/VESSEL:	6S70MC-C7	Load:	100			
TUNNEL ID :	DT1					
BAROMETER mbar:	1011					
FUEL:	DF					

PARTICULATE MEASUREMENTS

	Left:		Right:	
Filter no:	GL-30356		GL-30357	
Type:	Pallflex WW			
Weight after:	#N/A		#N/A	
Weight before:	#N/A		#N/A	
Particulates (mg):	7.0026		6.9754	
Gasmeter, after:	746.823		765.339	
Gasmeter, before:	744.767		763.282	
Gas volume:	2.056	Cub. met.	2.057	
Corr. gas volume:	*1.645*	Cub. met.	*1.655*	

Average BSN:		at 10 stroke

TEMPERATURES:	
Exhaust	239
Transfer	264
Upstream	35
Downstream	49

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	35.6	37	37.2	37.2					36.2
filter	D-press	91.5	95.4	96.6	98.2					93
Right	Temp	35	34.4	36.6	34.5					34.6
filter	D-press	91.9	94.7	95.9	97.8					92
SAMPLE	MIN		10	19	29	30				
TIME	SEK	47		21	17	18				
										Max time:
TIME	SEK	47	600	1161	1757	1818	0	0	0	1818

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
4.55	0.273	0.04	19.3

COMMENTS:

Left filter								
~~MELLEM~~	47	553	561	596	61	0	0	0

REGNING		45.75	93.45	96	97.4	49.1	0	0	0	
FOR		2150.25	51677.85	53856	58050.4	2995.1	0	0	0	92.8105611
MIDLING		35.6	36.3	37.1	37.2	18.6	0	0	0	
		1673.2	20073.9	20813.1	22171.2	1134.6	0	0	0	36.229923
Right filter										
MELLEM		47	553	561	596	61	0	0	0	
REGNING		45.95	93.3	95.3	96.85	48.9	0	0	0	
FOR		2159.65	51594.9	53463.3	57722.6	2982.9	0	0	0	92.3670792
MIDLING		35	34.7	35.5	35.55	17.25	0	0	0	
		1645	19189.1	19915.5	21187.8	1052.25	0	0	0	34.6477723

DATASHEET: PARTICULATE MEASUREMENTS						PART-CONCENTRATION				2013-01-02
ver 950425						Left	27.62	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C3**				Right	27.62	mg/NORMAL CUBIC METER		
						Average	27.62			
TEST NO:	**T07**		DATE	27-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	10					
TUNNEL	ID :	DT1								
BAROMETER mbar:		1015								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		C120905-017		C120905-018						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		*2.12*		*2.13*						
Gasmeter, after:		726.100		744.703		**Average BSN:**			at 10 stroke	
Gasmeter, before:		724.340		742.912						
Gas volume:		1.760	Cub. met.	1.791						
Corr. gas volume:		*1.420*	Cub. met.	*1.426*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		175			DIL. AIR				1.5	
Transfer		265			DIL. TUN. UPSTREAM				0.6	
Upstream		28			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		41			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	33.1	33.2	33.6	34.1					33.4
filter	D-press	93.2	98.1	103.6	106.3					98
Right	Temp	37.4	36.9	37.7	38.2					37.4
filter	D-press	92.9	98.6	102.7	106.2					98
SAMPLE	MIN		10	19	25					
TIME	SEK	50	19	28	7					
										Max time:
TIME	SEK	50	619	1168	1507	0	0	0	0	1507
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
2.71	0.184	0.04	18.5							
COMMENTS:										
Left filter										
MELLEM		50	569	549	339	0	0	0	0	

REGNING		46.6	95.65	100.85	104.95	53.15	0	0	0	
FOR		2330	54424.85	55366.65	35578.05	0	0	0	0	98.0089914
MIDLING		33.1	33.15	33.4	33.85	17.05	0	0	0	
		1655	18862.35	18336.6	11475.15	0	0	0	0	33.3968812
Right filter										
MELLEM		50	569	549	339	0	0	0	0	
REGNING		46.45	95.75	100.65	104.45	53.1	0	0	0	
FOR		2322.5	54481.75	55256.85	35408.55	0	0	0	0	97.8564366
MIDLING		37.4	37.15	37.3	37.95	19.1	0	0	0	
		1870	21138.35	20477.7	12865.05	0	0	0	0	37.3928998

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	28.36	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	28.38	mg/NORMAL CUBIC METER		
						Average	28.37			
TEST NO:	**T13**		DATE	28-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	10					
TUNNEL	ID :	DT1								
BAROMETER mbar:		1011								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		C120905-029		C120905-030						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		*2.50*		*2.51*						
Gasmeter, after:		749.895		768.405		**Average BSN:**			at 10 stroke	
Gasmeter, before:		747.800		766.303						
Gas volume:		2.095	Cub. met.	2.102						
Corr. gas volume:		*1.710*	Cub. met.	*1.715*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		179			DIL. AIR				1.5	
Transfer		266			DIL. TUN. UPSTREAM				0.6	
Upstream		27			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		40			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	28.3	30	31.1	30.5					29.7
filter	D-press	93.3	96	98.4	101.5					94
Right	Temp	28.1	30.5	30.8	31.4					29.9
filter	D-press	93	95.6	97.9	101.1					94
SAMPLE	MIN	1	9	19	29	30				
TIME	SEK	3	40	30	32	24				
										Max time:
TIME	SEK	63	580	1170	1772	1824	0	0	0	1824
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
2.67	0.176	0.04	19.4							
COMMENTS:										
Left filter										
MELLEM		63	517	590	602	52	0	0	0	

REGNING		46.65	94.65	97.2	99.95	50.75	0	0	0	
FOR		2938.95	48934.05	57348	60169.9	2639	0	0	0	94.3146382
MIDLING		28.3	29.15	30.55	30.8	15.25	0	0	0	
		1782.9	15070.55	18024.5	18541.6	793	0	0	0	29.7217928
Right filter										
MELLEM		63	517	590	602	52	0	0	0	
REGNING		46.5	94.3	96.75	99.5	50.55	0	0	0	
FOR		2929.5	48753.1	57082.5	59899	2628.6	0	0	0	93.9104715
MIDLING		28.1	29.3	30.65	31.1	15.7	0	0	0	
		1770.3	15148.1	18083.5	18722.2	816.4	0	0	0	29.9015899

DATASHEET: PARTICULATE MEASUREMENTS						PART-CONCENTRATION				2013-01-02
ver 950425						Left	28.20	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	28.00	mg/NORMAL CUBIC METER		
						Average	28.10			
TEST NO:	**T13**		DATE	28-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	10					
TUNNEL ID :		DT1								
BAROMETER mbar:		1011								
FUEL:	DF									

PARTICULATE MEASUREMENTS

		Left:		Right:				
Filter no:		GL-30358		GL-30359				
Type:		Pallflex WW						
Weight after:		#N/A		#N/A				
Weight before:		#N/A		#N/A				
Particulates (mg):		2.5144		2.4781				
Gasmeter, after:		752.001		770.498		**Average BSN:**		at 10 stroke
Gasmeter, before:		749.895		768.405				
Gas volume:		2.106	Cub. met.	2.093				
Corr. gas volume:		*1.723*	Cub. met.	*1.710*				

TEMPERATURES:			**PRESSURES:**	
Exhaust		172	DIL. AIR	1.5
Transfer		266	DIL. TUN. UPSTREAM	0.6
Upstream		27	DIL. TUN. DOWN STREAM (Valve open)	
Downstream		39	DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	29.2	31	31.8	32.4					30.6
filter	D-press	89.9	91.5	92.3	92.2					89
Right	Temp	31	31.4	31.7	32.4					31.0
filter	D-press	89.9	92	91.7	91.6					89
SAMPLE	MIN		9	19	29	30				
TIME	SEK	30	49	41	33	39				
										Max time:
TIME	SEK	30	589	1181	1773	1839	0	0	0	1839

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
2.69	0.177	0.04	19.3

COMMENTS:

Left filter									
MELLEM		30	559	592	592	66	0	0	0

REGNING		44.95	90.7	91.9	92.25	46.1	0	0	0	
FOR		1348.5	50701.3	54404.8	54612	3042.6	0	0	0	89.23828167
MIDLING		29.2	30.1	31.4	32.1	16.2	0	0	0	
		876	16825.9	18588.8	19003.2	1069.2	0	0	0	30.64877651
Right filter										
MELLEM		30	559	592	592	66	0	0	0	
REGNING		44.95	90.95	91.85	91.65	45.8	0	0	0	
FOR		1348.5	50841.05	54375.2	54256.8	3022.8	0	0	0	89.09426319
MIDLING		31	31.2	31.55	32.05	16.2	0	0	0	
		930	17440.8	18677.6	18973.6	1069.2	0	0	0	31.04469821

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	35.79	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	36.91	mg/NORMAL CUBIC METER		
						Average	36.35			
TEST NO:	**T14**		DATE	28-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	15					
TUNNEL ID :		DT1								
BAROMETER mbar:		1011								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		C120905-031		C120905-032						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		*3.11*		*3.17*						
Gasmeter, after:		754.088		772.604		**Average BSN:**			at 10 stroke	
Gasmeter, before:		752.001		770.498						
Gas volume:		2.087	Cub. met.	2.106						
Corr. gas volume:		*1.730*	Cub. met.	*1.710*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		206			DIL. AIR				1.5	
Transfer		263			DIL. TUN. UPSTREAM				0.6	
Upstream		28			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		40			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	29.1	31.1	31.7	32.7					30.8
filter	D-press	94.7	36.5	99	106					76
Right	Temp	31.3	31.2	31.6	32.8					31.2
filter	D-press	93.6	95.8	98.1	99.8					94
SAMPLE	MIN		9	20	29	30				
TIME	SEK	48	40	47	47	32				
										Max time:
TIME	SEK	48	580	1247	1787	1832	0	0	0	1832
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
3.34	0.206	0.04	19.9							
COMMENTS:										
Left filter										
MELLEM		48	532	667	540	45	0	0	0	

REGNING		47.35	65.6	67.75	102.5	53	0	0	0	
FOR		2272.8	34899.2	45189.25	55350	2385	0	0	0	76.47175218
MIDLING		29.1	30.1	31.4	32.2	16.35	0	0	0	
		1396.8	16013.2	20943.8	17388	735.75	0	0	0	30.82835699
Right filter										
MELLEM		48	532	667	540	45	0	0	0	
REGNING		46.8	94.7	96.95	98.95	49.9	0	0	0	
FOR		2246.4	50380.4	64665.65	53433	2245.5	0	0	0	94.41645742
MIDLING		31.3	31.25	31.4	32.2	16.4	0	0	0	
		1502.4	16625	20943.8	17388	738	0	0	0	31.22117904

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	37.04	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	38.20	mg/NORMAL CUBIC METER		
						Average	37.62			
TEST NO:	**T14**		DATE	28-09-2012						
					.					
PLANT/VESSEL:		6S70MC-C7		Load:	15					
TUNNEL ID :		DT1								
BAROMETER mbar:		1011								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30360		GL-30361						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		3.1351		3.1248						
Gasmeter, after:		756.153		774.607		**Average BSN:**			at 10 stroke	
Gasmeter, before:		754.088		772.604						
Gas volume:		2.065	Cub. met.	2.003						
Corr. gas volume:		*1.680*	Cub. met.	*1.624*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		213			DIL. AIR				1.5	
Transfer		266			DIL. TUN. UPSTREAM				0.6	
Upstream		29			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		42			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	29.3	32.5	32.5	33.1					31.5
filter	D-press	92.3	93.8	94.5	95.1					92
Right	Temp	32.5	32.8	33.4	34.5					32.7
filter	D-press	92.2	93.5	94.8	95					92
SAMPLE	MIN		9	20	28	29				
TIME	SEK	36	22	10	57	54				
										Max time:
TIME	SEK	36	562	1210	1737	1794	0	0	0	1794
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
3.31	0.205	0.04	19.8							
COMMENTS:										
Left filter										
MELLEM		36	526	648	527	57	0	0	0	

REGNING		46.15	93.05	94.15	94.8	47.55	0	0	0	
FOR		1661.4	48944.3	61009.2	49959.6	2710.35	0	0	0	91.57460981
MIDLING		29.3	30.9	32.5	32.8	16.55	0	0	0	
		1054.8	16253.4	21060	17285.6	943.35	0	0	0	31.54802118
Right filter										
MELLEM		36	526	648	527	57	0	0	0	
REGNING		46.1	92.85	94.15	94.9	47.5	0	0	0	
FOR		1659.6	48839.1	61009.2	50012.3	2707.5	0	0	0	91.54275362
MIDLING		32.5	32.65	33.1	33.95	17.25	0	0	0	
		1170	17173.9	21448.8	17891.65	983.25	0	0	0	32.70211817

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	44.99	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	44.81	mg/NORMAL CUBIC METER		
						Average	44.90			
TEST NO:	**T15**		DATE	28-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	25					
TUNNEL ID :		DT1								
BAROMETER mbar:		1009								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		C120905-033		C120905-034						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		*3.66*		*3.73*						
Gasmeter, after:		758.197		776.704		**Average BSN:**		at 10 stroke		
Gasmeter, before:		756.153		774.607						
Gas volume:		2.044	Cub. met.	2.097						
Corr. gas volume:		*1.651*	Cub. met.	*1.689*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		233			DIL. AIR				1.5	
Transfer		266			DIL. TUN. UPSTREAM				0.6	
Upstream		31			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		44			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	29.8	32.3	33.1	32.6					31.7
filter	D-press	95.8	96.6	99.6	102.2					96
Right	Temp	32.3	32.1	33.6	35.8					32.7
filter	D-press	94.6	95.9	98.8	101.5					95
SAMPLE	MIN		10	21	29	30				
TIME	SEK	42	54	3	24	12				
										Max time:
TIME	SEK	42	654	1263	1764	1812	0	0	0	1812
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
3.64	0.217	0.04	20.3							
COMMENTS:										
Left filter										
MELLEM		42	612	609	501	48	0	0	0	

REGNING		47.9	96.2	98.1	100.9	51.1	0	0	0	
FOR		2011.8	58874.4	59742.9	50550.9	2452.8	0	0	0	95.82384106
MIDLING		29.8	31.05	32.7	32.85	16.3	0	0	0	
		1251.6	19002.6	19914.3	16457.85	782.4	0	0	0	31.68253311
Right filter										
MELLEM		42	612	609	501	48	0	0	0	
REGNING		47.3	95.25	97.35	100.15	50.75	0	0	0	
FOR		1986.6	58293	59286.15	50175.15	2436	0	0	0	95.02036424
MIDLING		32.3	32.2	32.85	34.7	17.9	0	0	0	
		1356.6	19706.4	20005.65	17384.7	859.2	0	0	0	32.73319536

DATASHEET: PARTICULATE MEASUREMENTS					**PART-CONCENTRATION**				2013-01-02
ver 950425					Left	44.80	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**			Right	44.59	mg/NORMAL CUBIC METER		
					Average	44.69			
TEST NO:	**T15**		DATE	28-09-2012					
PLANT/VESSEL:		6S70MC-C7		Load:	25				
TUNNEL ID :		DT1							
BAROMETER mbar:		1009							
FUEL:	DF								

PARTICULATE MEASUREMENTS

		Left:		Right:
Filter no:		GL-30362		GL-30363
Type:		Pallflex WW		
Weight after:		#N/A		#N/A
Weight before:		#N/A		#N/A
Particulates (mg):		3.6104		3.7487
Gasmeter, after:		760.182		778.792
Gasmeter, before:		758.197		776.704
Gas volume:		1.985	Cub. met.	2.088
Corr. gas volume:		*1.603*	Cub. met.	*1.672*

Average BSN:		at 10 stroke

TEMPERATURES:		
Exhaust		227
Transfer		265
Upstream		32
Downstream		44

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	32.1	33.8	33.5	34					33.1
filter	D-press	92.1	94	95.1	95.4					92
Right	Temp	34.4	36.6	36.7	37.1					36.0
filter	D-press	91.2	92.9	93.9	94.7					91
SAMPLE	MIN		9	19	29	30				
TIME	SEK	54	29	50	23	1				
										Max time:
TIME	SEK	54	569	1190	1763	1801	0	0	0	1801

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.62	0.220	0.04	19.9

COMMENTS:

Left filter								
MELLEM	54	515	621	573	38	0	0	0

REGNING		46.05	93.05	94.55	95.25	47.7	0	0	0	
FOR		2486.7	47920.75	58715.55	54578.25	1812.6	0	0	0	91.90108273
MIDLING		32.1	32.95	33.65	33.75	17	0	0	0	
		1733.4	16969.25	20896.65	19338.75	646	0	0	0	33.08387007
Right filter										
MELLEM		54	515	621	573	38	0	0	0	
REGNING		45.6	92.05	93.4	94.3	47.35	0	0	0	
FOR		2462.4	47405.75	58001.4	54033.9	1799.3	0	0	0	90.89547474
MIDLING		34.4	35.5	36.65	36.9	18.55	0	0	0	
		1857.6	18282.5	22759.65	21143.7	704.9	0	0	0	35.95133259

DATASHEET: PARTICULATE MEASUREMENTS		PART-CONCENTRATION			2013-01-02
ver 950425		Left	48.17	mg/NORMAL CUBIC METER	
TEST PURPOSE:	C11	Right	49.77	mg/NORMAL CUBIC METER	
		Average	48.97		

TEST NO: T16		DATE	28-09-2012
PLANT/VESSEL:	6S70MC-C7	Load:	50
TUNNEL ID :	DT1		
BAROMETER mbar:	1008		
FUEL:	DF		

PARTICULATE MEASUREMENTS

	Left:		Right:
Filter no:	C120905-035		C120905-036
Type:	Pallflex WW		
Weight after:	#N/A		#N/A
Weight before:	#N/A		#N/A
Particulates (mg):	*4.06*		*4.08*
Gasmeter, after:	762.243		780.875
Gasmeter, before:	760.182		778.792
Gas volume:	2.061	Cub. met.	2.083
Corr. gas volume:	*1.655*	Cub. met.	*1.610*

Average BSN:		at 10 stroke

TEMPERATURES:	
Exhaust	212
Transfer	264
Upstream	33
Downstream	46

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	30.7	32.8	34.6	36					33.0
filter	D-press	95.8	97.8	101	103.1					96
Right	Temp	31.5	35.3	37.4	102.5					45.2
filter	D-press	95.6	97.1	100.6	102.5					96
SAMPLE	MIN	1	9	21	29	30				
TIME	SEK	3	44	2	32	25				
										Max time:
TIME	SEK	63	584	1262	1772	1825	0	0	0	1825

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.80	0.232	0.04	19.6

COMMENTS:

Left filter								
MELLEM	63	521	678	510	53	0	0	0

REGNING		47.9	96.8	99.4	102.05	51.55	0	0	0	
FOR		3017.7	50432.8	67393.2	52045.5	2732.15	0	0	0	96.23087671
MIDLING		30.7	31.75	33.7	35.3	18	0	0	0	
		1934.1	16541.75	22848.6	18003	954	0	0	0	33.03093151
Right filter										
MELLEM		63	521	678	510	53	0	0	0	
REGNING		47.8	96.35	98.85	101.55	51.25	0	0	0	
FOR		3011.4	50198.35	67020.3	51790.5	2716.25	0	0	0	95.74619178
MIDLING		31.5	33.4	36.35	69.95	51.25	0	0	0	
		1984.5	17401.4	24645.3	35674.5	2716.25	0	0	0	45.16271233

DATASHEET: PARTICULATE MEASUREMENTS				
ver 950425				
TEST PURPOSE:	**C11**			
TEST NO: T16		DATE	28-09-2012	
PLANT/VESSEL:	6S70MC-C7		Load:	50
TUNNEL ID :	DT1			
BAROMETER mbar:	1008			
FUEL:	DF			

PART-CONCENTRATION			2013-01-02
Left	50.28	mg/NORMAL CUBIC METER	
Right	50.60	mg/NORMAL CUBIC METER	
Average	50.44		

PARTICULATE MEASUREMENTS

	Left:		**Right:**
Filter no:	GL-30364		GL-30365
Type:	Pallflex WW		
Weight after:	#N/A		#N/A
Weight before:	#N/A		#N/A
Particulates (mg):	4.1621		4.2231
Gasmeter, after:	764.281		782.945
Gasmeter, before:	762.243		780.873
Gas volume:	2.038	Cub. met.	2.072
Corr. gas volume:	*1.633*	Cub. met.	*1.646*

Average BSN:		at 10 stroke

TEMPERATURES:	
Exhaust	222
Transfer	265
Upstream	34
Downstream	47

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	35.5	36.5	36.2	37.1					35.9
filter	D-press	90.9	92.3	93.1	94.3					90
Right	Temp	38.2	39.2	39.2	40.1					38.7
filter	D-press	90.1	91.9	92.1	93.6					89
SAMPLE	MIN	1	10	19	29	30				
TIME	SEK	20	3	35	44	24				
										Max time:
TIME	SEK	80	603	1175	1784	1824	0	0	0	1824

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
3.79	0.230	0.04	19.7

COMMENTS:

Left filter								
MELLEM	80	523	572	609	40	0	0	0

REGNING		45.45	91.6	92.7	93.7	47.15	0	0	0	
FOR		3636	47906.8	53024.4	57063.3	1886	0	0	0	89.64720395
MIDLING		35.5	36	36.35	36.65	18.55	0	0	0	
		2840	18828	20792.2	22319.85	742	0	0	0	35.92217654
Right filter										
MELLEM		80	523	572	609	40	0	0	0	
REGNING		45.05	91	92	92.85	46.8	0	0	0	
FOR		3604	47593	52624	56545.65	1872	0	0	0	88.94662829
MIDLING		38.2	38.7	39.2	39.65	20.05	0	0	0	
		3056	20240.1	22422.4	24146.85	802	0	0	0	38.74306469

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	80.17	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	80.21	mg/NORMAL CUBIC METER		
						Average	80.19			
TEST NO:	**T17**		DATE	28-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	75					
TUNNEL ID :		DT1								
BAROMETER mbar:		1008								
FUEL:	DF									

PARTICULATE MEASUREMENTS

	Left:		**Right:**					
Filter no:	C120905-037		C120905-038					
Type:	Pallflex WW							
Weight after:	#N/A		#N/A					
Weight before:	#N/A		#N/A					
Particulates (mg):	*6.53*		*6.71*					
Gasmeter, after:	766.306		785.036		**Average BSN:**		at 10 stroke	
Gasmeter, before:	764.281		782.945					
Gas volume:	2.025	Cub. met.	2.091					
Corr. gas volume:	*1.602*	Cub. met.	*1.645*					

TEMPERATURES:			**PRESSURES:**	
Exhaust	187		DIL. AIR	1.5
Transfer	264		DIL. TUN. UPSTREAM	0.6
Upstream	34		DIL. TUN. DOWN STREAM (Valve open)	
Downstream	48		DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	34.3	36.4	37.6	37.7					36.1
filter	D-press	96.4	100	105.1	111					100
Right	Temp	34.5	38.3	40.2	40.6					38.1
filter	D-press	95.9	99.2	103.6	110.5					100
SAMPLE	MIN		9	19	29	30				
TIME	SEK	43	43	20	28	20				
										Max time:
TIME	SEK	43	583	1160	1768	1820	0	0	0	1820

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
4.05	0.244	0.04	19.7

COMMENTS:

Left filter								
MELLEM	43	540	577	608	52	0	0	0

REGNING		48.2	98.2	102.55	108.05	55.5	0	0	0	
FOR		2072.6	53028	59171.35	65694.4	2886	0	0	0	100.4683242
MIDLING		34.3	35.35	37	37.65	18.85	0	0	0	
		1474.9	19089	21349	22891.2	980.2	0	0	0	36.14521978
Right filter										
MELLEM		43	540	577	608	52	0	0	0	
REGNING		47.95	97.55	101.4	107.05	55.25	0	0	0	
FOR		2061.85	52677	58507.8	65086.4	2873	0	0	0	99.56376374
MIDLING		34.5	36.4	39.25	40.4	20.3	0	0	0	
		1483.5	19656	22647.25	24563.2	1055.6	0	0	0	38.13491758

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	79.97	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	81.03	mg/NORMAL CUBIC METER		
						Average	80.50			
TEST NO:	**T17**		DATE	28-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	75					
TUNNEL	ID :	DT1								
BAROMETER mbar:		1008								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30366		GL-30367						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		6.6246		6.5489						
Gasmeter, after:		768.357		787.052		**Average BSN:**			at 10 stroke	
Gasmeter, before:		766.306		785.036						
Gas volume:		2.051	Cub. met.	2.016						
Corr. gas volume:		*1.632*	Cub. met.	*1.592*						

TEMPERATURES:				**PRESSURES:**				
Exhaust		194		DIL. AIR				1.5
Transfer		267		DIL. TUN. UPSTREAM				0.6
Upstream		35		DIL. TUN. DOWN STREAM (Valve open)				
Downstream		48		DIL. TUN. DOWN STREAM (Valve closed)				

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	36.6	38.5	38.1	38.2					37.6
filter	D-press	90.3	92.8	94.3	95.1					91
Right	Temp	38.4	40.9	40.7	41					39.9
filter	D-press	90.3	92.8	93.8	94.6					91
SAMPLE	MIN		10	20	29	30				
TIME	SEK	35		3	27	8				
										Max time:
TIME	SEK	35	600	1203	1767	1808	0	0	0	1808

CO2 EMISSIONS:			
CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
4.04	0.243	0.04	19.7

COMMENTS:

Left filter								
MELLEM	35	565	603	564	41	0	0	0

REGNING		45.15	91.55	93.55	94.7	47.55	0	0	0	
FOR		1580.25	51725.75	56410.65	53410.8	1949.55	0	0	0	91.30365044
MIDLING		36.6	37.55	38.3	38.15	19.1	0	0	0	
		1281	21215.75	23094.9	21516.6	783.1	0	0	0	37.55052544
Right filter										
MELLEM		35	565	603	564	41	0	0	0	
REGNING		45.15	91.55	93.3	94.2	47.3	0	0	0	
FOR		1580.25	51725.75	56259.9	53128.8	1939.3	0	0	0	91.05862832
MIDLING		38.4	39.65	40.8	40.85	20.5	0	0	0	
		1344	22402.25	24602.4	23039.4	840.5	0	0	0	39.94941925

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	81.39	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	81.49	mg/NORMAL CUBIC METER		
						Average	81.44			
TEST NO:	**T18**		DATE	28-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	100					
TUNNEL ID :		DT1								
BAROMETER mbar:		1008								
FUEL:	DF									

PARTICULATE MEASUREMENTS

		Left:		Right:
Filter no:		C120905-039		C120905-040
Type:		Pallflex WW		
Weight after:		#N/A		#N/A
Weight before:		#N/A		#N/A
Particulates (mg):		*6.57*		*6.56*
Gasmeter, after:		770.415		789.114
Gasmeter, before:		768.357		787.052
Gas volume:		2.058	Cub. met.	2.062
Corr. gas volume:		*1.623*	Cub. met.	*1.619*

Average BSN:			at 10 stroke

TEMPERATURES:		
Exhaust		224
Transfer		267
Upstream		35
Downstream		49

PRESSURES:	
DIL. AIR	1.5
DIL. TUN. UPSTREAM	0.6
DIL. TUN. DOWN STREAM (Valve open)	
DIL. TUN. DOWN STREAM (Valve closed)	

FILTER TEMPERATURE AND PRESSURE:

		1	2	3	4	5	6	7	8	Average:
Left	Temp	34.5	37	37.7	37.9					36.4
filter	D-press	97.5	103.4	107	113.4					103
Right	Temp	34.5	38.9	40.1	40.5					38.2
filter	D-press	96.3	101.8	106.3	112.6					101
SAMPLE	MIN		10	19	29	30				
TIME	SEK	40	17	38	27	24				
										Max time:
TIME	SEK	40	617	1178	1767	1824	0	0	0	1824

CO2 EMISSIONS:

CO2 EXH	CO2 DT	CO2,back	Dil. ratio
%	%	%	
4.57	0.265	0.04	20.1

COMMENTS:

Left filter									
MELLEM		40	577	561	589	57	0	0	0

REGNING		48.75	100.45	105.2	110.2	56.7	0	0	0	
FOR		1950	57959.65	59017.2	64907.8	3231.9	0	0	0	102.558416
MIDLING		34.5	35.75	37.35	37.8	18.95	0	0	0	
		1380	20627.75	20953.35	22264.2	1080.15	0	0	0	36.3516721
Right filter										
MELLEM		40	577	561	589	57	0	0	0	
REGNING		48.15	99.05	104.05	109.45	56.3	0	0	0	
FOR		1926	57151.85	58372.05	64466.05	3209.1	0	0	0	101.493997
MIDLING		34.5	36.7	39.5	40.3	20.25	0	0	0	
		1380	21175.9	22159.5	23736.7	1154.25	0	0	0	38.1613761

DATASHEET: PARTICULATE MEASUREMENTS						**PART-CONCENTRATION**				2013-01-02
ver 950425						Left	70.51	mg/NORMAL CUBIC METER		
TEST PURPOSE:		**C11**				Right	70.50	mg/NORMAL CUBIC METER		
						Average	70.51			
TEST NO:	**T18**		DATE	28-09-2012						
PLANT/VESSEL:		6S70MC-C7		Load:	100					
TUNNEL ID :		DT1								
BAROMETER mbar:		1008								
FUEL:	DF									
PARTICULATE MEASUREMENTS										
		Left:		**Right:**						
Filter no:		GL-30368		GL-30369						
Type:		Pallflex WW								
Weight after:		#N/A		#N/A						
Weight before:		#N/A		#N/A						
Particulates (mg):		5.7547		5.6393						
Gasmeter, after:		772.477		791.152		**Average BSN:**			at 10 stroke	
Gasmeter, before:		770.415		789.114						
Gas volume:		2.062	Cub. met.	2.038						
Corr. gas volume:		*1.639*	Cub. met.	*1.607*						
TEMPERATURES:					**PRESSURES:**					
Exhaust		225			DIL. AIR				1.5	
Transfer		267			DIL. TUN. UPSTREAM				0.6	
Upstream		35			DIL. TUN. DOWN STREAM (Valve open)					
Downstream		49			DIL. TUN. DOWN STREAM (Valve closed)					
FILTER TEMPERATURE AND PRESSURE:										
		1	2	3	4	5	6	7	8	Average:
Left	Temp	36.8	37.7	37.8	37.9					37.1
filter	D-press	92.1	94.6	96.6	97.9					93
Right	Temp	39.1	40.2	40.9	40.8					39.8
filter	D-press	91.7	94.6	96.3	97.2					93
SAMPLE	MIN		9	19	29	30				
TIME	SEK	47	50	40	34	20				
										Max time:
TIME	SEK	47	590	1180	1774	1820	0	0	0	1820
CO2 EMISSIONS:										
CO2 EXH	CO2 DT	CO2,back	Dil. ratio							
%	%	%								
4.57	0.265	0.04	20.1							
COMMENTS:										
Left filter										
MELLEM		47	543	590	594	46	0	0	0	

REGNING		46.05	93.35	95.6	97.25	48.95	0	0	0	
FOR		2164.35	50689.05	56404	57766.5	2251.7	0	0	0	93.0085714
MIDLING		36.8	37.25	37.75	37.85	18.95	0	0	0	
		1729.6	20226.75	22272.5	22482.9	871.7	0	0	0	37.1337637
Right filter										
MELLEM		47	543	590	594	46	0	0	0	
REGNING		45.85	93.15	95.45	96.75	48.6	0	0	0	
FOR		2154.95	50580.45	56315.5	57469.5	2235.6	0	0	0	92.7230769
MIDLING		39.1	39.65	40.55	40.85	20.4	0	0	0	
		1837.7	21529.95	23924.5	24264.9	938.4	0	0	0	39.8326648

Appendix 13 - SOF gas-chromatography analysis by DTU-MEK

SOF analysis of MAN PM samples

DTU-MEK, February 2013
Anders Ivarsson

Contents

Method

The sample filter is folded and placed in a sterilized disposable 5 mL syringe barrel. A disposable syringe filter for GC sample cleanup is attached to the syringe barrel. Approximately 1 mL of Dichloromethane (DCLM) is poured into syringe barrel until the sample filter is flooded. After 20-30 seconds of waiting, the solvent is pushed through the cleanup filter with pressurized nitrogen. The solution is collected in a 7 mL sterilized disposable glass vial that has been weighed on a precision scale (+/- 0.02 mg) prior to the extraction. The extraction procedure is repeated approximately 6 times until the vial is almost full. The SOF solution in the vial is re-concentrated by evaporating the DCLM under a stream of nitrogen. The vial with the SOF weighed again in order to determine the SOF weight.

Some validation tests of the procedures were performed.

First the mass loss during re-concentration was determined by diluting a known mass of fuel/lube oil with DCLM in the vial, re-concentrate it and measure the weight again. It was concluded that 26 % of the fuel mass was lost but there was no measurable loss of lubricant oil. The chromatograms in Appendix A: Chromatograms*Fuel and re-concentrated fuel* and *Lubricant oil and re-concentrated lubricant oil* shows that only the lightest fraction of the fuel is lost during the re-concentration.

Next the mass loss during extraction was determined by putting 2.32 mg lubricant oil and 1.37 mg fuel on a teflon coated quartz filter and performing the described extraction procedure. Lost mass of fuel and lubricant oil after extraction and re-concentration was 0.64 mg. It corresponds to an extraction efficiency of more than 90 % if the mass loss of light fuel components is taken into account. The chromatograms in Appendix A: *Extraction, filtration and re-concentration of sample filter with known mass of fuel and lubricant oil* shows that no qualitative changes to the boiling point distribution have occurred by the mass loss. However, some distinct peaks show up in the chromatograms of the extracted samples. A chromatogram of a blank extraction in shown in Appendix A: *Blank extraction* proofs that these peaks come from contaminants in the extraction procedure. Further investigations showed that they are wax components from the syringe barrel. They should not be present as the syringe barrels are from sterilized disposable non-lubricated syringes from HSW. They are made of polypropylene that should possess relatively high chemical resistance against DCLM. We have never had that problem before with these syringes, and it may simply be due to a bad production batch. However, the contaminant peaks are very distinct and can easily be accounted for in the chromatogram analysis.

The SOF's were prepared for GC analysis by diluting them to 20 mg/ml with DCLM.

The GC method is a simulated distillation based on ASTM standards D3524 and D2887. The column, a Petrocol EX2887 (5 m x 0.53 mm x 0.1 µm fused silica), is used in a Shimadzu GC-9A chromatograph with split injector and FID detector. The injector temperature is 350 ^{o}C and the initial column temperature is 55 ^{o}C. A sample size of 0.5 µl is injected with a 1 µl syringe. 3 minutes after injecting the sample a linear temperature ramp of the column oven starts. The temperature increases 10 ^{o}C/min until a final temperature of 350 ^{o}C is reached. The final temperature is maintained for 15 minutes.

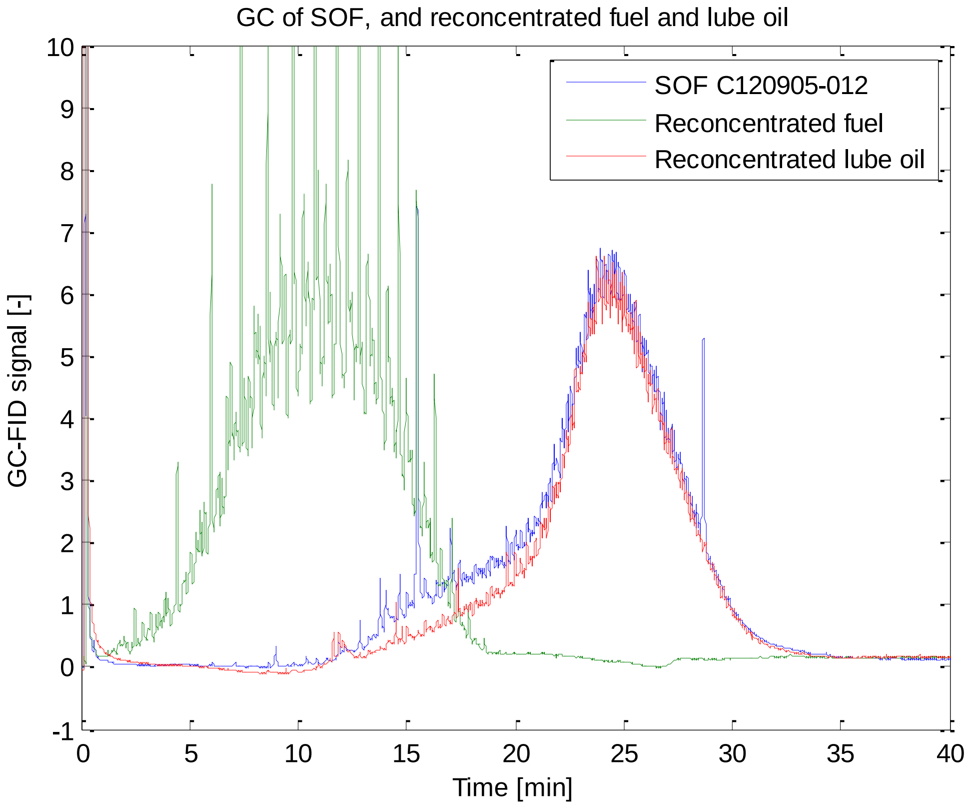
Results

The results are summarized in the following table.

PM sample	SOF weight [mg]	Lube oil fraction [wt%]
C120905-008	1.65	89.6
C120905-010	2.71	89.6
C120905-012	6.12	87.9
C120905-014	6.10	88.2

The precision of the SOF weight is typically within +/- 0.2 mg. The extraction efficiency depends on the SOF's solvability in DCLM, but it is typically better than 90 % and not less than 80 %. These estimates are based on experiences from different investigations, like the one described in the method section.

The chromatogram below shows that the small fraction of fuel contained in the SOF is consisting if high boiling components. The mass loss of SOF during the re-concentration may therefore be assumed negligible.



The lube oil fraction on mass basis is determined from the areas of the SOF and lubricant oil chromatograms. The individual chromatograms are corrected for column bleeding by subtraction of a blank run chromatogram. The area of peaks from contaminants is subtracted from the SOF chromatogram. The SOF chromatograms are scaled to match the height of the lube oil chromatogram due to variations of the injected sample size. This is necessary in order to compensate the low reproducibility of the very small injected sample size (here 0.5 µl). A small sample size is required in order to avoid overloading of the capillary column.

The FID signal is assumed proportional to the number of carbon atoms from hydrocarbons passing through the detector. The sensitivity depends slightly on the molecular structure, but this dependency is normally considered much smaller than other uncertainties of the GC method.

The molecular mass of the analyzed hydrocarbons is assumed proportional to carbon number. The error of this assumption is also in generally considered much smaller than other uncertainties of the GC method.

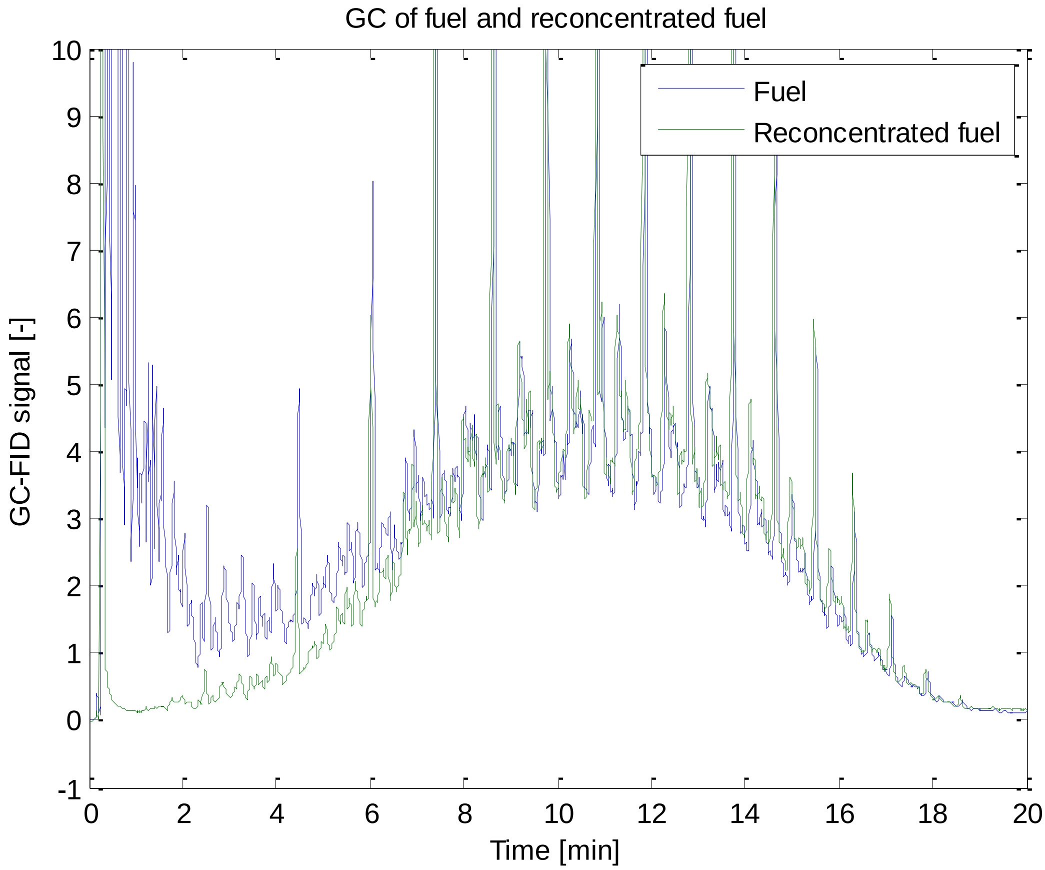
With these assumptions the mass fraction of lubricant oil in the SOF can be calculated by use of the area ratio. The area calculations of the SOF's are contained in the appendix.

The major contribution to inaccuracy of the lube oil mass fraction occurs from the selective evaporation of the sample in the split injector. High boiling components are less likely to evaporate spontaneously after entrance in the heated injector. This causes the effective split ratio to increase with the boiling point temperature of an analyte. An absolute worst case scenario is assessed with the analysis of weighed samples of fuel and lubricant oil extracted from a teflon coated quartz fiber filter (Appendix A: Chromatograms *Extract of fuel and lubricant oil*). Based on the weights and the pre-investigation of mass loss of fuel/lube oil during re-concentration it may be concluded that 2.09 mg of the 3.05 mg extract must be lubricant oil (68 wt%). The result from GC analysis in Appendix A: Chromatograms *Extract of fuel and lubricant oil* is 57 wt% corresponding to 1.74 mg lubricant oil. This rather large discrepancy of 11 percentage points is caused by the wide boiling point distribution of the fuel and lube oil mix. A more accurate determination of the lube oil fraction in the SOFs may be expected, as they have a much narrower boiling point distribution.

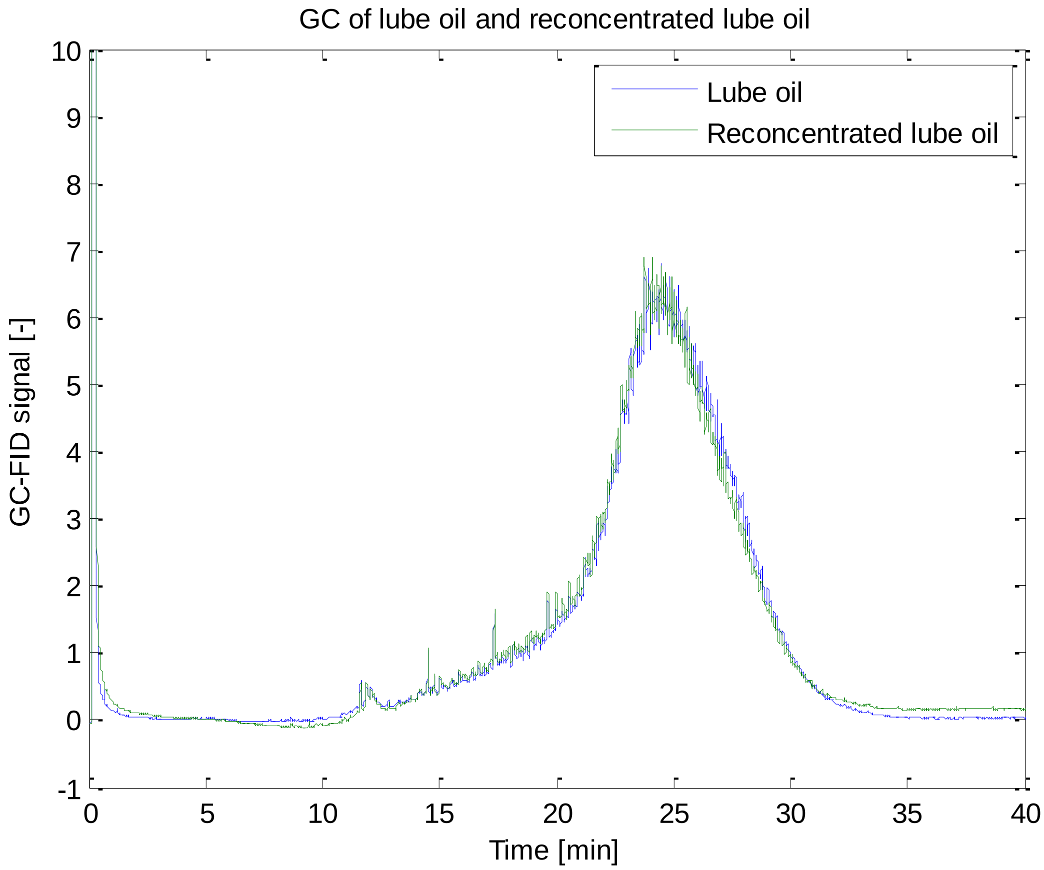
The uncertainty of lube oil mass fractions in the investigated SOFs is conservatively estimated to be +4/-0 percentage points.

Appendix A: Chromatograms

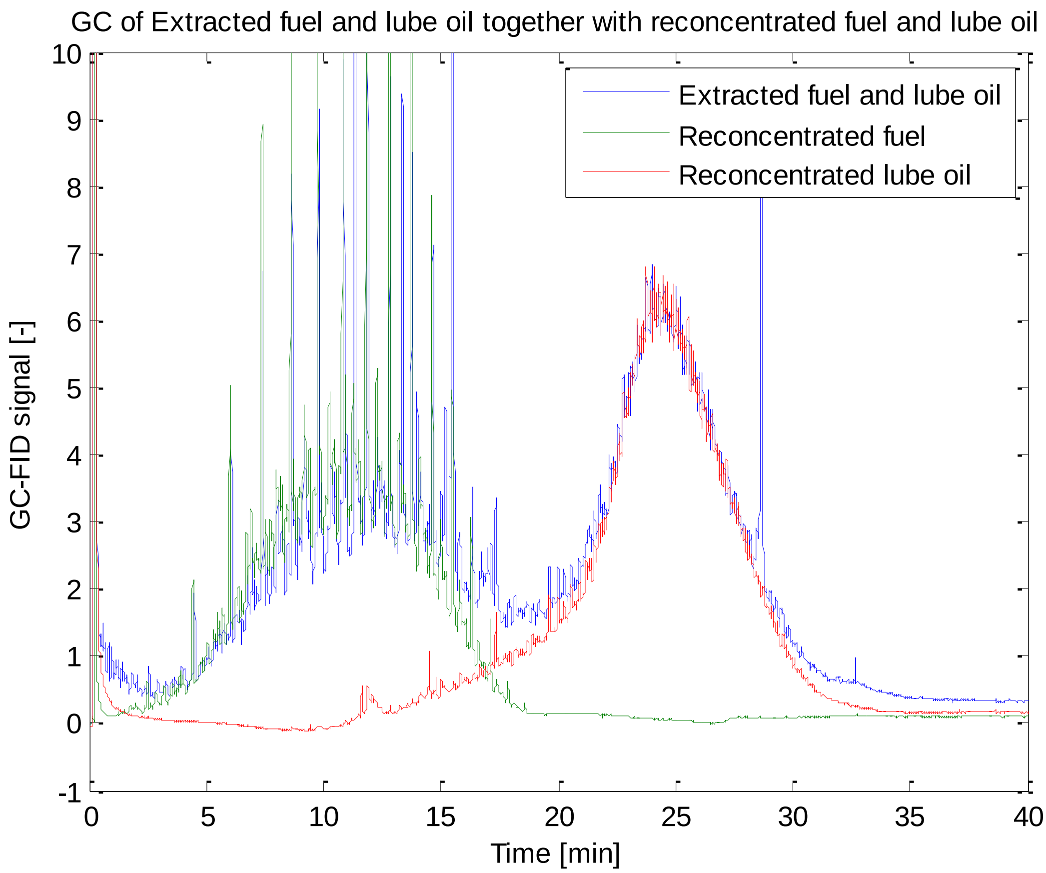
Fuel and re-concentrated fuel



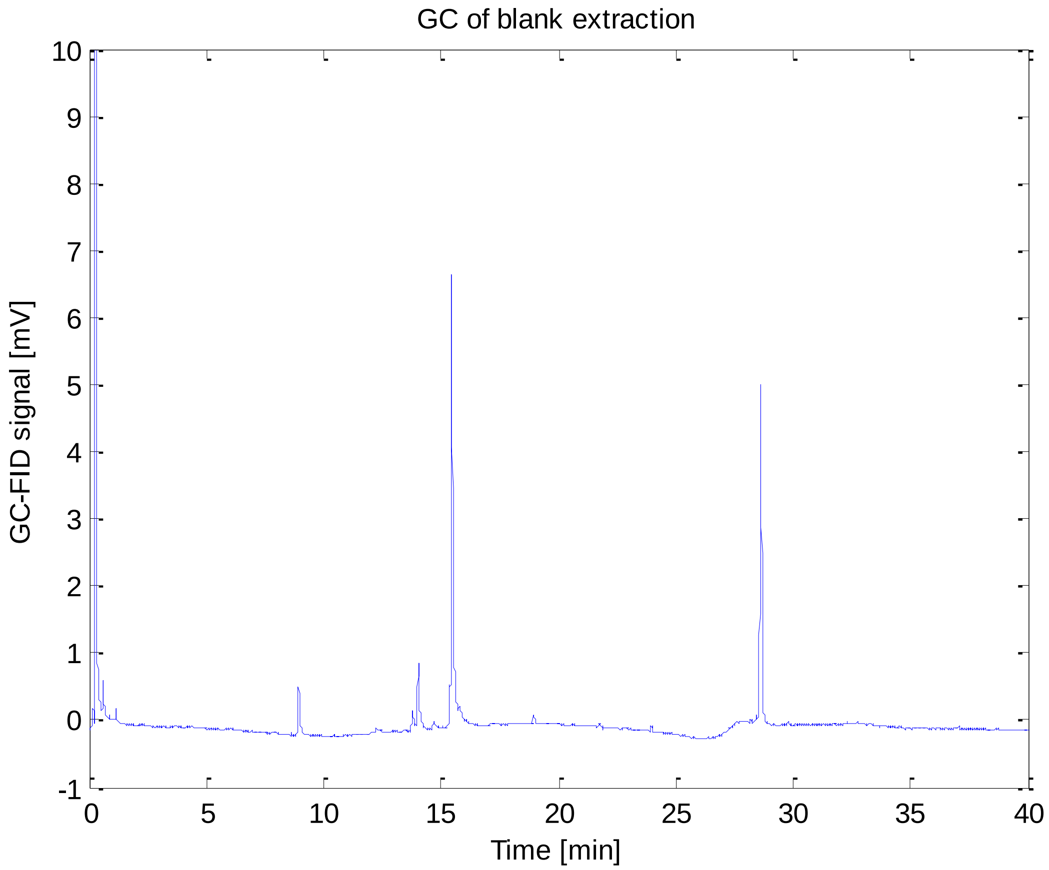
Lubricant oil and re-concentrated lubricant oil



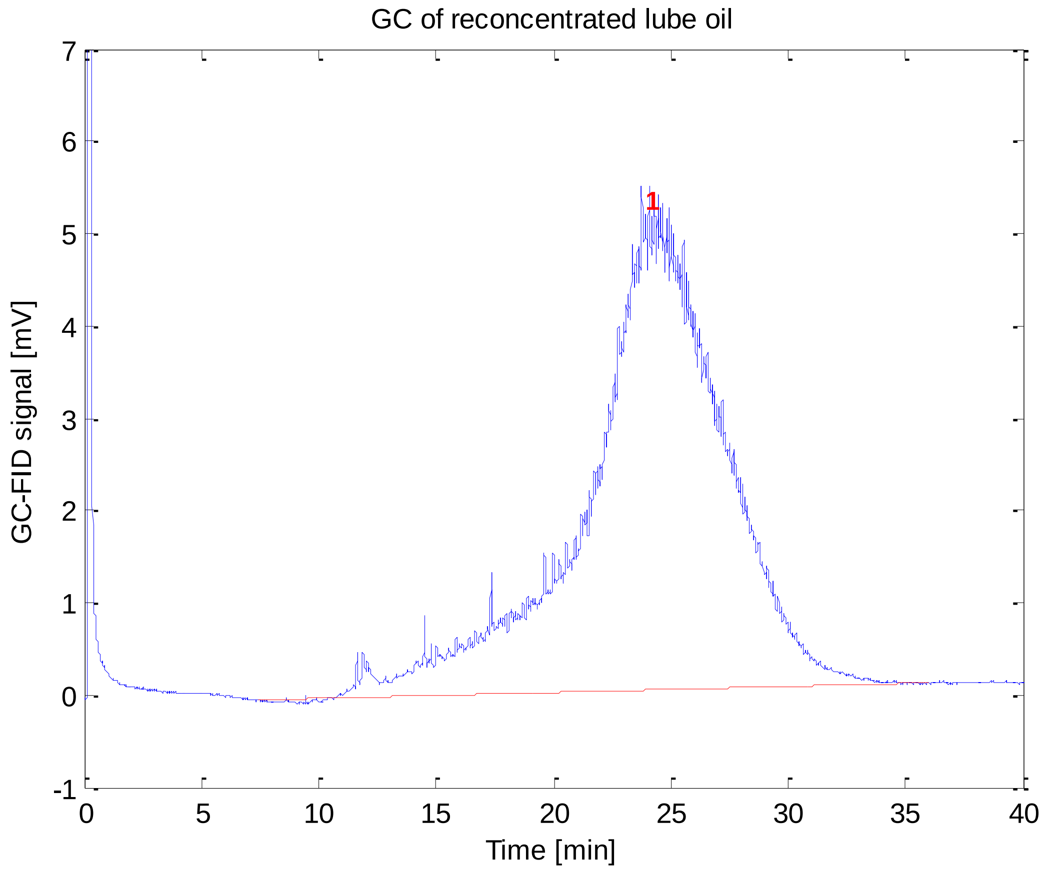
Extraction, filtration and re-concentration of sample filter with known mass of fuel and lubricant oil



Blank extraction



Re-concentrated lubricant oil

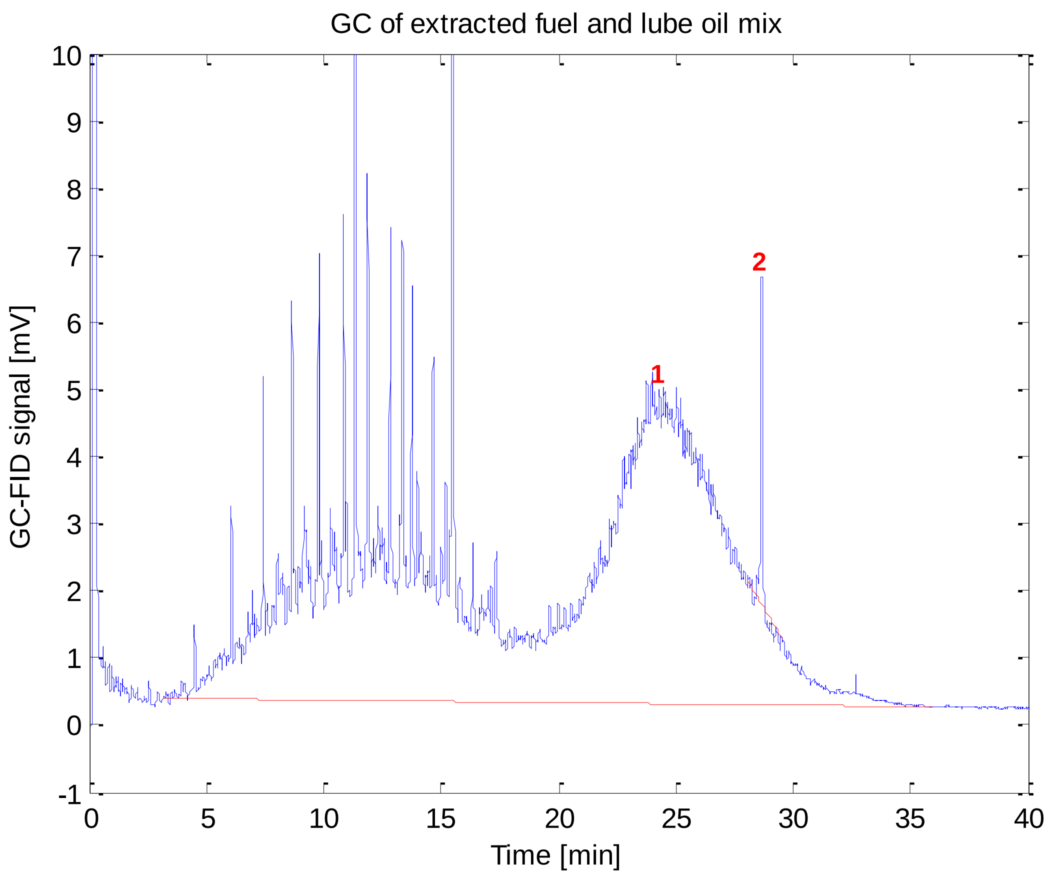


GC of reconcentrated lube oil: Peak calculations

Peak nr	Component	Time [min]	Area [mV*min]	Height [mV]
1	Lube oil	24.073	34.354	5.137

Lube oil area normalized to lube oil height 6.688 [mV*min/mV]

Extract of fuel and lubricant oil

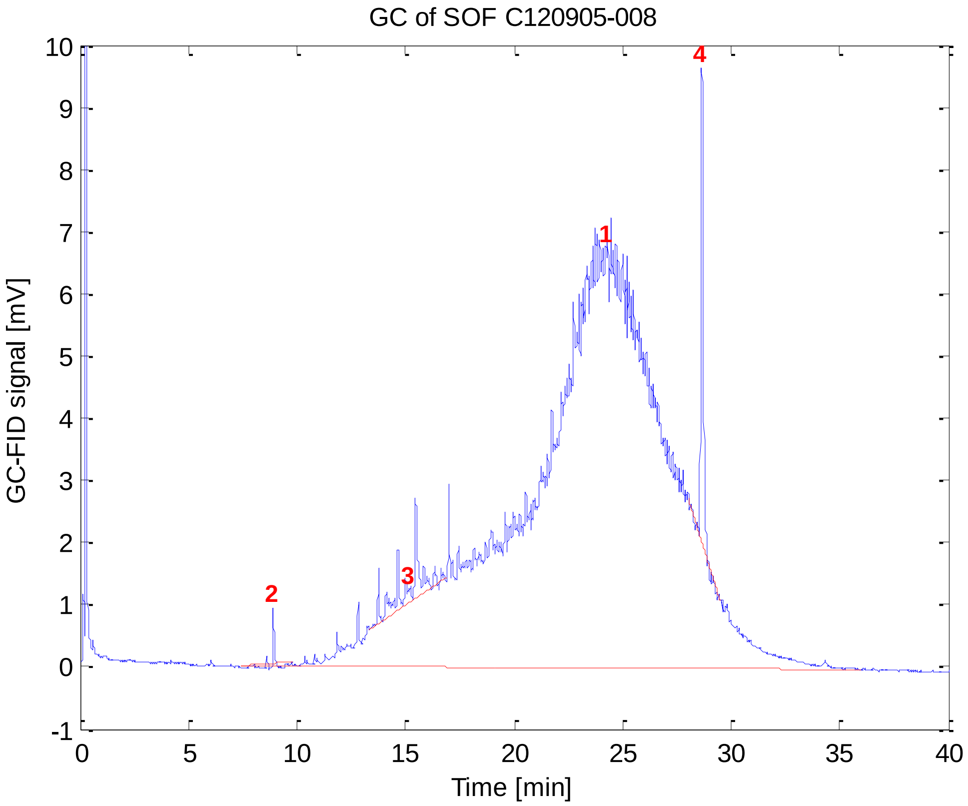


GC of extracted fuel and lube oil mix: Peak calculations

Peak nr	Component	Time [min]	Area [mV*min]	Height [mV]
1	Extract	11.359	55.006	4.668
2	Syringe wax 3	28.659	0.386	4.880

Extract area normalized to "lube" height	11.700	[mV*min/mV]
Mass fraction of lube oil in extracts	57.2	[wt%]

SOF C120905-008

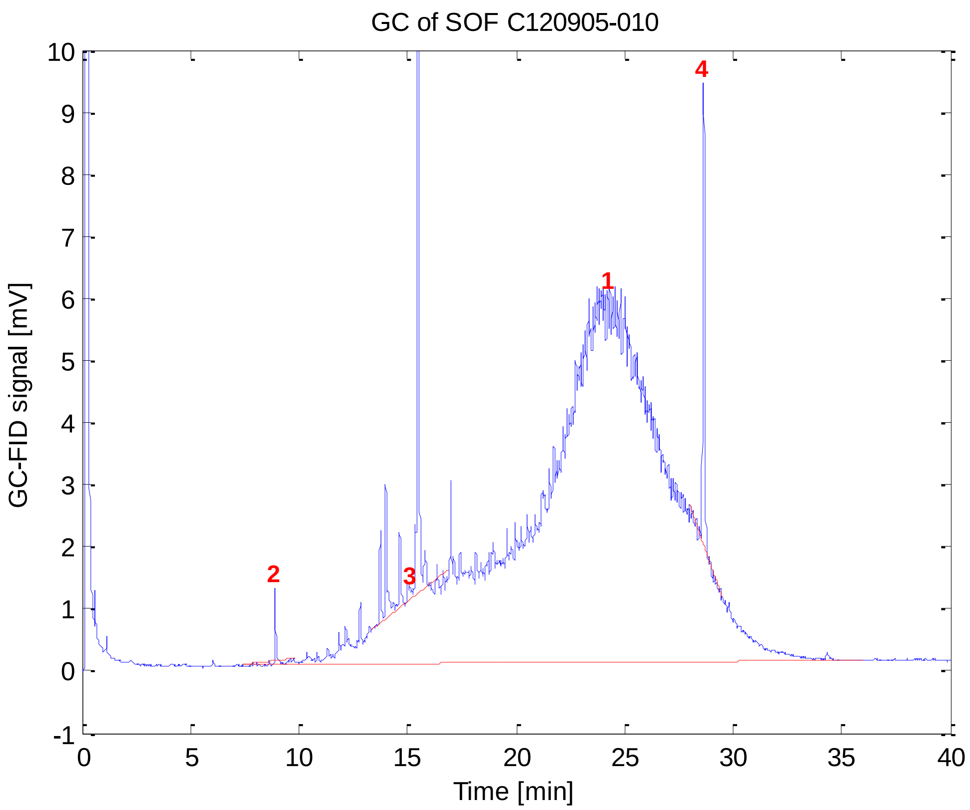


GC of SOF C120905-008: Peak calculations

Peak nr [mV]	Component	Time [min]	Area [mV*min]	Height
1	Extract	28.650	52.142	6.762
2	Syringe wax 1	8.909	-0.037	0.896
3	Syringe wax 2	15.469	0.755	1.630
4	Syringe wax 3	28.650	0.950	7.613

SOF area normalized to SOF height	7.465	[mV*min/mV]
Mass fraction of lube oil in SOF C120905-008	89.6	[wt%]

SOF C120905-010

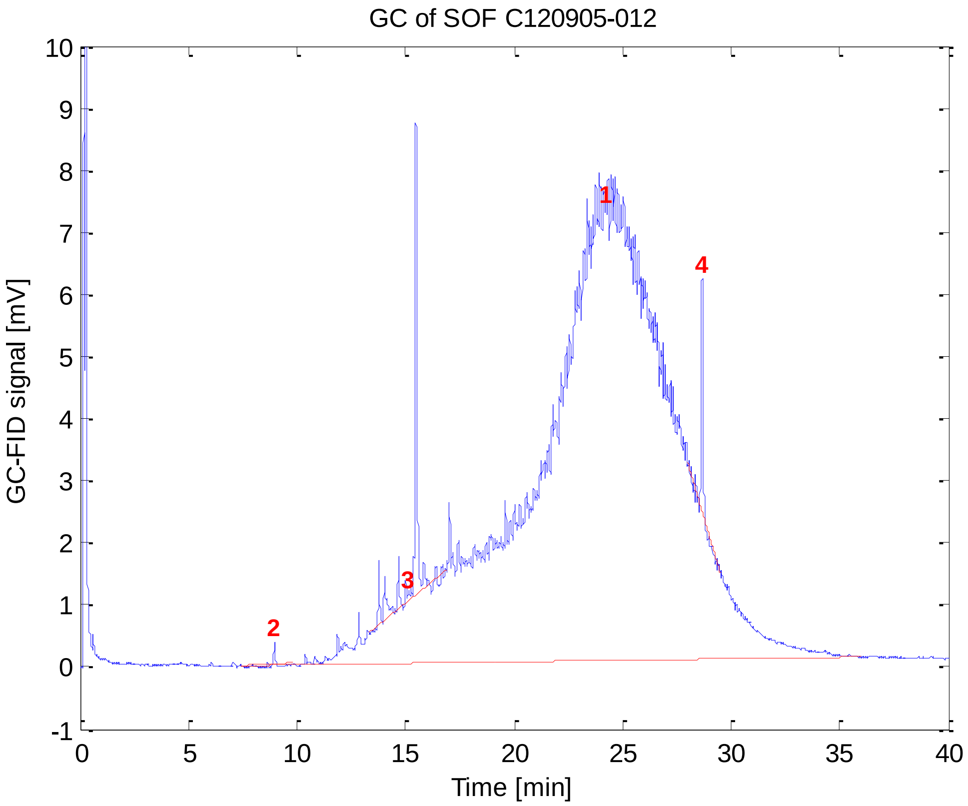


GC of SOF C120905-010: Peak calculations

Peak nr [mV]	Component	Time [min]	Area [mV*min]	Height
1	Extract	15.469	46.580	5.912
2	Syringe wax 1	8.895	-0.015	1.174
3	Syringe wax 2	15.469	1.679	0.126
4	Syringe wax 3	28.644	0.789	7.437

SOF area normalized to SOF height	7.464	[mV*min/mV]
Mass fraction of lube oil in SOF C120905-010	89.6	[wt%]

SOF C120905-012

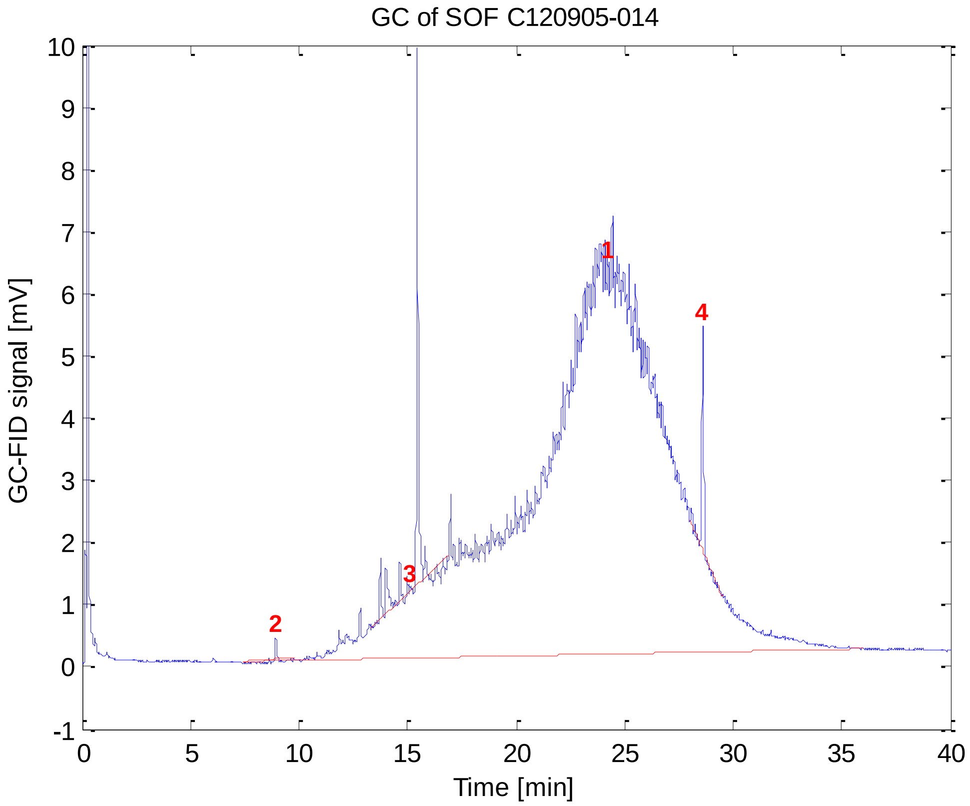


GC of SOF C120905-012: Peak calculations

Peak nr	Component	Time [min]	Area [mV*min]	Height [mV]
1	Extract	15.481	56.711	7.289
2	Syringe wax 1	8.956	-0.048	0.338
3	Syringe wax 2	15.481	1.053	0.083
4	Syringe wax 3	28.665	0.280	3.739

SOF area normalized to SOF height	7.604	[mV*min/mV]
Mass fraction of lube oil in SOF C120905-012	87.9	[wt%]

SOF C120905-014



GC of SOF C120905-014: Peak calculations

Peak nr	Component	Time [min]	Area [mV*min]	Height [mV]
1	Extract	15.450	48.879	6.279
2	Syringe wax 1	8.940	-0.068	0.344
3	Syringe wax 2	15.450	0.972	0.031
4	Syringe wax 3	28.605	0.340	3.609

SOF area normalized to SOF height	7.587	[mV*min/mV]
Mass fraction of lube oil in SOF C120905-014	88.2	[wt%]