PILOT PROJECT

Report produced by
Company BIMONT Ltd. Slovenia

TECHNOLOGICAL SYSTEM FOR PREPARATION OF HEAVY FUEL FOR THE SHIP'S ENGINES USING HYDRODYNAMIC HOMOLOGIZER FOR HEAVY FUELS AND COMBUSTIBLE MIXTURES MODULE TRGA

Project Manager:	Mr. Darij ŠTOK, marine engineer
Object:	RO-RO ship »LARKSPUR«, c/o Transeuropa Shipping Lines Ltd. Portside ship's engine
Route:	Oostende (B)-Ramsgate (GB)-Oostende (B)

Izola,Slovenia, October 2012

TABLE OF CONTENTS

A) PROJECT TEAM

Mr. **Darij ŠTOK**, marine engineer, constructor of ship's module TRGA for dispersion/emulation and homologation of ship's heavy fuel, co-owner and General Manager of Company BIMONT Ltd. and Head of the Pilot Project;

Mr. **Andrei RUBAN**, MS, inventor and constructor of hydrodynamic dispersion and homologation Module for fuel, Type TRGA-3G, technical consultant in the company BIMONT Ltd.;

Mr. **Samo DJUZIČ**, BC in chemistry, General Representative for Brookfield Viscometers and General Manger's Consultant;

Mr. **Stanislav DEKLEVA**, electronic engineer, expert for ship electronic, co-owner and Procurator for the company BIMONT Ltd.;

Mr. **Sulejman BRKIĆ**, professional welder, highly skilled for ship welding, holder of Germanischer Lloyd welding Certificate; in a contractual relationship with the company BIMONT Ltd.;

Mr. **Richard STERGULC**, marine engineer, Fleet Manager and Director of the company TransEuropa Shipping Lines Ltd., Koper, Slovenia;

Mr. **Igor MAVRIČ**, marine engineer, ship technical Inspector of the company TransEuropa Shipping Lines Ltd., Koper, Slovenia;

Mr. **Mario SIRONI**, marine engineer, Chief Engineer in charge onboard RO-RO ship "Larkspur" during the assembly of TRGA Module on buffer tank in November 2011;

Mr. **Srečko JAZBEC**, marine engineer, Chief Engineer in charge onboard RO-RO ship "Larkspur" during the assembly TRGA Module on settling tank and in course of measuring of toxic air emissions in August 2012;

Mr. **Aleš ŠKUFCA**, BC in chemistry, responsible for measuring of toxic discharges onboard RO-RO ship "Larkspur", employed in the company RACI Ltd. Ljubljana, holder of following Slovene accreditations:
* SIST EN ISO / IEC 17025 LP-076
* SIST EN ISO / IEC 17020 / C K-085

B) TECNICAL DETAILS OF RO-RO SHIP »LARKSPUR«

Owner: Marine Company Transeuropa Shipping Lines Ltd.
(Transeuropa Ferries) Koper, Slovenia
www.transeuropaferries.com
Ship details: www.transeuropaferries.com/index.php?page=ships

· Length (m)	143.85
· Beam (m)	20.5
· Gross tonnage (tons)	14.458
· Number of passenger	1.155
· Number of cars	127
· Number of accompanied vehicles	58
· Lane meters (meter)	1070
· Maximum speed (knots)	18
· Engine power (bhp)	12.000

C) MAIN PURPOSE AND OPERATIONAL GOALS OF THE PROJECT

The main purpose of this Pilot Project is to determine and to prove/show the effects of hydrodynamic Homologizer[1] and disperser/emulsifier[2] for fuels and other combustible mixtures with Module TRGA, in the process of preparing fuel for marine engines, including the results of the measurement of exhaust emissions derivates from the ship's engines.

The Pilot Project will undoubtedly prove efficient, safe and ecologically oriented use of Module TRGA in the preparation of heavy fuel oil (here and after: HFO or fuel) onboard ships.

Having in mind that Module TRGA-3G is highly innovative product on the market and represents a novelty, such kind of Pilot Project is an important step towards the use of new technologies, which will allow ship owners not only to save on fuel consumption, but also on fuel's higher quality combustion and to meet regulatory requirements to reduce the sulfur content in the fuel and for consequently reducing of toxic emissions into the atmosphere.

Annex VI of the MARPOL Convention from the year 2008 and the Directive of the European Parliament and EU Council Directive 1999/32/EC, are determine a significant gradual reduction for the sulfur content in marine fuels up to 0.5% by the year 2020, including any "technological" problems but not later than in the year 2025.

In this context, our Module is unique in the whole market, without any direct competition and will represent a new era Homologizer. All existing devices on the market are designed to purify and to process heavy fuels, are based on the technology called »micronization«[3].
The operational objective of this Project is to introduce the device – Module to the market, which will provide the following advantages over other competing products:

- Enable higher quality burn of different types of marine fuels
- Reduced consumption of marine fuels
- Have a positive impact on the environment
- Energy saving
- Low-weight, easy installation and servicing.

The positive effects of implementation of our Module TRGA must be analyzed trough the market analysis, verified and used in the preparation of future marketing strategy and commercialization of entire Project (purchasing, production, sale/distribution).

All collected technical and technological information must be analyzed, processed and used of the downstream of technological development of Homologizer using cavitation principle. Nevertheless, in the further development it will be necessary to examine the real possibility of complete elimination of the sulfur content in marine fuels and in this context, to construct or improve existing Module TRGA.

---

[1] All types of mixers achieve mixing by rapidly changing the direction of the fluid, accelerating the fluid, or subjecting the fluid to cavitation

*[2] An **emulsion** is a mixture of two or more liquids that are normally immiscible (nonmixable or unblendable).*

*[3] To **reduce** (a material) to a very fine powder, esp. to particles only a few microns in diameter*

D) TECHNICAL SOLUTION AND DESCRIPTION, INCLUDING CERTIFICATION OF MODULE TRGA-3G

Technical solution includes hydrodynamic cavitation and fuel processing, which means simultaneous performing of mixing, dispersion and destruction of present fuel appearance and activation of some chemical chains...

Module TRGA should be used in the process of engine operation using the diverse fuels, such as marine fuel of normal or any degraded types of fuel oil, residual ship's fuel oil, diesel, used oil and oil processing residues.

The hydrodynamic process means that the fuel should be pushed the Module by the help of gear or screw pumps, under high pressure between 5 to 20 atmospheres (this is depending on the capabilities of the pump used), using the physical principle of cavitation in the process of controlled hitting of molecules in the wall, under the corresponding angle which provides breaking and destroying of same molecules.
This process is creating and providing stable emulsion without adding any ecologically unfriendly additives improving that stable particles in the heavy fuel will burn, reducing the consumption and significantly reduce the emission of toxic gases into the atmosphere.
The introduction of that technology or use of our Module TRGA allows optimization in the process of purification and processing of fuel, without significant technological changes in the process of exploitation and use of any type of fuel.

Structural Module TRGA does not contain any mechanical rotating parts or elements, and this is a unique feature and competitive advantage, since all other technological and technical solutions used for refining and processing of marine fuel are largely exposed to damage, because of use of rotating parts and, consequently, producing higher maintenance costs.

The Module TRGA-3G with working range between 3 and 50 m3/h, was obtained a Certificate No. N-PED-A1-06-810-11-01. (the Certificate is integral part of This Pilot Project), issued by the Welding Institute Ljubljana, R of Slovenia, in accordance with the European Directive for Pressure Equipment PED 97/23/EC, as notified body for such certification process, and gives the right to the manufacturer of Module TRGA, company BIMONT Ltd., to use the identification number 2042.
Statement of compliance with the Pressure Equipment Directive PED 97/23/ES contains following information:

Product-type:	TRGA-3G pressure pipeline
Serial number:	001
Max operating pressure:	40 bar
Max allowable temperature:	250°C
Diameter:	125mm
Year of manufacture:	2011
Test pressure:	60 bar
Medium for testing:	water, 20°C
Used procedure:	Module A1
Used standards and Tech. specification:	AD 2000-Regelwerk, BS EN 3834-4
Quality control QS:	DIN EN 3834-4

E) FUEL PREPARATION TECHNOLOGICAL SYSTEMS FOR SHIP'S ENGINE USING MODULE TRGA-3G

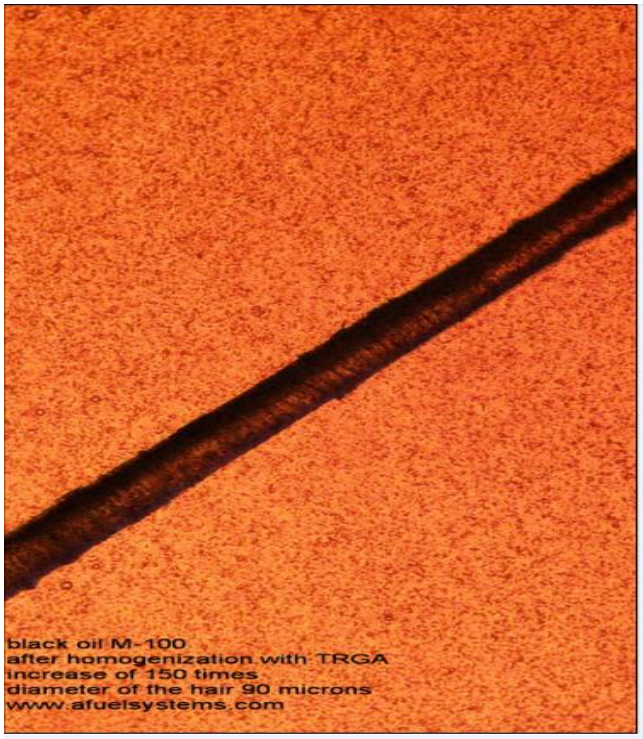
E.1 Existing technological systems

The existing technological systems for the purification and processing of marine fuels, such as separators and filters, at the best solution will reduce the size of components in marine fuel at size of 70-100 microns. Water is not completely removed, and percentage of water may reach up to about 0.5%.

In practice, a part of use of Separators, different ecologically controversial additives for providing a higher quality of combustion are used.
In conjunction with Separators are in use also fuel Homologizers working on the principle of rotation. These Homologizers are not well seen by the ship owners due to structural failures, rapid deterioration, energy dissipation, relatively low productivity and excessive maintenance costs and his big size, so most of them were removed from use.

E.2 Homologizer on the principle of hydrodynamic and cavitation - Module TRGA-3G

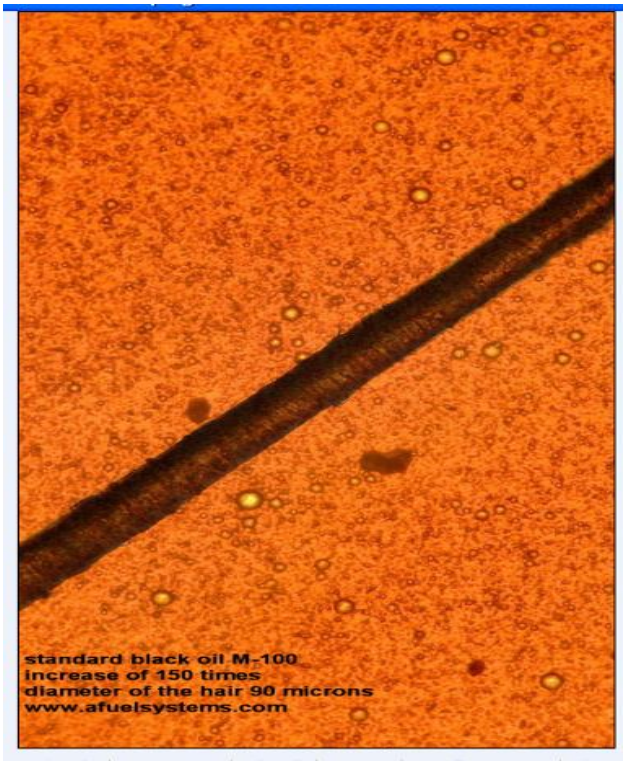
The company BIMONT Ltd. was developed Homologizer Module TRGA-3G, which does not contain any rotating working elements or components. Fuel flowing through Module TRGA-3G is constantly subjected to repeated compression and decompression process. Under the influence of high-frequency oscillations and due to process of changes between the layers of the fuel, this is causing the breach of polymerized molecular chains. Size of all components of the fuel, including the mechanical and waste water on the output is of size 3-5 microns.



The process of dispensation is allowing fuel to flow through the customized configuration of internal cavities of Module TRGA-3G. There is a very small probability that the Module will be subject to failure. This can occur only when entering some external or third factors. In the case of "blockage" that can occur, in case of sand invasion, abrasives, scrap rags and other subject matters in marine fuel, the Module shall be purged with steam under pressure of 5 bar for the period of 30 to 50 minutes, that time period will allow steam to soften the resin and to be removed from the surface of the Module. Prior to this, the Module should be soaked in hot diesel fuel or some appropriate thinner, to remove resin particles (*please see Instructions for the installation, use and servicing of the Module*).

Compared with the existing rotary Homologizers, our Module TRGA-3G is not noisy and the noise level is 2 to 3 times smaller than usual. No any ultrasound and infrasound are detected. It is a very efficient device with power consumption saving, ranging from 0,5 to 1kW/h on one (1) tone of product. Productivity of single Module TRGA-3G is max 90 m3/h. For operation in addition to

its own, does not require any additional pumps. Steel construction of Module can withstand high temperatures, any pressure and aggressive flows. Module contains no any moving parts, no any bearings; it is vibration-free and without any seals. There is no increase of vibrations in the operational stage. Maintenance expenses due to slight wear of working elements are irrelevant and time service of the Module for heavy fuel are max. twice in the two (2) years or up to 15.000 working hours.



Before installation of the Module must be installed grave fuel filter with the gaps up to 5 mm. If the fuel is filtered and does not contain any resins, curds, solid particles, etc., Module extends his operating time of up to three (3) times and in such case it is not necessary to purify the fuel.

Resource operation of the Module is sufficient and materials used in the Module production are strong and resistant to wear. The penetration of particulate matter in the area of treatment does not cause destruction of Homologizer. In the fuel line delivery Module TRGA works under pressure up to 40 bars and a temperature of +250°C.

E.3 Module installation, operation of the Module

The proposed Module TRGA-3G, produced by company BIMONT ltd., for the scope of better quality marine fuel combustion, better fuel economy, use of non-burned sediments in the settling and buffer tank, for use of waste oil and oily waters into the ship's boilers and for the goal of reducing emissions of toxic gases and particles in the atmosphere.

Module structure consists of: TRGA-3G device, optimized with the necessary working facilities, gear or screw pump with the including appropriate electric motor, electrical power box with necessary electronics parts, pressure gauges, sensors, marine fuel filter cartridge for filtering the parts between 2 to 5mm, which depending on the processing or fuel type, size of non-burned sediments and other ingredients, valves, flanges, seamless pipes with bends, screws, washers and other filler material, if necessary.

Installation of Module TRGA, in order to carry out the fuel recirculation, shall be obtained on the settling tank, the module shall be connected on the way input and output from the settling tank. The fuel, driven trough the module TRGA by the appropriate pump, will return back to settling tank and then, by the main engine fuel line coming back for treatment in other Module TRGA, which is in the form of circuit-bypass mounted in front of the buffer tank. The purpose of reprocessing fuel already treated, is to provide or maintains the quality of fuel and complete destruction of heavy grades of fuel and thoroughly reduction of emission of toxic substances into the atmosphere.

It should be noted that the shipping Module TRGA operates with his own pump and not on the basis of pre-installed pumps onboard ship. It must be also notified that the fuel flow on a parallel line connected to the diesel engine. This condition means that direct effect from Module TRGA does not depend by the amount of fuel used by the ship's engine but depends on quantities of fuel in the settling tank and only »partially« by the engine.

This is the reason of efficiency of the processing inside settling tank from 6 to 40m3/h and our Module TRGA in the working phase allow this production undeniably and excellently.
Module TRGA operates on the buffer tank and in this context it have sufficient processing efficiency of 3 to 5m3/h which our Module TRGA also allows.

SOME IMPORTANT COMMENTS

* Module TRGA is not installed in the "factory" fuel feed line to the ship's engine, but it is installed on the settling and buffer tank. The reason is independent fuel consumption;
* Last Module TRGA starts to operate on 5-6 atmospheres;
* The duration of the operation of the Module TRGA is up to 15.000 hours. We estimate that, depending of manufacturing material used in Module TRGA, operating life is satisfactory and sufficient;
* When ship's engine is switched off, our Module TRGA can also be switched off.

F) The specific results of this Pilot Project

Initially it is necessary to say that the testing object, RO-RO ship "Larkspur", was chosen because of a long lasting successful cooperation with company TransEuropa Shipping Lines Ltd. from Koper, Slovenia, cooperation with their Fleet Managers and due to navigation area of m/v "Larkspur", which is between Oostende (B) and Ramsgate (GB). This is in accordance with Annex VI of MARPOL IMO-2008 and Directive of the European Parliament and EU Council 1999/23/EC, which defined the control of permitted sulfur content in marine fuel.
Now is in the process of adopting by the EU bodies the update/adaptation of Directive 1999/23/EC, Annex VI to MARPOL Convention, under which the maximum permissible sulfur content of marine fuels in the Baltic and North Sea and English Channel area should be first reduced by 1%, and from 01.01.2015 (for passenger ships from 01.01.2020) for the 0,1% (the current limit is 1,5%).
Maximum permissible sulfur content in fuels for the vessels in other areas fell to 3,5% and from 01.01.2020 for the 0,5%.
Maximum permissible sulfur content in fuels for passenger ships in the territorial sea, exclusive economic zones and control zones of pollution shall fall from 01.01.2020 for the 0,1% (the current limit is 1,5%). The directive introduces the possibility of using a greater range of methods to reduce the emissions of sulfur oxides.
Results from this Pilot Project shall give concrete answers to the IMO and EU applicable norms, or the possibility for apply of hydrodynamic cavitation in the technological process for reducing SO2 emissions.
Measurements of emissions into the air onboard m/v Larkspur was made on our order by the representatives from the accredited company RACI Ltd from Ljubljana/Slovenia/EU and the conclusions were stated in their Report number 201209A dated 07.09.2012, which is an integral part of this Pilot Project (see attachment).

F.1 The final comparative table of harmful emissions using Module TRGA in the fuel system of RO-RO vessel Larkspur

On 19 August 2012

Average numerical size of smoke gases using standard marine fuel:

CO = 384.581 SO = 239.96 NO = 899.84 - considered to be standard

The use of Module TRGA in the treatment of heavy marine fuel in the buffer tank, with increase of cargo loaded onboard, was reduced emissions of CO as follows:

a) The total time interval from 1,24 to 6,4%

b) Excluding interval of the frontal wind in the area from 3,38 to 6,4%

On 20 August 2012

The use of Module TRGA for the treatment of heavy marine fuel in the buffer tank, counting on mutually compensatory weather conditions, was decreased CO emissions as follows:

a) The total time interval from 5,27 to 12,1%

b) The most authentic result from 5,27 to 6,0%

On 21 August 2012

Use of two Modules TRGA for the treatment of heavy marine fuel on the buffer tank and settling tank, counting on mutually compensatory weather conditions, was reduced CO emissions as follows:

a) The total time interval from 10,0 to 14,97%

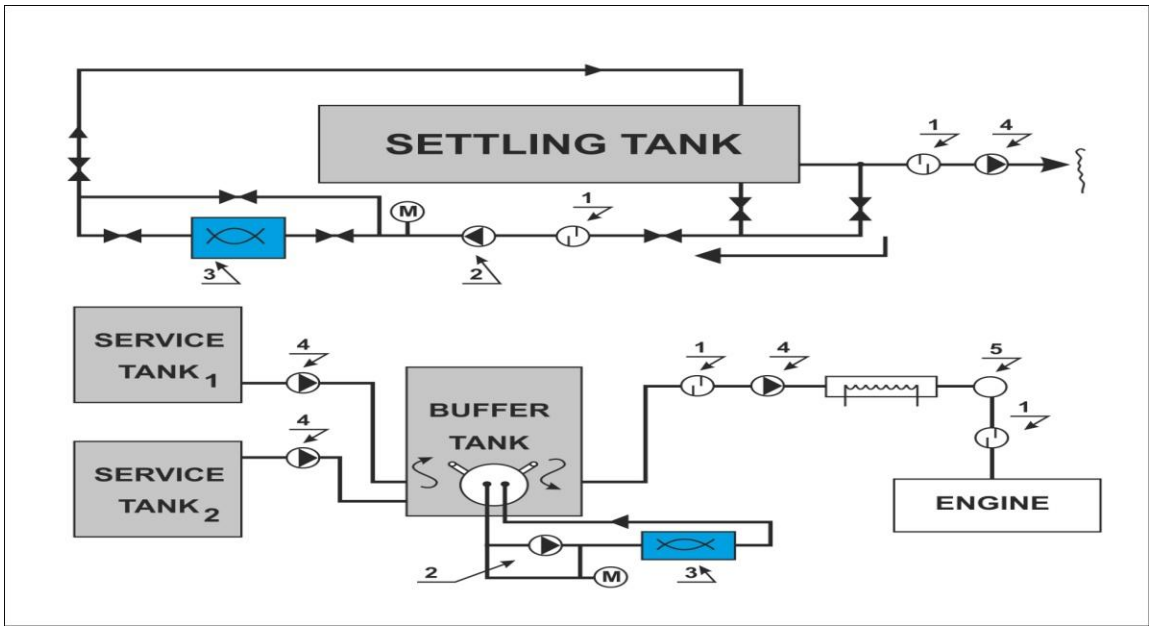
б) The most authentic result from 12,34 to 13,67%

On 22 August 2012

Using one Module TRGA for processing heavy marine fuel in settling tank, counting on mutually compensatory weather conditions, was reduced CO emissions as follows:

a) The total interval from 6,47 to 10,39%

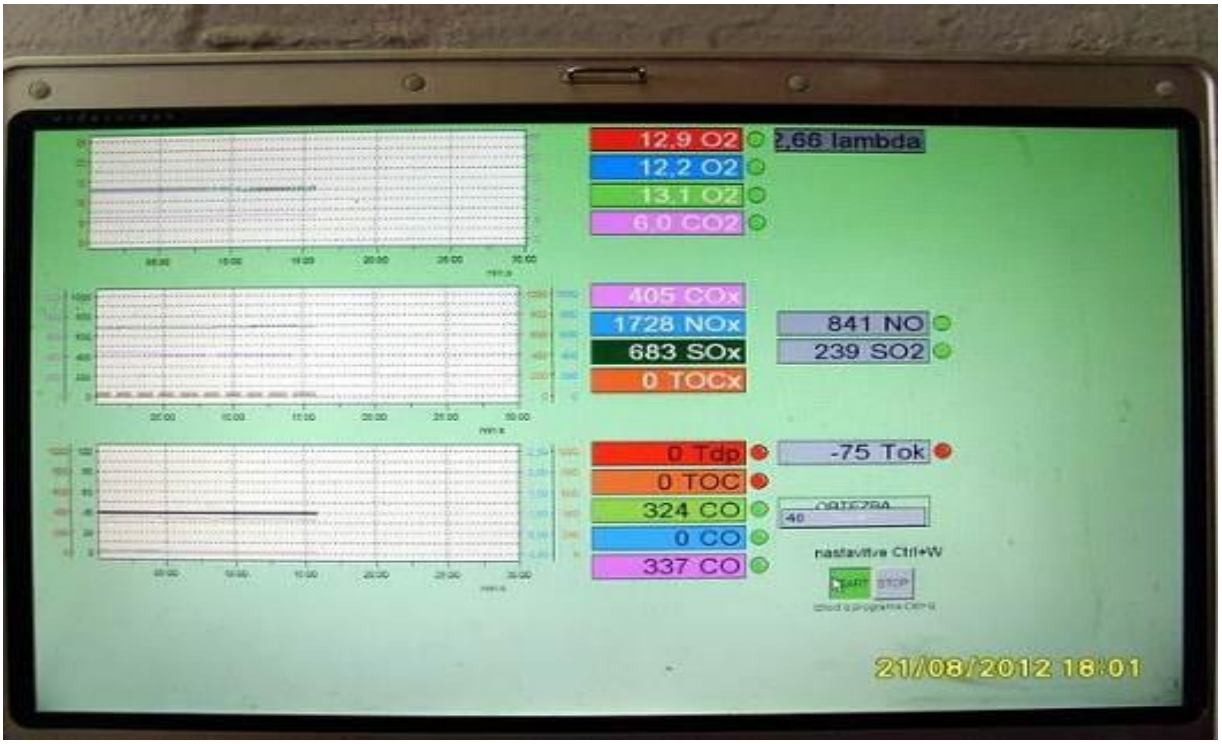
Analysis of the conclusions follows on the following pages.



Below please find some indicative photos.

Engine using standard fuel HFO

Engine using standard fuel HFO, treated by two (2) Modules TRGA



Smoke gases from same ship's engine using marine heavy fuel HFO, onboard RO-RO vessel »Gardenia«, c/o Transeuropa Shipping lines Ltd. Koper, on route Ramsgate(GB) – Oostende(B), (sister ship of RO-RO vessel »Larkspur«)

Smoke gases from ship's engine using marine heavy fuel HFO, treated by two (2) Module TRGA, onboard RO-RO vessel »Larkspur«, on route Oostende (B) - Ramsgate (GB),

F.2 Fuel Separator and fuel mud (or sludge)

According to the information obtained from the company TransEuropa Shipping Lines Ltd., during the period of use of Module TRGA placed on the settling tank, during the period from 21 August 2012 to 14 September 2012, the amount of fuel sludge in the settling tank was stopped to increase.

Overlook on the one of the ship's engines


22/08/2012 07:08

MAIN RESULTS OF TESTING

In accordance with the technical data about volume of fuel sludge produced by ship's separator and accumulated into settling tank, this is equal from 0,5% to 1% of the total amount of fuel onboard ship.

Total quantity of fuel used in 28 days is 20x28 tons = 560 tons of fuel.

At the same time it was notified that fuel sludge in amount of 10 cbm (or 9,7 tons) was discharged ashore every 14 days or altogether 19,4 tons in 28 days, this is 3,46% of the total amount of loaded fuel onboard.
Composition of fuel sludge is 50% to 70% of fuel and 50% to 30% of water. Considering that the average amount of fuel in the fuel mud/sludge is abt. 60%, quantity of the fuel sludge generated from the fuel is approx. 11,64 tons or 2,07% of the total fuel consumed.

Means that every 24 hours ship's fuel separator is putting inside the fuel mud/sludge of a quantity of 415 liters which, in accordance with separator's technical settings, is not qualified as HFO.

CONCLUSION

Using a Module TRGA for the treatment of HFO helped to save 2,07% of HFO consumed plus saving of costs for discharging of fuel sludge by the offshore service and necessary periodic cleaning of settling tank.

These testing results are corresponding to the results notified by thesis entitled "PROCEDURES FOR THE PREPARATION OF HEAVY FUEL FOR DIESEL ENGINES USING HYDRODYNAMIC METHOD" from year 1984, referred by Mr. Šunin Sergei ARKADJEVIČ on the Higher Maritime School in Odessa, Ukraine.
Very similar testing results (but with lower results) were recorded using some German made Homogenizers.

EXAMPLES

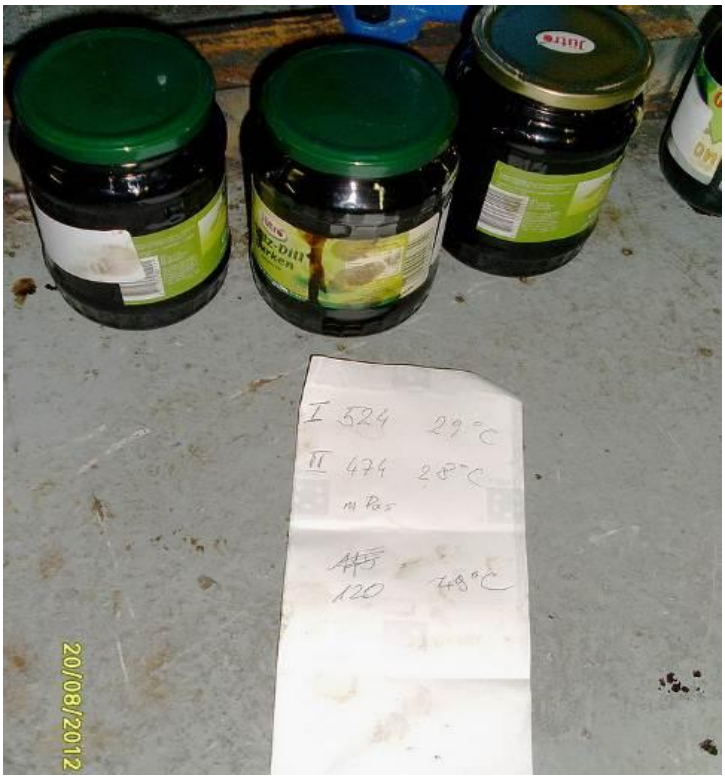
Immediately after installation of TRGA Homogenizer on the settling tank was examined patterns of fuel before and after treatment, at:
- Incoming HFO temperature was 29°C, on 524 centistokes[4]
- After treatment of HFO temperature was 28°C, on 474 centistokes.

The difference was of 10%, which means lowering of internal friction due to the reduction in particle size inside the fuel, without any use of additives.

Sampling and tests was done by Mr. Darij ŠTOK, using the viscometer type Brookfield, after prior consultations with Mr. Samo DJUZIČ, BC in chemistry, US representative of the Company Brookfield's for EU markets, who was responsible to place testing devices and for settings, servicing and other, because ship's viscometer onboard m/v "Larkspur« was out of order for a long time.

[4] ***1 centistokes*** *= 0.206264806 m^2*

Samples of HFO used



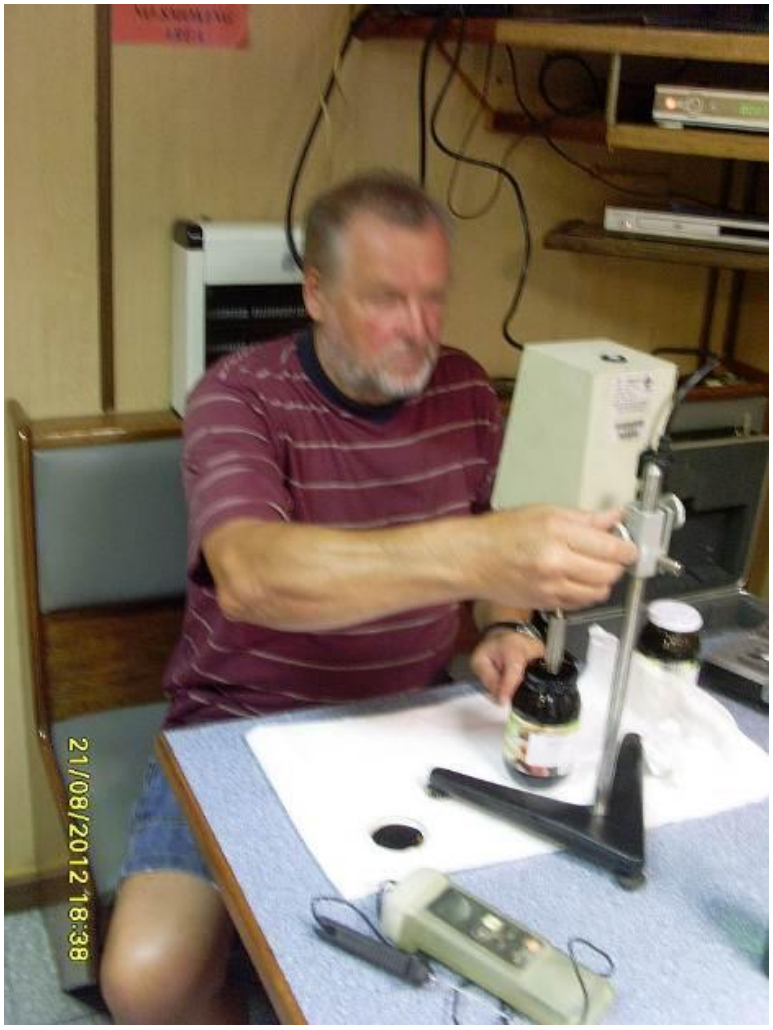
Module TRGA assembled on the settling tank

Initially, below reported results have been obtained, at the pressure of 3,5 bars, after one cycle of fuel treatment.

Most comparable or similar studies showed the same results of processing:
1. at a pressure of 8 to 12 bar,
2. at a temperature of processing at least of 50°C,
3. after 2-3 cycles of fuel treatment.

To clarify this effect, find the photos taken ref. to the Module TRGA before processing HFO.

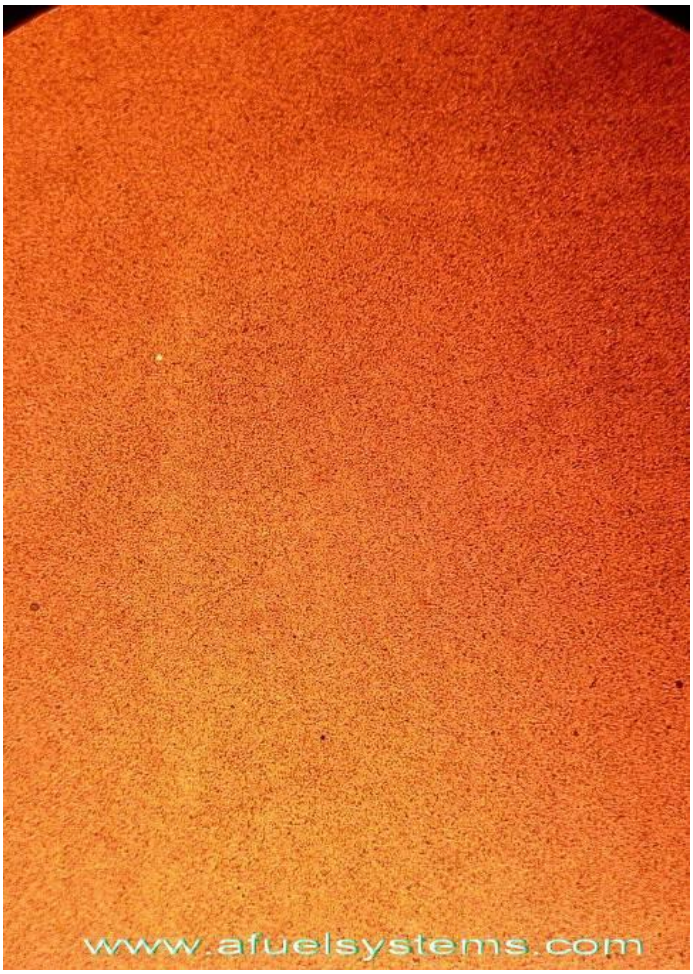
Later it was tested complexity of HFO at temperature of 20°C on the fuel arriving from settling tank after passing the Module TRGA and from double bottom fuel tank from which the fuel is arriving to the settling tank.
Treated fuel from settling tank had less complexity for 7%.




BROOKFIELD
mPas 623
6.0RPM %62.3 s61
SPEED
SELECT
SPINDLE
21/08/2012 18:40


mPas 382.2
18OFF %96.7 s61
21/08/2012 19:26

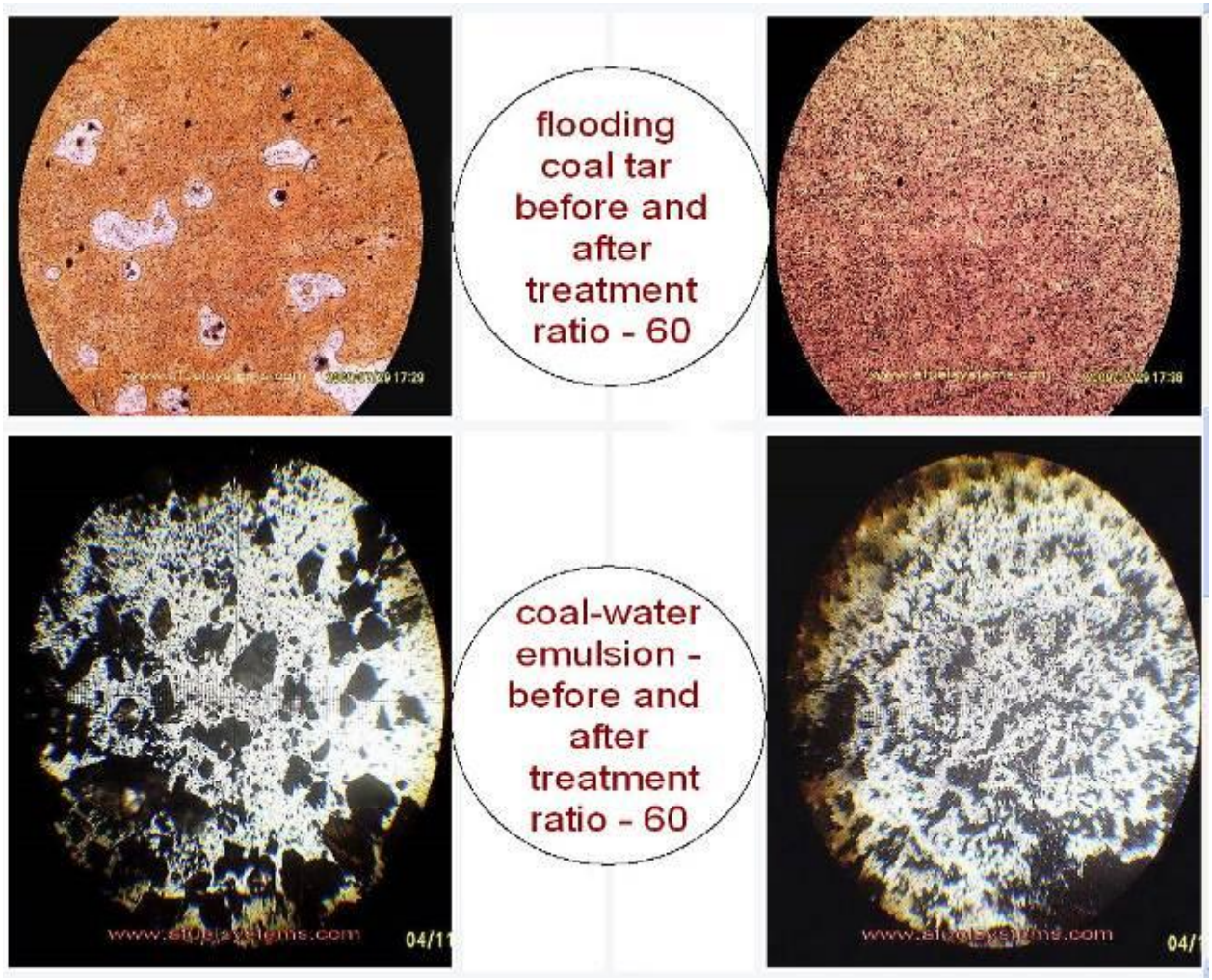
Sample of HFO M100 <u>before</u> the treatment with module TRGA



Sample of HFO M100 <u>after</u> the treatment with module TRGA

Operational intensity of Module TRGA on:

1. Flooding Coal Tar
2. Emulsion of Coal and Water



F.3 GENERAL RISULTS IN USE OF MODULE TRGA

	Use of standard HFO	Use of module TRGA only on buffer tank	Use of module TRGA only on settling tank	Use of Module TRGA on buffer tank and on settling tank
Basic notified results				
Temperature of smoke gases (°C)	325 326 337	356 356 357	353 347 353	**368** **370** **370**
Level of CO	100%	fm -3,8% to -6,4 % fm -5,27% to -6,0%	fm -6,47% to -10,39%	**fm -10,0% to -14.97%** **fm -12.34% to 13.67%**
Visual quantity of smoke **water trail length (m)**	100% Engine start – extreme quantity of smoke in navigation 30 to 80 m	Engine start – less smoke at least for 30% in navigation 5 to 40 m	**Engine start – less for 40%** **in navigation** **5 to 10 m**	Engine start – less for 30% in navigation 5 to 20 m
Quantity of sludge/mud from the ship's Separator	0,692 tons per day From this fuel was 415 kg	0,692 tons per day From this fuel was 415 kg	0	**0**
OPTION	**1**	**2**	**3**	**4**

In terms of achieving maximum fuel economy on the ship's engine Option No. 4 is the best technological solution - use of two Modules TRGA:

1. Use on the settling tank, which provides the greatest reduction of CO (non chemical combustion of fuel and his highest calorific burn) this is -66% the effect of reduction of CO. This also saves 415 liters of fuel every day, which amounts to 2,07% of the total fuel consumed.

2. Use on the buffer tank with 34% reduction CO effect observed, providing further reduction in the fuel connectivity, change of fuel carbon hydrate composition in terms of formation of free radicals, rapid oxidation exceeds the standard rate of oxidation of the fuel.

Additionally, use of module TRGA on the buffer tank is reducing the surface power of fuel stretching, which provides better dispersion on the ship's engine injectors, increasing the rate of fuel combustion, which has a direct impact on reducing the amount of it, saving fuel and prolongation of the periodic time for engine maintenance.

The Module TRGA on buffer tank additionally is mixing resins and asphaltene in the fuel, which can be passed through the engine separator, which increases the capacity of piston pair of steam engine from 2 to 8 times.

8.12. IMPACT OF IMPURITY OF MARINE DIESEL OIL ON LIFETIME OF PISTON PAIR IN THE DIESEL ENGINE

	Relative lifetime In %
Marine diesel oil before filtration	100
Same oil after filtration over the filters with fine filtration, in microns	
24	130
19	180
13	350
5 to 7	850

8.13. IMPACT OF IMPURITY OF DIESEL OIL ON WEARNESS OF CYLINDERS AND ON UPPER PISTON'S RING

Size of parts, in microns	Content of mechanical admixtures, in %	Wear rate	
		Radial cylinder. microns/h	**Piston ring mg/h**
Up to 100	0,027	2,1	3,1
Up to 50	0,1	0,35	6
Up to 30	0,176	---	8

8.14. IMPACT ON PRESENCE OF SULFUR IN FUEL TO THE FORMATION OF DEPOSITS

Type of Fuel	Coal number of waste oil, in %	Deposits, in g		
		On the filters		On the piston
		For hard cleaning	For fine cleaning	
Standard fuel without Sulfur	0,8	58	700	5,4
Fuel with Sulfur, in %:				
0,58	1,4	54	870	12,4
0,89	1,9	110	990	181

8.15. QUALITY INDICATORS OF PETROLEUM PRODUCTS, MORE VULNERABLE TO CHANGES DURING THE STORAGE

Petroleum Products	Indicators
Ethyl Gasoline	The fractional composition, content of Lead Tetraethyl, a period of stability, resin content, acidity
Gasoline without Ethanol	The fractional composition, resin content, acidity
Diesel Oil	Acidity, resin content
Diesel Oil for cars	Acidity
Synthetic Oils	Penetration, temperature, drip, acid number, water content
Fluids based on Alcohol and Glycerin	Content of alcohol, water and glycerin

At the same time, when the Module TRGA operating on the buffer tank was switched off, in this particular case the result was reduction of amounts of smoke.

This means that the connectivity of fuel which was treated was reduced if compared with connectivity of the fuel, which is necessary for the smooth operation and for the current state of injectors. Considering the fact that the injectors on the engine were quite worn, the effect of the accelerated combustion of fuel was reduced due to fuel flow.

Calculation of direct fuel saving including the reduction of CO will be made later on in this Pilot Project. Reducing of CO for 10% improves less fuel consumption for 1,5% to 2%.

Finally, use of two modules TRGA provide direct saving impact on fuel consumption for 3,5% to 4%.

Option 3. is cheaper, faster in production, can be installed and used on ships without a buffer tank, or on the ships with engines having worn injectors. At the same time there is no guaranteed minimum grinding of resin and other particles in the fuel (deposited on pipes and weariness).

Option 2. Installation of Module TRGA exclusively on the buffer tank.

Use of a module TRGA on the buffer tank provides immediate savings effect, namely 1,5% to 2% of fuel consumption, without taking into account other additional effects.

Important!

The results obtained refer exclusively to the concrete type of the engine and with active mechanical condition. For engines with increased wear of pistons and valves, these figures can be increased by 1% to 2%. For engines with ideal pistons, rings and valves, these figures can be reduced by 1% to 2%.

ADDITIONAL EFFECTS OF THE INSTALLATION OF MODULE TRGA

1. Additional heating of fuel: Module TRGA provides heating of the fuel in the buffer tank to a temperature of 85° to 90°C, this reduces fuel connectivity with high fuel binder or malfunctioning heating fuel due to resin lining.

Module TRGA provides heating of the fuel in the settling tank so the fuel warm up for 5°C by only one passing through the Module.

2. **Reducing the amount and size of solid particles in the fuel** decrease speed and quantity of fuel mud/sludge into the sludge tank and, in addition to direct saving of fuel consumption, is reducing costs for discharging of fuel mud/sludge, charged by Port agencies.

3. **Reducing the amount and size of solid particles in the fuel separator** ensures reduced wear and money saving effects including lower costs for tank maintenance.

4. **Reducing the amount and size of solid particles in the fuel provides pollution reduction** inside the settling tank and money saving effect for tank cleaning.

5. **Use of buffer tank provides more sleek engine transition** from heavy to light fuel and vice versa, including the reduction of heating of heavy fuel in less time and thus means additional saving on fuel consumption.

RECOMMENDATIONS TO THE TEST RESULTS

Observing the operation of the Module TRGA, there have been identified some further steps for possible modernization.

1. Working capacity and intensity of Module TRGA on the buffer tank should be decreased; thereby this will reduce energy costs and will cause chipper production of Module TRGA on the market.

2. Working capacity and intensity of the module TRGA in the settling tank should be increased, installing some additional sensors on the filter and to add the remote control.

OPERATIONAL RELIABILITY OF MODULE TRGA

Module TRGA on the buffer tank was operated continuously from 28 November 2011 up to 15 August 2012, or almost for 9 months. The Module does not require continuous observation and any maintenance.

The Module does not need any cleaning, adjustment, replacement of any parts, neither wholly or partially, or additional regulation.

The Module was inserted in the system before the start of testing in August 2012, after testing Module is working smooth and sufficiently. Reviewing of the Module during testing showed that the Module is in excellent mechanical condition and has no any signs of wear.

SOME PHOTOS OF MODULE TRGA

Installed Module TRGA on the buffer tank on 28 November 2011

Module TRGA on the buffer tank on 19 August 2012

Module TRGA on the settling tank on 20 August 2012

Command bridge of m/v »Larkspur« used for chart positioning


QUEENS CHANNEL
MARGATE SAND
MARGATE ROAD
RAMSGATE
GULL STREAM
GOODWIN
KELLET GUT
THE DOWNS
SANDS
SOUTH FALL
1°40'E
51°15'N
23/08/2012 14:46


23/08/2012 16:46

Exhaust from ship's funnel, 23 August 2012

F.4 APLICATIONS

F.4.1 SELECTION OF AREAS FOR OBTAINING OBJECTIVE DATA MEASUREMENTS

Standard requirements for the implementation of all benchmark tests, including the same level for all test equipment, reasonable testing regime for stable results (no transitional procedures)

For tests to be applied for the engine with internal combustion, it is necessary to provide the same external factors as follows:

	Parameters	Sign	Dynamics of changes	Description of changes	Way of evidence
1	Outside air Temperature	Ta	During the day	Depends of same hour, repeated each day	As correction for other data under same circumstances
2	Air Pressure	Pa	During the day	Stabile in the time of testing, no changes of weather	As equivalent
3	Fuel used	F	Relatively stabile	- during each fuel charge - different on arrival and departure from Ramsgate	- As equivalent - Excluded from measurement
4	Cooling liquid temperature	To	Depends on sea water temperature	Depends on the presence and characteristics of sea currents and season	Considered as permanent due to constant temperature of the test
5	Oil temperature	Tm	Depends on engine load	Depends on load of each ship's propeller and his revolutions	Comment 1.
6	Engine under load, engine revolutions and angle of propeller blades	N	Regulator care for stabile engine revolutions	- Depends on external factors - Depends on deck officers on bridge - Depends on ship's draft - Depends on maneuvering ship skills	Comment 2.
7	Working stability of measuring certified apparatus	Si	Stabile, out of possible moderation periods	Occasionally, short terms, showing periods of moderation	Non including periods of moderation
8	Engine technical status	Sm	Stabile	no	no

SOME SPECIFIC DETAILS OF TESTING

1. Testing was done onboard RO RO ship Larkspur, c/o company Transeuropa Ferries.
Web page: **www.transeuropaferries.com**

Larkspur	
· Length (m)	**143.85**
· Beam (m)	**20.5**
· Gross tonnage (tons)	**14458**
· Number of passenger	**1155**
· Number of cars	**127**
· Number of accompanied vehicles	**58**
· Lane meters (m)	**1070**
· Maximum speed (knots)	**18**
· Engine power (bhp)	**12.000**

2. Navigational range was route between Oostende (Belgium) and Ramsgate (GB), over the Channel. Ship's voyages were 4 per day, one way duration of voyage was approx. 4 hours.

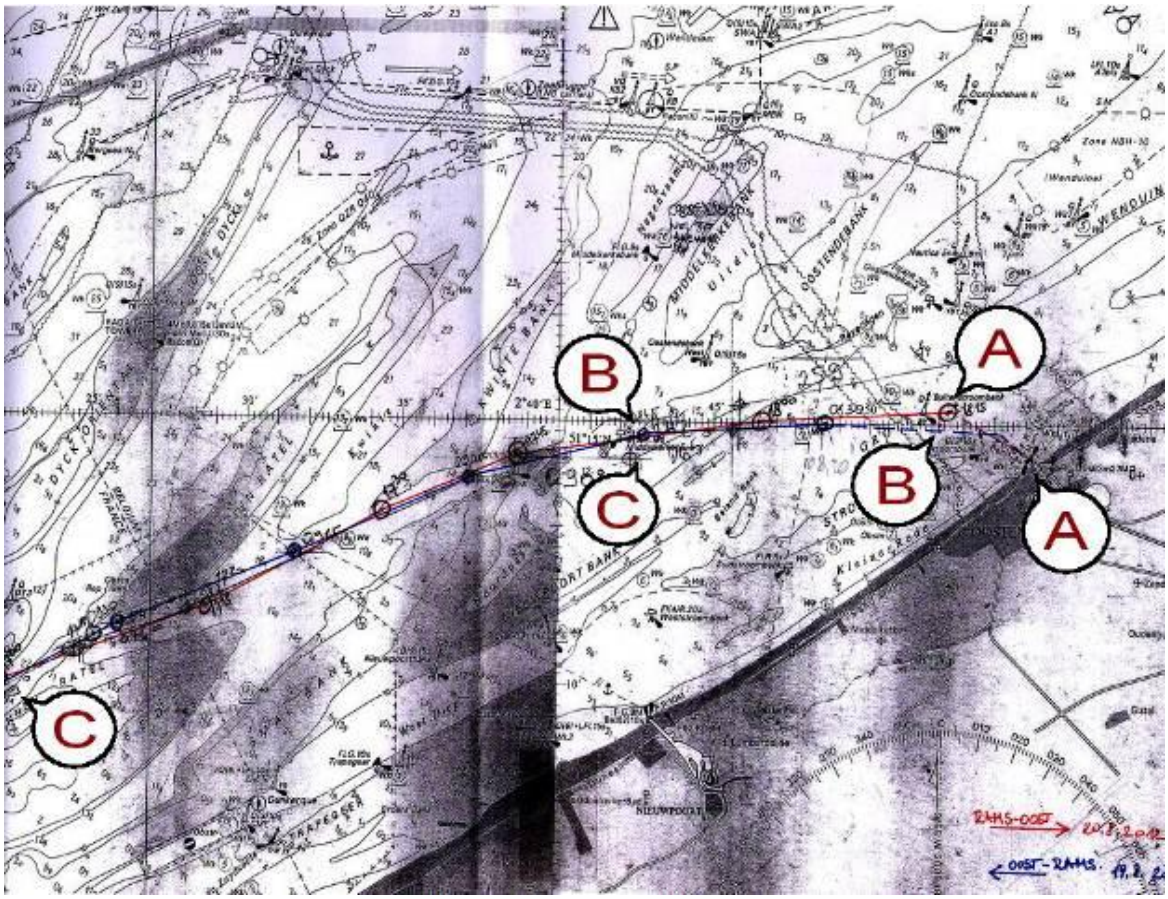
The route course from Oostende to Ramsgate	**The route course from Ramsgate to Oostende**
5 minutes – course 305° (AA)	**130 minutes - 115° (DD)**
30 minutes – course 265° (BB)	**60 minutes - 65° (CC)**
60 minutes – course 245° (CC)	**30 minutes - 85° (BB)**
130 minutes – course 295° (DD)	**05 minutes - 125° (AA)**

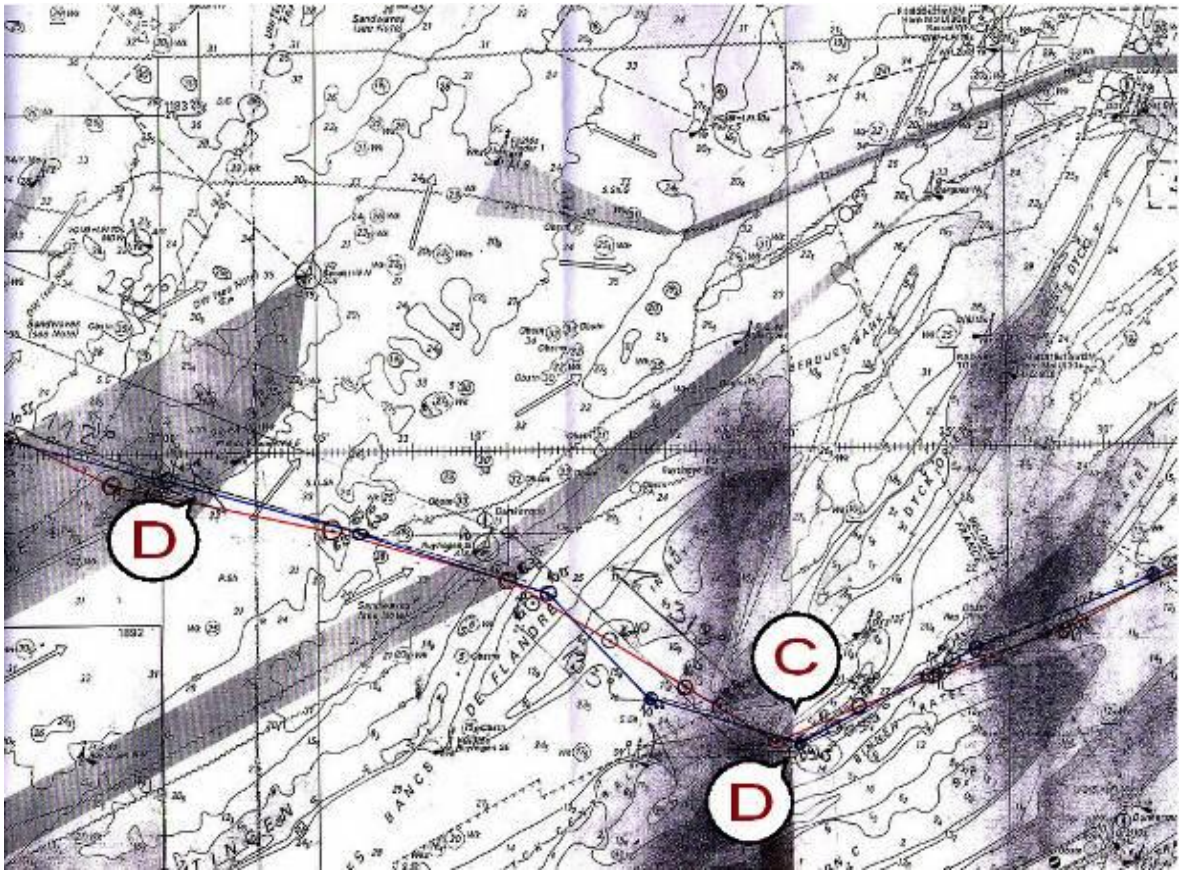
Characteristics of this navigational area were:
1. Ocean currents, occasionally repeatable, direction and speed change twice (2) per day;
2. Wind and wave height cannot be predicted;
3. Various sea depths, depending on the hourly changes each day;
4. A large numbers of big and small shoals;
5 A large numbers of ships in navigation in the Channel, which must also maneuver and change speed and direction of routes.

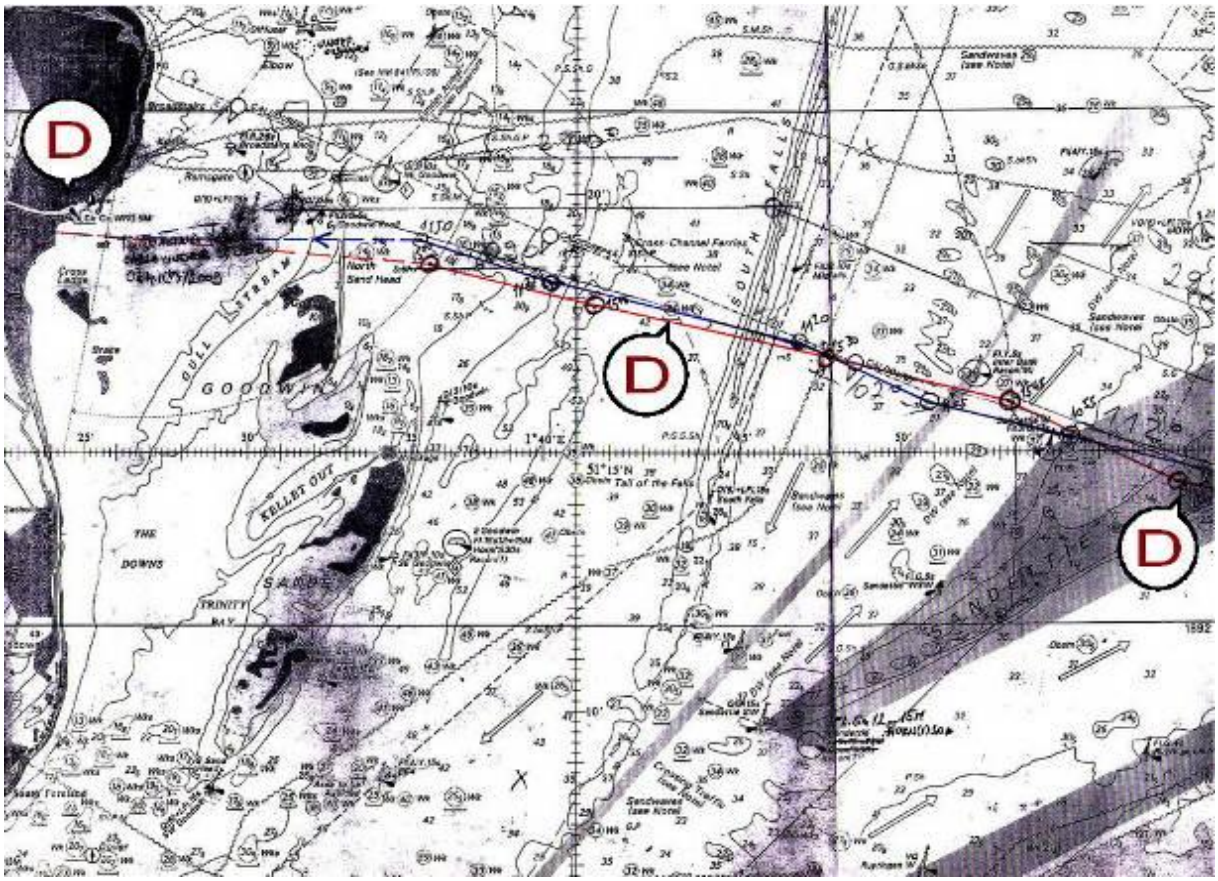
All these factors have affected the load of the propeller as well as the impact on fuel consumption and, consequently, on the amount of smoke gases, which were the subject of testing/measurements.

3. In addition, cargo loading of the ship was each time different, which resulted in different ship's draft; this affected also the load of engine and propeller as well.

4. Some of previous factors in the various combinations also have affect to the fuel consumption.


A
B
C
A
B
C
RAMS-OOST
OOST-RAMS


D
C
D



All navigational charts with routes of navigation are attached to the Annex to this Pilot Project (see maps.doc).

5. Some deviations were taken into account during the testing:

5.1 **Ambient air temperature** was not measured all the time, but measurements were conducted at the same time: morning - noon – night, under the same conditions, so this should be taken into account.

5.2. **Air pressure** was not measured during the entire test, because from 19 to 22 August 2012, the weather was the same, sunny, no precipitations and partly cloudy. It was considered that the air pressure data for this testing was irrelevant.

5.3. **The fuel** used for combustion had always the same composition. The shipping company was provided necessary amount of fuel samples from the same tank and from fuel shipments during the entire duration of the test.
HFO was changed regularly with diesel oil before arrival or departure from the Port of Ramsgate, same on arrival or departure from the Port of Oostende, and those intervals are excluded from the test.

5.4. **Coolant temperature** – conditionally the same all the time.

5.5. O**il temperature** depends on the load of the engine and it is changing proportionally (in permitted areas), while engine loads directly affecting the fuel consumption, for this testing this parameter was excluded.

5.6 **Engine loads**

1.	Engine revolutions	To be regulated in the engine room. Regulator maintains constant engine revolutions Engine must have same revolutions (not a speed) on 75% of engine power	Important to notify the factors
2.	To maintain same engine revolutions need to compensate loads, depends on:		
2.1	Ship's draft	Verification of cargo tonnage and draft noted in the documentation	Important factor for engine load
2.2	Frontal Sea Current	Notified characteristics of the sea current: speed and direction Relevant factor for engine load	Important factor for engine load
2.3	Stern Sea Current	Increasing the speed, no changes on engine revolutions.	Not been calculated.
2.4	Sea Current by side	Decreasing the speed, due to rudder load, but less then frontal sea current	Secondary factor for engine load
2.5	Frontal Wind	Notified characteristics of wind: speed and direction	Important factor for engine load
2.6	Stern wind	Increasing the speed, no changes on engine revolutions	Not been calculated
2.7	Wind by side	Decreasing the speed, due to rudder load, but less then frontal wind	Secondary factor for engine load
2.8	Frontal waves	Generally same as wind, including the sea current effect. Important factor of engine load.	Important factor for engine load
2.9	The depth under the ship's propeller	Shallow water increase engine load Sailing over shallow water causing direct, short engine loads, notified inside graphs Due to similar time and geographic intervals of measuring, the tide figures are not calculated	-Excluding results with highest and lowest point - Longer period of measuring due to compensations
2.10	Ship maneuvering capability	Shorter (maneuvering inside port is not calculated) change engine load	- Longer period of measuring due to compensations
2.11	Ship's propeller angle	Was maintained as fixed	Not been calculated

CONCLUSION No. 1

The selection of credible intervals for measurements according to the criteria of equality of external factors should be based on:

1. Maximum possible coincidence of these factors;
2. Maximum possible mutual compensation with one of the other factors (for example: a bigger draft and calm seas with less wind and draft);
3. For the selected area should be characterized by stable regimes of the engine.

6. Selection of parameters for verifying the authenticity of measurements

Mode of operation and change of engine load was reflected on the fuel consumption.

There was no counter for fuel consumption, but indirectly, with a constant or changing mode of engine operation and engine load changes (lower or higher load) assessed the relation to the changes in SO2 emissions, which had direct reflection on fuel consumption quantity.

In addition, the level of SO2 marks are not useful in testing using the module TRGA on the settling tank, because in the processing of heavy fuel with some content of water, the part of sulphurous compounds was formed insoluble salts of sulfuric acid, which was reduced the level of sulphurous gases.

At the same time during the operation of the Module TRGA on the settling tank the rest of the water was transformed into water-soluble emulsion, which at the same time increased the rate of combustion (fuel saving) and lower the burning temperature (reduction of NO).

CO parameter is specific for the integrity of the combustion of fuel and depends on:
- Fuel quality,
- The degree of dispersion of the injectors,
- Quantity of air in excess, which is maintained automatically and is about the same level.

NO parameter is typical indirect indicator for calorific fuel value and for presence of emulsified water in the fuel.

With all of the same conditions and with the same fuel consumption increasing of NO means increase of fuel combustion temperature, which is directly related to the fuel caloric values.

SO2 Parameter is directly related to the amount of fuel consumed in the engine with internal combustion, especially in the comparative tests.

So, the selection of a credible time intervals for measurements should be based on the interval (intervals), when the quantity of the SO2 in the flue gas are maximum stable, and does not depend on his absolute amount.

The credibility of this selection is confirmed by significantly reducing of SO2 in the transition from the engine with internal combustion to the engine using diesel oil, and with the highest and lowest points on the graphs when maneuvering the ship, including entrance of the ship in the area with sea current having good circumscribing limits, with the navigation through the short zones of less depth.

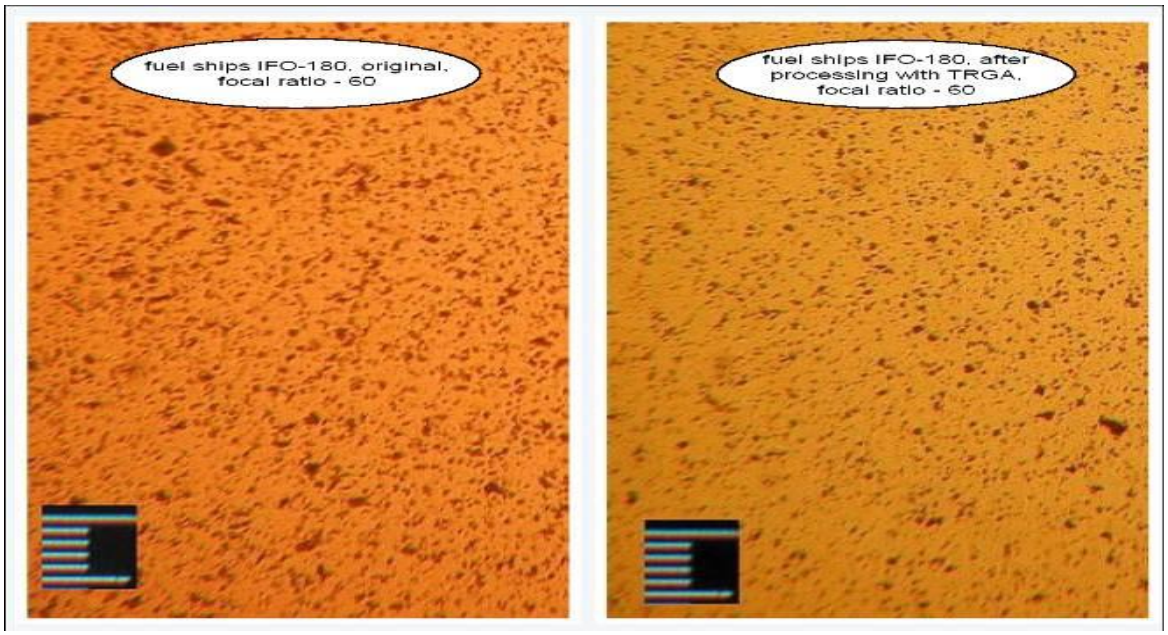
7. State of the engine with internal combustion

Before the start of testing both vessels' engine there were two major technical problems:
1. Worn of air turbine and
2. Worn of injectors including non optimal fuel dispersion.

Before the start of testing, the ship's crew installed a new air turbine on the port side engine with internal combustion, so all measurements should be carried out on the port side engine with internal combustion, because this engine shall produce relevant and useful information.

Relevant comments

1.1 It is certain that a result of fuel treatment with the Module TRGA is reducing/crushing hard resin particles and impurities in the fuel.



This causes a decrease of the fuel connectivity, which on other side increases fuel consumption on the injectors. So, there was a risk that the malfunctioning of injectors and unmodified coefficient of excess air will increase the amount of smoke and reduce the integrity of the fuel combustion.

1.2. The result of fuel processing with Module TRGA is fractional change in fuel composition, increase the amount of light fractions from the recombination of free radicals (which is also confirmed by the results of the fractional composition of petroleum products) and, as a result, increase the speed of the combustion of fuel in the cylinder, this reduce the amount of smoke, increase the integrity of combustion, of combustion temperature and increase of NO; there is no residual water in the emulsified fuel.

In this way, the function of Module TRGA on the buffer tank (with fuel processing separator without presence of residual water) has two effects in case of good function of injectors, one is the increase of the fuel amount and second higher speed, including the temperature of combustion. All this was useful to remember when analyzing the results!

2. The increase of exhausted gas temperature, which is confirmed by an increase in the amount of NOx, resulting the burning deposits in ship's funnel, accompanied by increased content of CO and smoke during the "funnel cleaning" 2 to 6 hours from the moment of use of Module TRGA for the fuel processing.

8. Specification of the measuring devices and selection of credible time intervals for measurements with respect to these features

8.1 All measurements were performed with certified gas analyzers made by Siemens (see also report from measuring laboratory). Special feature of this equipment is periodically reversing of current results due to automatic moderation of measuring devices.
For such reason those intervals were excluded from credible intervals and all intervals near zero values but also those intervals, where those parameters were decreased (before annulling) and increased (after annulling), before obtaining conditionally stable parameters.

8.2 From credible measurement results were excluded those parts of measurements, during which the change of paper for recording of data was changed. Such intervals were few, but all such intervals were marked and excluded.

8.3 Some of the measurements were duplicated in parallel with continuous work of gas analyzer, as the difference in sizes of CO was constant; we considered only first column from the measuring table.

8.4 The entire testing process was recorded by photos and on the tape/film.

There are photos and tapes taking the moments of start and stop of Modules for processing the fuel, as well as visual monitoring of smoke levels during engine operation in different regimes.

9. Compensators of tolerance and assumptions

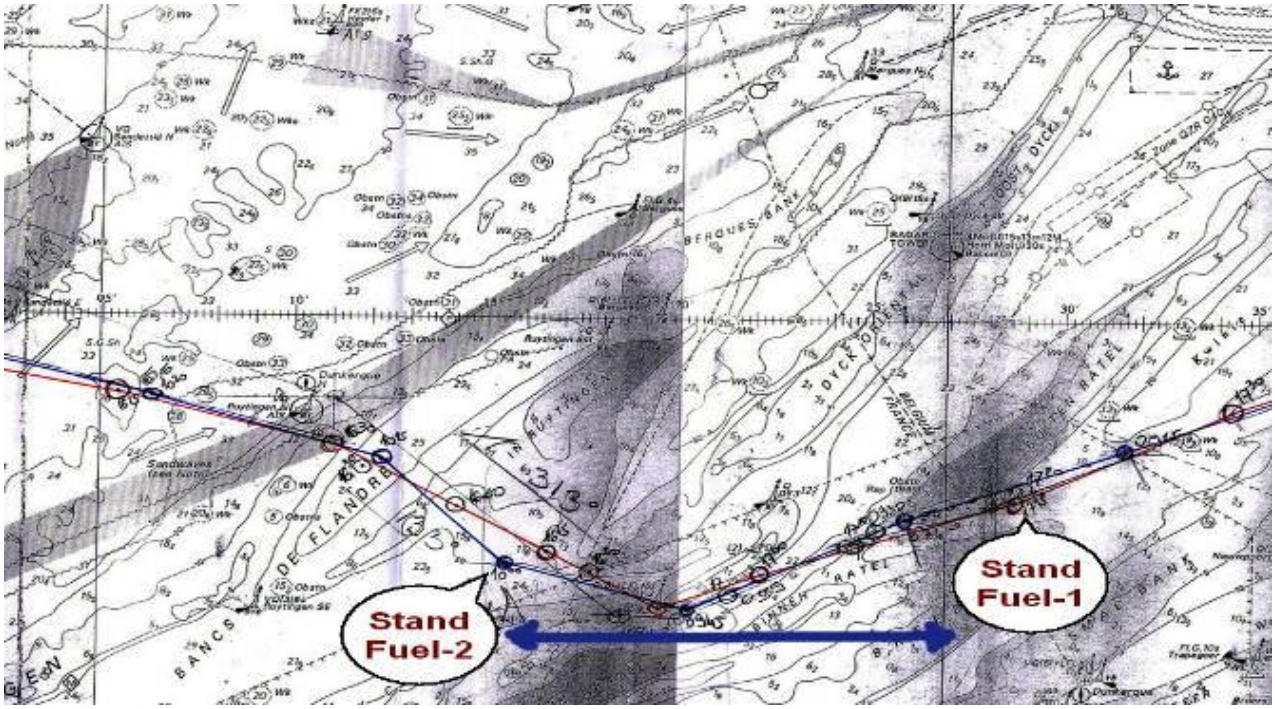
9.1 All tests were carried out in equal intervals, during regular navigational route between Oostende and Ramsgate (approx. voyage daily time was between 08.15 hrs am and 12.40 hrs)

and on navigation between Ramsgate to Oostende (the approximate voyage duration from 14.30 hrs to 16.40 hrs) or in the intervals morning/noon time and noon time/evening.

This approach guarantees mostly the same ambient temperatures.

9.2 Testing the basic operation of an engine with internal combustion, using standard fuel, without using the Module of homogenizer, was conducted in the following conditions:

9.2.1 Ship loaded with cargo (draft of 5 m)
9.2.2 Speed of side sea current was 1 Nm/h,
9.2.3 Wind - calm,
9.2.4 Sea - calm



9.2.5 Engine regime was stable.
9.2.6 Mode of measuring devices was stable.

The selection of a credible interval for measurements is described in detail in other sections of this Report.

9.3 Changes in quantities of fuel sludge formation during the operation of the ship's separator were recorded between 21 August 2012 and 14 September 2012, obtained from the ship owner, company TransEuropa Shipping Lines Ltd.

9.4. Evaluation of changes in the amount of smoke (quantity of exhausted gases) was performed visually, by photo and video records, including the comparison with similar ship of same class and with same engine and using same fuel.

The comparison is obvious. All photos have:
1. Automatically logged date: day, month and year, hour and minute
2. Time synchronization with the operation of measuring devices
3. Not been in any way repaired, improved or corrected, except for readability.

RO-RO ship »Larkspur«, where the testing was performed.

Sister ship, RO-RO »Gardenia«, owned by same company, Transeuropa Shipping Lines Ltd.

F.4.2 Plans for testing, data about technical parameters of the engine at the time of use of Module TRGA and weather conditions at the time of testing

1. Technical Specifications

Volume of preparatory tank is 250 liters.
Volume of main supply line from the preparatory tank before the engine with internal combustion is of 150 liters.
Fuel consumption on both engines with internal combustion was of 1.000 liters per hour, or 16 liters per minute.
Module TRGA capacity on the buffer tank is 100 liters per minute.
The fuel temperature on the outlet of the buffer tank reaches 85°C.
Module TRGA capacity on the settling tank is 133 liters per minute.

The fuel temperature at the entrance and at the exit from the Module on the settling tank was 20 to 50°C (at the entrance) and 25 to 55°C (on exit). The temperature of fuel heating by the Module on the settling tank was 5 to 3°C.
Measurement systems are installed on the port side engine, which has a new air turbine.

The amount of fuel sludge from the ship's separator is 10 cbm in 14 days of operation or 0,7 cbm per day (the amount of fuel sludge shall be checked also after 45 days).

2. Information about voyages

Average navigation duration was between 225 and 240 minutes.

Route between Oostende and Ramsgate
5 minutes on course 305° (AA) and 30 minutes on course 265° (BB)
60 minutes on course 245° (CC) and 130 minutes on course 295° (DD)

Route between Ramsgate – Oostende
130 minutes on course 115° (DD) and 60 minutes on course 65° (CC)
30 minutes on course 85° (BB) and 5 minutes on course 125° (AA)

	Data	***Notes***
Date	19 August 2012	
Place and event Measurements on the PORT side engine 19-test-1	Port of Oostende, Belgium. Navigation from Oostende to Ramsgate All Modules TRGA are switched OFF. Engine start: 08.09 hrs Leaving the Pear 08.15 hrs Maneuvering start on arrival 11.41 hrs Arrival Ramsgate 12.48 hrs Switch ON of Module TRGA on the buffer tank at 09.28 hrs Module on the buffer tank was operative on arrival to Ramsgate, on maneuvering and berthing and on departure from Ramsgate. Data from the ship's bridge Log: 19 August 2012 Wind: SW, force 1 Sea: calm Draft: 5,0 m Current: speed 0,8 to 1,2 Nm/h Cargo: 1.555,5 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines. Switch ON of Module on the buffer tank was affected after longer period of time.

	Data	***Notes***
Date	19 August 2012	
Place and event Measurements on the PORT side engine 19-test-2	Port of Ramsgate, UK. Navigation from Ramsgate to Oostende Module TRGA on the buffer tank is switched ON. Engine start: 14.10 hrs Leaving the Pear 14.20 hrs Arrival Oostende 18.40 hrs Data from the ship's bridge Log: 19 August 2012 Wind: calm Sea: calm Draft: 5,0 m Current: speed 0,0 Nm/h Cargo: 3.700 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

	Data	***Notes***
Date	20 August 2012	
Place and event Measurements on the PORT side engine 20-test-1	Port of Oostende, Belgium Navigation from Oostende to Ramsgate Module TRGA on the buffer tank is switched ON. Engine start: 07.40 hrs Leaving the Pear 07.50 hrs Arrival Ramsgate 12.20 hrs Data from the ship's bridge Log: 20 August 2012 Wind: W, force 4 Sea: 2 Draft: 4,6 m Current: speed 0,4 Nm/h Cargo: 534,5 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

	Data	***Notes***
Date	20 August 2012	
Place and event Measurements on the PORT side engine 20-test-2	Port of Ramsgate, UK. Navigation from Ramsgate to Oostende Module TRGA on the buffer tank is switched ON. Engine start: 14.20 hrs Leaving the Pear 14.30 hrs Arrival Oostende 18.25 hrs Data from the ship's bridge Log: 20 August 2012 Wind: SE, force 1 - 5 Sea: 4 Draft: 5,0 m Current: speed 0,0 Nm/h Cargo: 590,4 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

	Data	***Notes***
Date	21 August 2012	
Place and event Measurements on the PORT side engine 21-test-1	Port of Ramsgate, UK. Navigation from Ramsgate to Oostende Module TRGA on the buffer tank is switched ON. Module TRGA on the settling tank is switched ON. Engine start: 14.20 hrs Leaving the Pear 14.30 hrs Arrival Oostende 18.25 hrs Data from the ship's bridge Log: 21 August 2012 Wind: NE, force 8 Sea: 2 Draft: 4,6 m Current: speed 0,1 Nm/h Cargo: 365,0 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

	Data	***Notes***
Date	22 August 2012	
Place and event Measurements on the PORT side engine 22-test-1	Port of Oostende, Belgium Navigation from Oostende to Ramsgate Module TRGA on the buffer tank is switched OFF. Module TRGA on the settling tank is switched ON. Engine start: 07.40 hrs Leaving the Pear 07.50 hrs Arrival Ramsgate 12.03 hrs Data from the ship's bridge Log: 22 August 2012 Wind: W, force 5 Sea: 3 Draft: 4,7 m Current: speed 0,5 to 1,25 Nm/h Cargo: 596,5 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

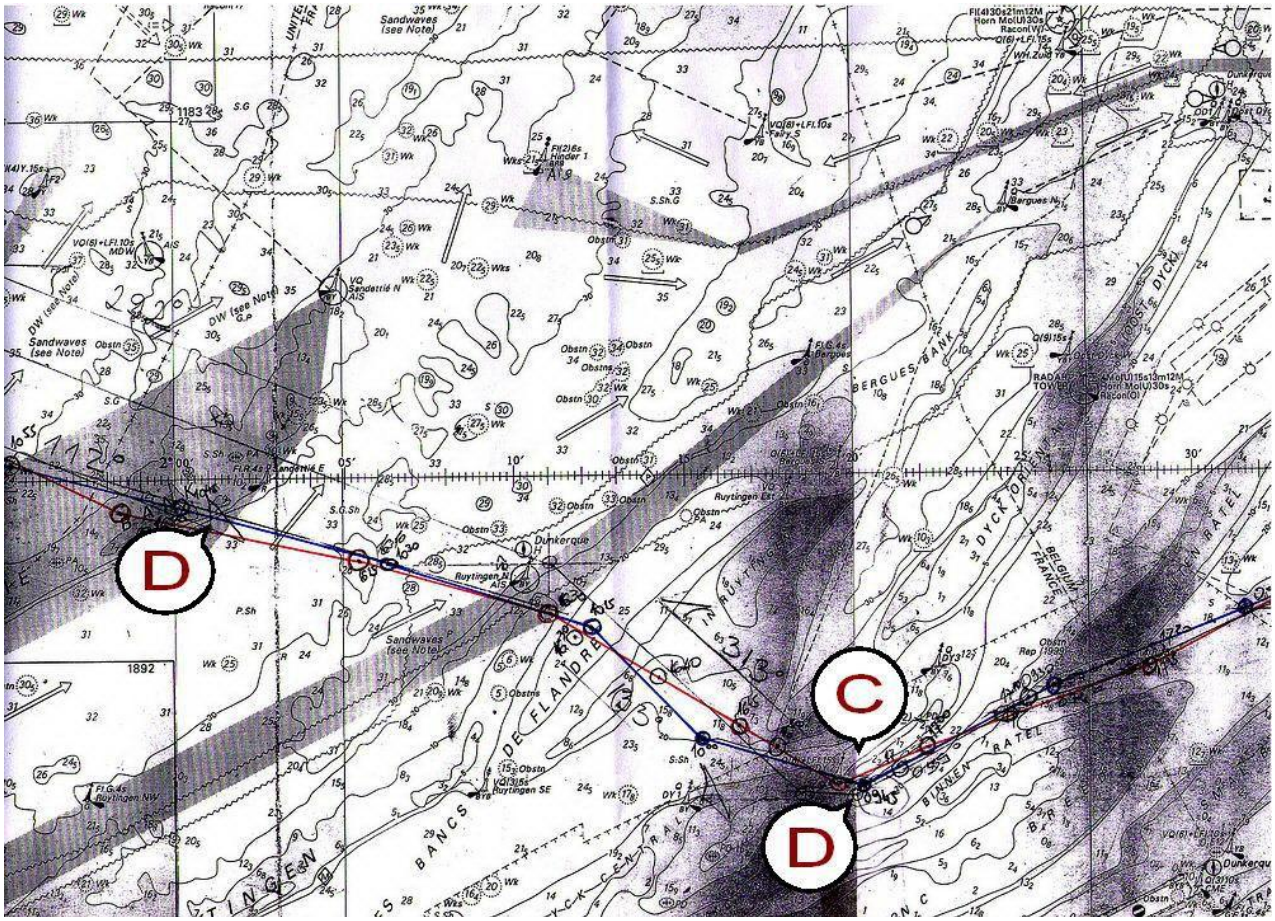
	Data	***Notes***
Date	22 August 2012	
Place and event Measurements on the PORT side engine 22-test-2	Port of Ramsgate, UK. Navigation from Ramsgate to Oostende Module TRGA on the buffer tank is switched ON. Module TRGA on the settling tank is switched ON. Engine start: 14.20 hrs Leaving the Pear 14.30 hrs Arrival Oostende 18.20 hrs Data from the ship's bridge Log: 22 August 2012 Wind: WSW, force 2 Sea: 2 Draft: 4,6 m Current: speed 0,5 to 1,25 Nm/h Cargo: 501,0 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

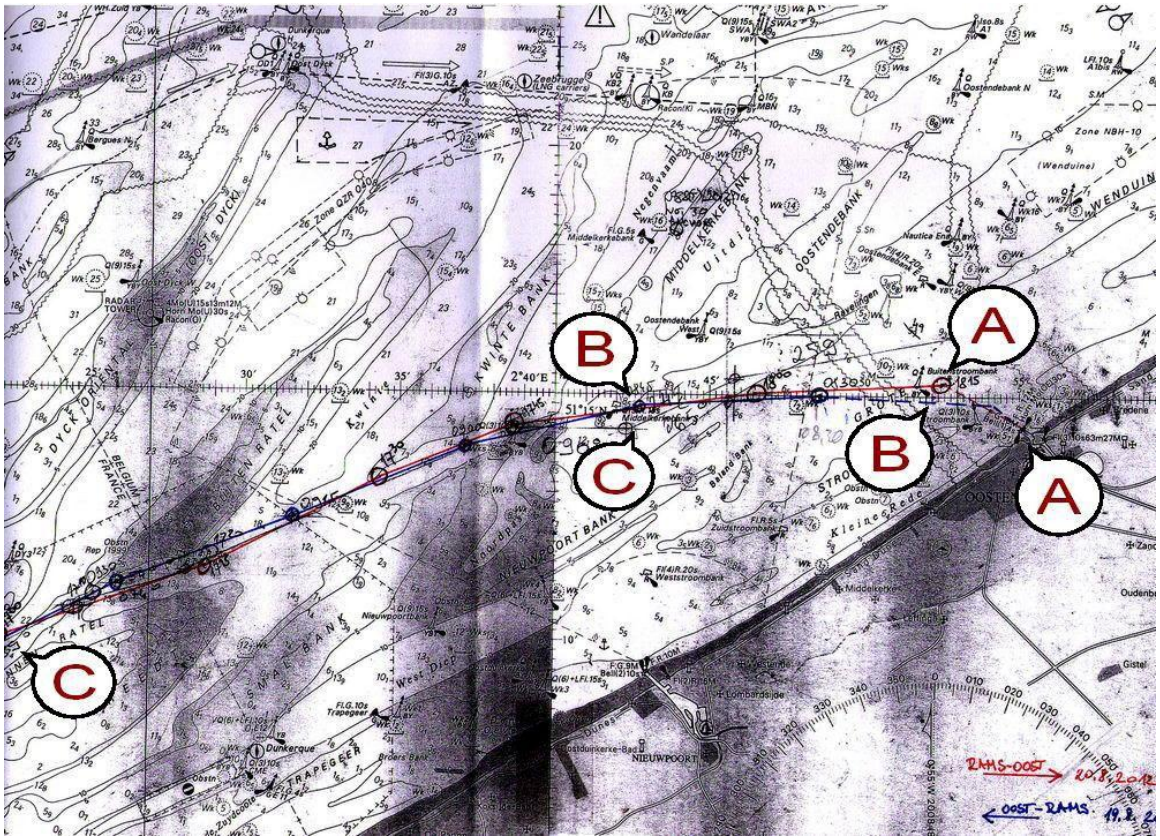
F.4.3 Navigational Charts
(Route Oostende, Belgium – Ramsgate, UK – Oostende, Belgium)

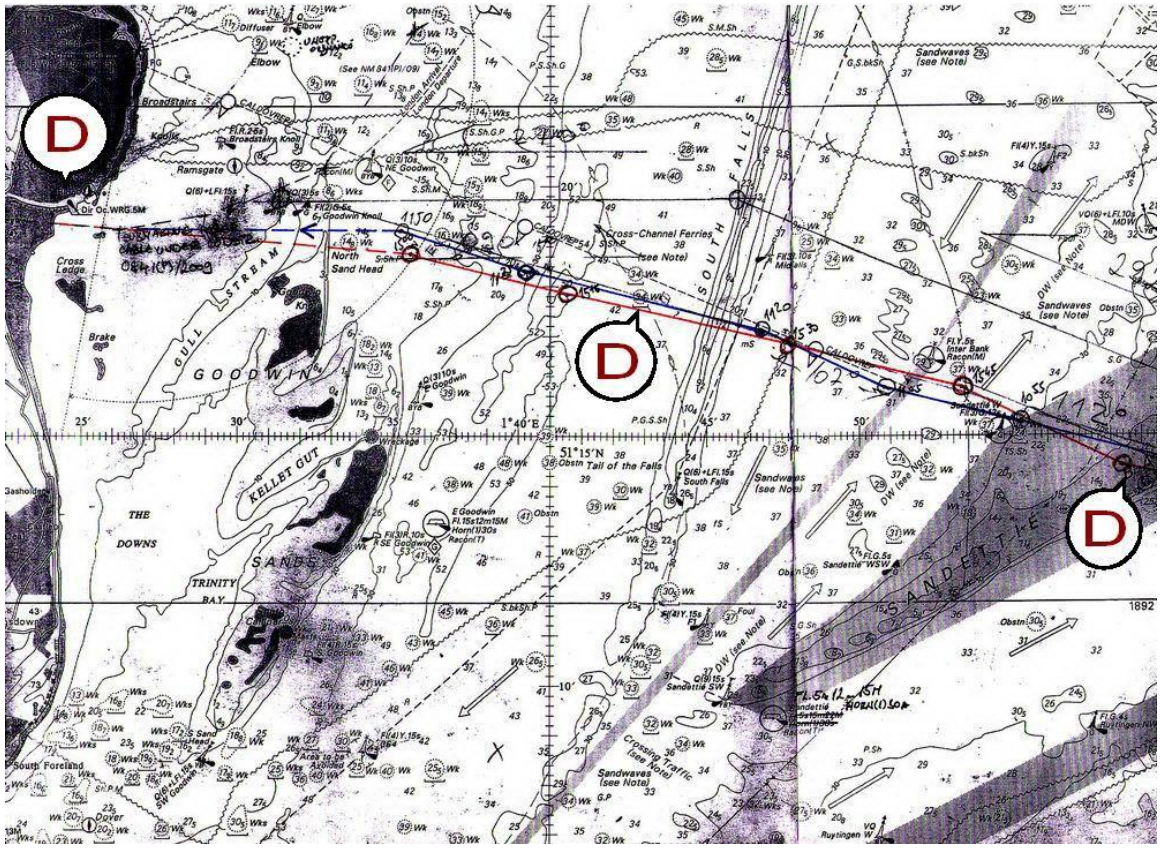
The course on route Oostende (B) – Ramsgate (UK):
5 minutes on course 305° (AA)
30 minutes on course 265° (BB)
60 minutes on course 245° degrees (CC)
130 minutes on course 295° (DD)

The course on route Ramsgate (UK) – Oostende (B)
130 minutes on course 115° (DD)
60 minutes on course 65° (CC)
30 minutes on course 85° (BB)
5 minutes on course 125° (AA)

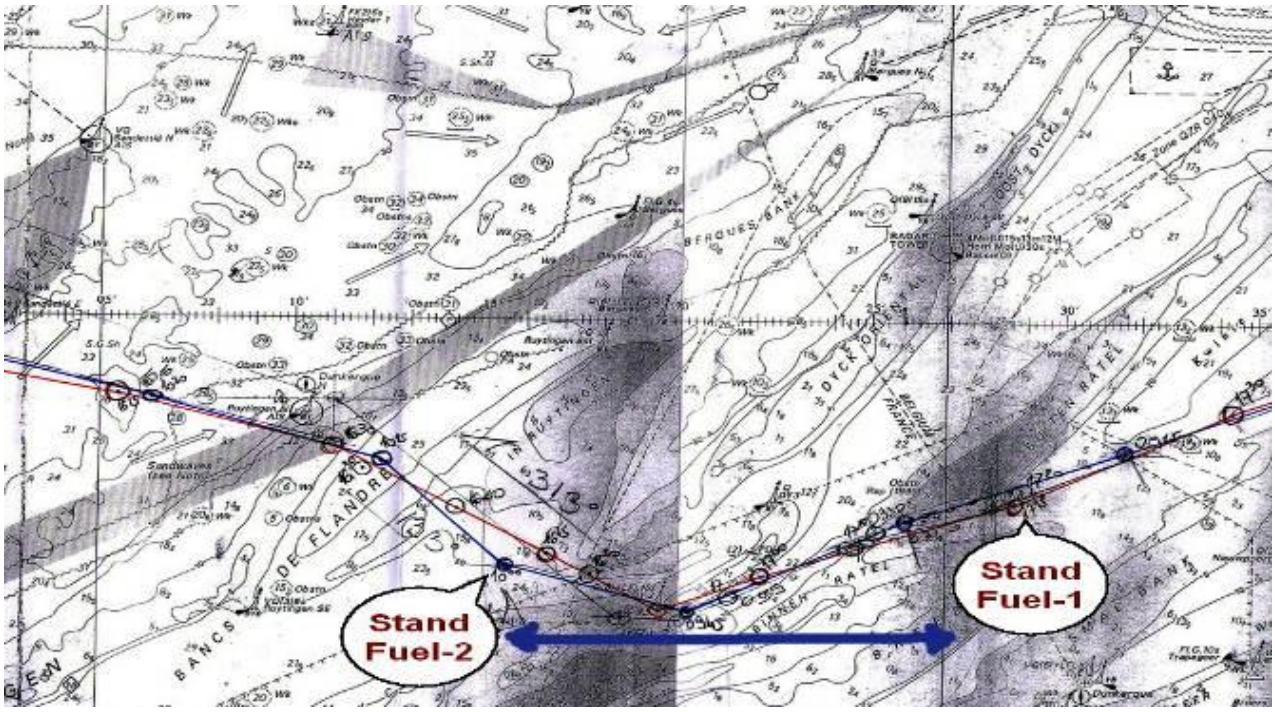
Area selected for measuring of emissions using standard fuel

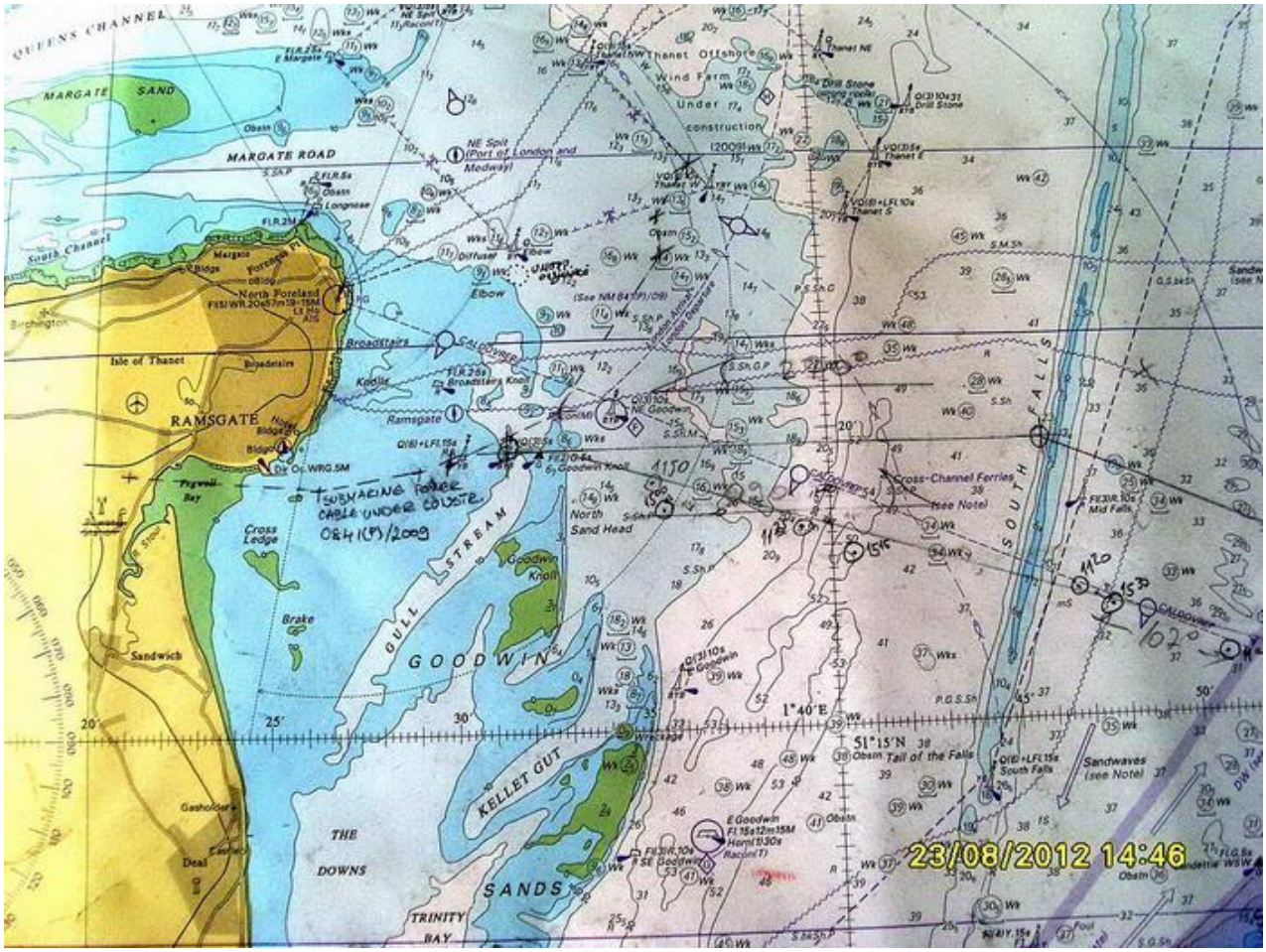






Area selected for measuring of emissions using standard fuel



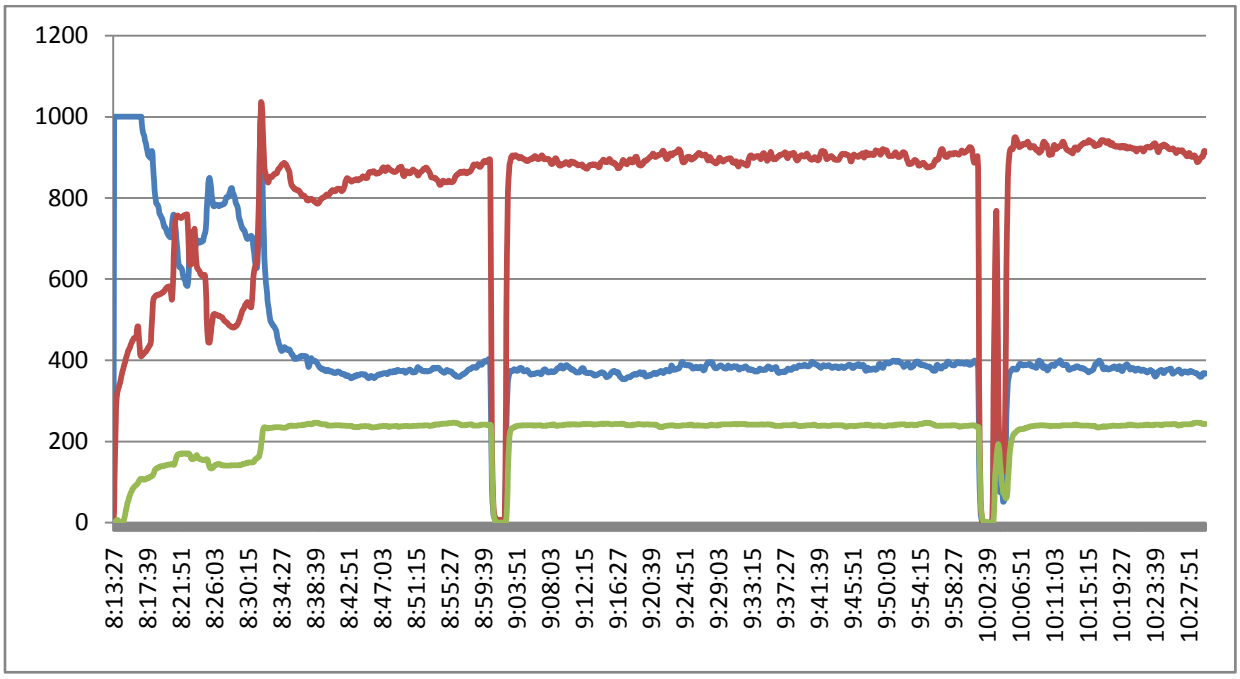


Area selected for measuring of emissions using standard fuel

F.4.4 Selection of credible area for emission measurements during the engine operation on the standard fuel (19 August 2012)

Baseline data

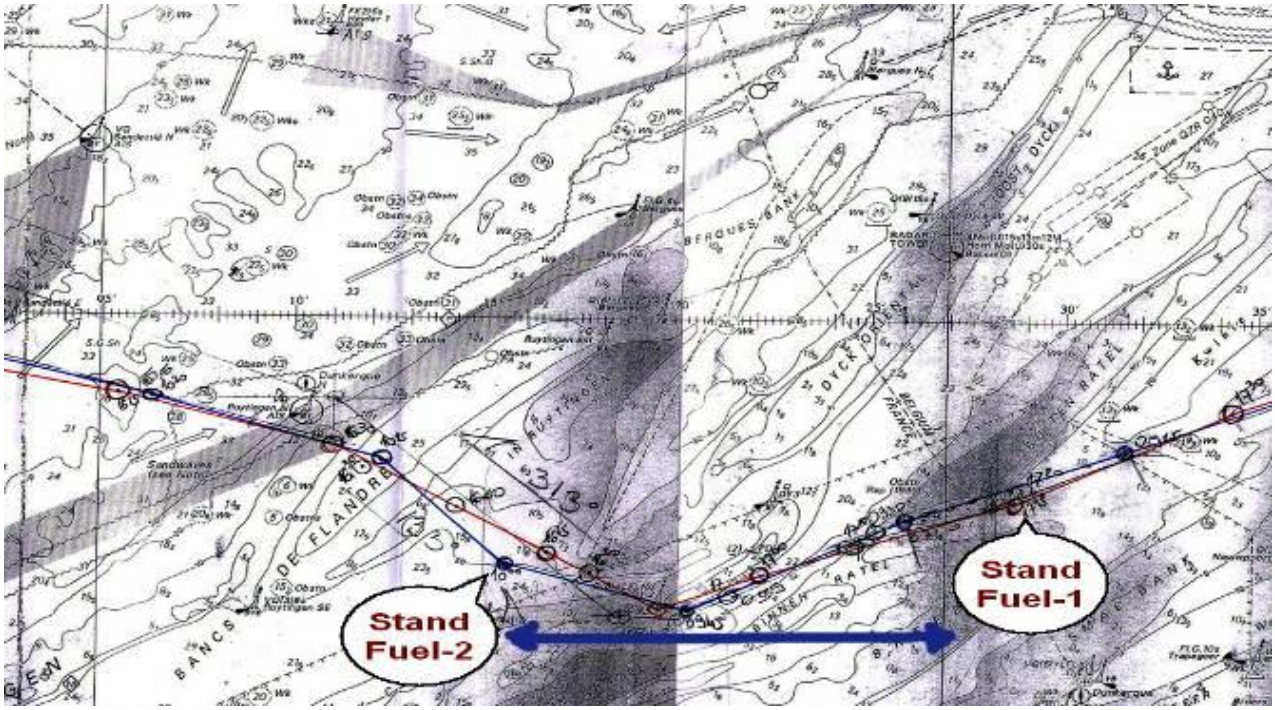
1. Engine start was at 08.13 am, on 19 August 2012,
2. Intervals between 09.02 and 09.03 almost were away for moderation and transitional regimes in the gas analyzer,
3. Time required for a complete replacement from standard fuel to the treated fuel (volume of preparatory tank is 250 liters, system volume is 150 liters, fuel consumption is 16 liters per minute) for duration of 25 minutes,
4. Module for homogenization was running on the buffer tank at 09.35 hrs.



The requirement for the selection of a credible area was because of no significant fluctuations in the smoke gas parameters (stable operating mode) according to the criteria (by subtracting the regional areas and associated to him areas of moderation):

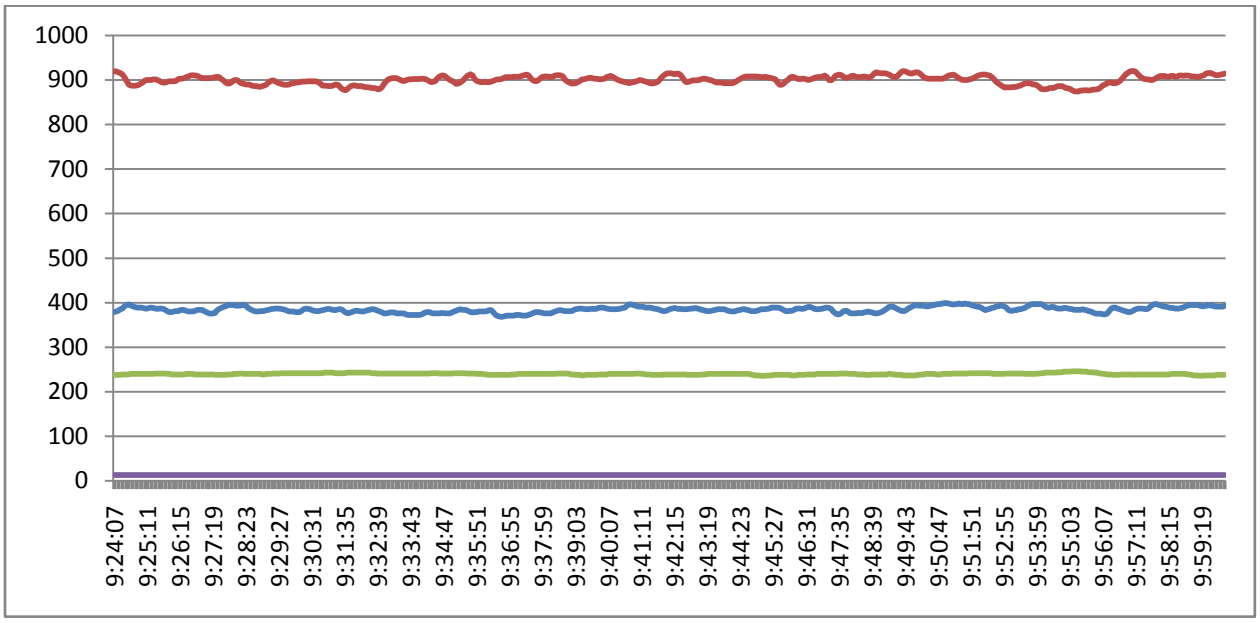
	Parameter	Interval, which respond to this criteria
1	**SO – indicator of fuel consumption**	from 08.41 to 09.59 hrs
2	**NO – rough indicator of constant engine load**	from 09.10 to 09.51 hrs
3	**CO – exact indicator of engine load**	from 09.22 to 09.58 hrs
4	**Start of use of treated fuel on engine injectors**	from 10.00 to 10.05 hrs
5	All loads included	from 09.24 to 10.00 hrs

Selected area on the nautical chart



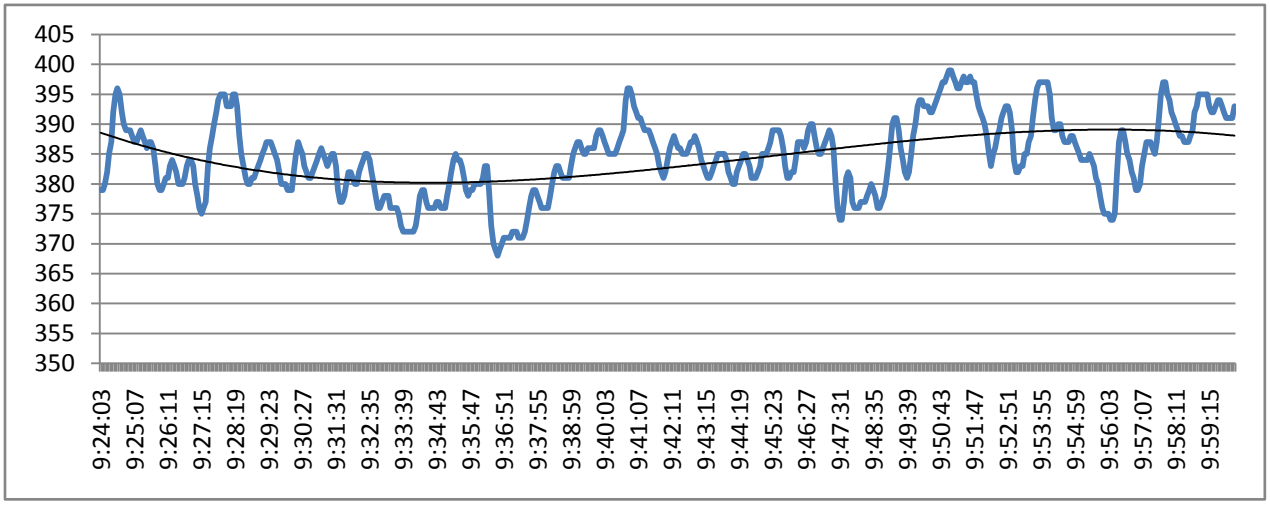
Specific features of the area chosen:

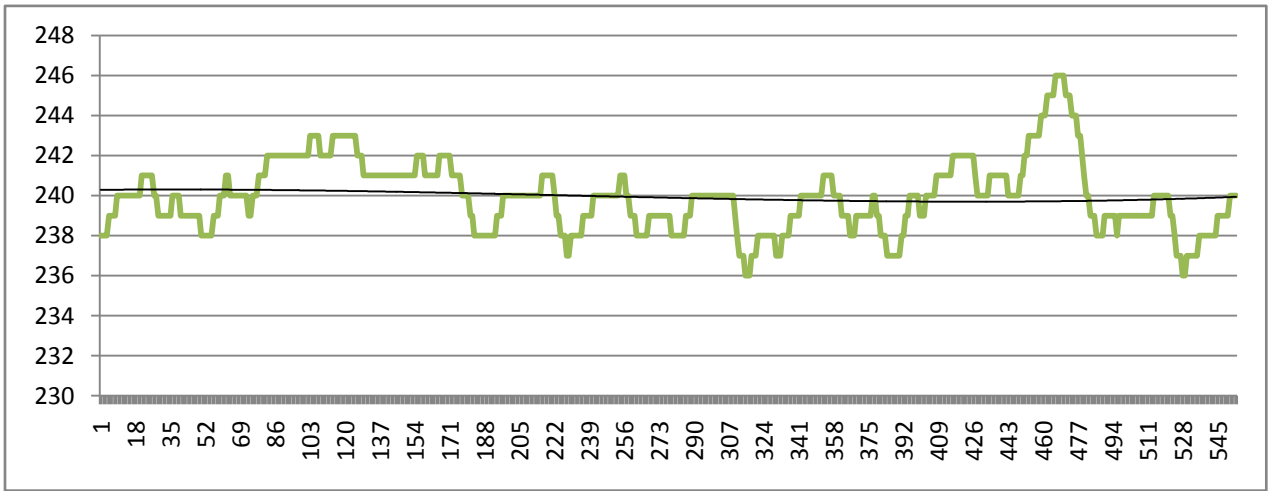
- A relatively longer duration of 34 minutes, which allows the equalization of differences in the operation of the engine,
- No longer shallow water areas,
- Symmetrical courses from and to destination Ports as: 245° and 295° to 310°,
- Majority lateral sea current that provides lower resistance than front current direction
- Stable modes of engine operation (see chart below)

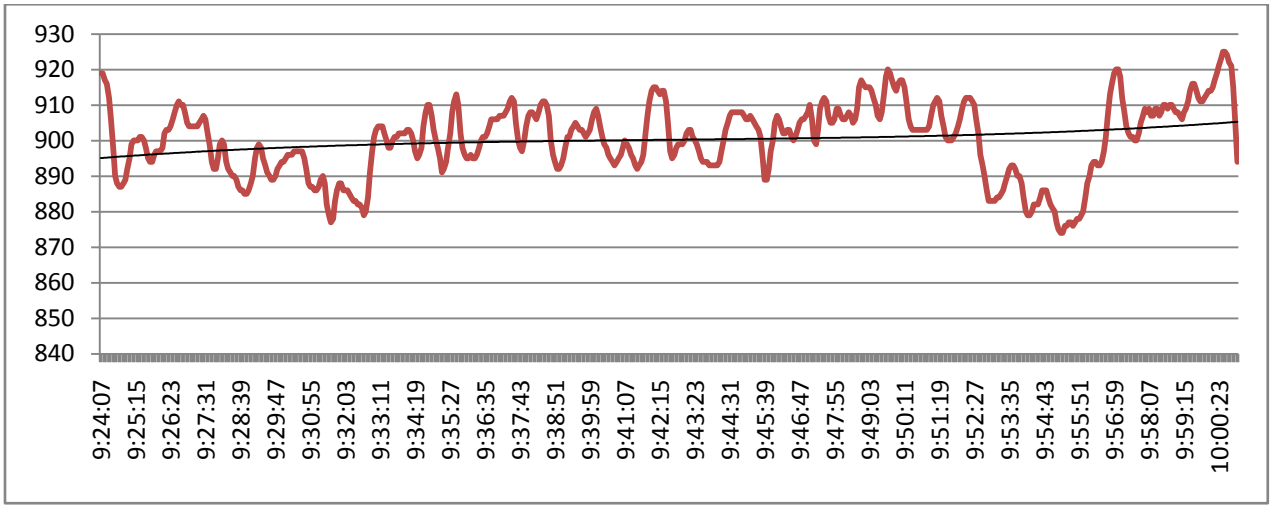


Medium quantities of smoke gases: CO = 384.581 NO = 899.84 SO = 239.96

Special Chart of CO SO2 NO emissions in correlation with trends confirming stable engine





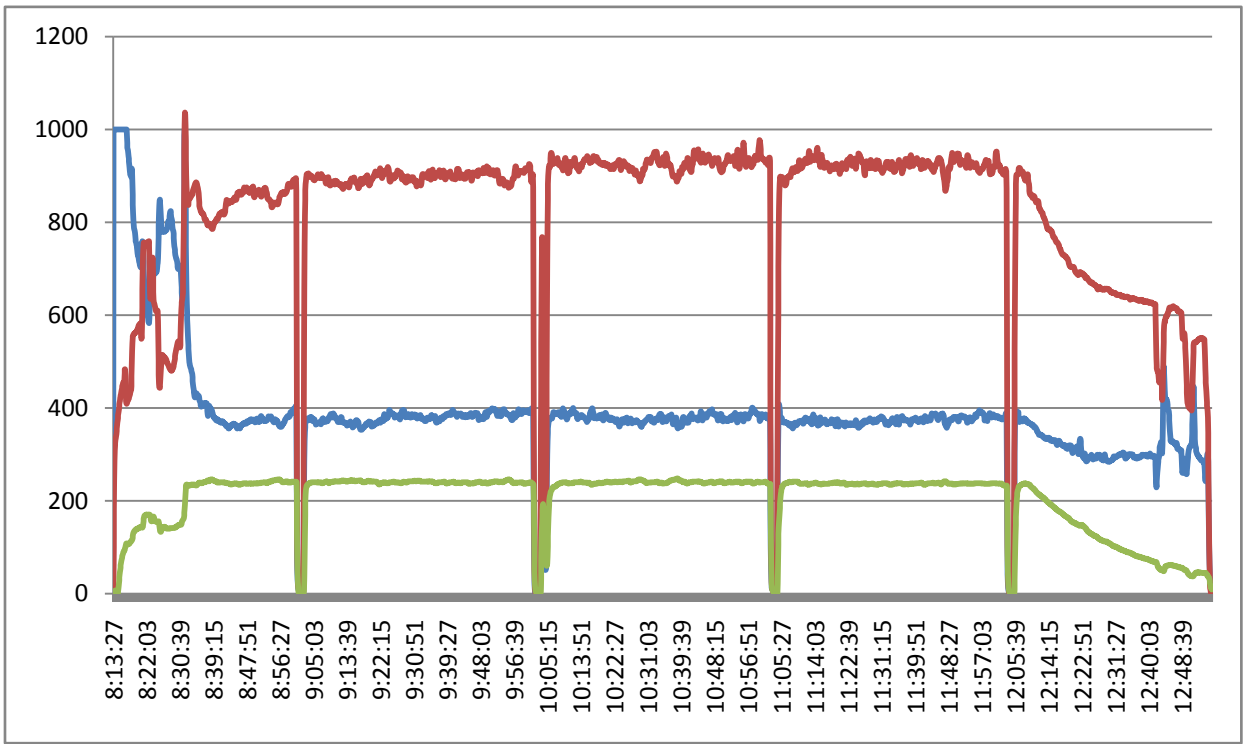


In this way, during the running of the engine on a standard, non treated fuel, with the highest level of credibility following levels of smoke gases was measured:
CO = 384.581 NO = 899.84 SO = 239.96

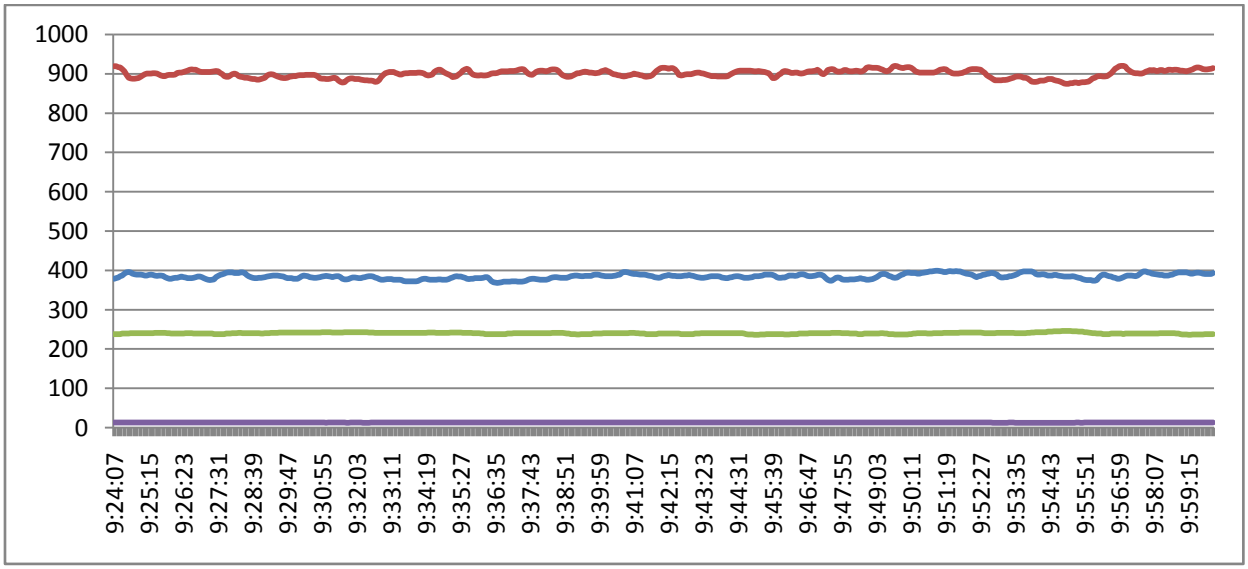
F.4.5 The comparative results of the emissions performance with standard fuel (19 August 2012) and during the operation with the treated fuel - Module TRGA on the buffer tank, with subsequent disconnection of the Module

	Data	***Notes***
Date	19 August 2012	
Place and event Measurements on the PORT side engine	Port of Oostende, Belgium. Navigation from Oostende to Ramsgate **All Modules TRGA are switched OFF.** Engine start: 08.09 hrs Leaving the Pear 08.15 hrs Maneuvering start on arrival 11.41 hrs Arrival Ramsgate 12.48 hrs	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases.
19-test-1	**Switch ON of Module TRGA on the buffer tank at 09.28 hrs** Module on the buffer tank was operative on arrival to Ramsgate, on maneuvering and berthing and on departure from Ramsgate. Data from the ship's bridge Log: 19 August 2012 Wind: SW, force 1 Sea: calm Draft: 5,0 m Current: speed 0,8 to 1,2 Nm/h Cargo: 1.555,5 tons	Wear of fuel injectors on both engines. Switch ON of Module on the buffer tank was affected after longer period of time.

Overall chart of navigation



Operation on the standard (untreated) fuel, Area of stabilized parameters

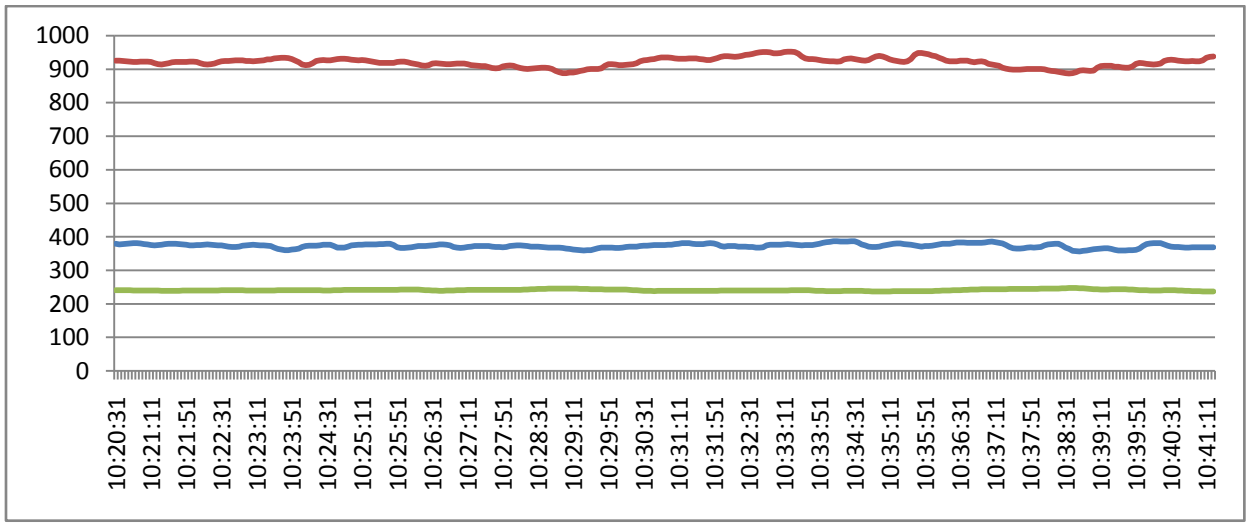


Numerical values of smoke gases with use of standard fuel:
CO = 384.581 SO = 239.96 NO = 899.84 are the standard values.

<u>Switch ON of the module TGA 3G on the buffer tank at 09.28hrs</u>
Delay due to arrival of treated fuel in the system for 25 minutes

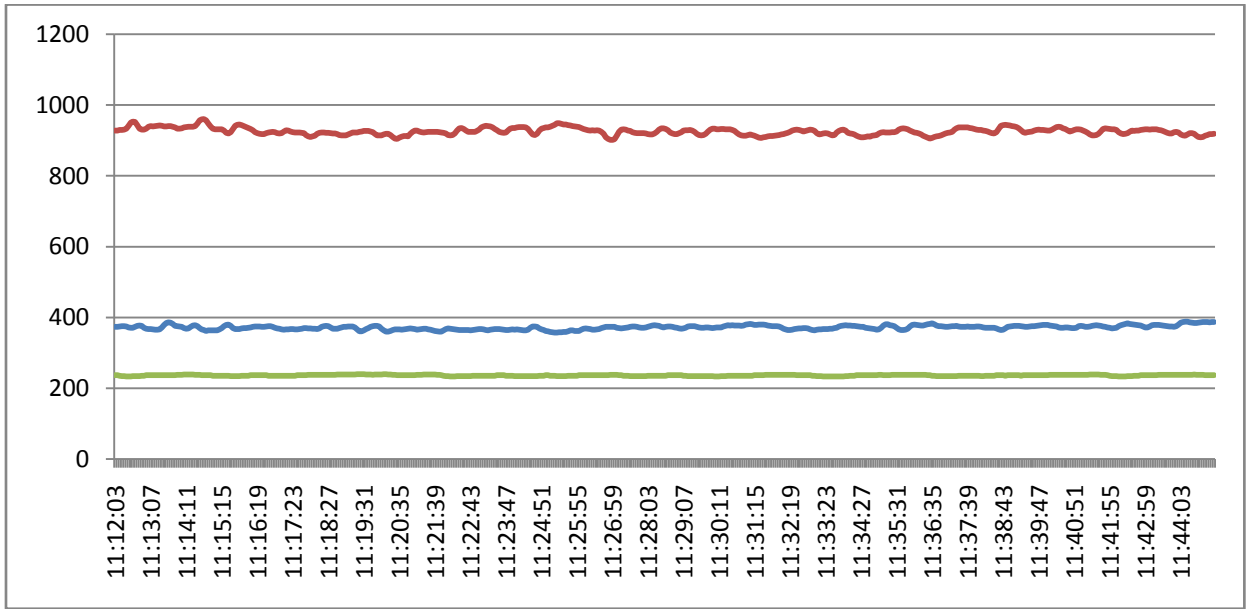
Overall Chart of emissions from the start of engine on the treated fuel and before start of use of diesel oil

Chart of verified intervals for measurements



Average values of smoke gases using the treated fuel

CO = 372.9 (-3%) SO2 = 241.2 (+0.54%) NO = 920 (+2.24%)



Average values of smoke gases using treated fuel

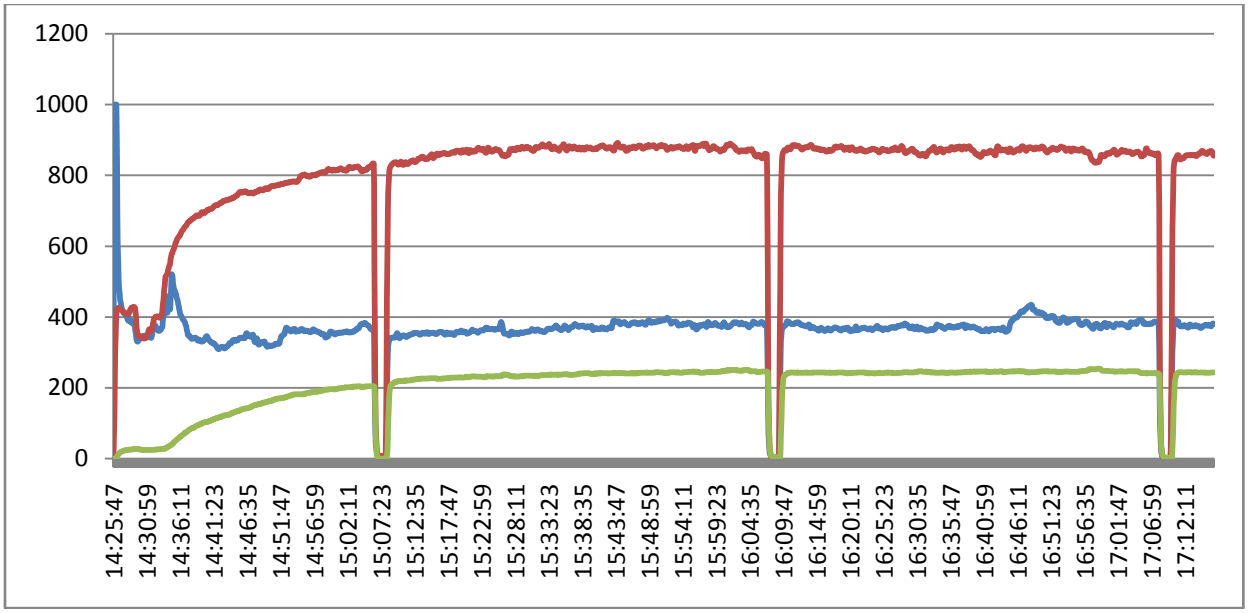
CO = 371.6 (-3.38%) SO2 = 236.7 (-1.35%) NO = 925.3 (+2.8%)

Observations:

1. Fuel was processed in the buffer tank.
2. Measurements are carried out continuously, immediately after changing the fuel from the buffer tank.

The only reason for the increase of the amount of NO is increase of the temperature in the combustion of fuel, or increase of the integrity of the combustion of fuel. This information is confirmed by reducing the level of CO.
This process is accompanied by increase of the temperature in exhausted gases, which causes a slow burning of funnel lining. This proves initial increase and then decrease of the level of SO2.

	Data	Notes
Date	19 August 2012	
Place and event Measurements on the PORT side engine 19-test-2	Port of Ramsgate, UK. Navigation from Ramsgate to Oostende **Module TRGA on the buffer tank is switched ON.** Engine start: 14.10 hrs Leaving the Pear 14.20 hrs Arrival Oostende 18.40 hrs Data from the ship's bridge Log: 19 August 2012 Wind: calm (not exact data) Sea: calm Draft: 5,0 m Current: speed 0,0 Nm/h Cargo: 3.700 tons **Module TRGA on the buffer tank switched OFF at 16.00 hrs**	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

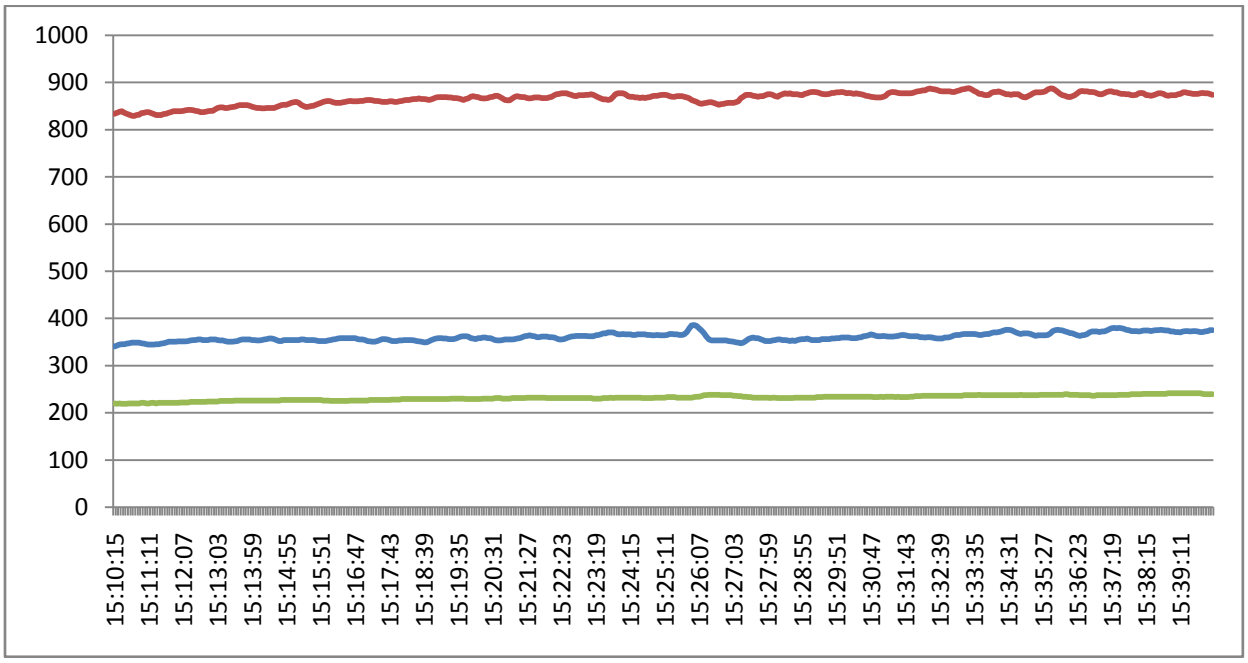


Exchange of the diesel oil with marine fuel from the buffer tank was started 10 minutes after departure from the Port of Ramsgate and we cannot explain following fact:

Why after 10 + 25 = 35 minutes and even later, from 15.10 hrs to 15.40 hrs, mainly in 75 minutes the level of SO_2 arise on former level of 240 ppm?

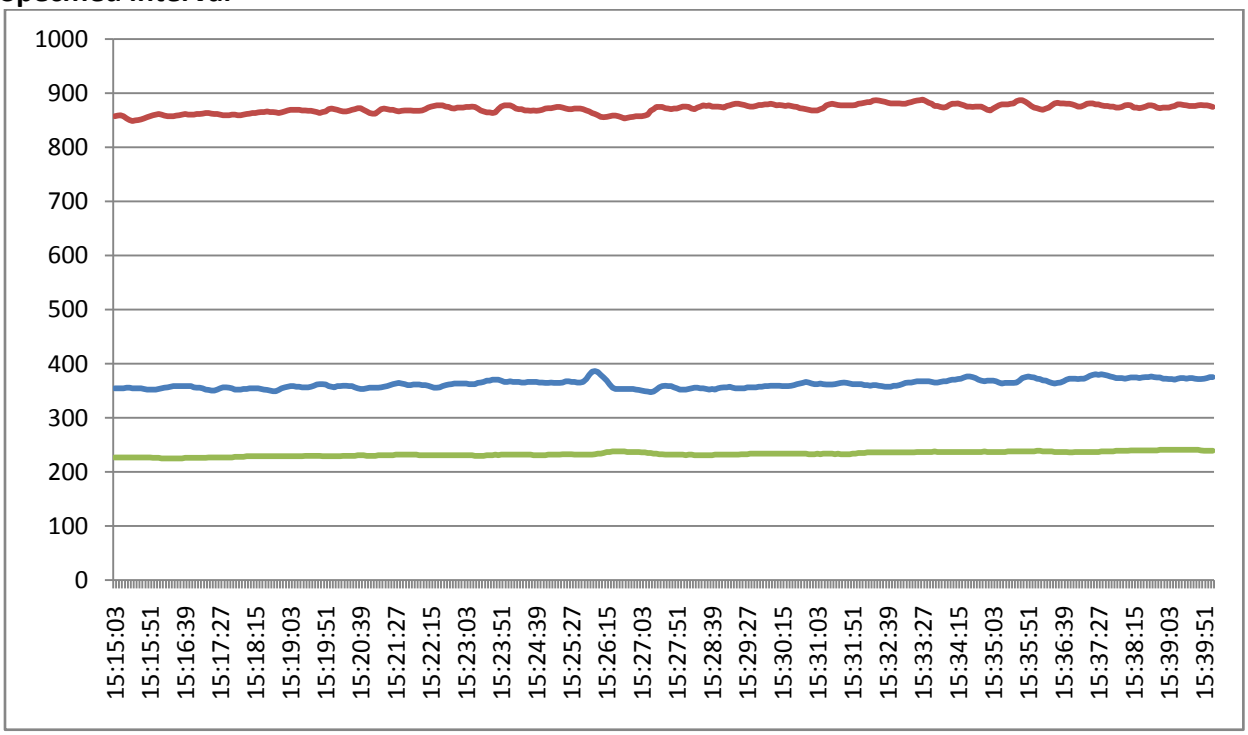
Having in mind that that vessel was carried two times more cargo onboard then on previous testing, the weather conditions were the same, in both testing no wind and no sea current was observed.

Chart of verified intervals for measurements 1.



Average values of smoke gases using treated fuel
CO = 360 (-6.4%) SO2 = 231.6 (-3.47%) NO = 866 (-3.76%)
(using standard fuel - CO = 384.58 SO = 239.96 NO = 899.84)

Specified interval



Average values of smoke gases using treated fuel
CO = 362.11 (-5.84%) SO2 = 231.63 (-3.47%) NO = 871 (-3.2%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)

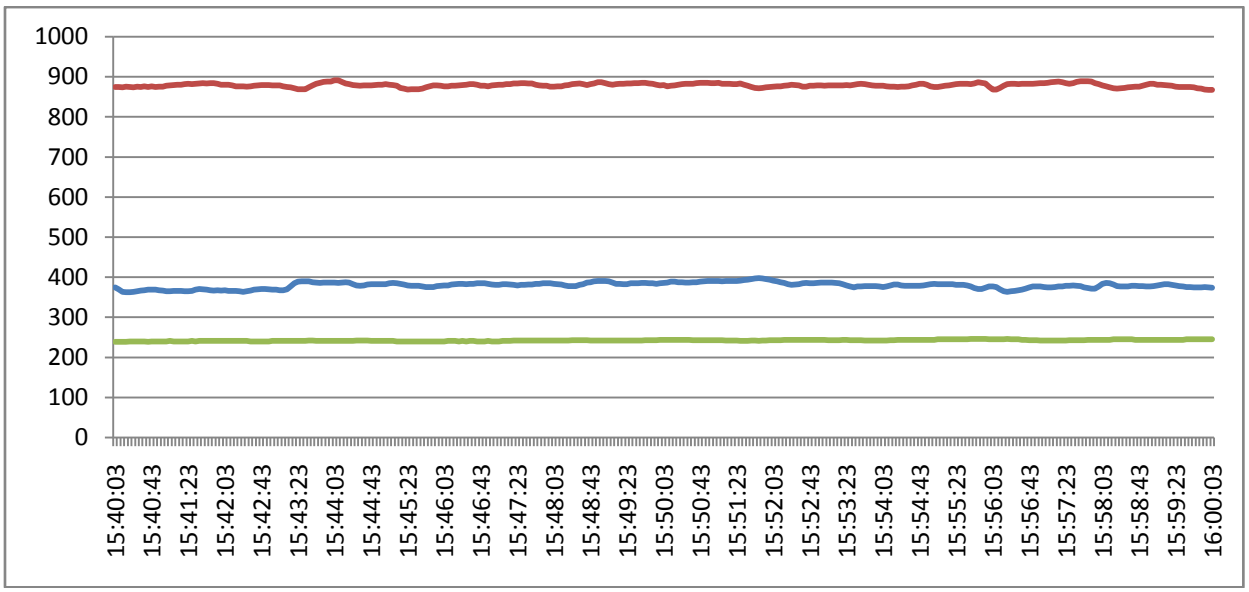
Observations:

1. At first startup of Module TRGA the following effects were generated:
1.1. Dilution of existing resin deposits in the fuel system and combustion of the same in the engine;
1.2. The increase of temperature of exhausted gases.

This caused a short-term increase of smoke, quantity and size of particles in the smoke gases and the increase of SO2 emissions due to combustion deposits in the funnel tube.

The time need to complete the combustion process depends on each system separately and can be varied from 2 to several hours.

Chart of verified intervals for measurements 2.

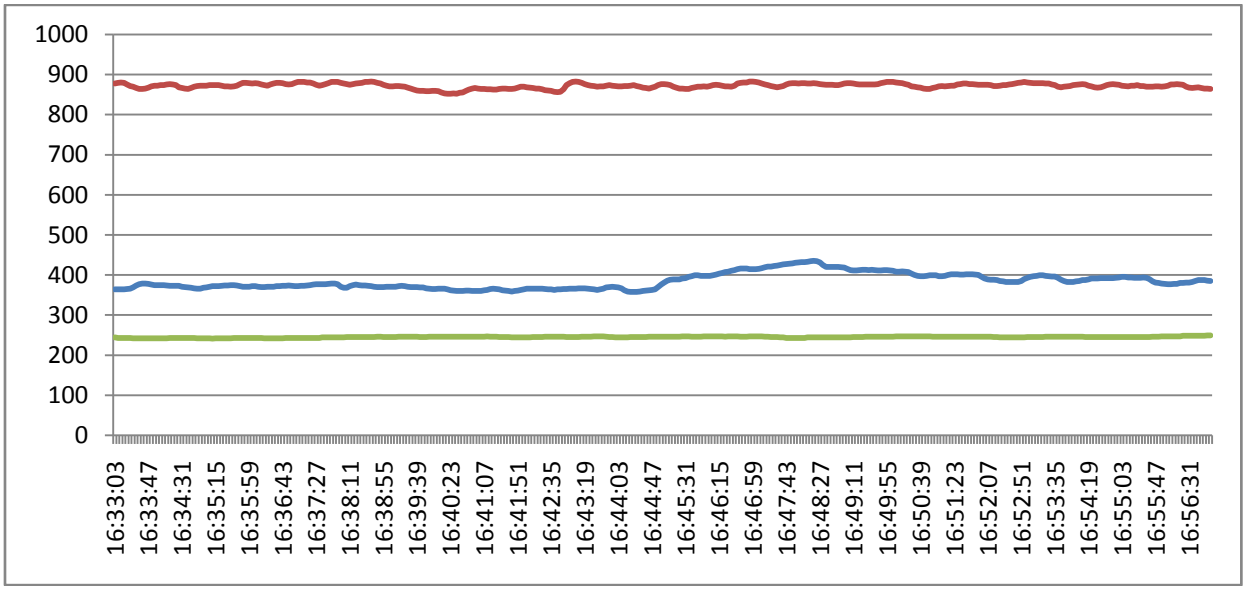


Time interval from 15.40 to 15.51 hrs, front wind and sea current were present.

Average values of smoke gases using treated fuel
CO = 379.8 (-1.24%) SO2 = 242.36 (+1%) NO = 878.7 (-2.3%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)

In this way, the fuel combustion was higher (more SO_2), level of CO was lower.

Interval of certified measurements with Module TRGA connected on preparatory tank



Average values of smoke gases using treated fuel
CO = 384.5 (0%) SO2 = 245 (+2.3%) NO = 871 (-3.2%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)

After disconnection of Module TRGA from the preparatory tank (at 16.00 hrs) and burned of all treated fuel (+25 minutes), the emissions of CO were returned on same levels.

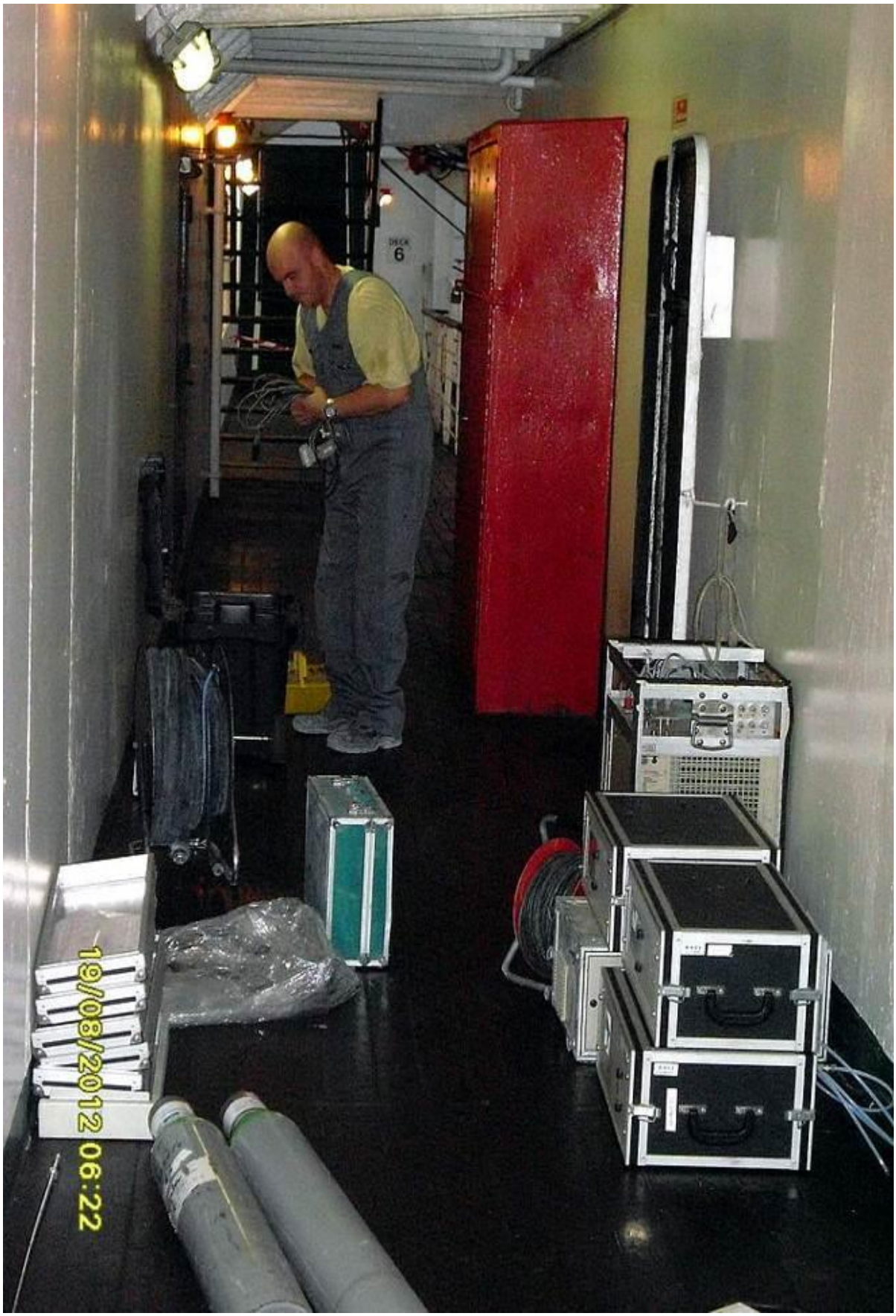
CONCLUSION

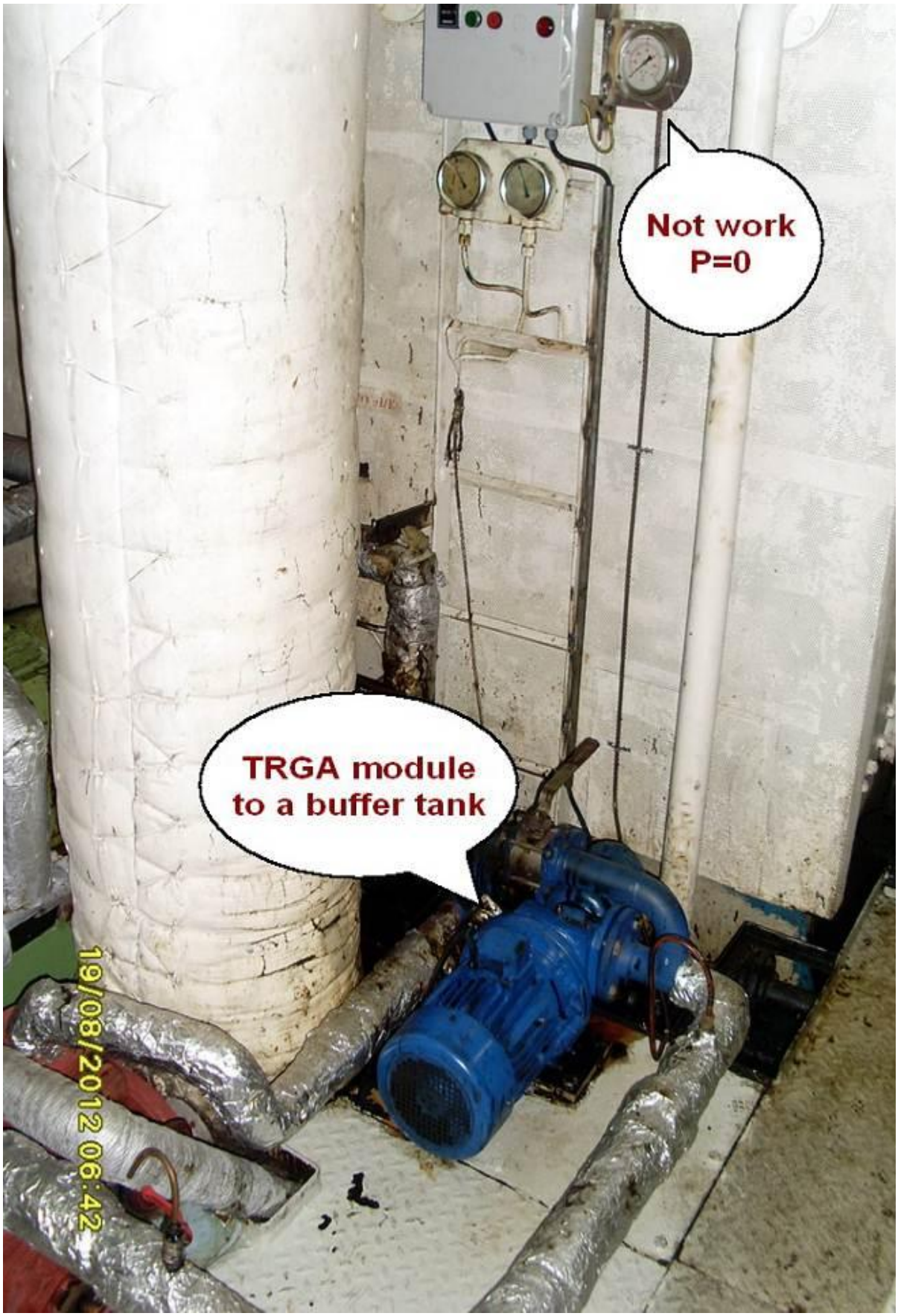
Navigational time was 4 hours and 30 minutes in both directions. This confirms the fact that more loaded ship also increase fuel consumption, but in the case of calm wind and sea, when the ship's speed is constant or equal due to automatically leveling of engine revolutions.

Use of Module TRGA for treatment of heavy fuel on the buffer tank, having in mind double increase of cargo onboard, decreased the CO emissions as follows:

а) On entire time interval	from -1.24% to -6.4 %
б) With excluding of interval of frontal wind	from -3.38% to -6.4 %

The short photo session as approval is following.


DECK
6
19/08/2012 06:22


Not work
P=0
TRGA module
to a buffer tank
19/08/2012 06:42


19/08/2012 08:26


19/08/2012 08:33

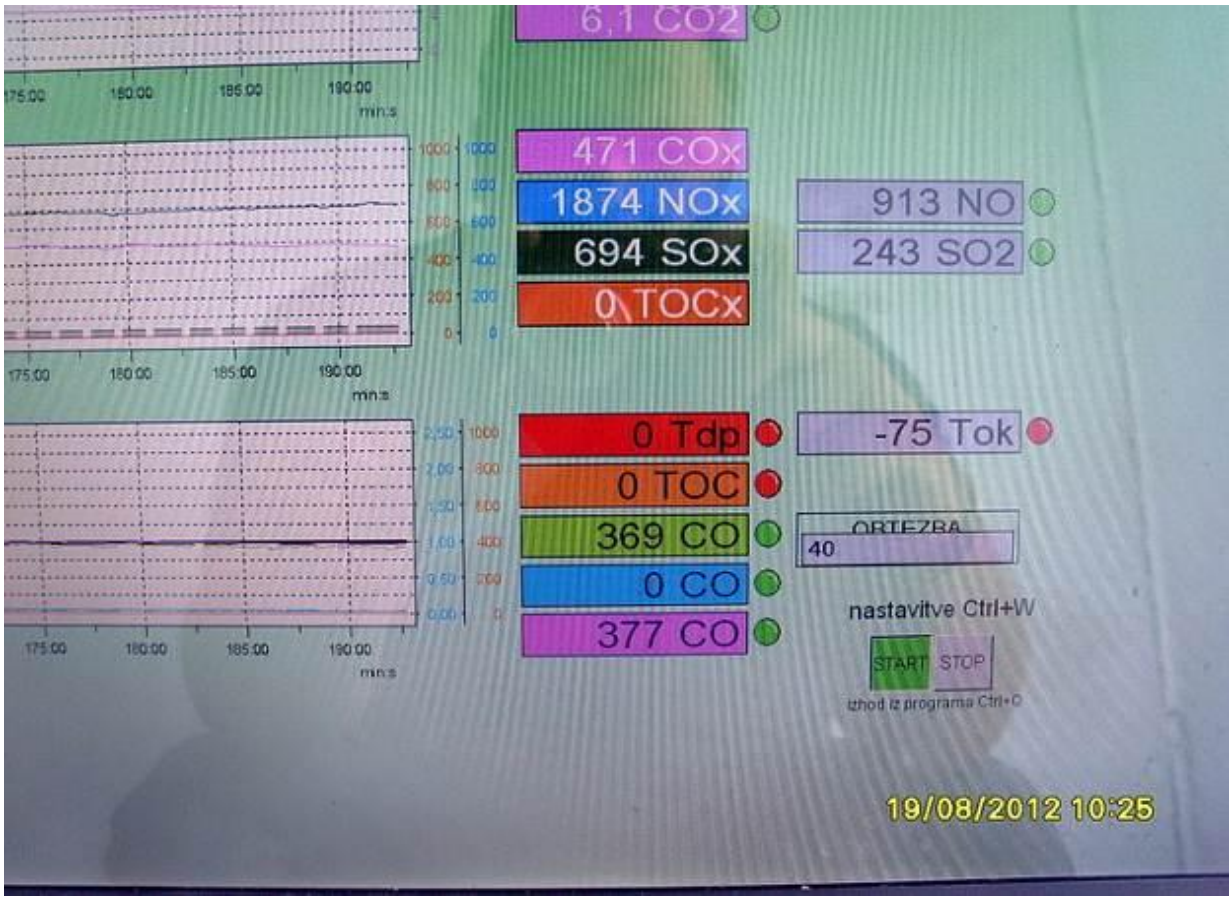

12,9 O2
2,66 lambda
12,6 O2
13,1 O2
6,2 CO2
500 COx
1821 NOx
690 SOx
0 TOCx
886 NO
241 SO2
0 Tdp
-75 Tok
0 TOC
385 CO
ORTEZBA
40
0 CO
400 CO
nastavitve Ctrl+W
START
STOP
19/08/2012 09:05


19/08/2012 09:08


19/08/2012 09:12


19/08/2012 09:13


start TRGA module to a buffer tank
19/08/2012 09:28


6,1 CO2
471 COx
1874 NOx
694 SOx
0 TOCx
913 NO
243 SO2
0 Tdp
0 TOC
369 CO
0 CO
377 CO
-75 Tok
ORTEZBA
40
nastavitve Ctrl+W
START
STOP
izhod iz programa Ctrl+Q
19/08/2012 10:25


19/08/2012 10:55

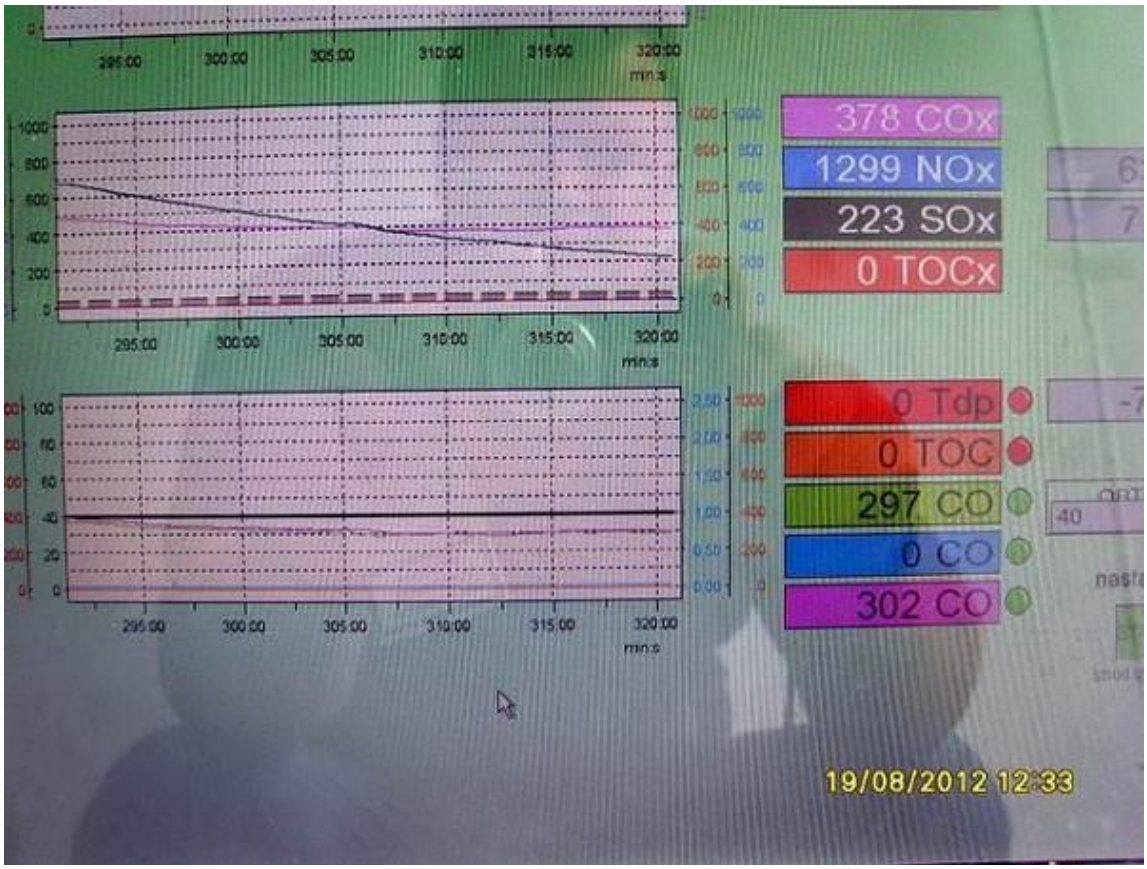

19/08/2012 10:56


19/08/2012 11:37


19/08/2012 11:38


13.4 O2
6.1 CO2
487 COx
1883 NOx
678 SOx
0 TOCx
917 NO
237 SO2
0 Tdp
0 TOC
379 CO
0 CO
390 CO
-75 Tok
40
nastavitve Ctrl+W
START
STOP
19/08/2012 11:48


lane of sea current
19/08/2012 11:42


378 COx
1299 NOx
223 SOx
0 TOCx
0 Tdp
0 TOC
297 CO
0 CO
302 CO
19/08/2012 12:33


19/08/2012 12:38

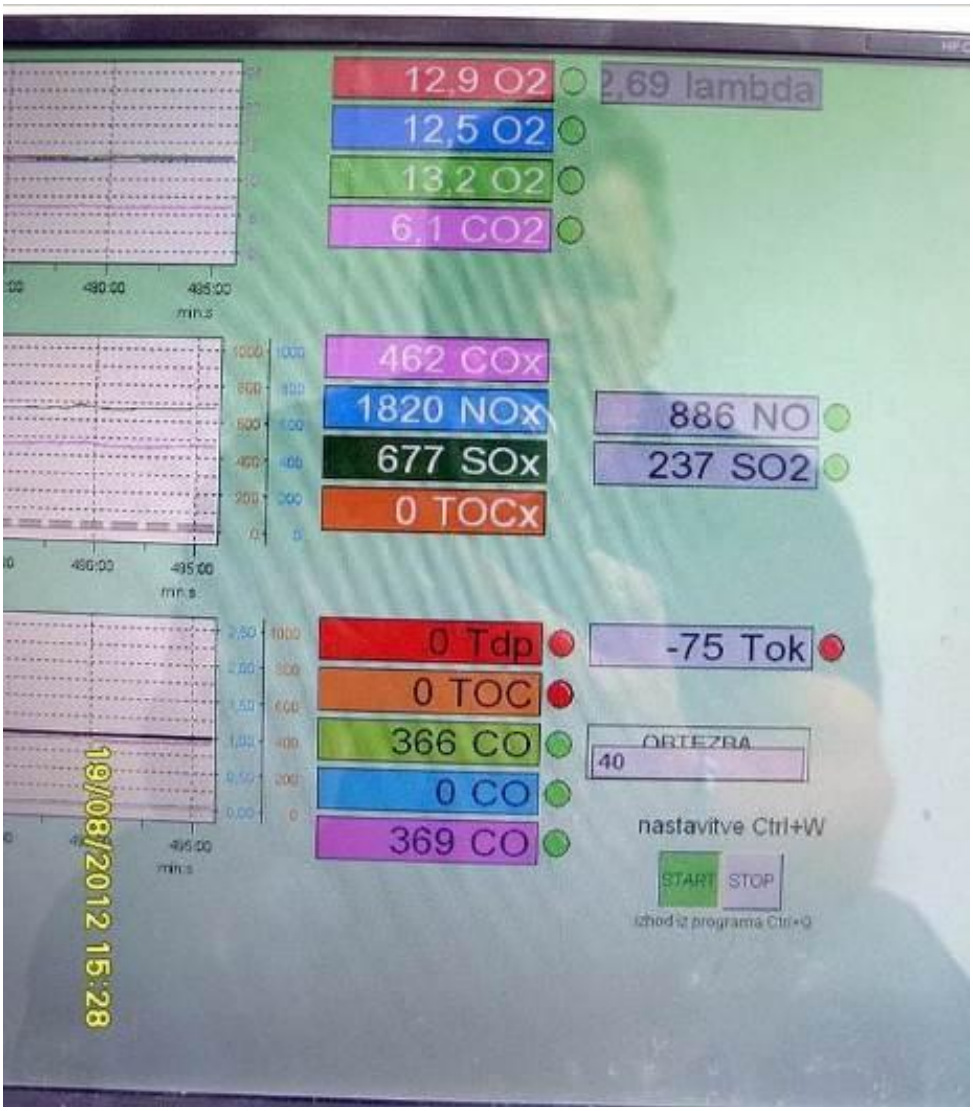

19/08/2012 14:27


13,2 O2
6,1 CO2
409 COx
1506 NOx
361 SOx
0 TOCx
733 NO
126 SO2
0 Tdp
0 TOC
325 CO
0 CO
327 CO
-75 Tok
40
nastavitve Ctrl+W
19/08/2012 14:38


19/08/2012 15:02


19/08/2012 15:09

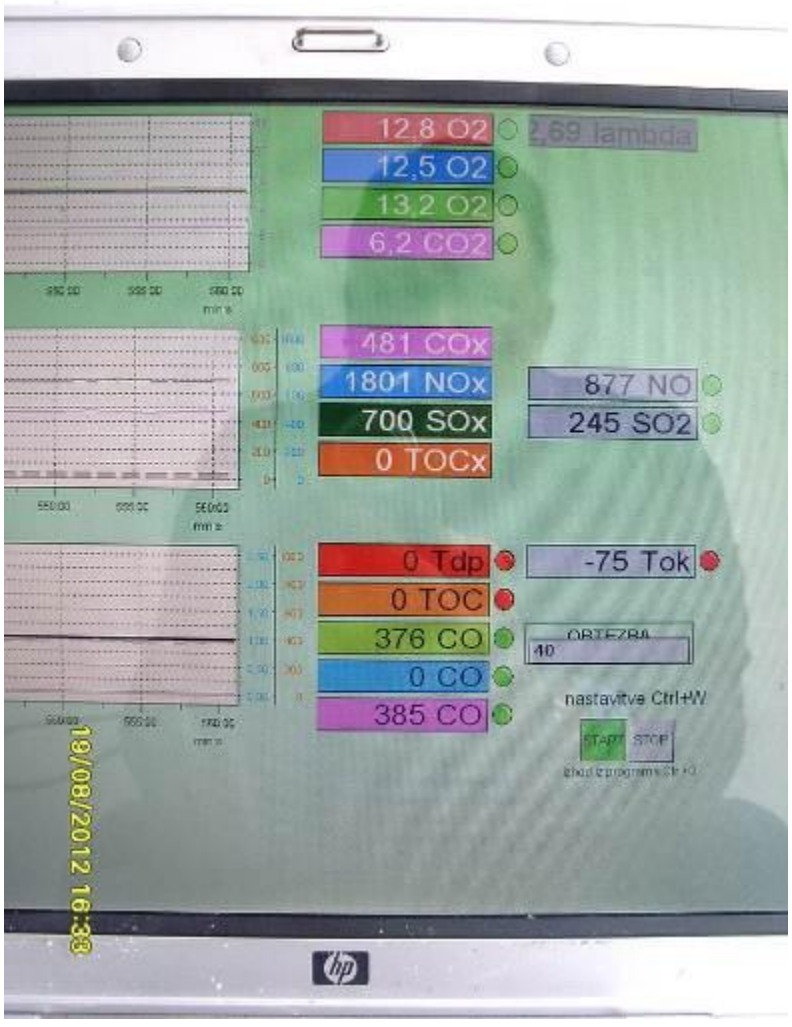

12,9 O2
12,5 O2
13,2 O2
6,1 CO2
460 COx
1775 NOx
663 SOx
0 TOCx
864 NO
232 SO2
0 Tdp
0 TOC
370 CO
0 CO
370 CO
-75 Tok
ORTEZBA
40
nastavitve Ctrl+W
START
STOP
19/08/2012 15:18

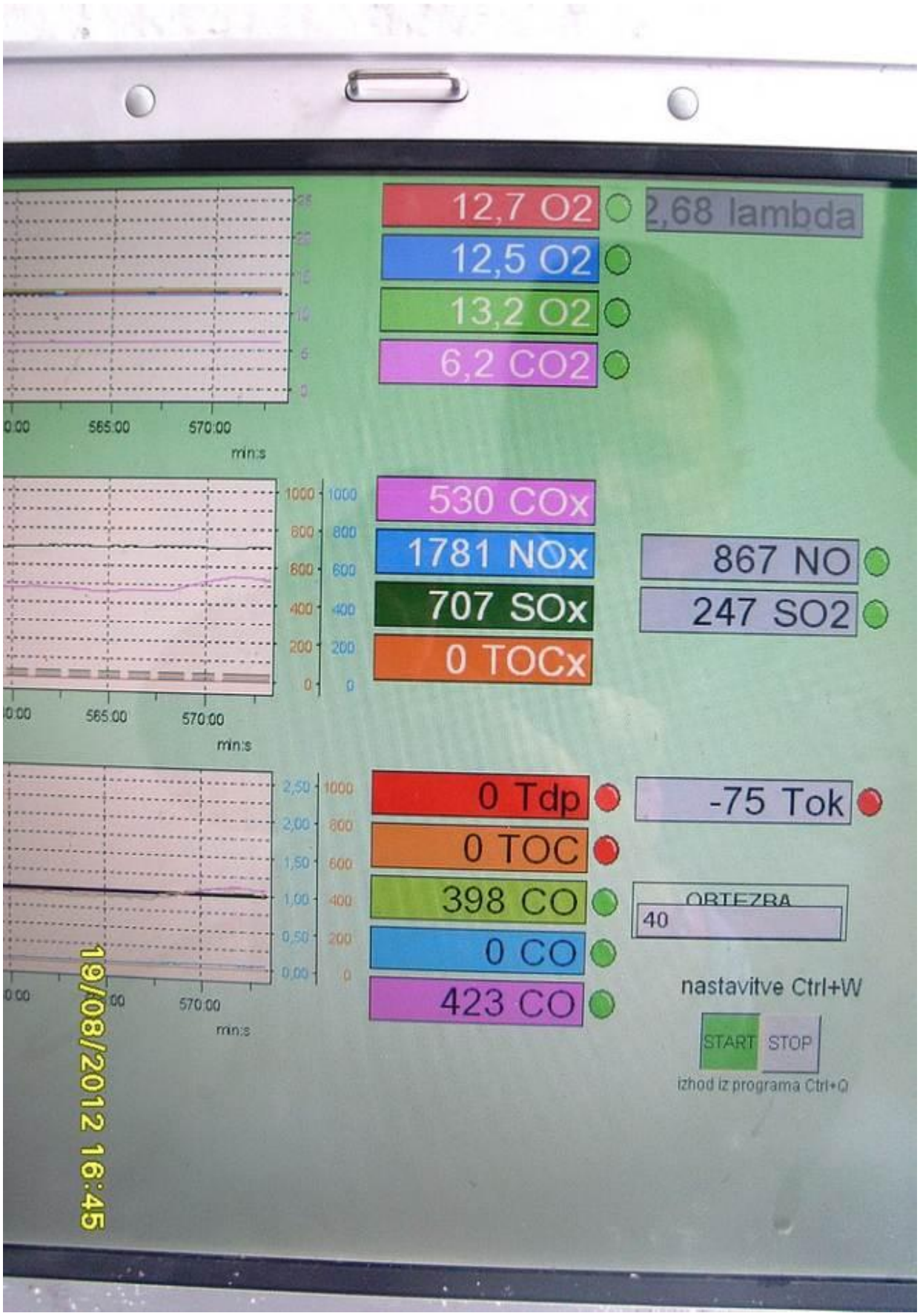

12,9 O2
12,5 O2
13,2 O2
6,1 CO2
462 COx
1820 NOx
677 SOx
0 TOCx
886 NO
237 SO2
0 Tdp
0 TOC
366 CO
0 CO
369 CO
-75 Tok
ORTEZBA
40
nastavitve Ctrl+W
START
STOP
19/08/2012 15:28


19/08/2012 15:32


19/08/2012 15:33

Switch OFF of Module TRGA




12,7 O2
2,68 lambda
12,5 O2
13,2 O2
6,2 CO2
565:00
570:00
min:s
530 COx
1781 NOx
707 SOx
0 TOCx
867 NO
247 SO2
0 Tdp
-75 Tok
0 TOC
398 CO
0 CO
423 CO
40
nastavitve Ctrl+W
START
STOP
izhod iz programa Ctrl+Q
19/08/2012 16:45

F.4.6 The comparative results of emissions during operation on the treated fuel - Module TRGA on the buffer tank (20 August 2012)

	Data	***Notes***
Date	20 August 2012	
Place and event Measurements on the PORT side engine 20-test-1	Port of Oostende, Belgium Navigation from Oostende to Ramsgate **Module TRGA on the buffer tank is switched ON.** Engine start: 07.40 hrs Leaving the Pear 07.50 hrs Arrival Ramsgate 12.20 hrs Data from the ship's bridge Log: 20 August 2012 Wind: W, force 4 Sea: 2 Draft: 4,6 m Current: speed 0,4 Nm/h Cargo: 534,5 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

Using of treated fuel: Module TRGA operates on the buffer tank.

Time correction of routes/tracking:

19 August 2012 departure from the Port of Oostende was at 08.15 hrs and arrival in the Port of Ramsgate was at 12.48 hrs (navigational time 04.38 hrs).

20 August 2012 departure from the Port of Oostende was at **07.50 hrs**, arrival in the Port of Ramsgate was at 12.20 hrs (navigational time 04.30 hrs).

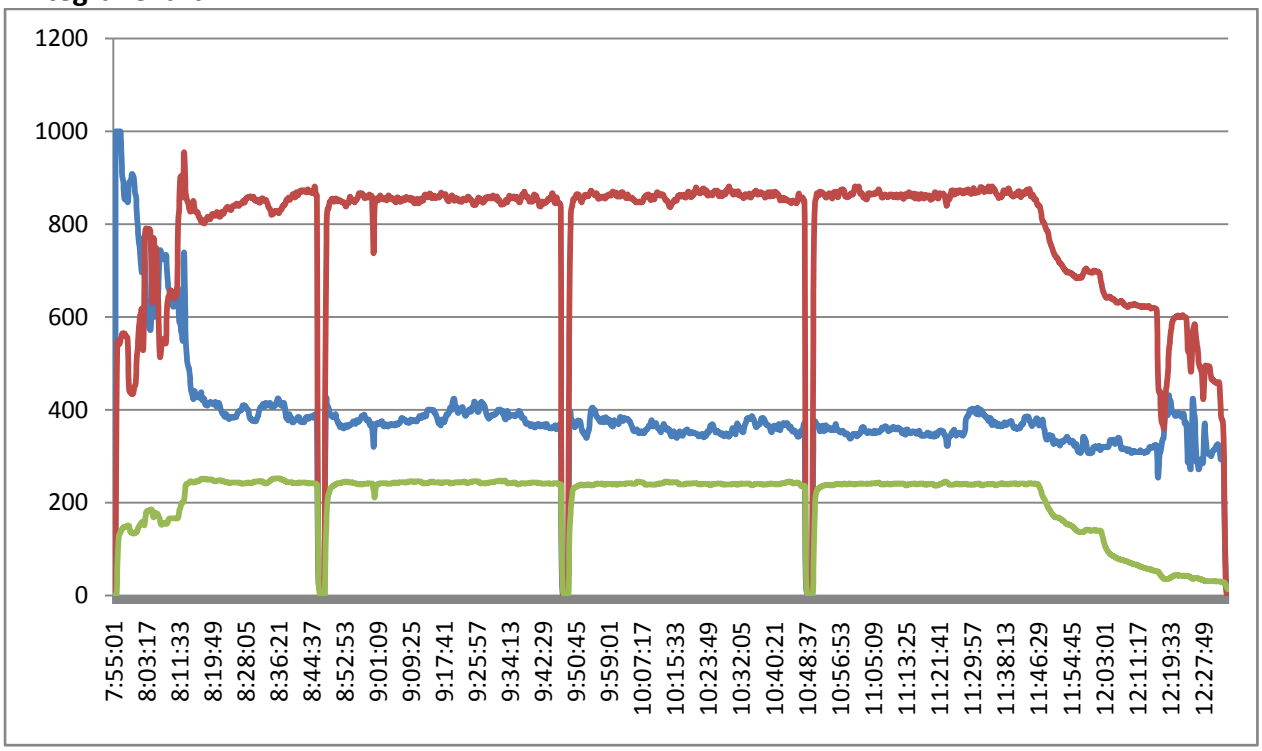
Taking into account the speed of the ship as conditionally steady all the time, we can use the previous navigational chart with following remark: correction "minus 25 minutes".

The selections of credible intervals of measurement were based on the following factors:

1. Stable regime of engine operation.
2. Stable regime of measuring devices.
3. The same wind direction at the time interval.
4. The assumption that the engine load was at least same as on 19 August 2012.

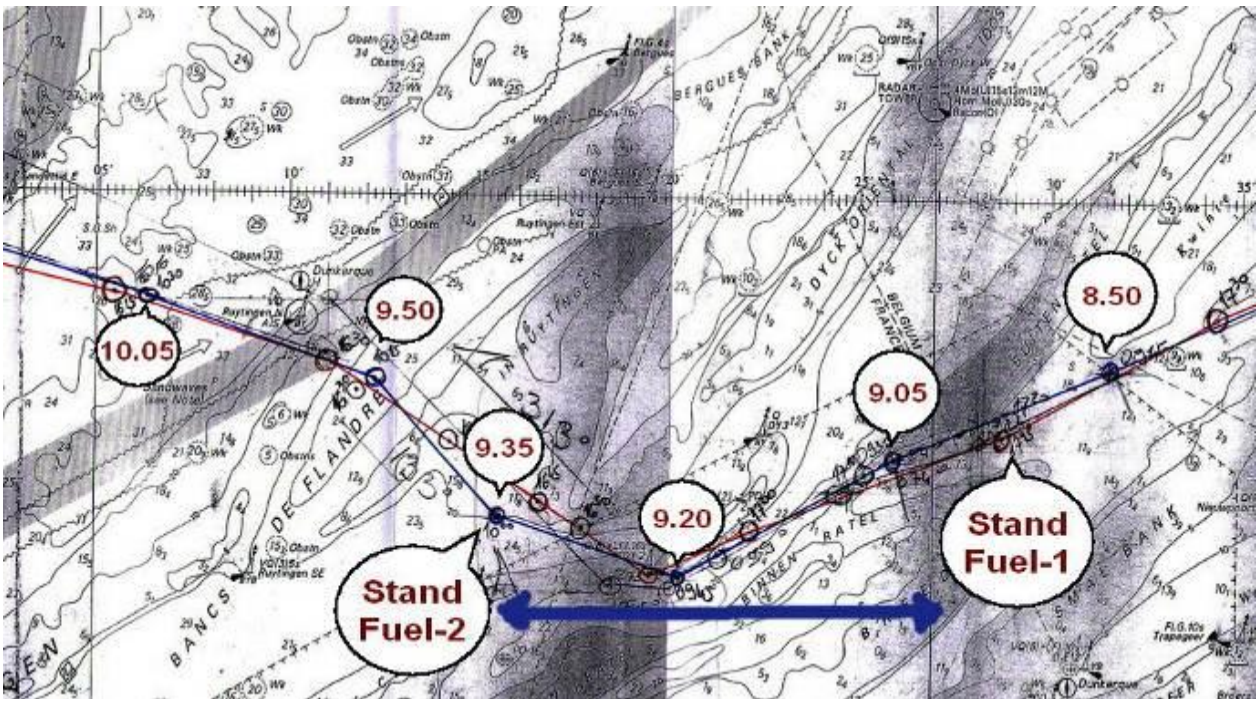
The actual facts were: ship's draft 4.6 m, frontal West wind with angle of 25° on the ship's course, the wind speed was 4 Nm/h, wave height was 2 (0.5 m).

Integral Chart



Interval up to sign of 09.05 hrs was not counted due to engine transfer and calibration of measuring devices.

Interval from o9.10 and up to 09.35 hrs was not counted due to ship's maneuvering and entering into frontal wind and wave.

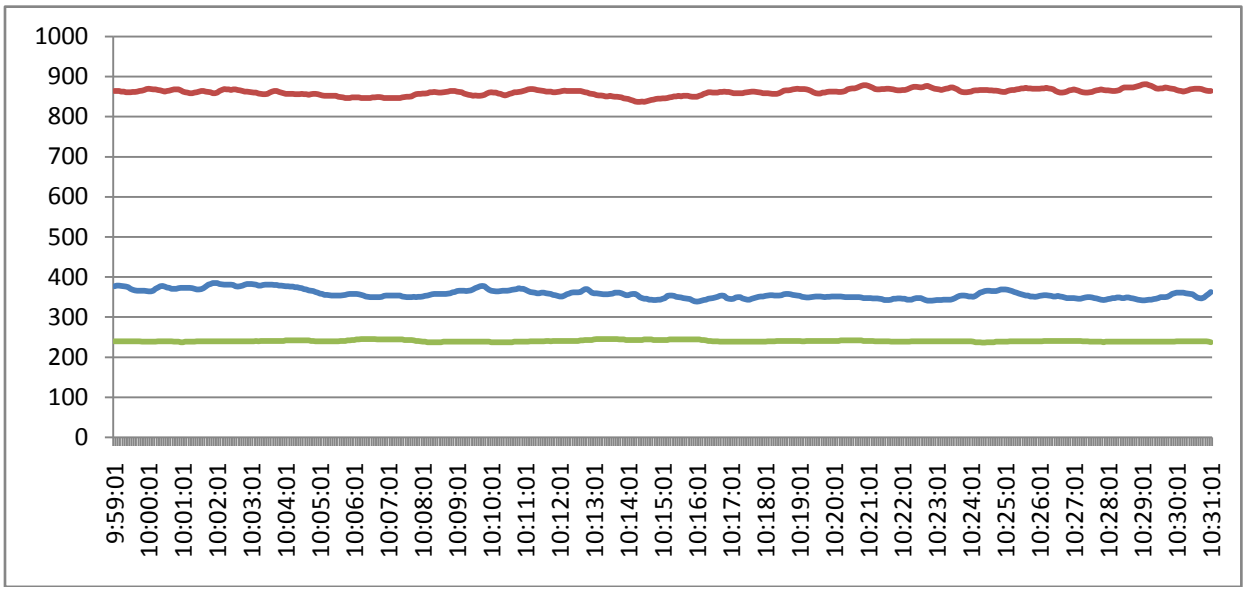


Interval between 09.35 and 09.47 hrs was not counted due to lower quantities of CO and due to short interval.

First approved interval for measurements was between 09.56 and 10.42 hrs. All chart values were stable. Interval duration was 45 minutes.

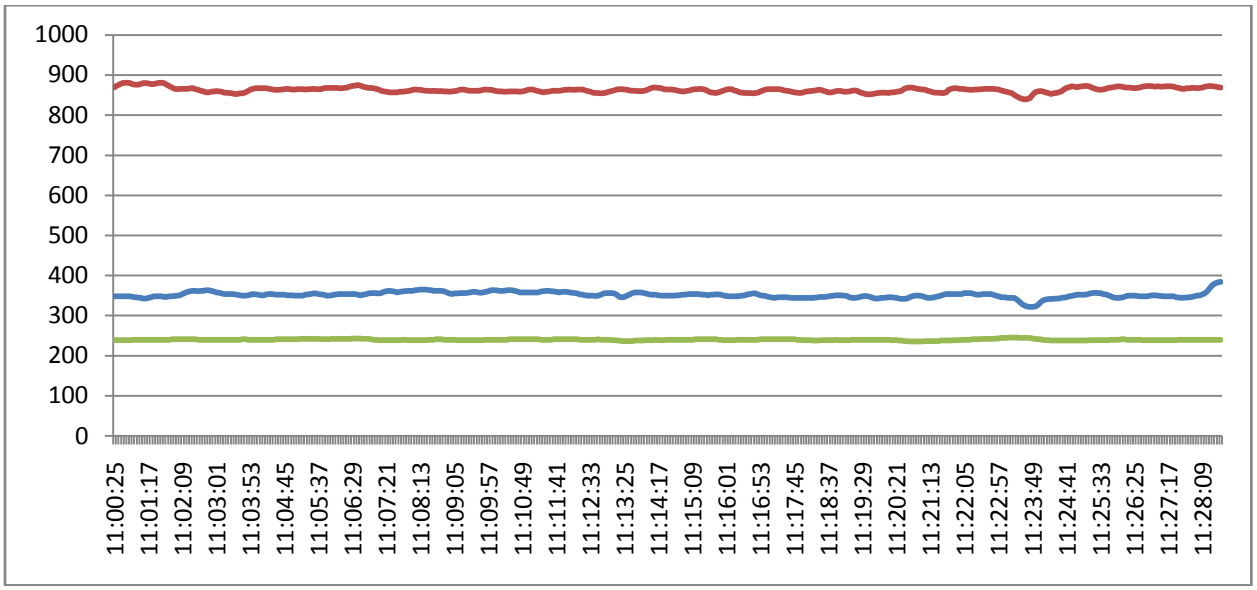
The average values of smoke gases using the fuel treated with module TRGA on the buffer tank were: CO = 361.48 (-6%) SO = 240.3 (+0.14) NO = 861.78 (-4.2%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)

At 10.30 hrs the engine load was higher, this was documented by photos and film: the wind was changing occasionally direction to the frontal side; the production of CO and SO_2 was higher, having in mind the most stable time interval for measurement between 10.00 and 10.30 hrs, the average values of measurements were as follows:



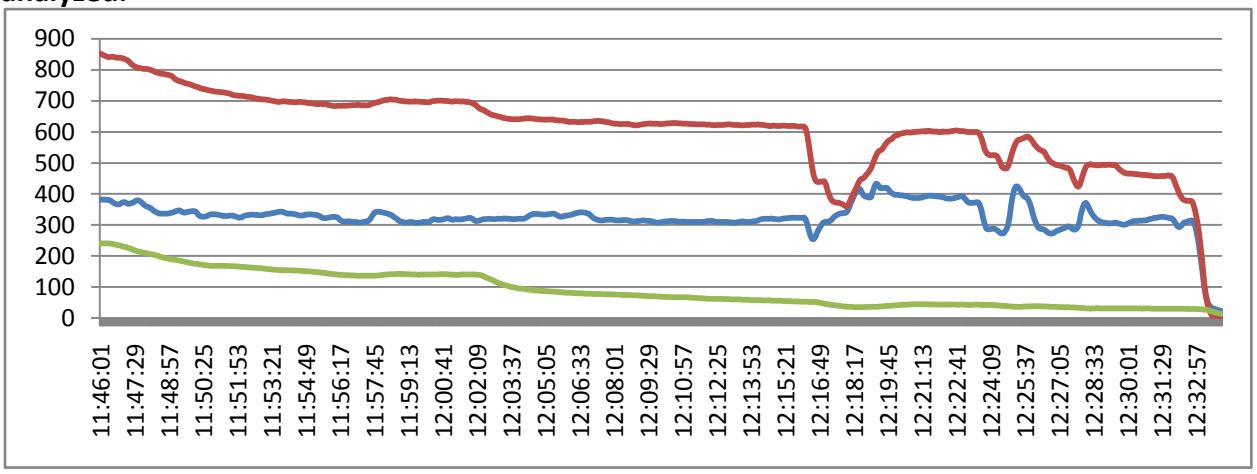
The average values of smoke gases using the fuel treated with module TRGA on the buffer tank were: CO = 357.15 (-7.13%) SO = 240.57 (+0.15) NO = 861.4 (-4.1%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)

Next verified interval was between 11.00 and 11.30 hrs.



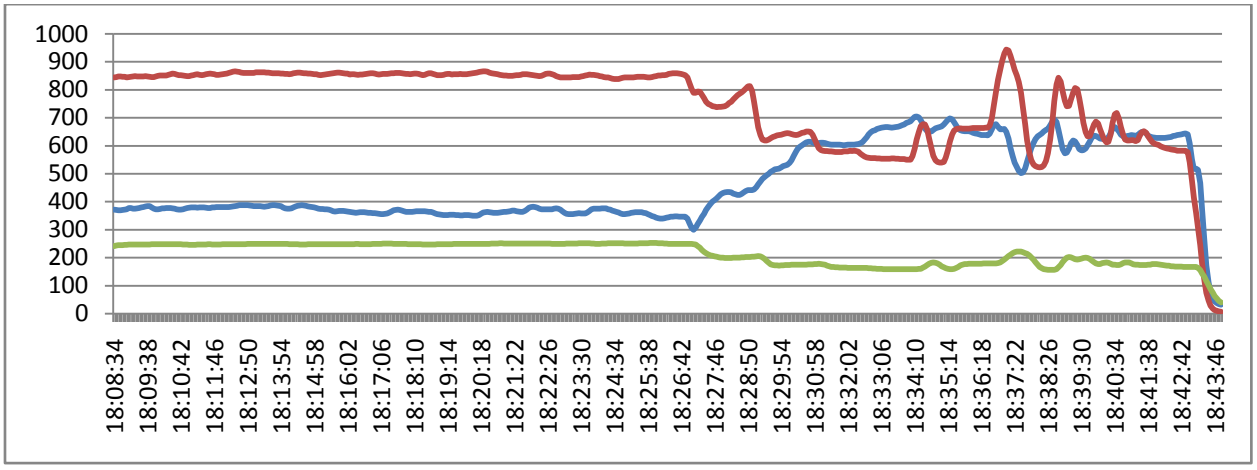
The average values of smoke gases using the fuel treated with module TRGA on the buffer tank were: CO = 351.76 (-8.53%) SO = 239.96 (0) NO = 863.16 (-4.07%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)

The area where the consumption was switched from heavy fuel to the diesel oil was not analyzed.



Above: arrival in the Port of Ramsgate with use of diesel oil treated with Module TRGA

Below: arrival in the Port of Oostende, using the heavy fuel, without using the module TRGA



The results of emissions
during the use of treated fuel - Module TRGA on the buffer tank
(20 August 2012)

	Data	***Notes***
Date	20 August 2012	
Place and event Measurements on the PORT side engine 20-test-2	Port of Ramsgate, UK. Navigation from Ramsgate to Oostende **Module TRGA on the buffer tank is switched ON.** Engine start: 14.20 hrs Leaving the Pear 14.30 hrs Arrival Oostende 18.25 hrs Data from the ship's bridge Log: 20 August 2012 Wind: SE, force 1 - 5 Sea: 4 Draft: 5,0 m Current: speed 0,0 Nm/h Cargo: 590,4 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

Using of treated fuel, Module TRGA on the buffer tank.

Time correction of routes/tracking: none, using the original navigational chart from the ship's bridge.

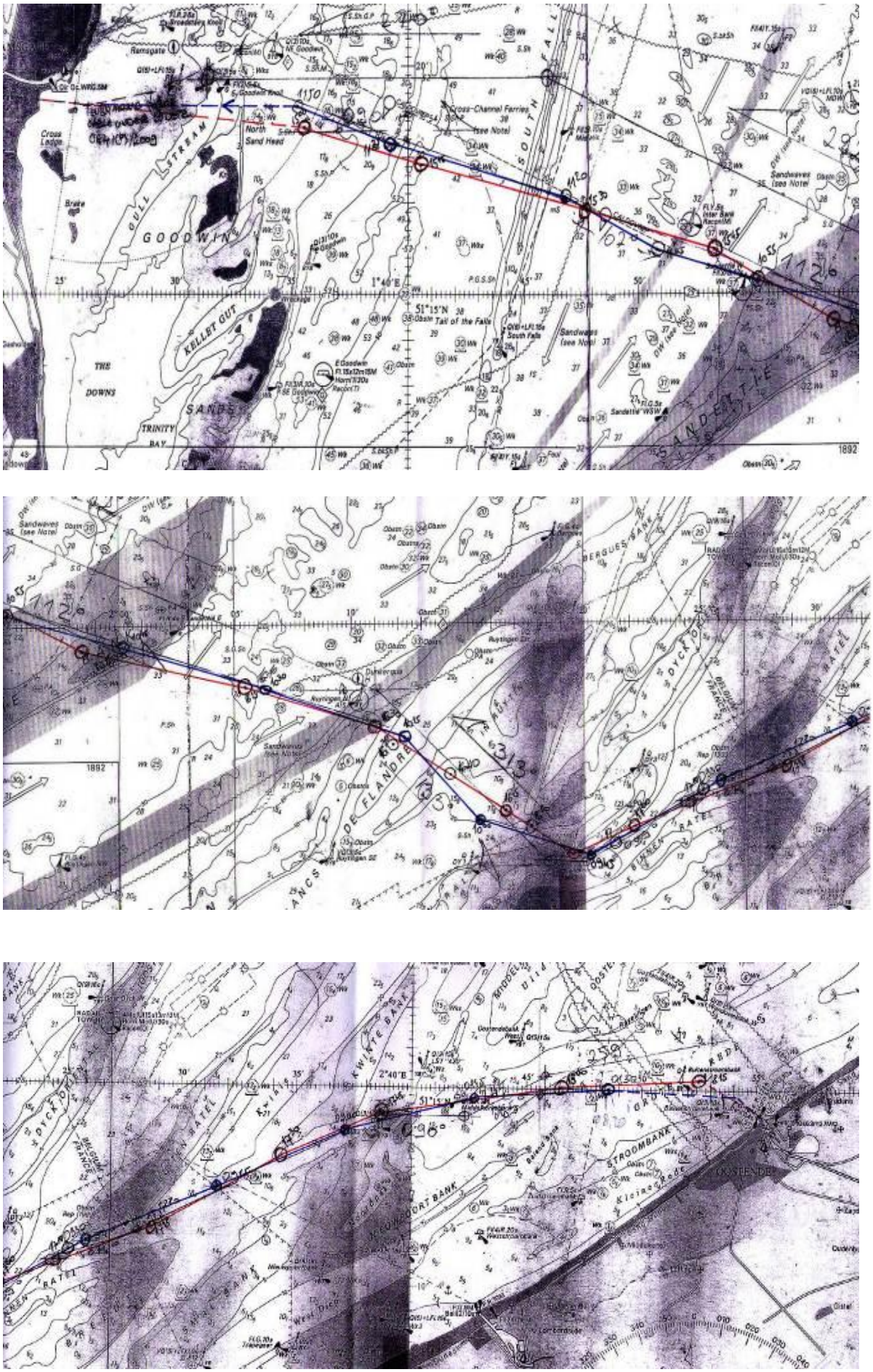
The selection of a credible intervals for measurement was based on the following factors:

1. Stable regime of engine operation,
2. Stable regime of measuring devices,
3. Same wind direction during the intervals,
4. The assumption that the engine load was at least same as on 19 August 2012.

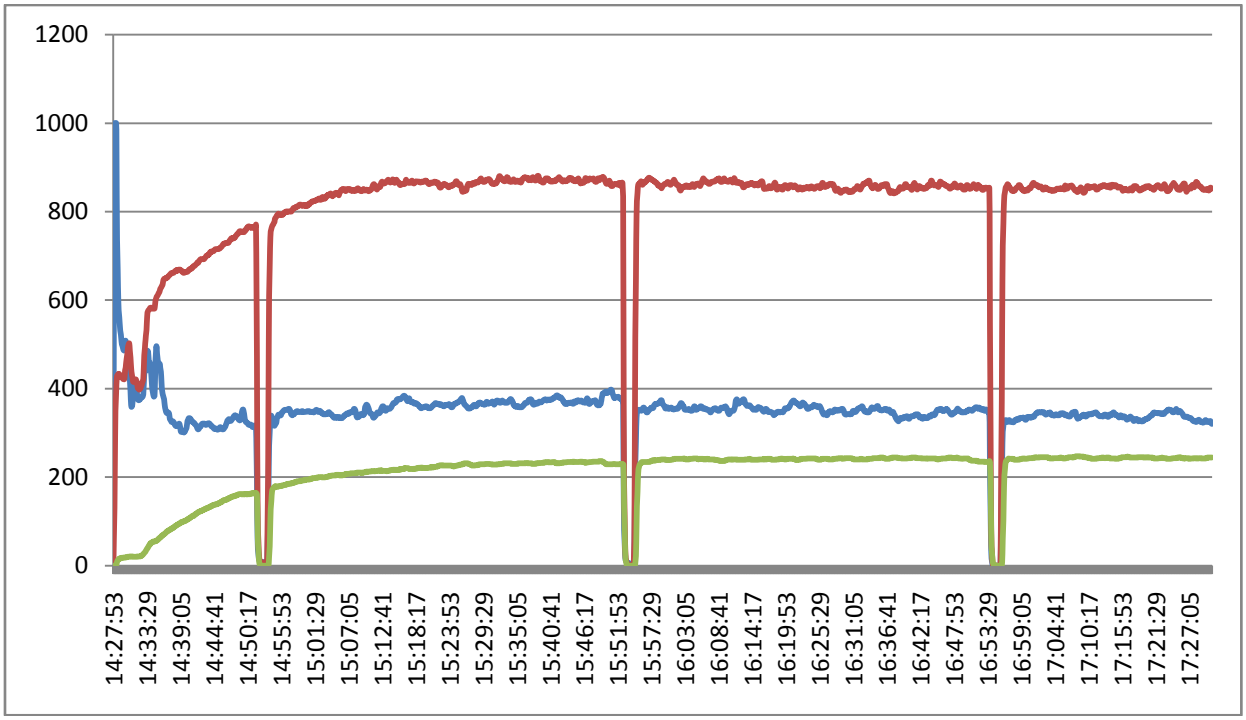
The actual facts were: ship's draft 5 meters, SE wind in the navigation towards Dunkirk, then the side wind, on the angle of 25° on the course of the ship. Wind speed was 1 Nm/h, the wave height was 4 (0.75-1.25 meters).

Taking into account the weather conditions, these should be considered as:

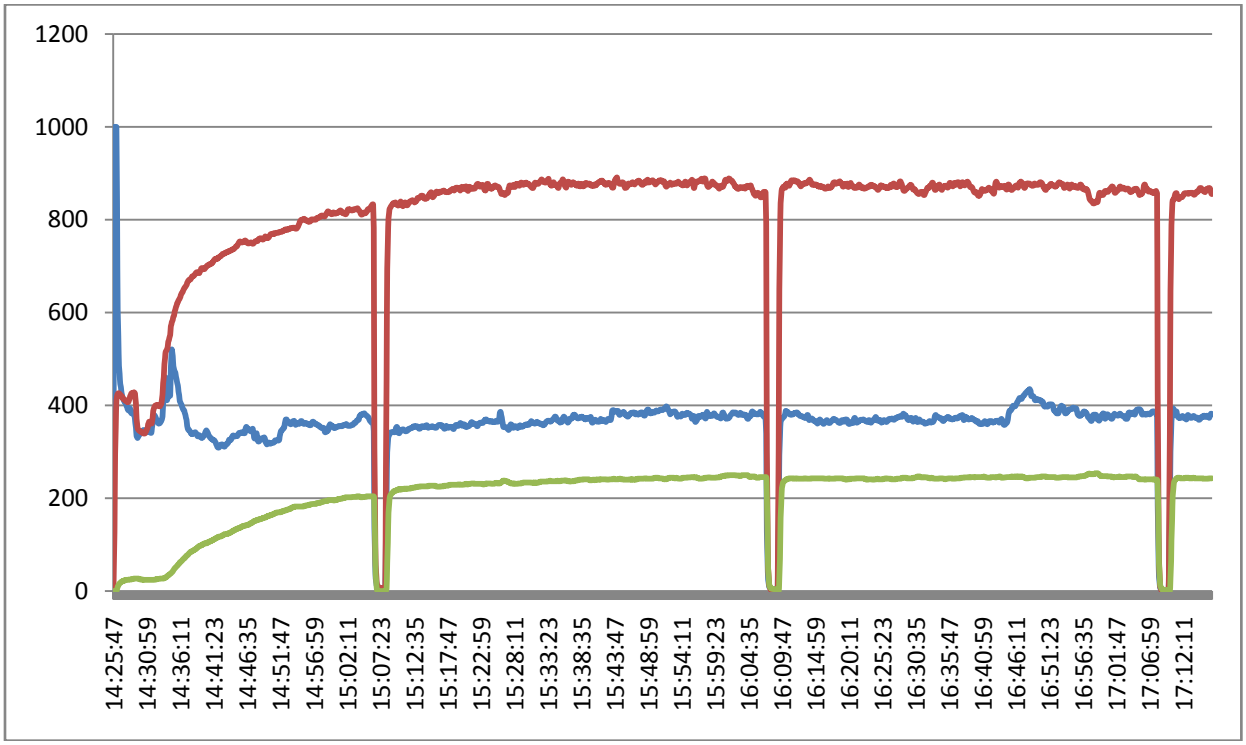
1. Comparable to the conditions on 19 August 2012,
2. Conditions were more burdensome than those on first testing of same day, 20 August 2012.



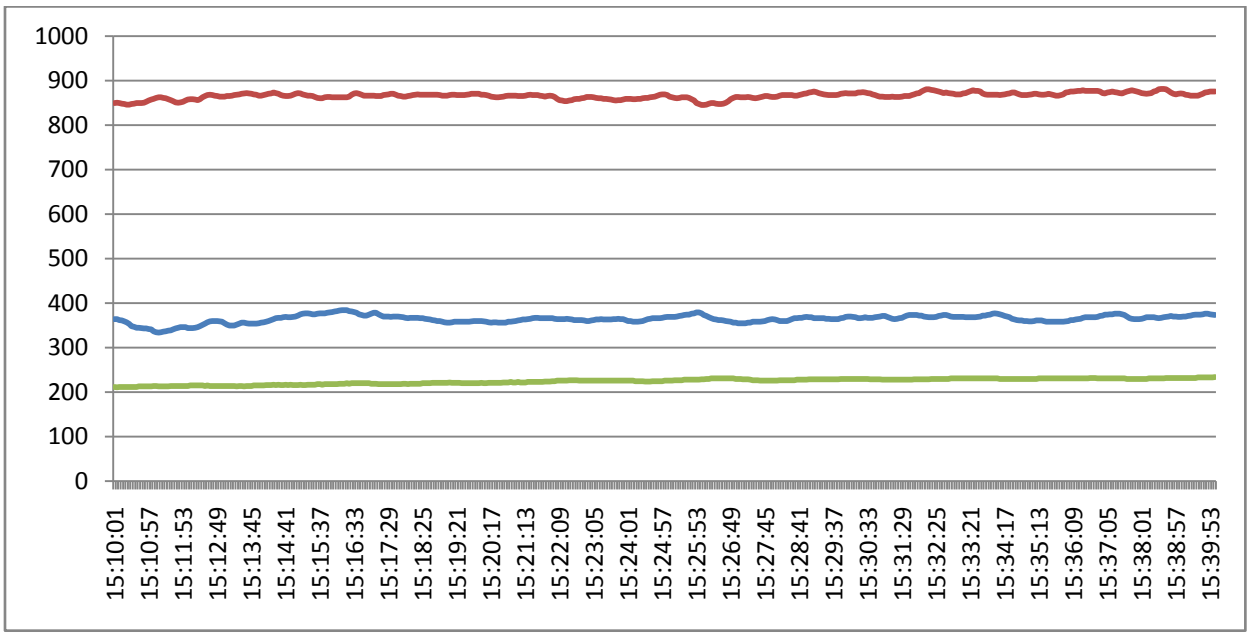
Navigational chart/routes on 20 August 2012 (present testing)



The chart of measurements dated 19 August 2012 (for comparison)
In both cases the departure was from the port of Ramsgate using Module TRGA on the buffer tank.

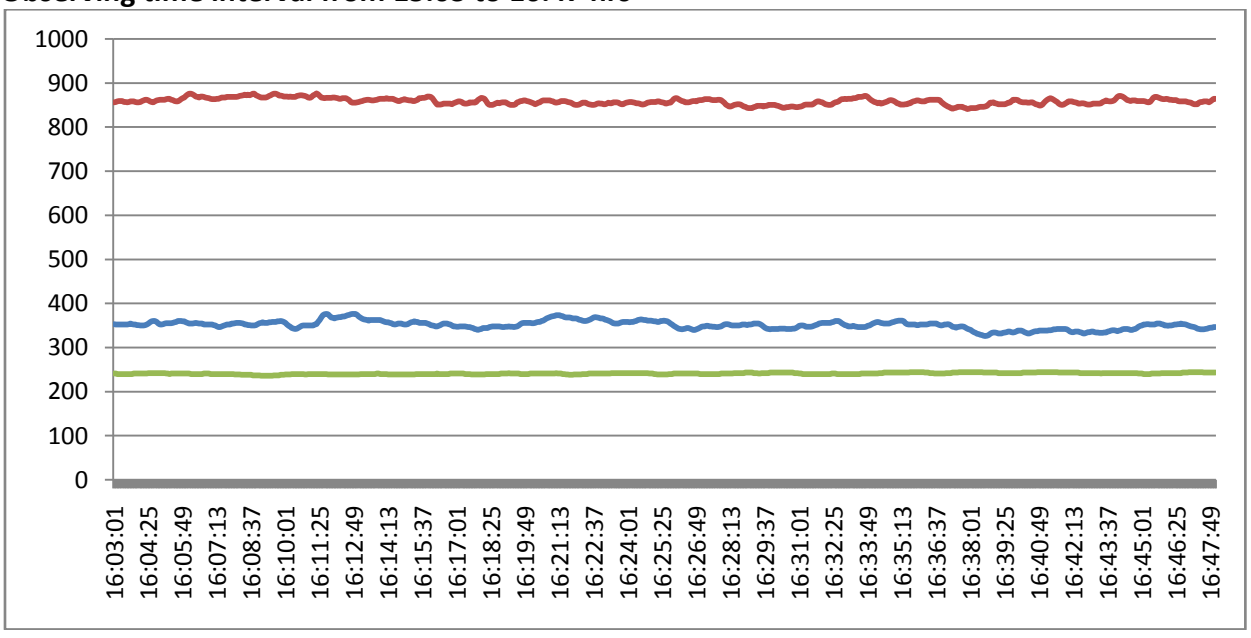


Comparing the same time Interval from 15.10 to 15.40 hrs



The average values of smoke gases using the fuel treated with module TRGA on the buffer tank were: CO = 364.3 (- 5.27%) SO = 224.5 (-6.44) NO = 865.7 (-3.8%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)
This interval from 15.10 to 15.40 hrs was excluded from the measurement due to diverse emissions SO_2 not stable on the level of 239 – 241 ppm.

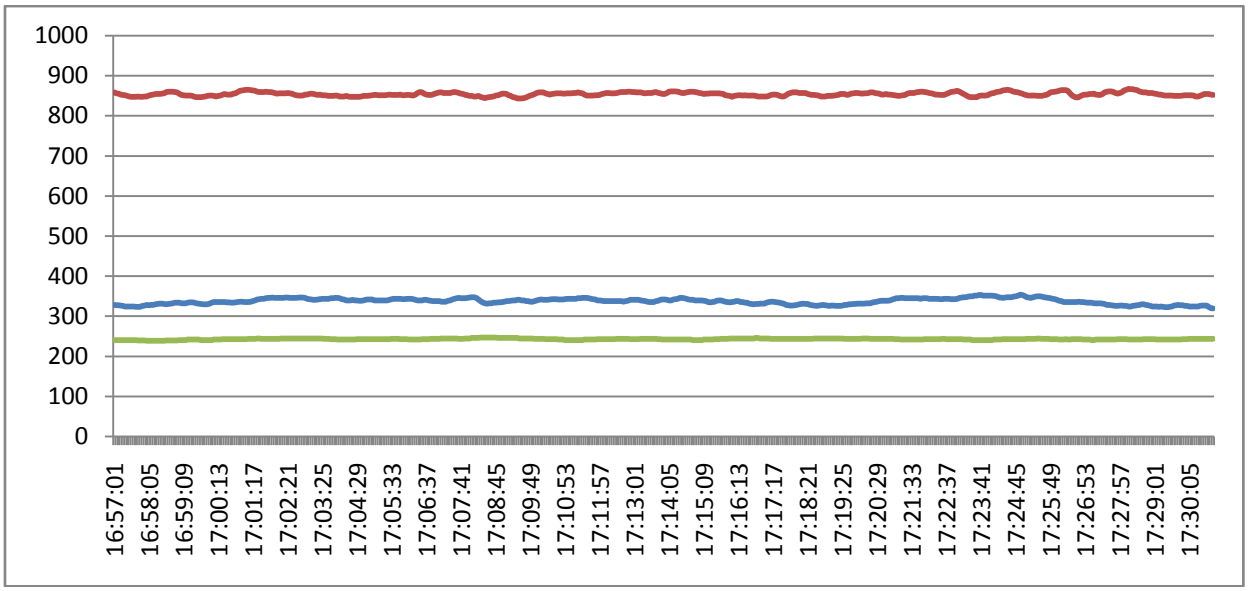
Observing time interval from 15.03 to 16.47 hrs



The average values of smoke gases using the fuel treated with module TRGA on the buffer tank were: CO = 351.02 (-8.72%) SO = 241 (+0.4) NO = 858.15 (-4.6%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)

<u>Time Interval from 16.50 to 16.56 hrs was excluded due to preparation work on measuring devices.</u>

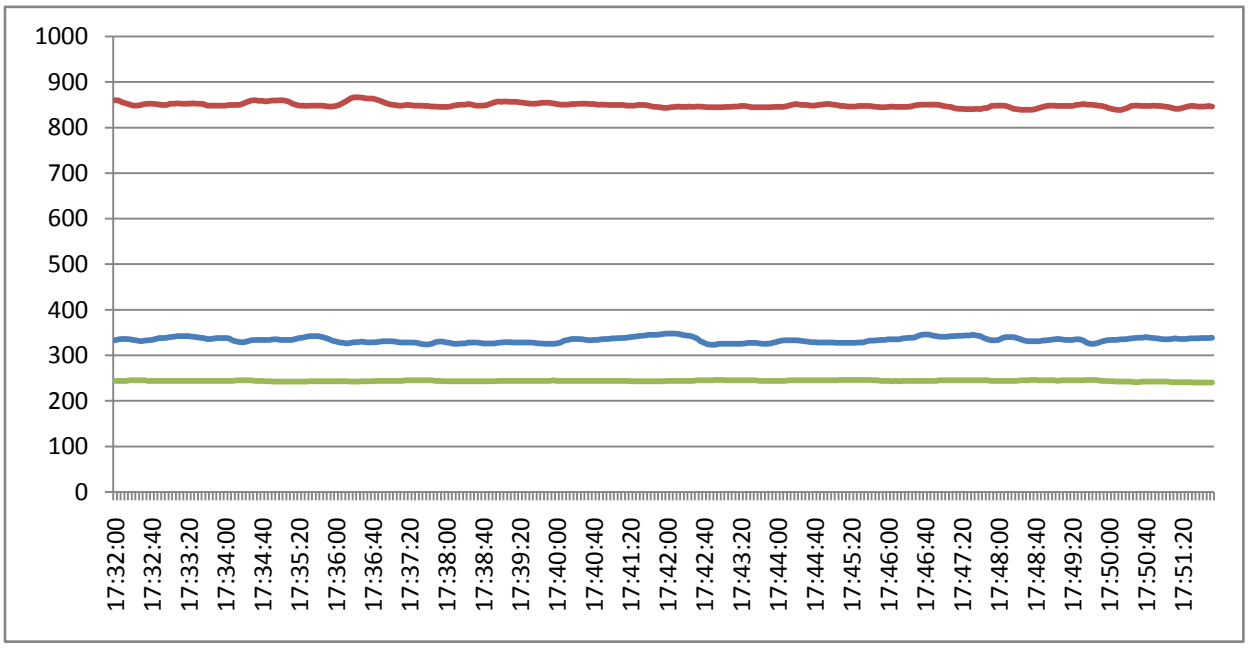
Time Interval from 16.57 to 17.30 hrs



The average values of smoke gases using the fuel treated with module TRGA on the buffer tank were: CO = 337.7 (-12.17%) SO = 243.15 (+0.4%) NO = 853.8 (-5.1%)
(using standard fuel CO = 384.58 SO = 239.96 NO = 899.84)

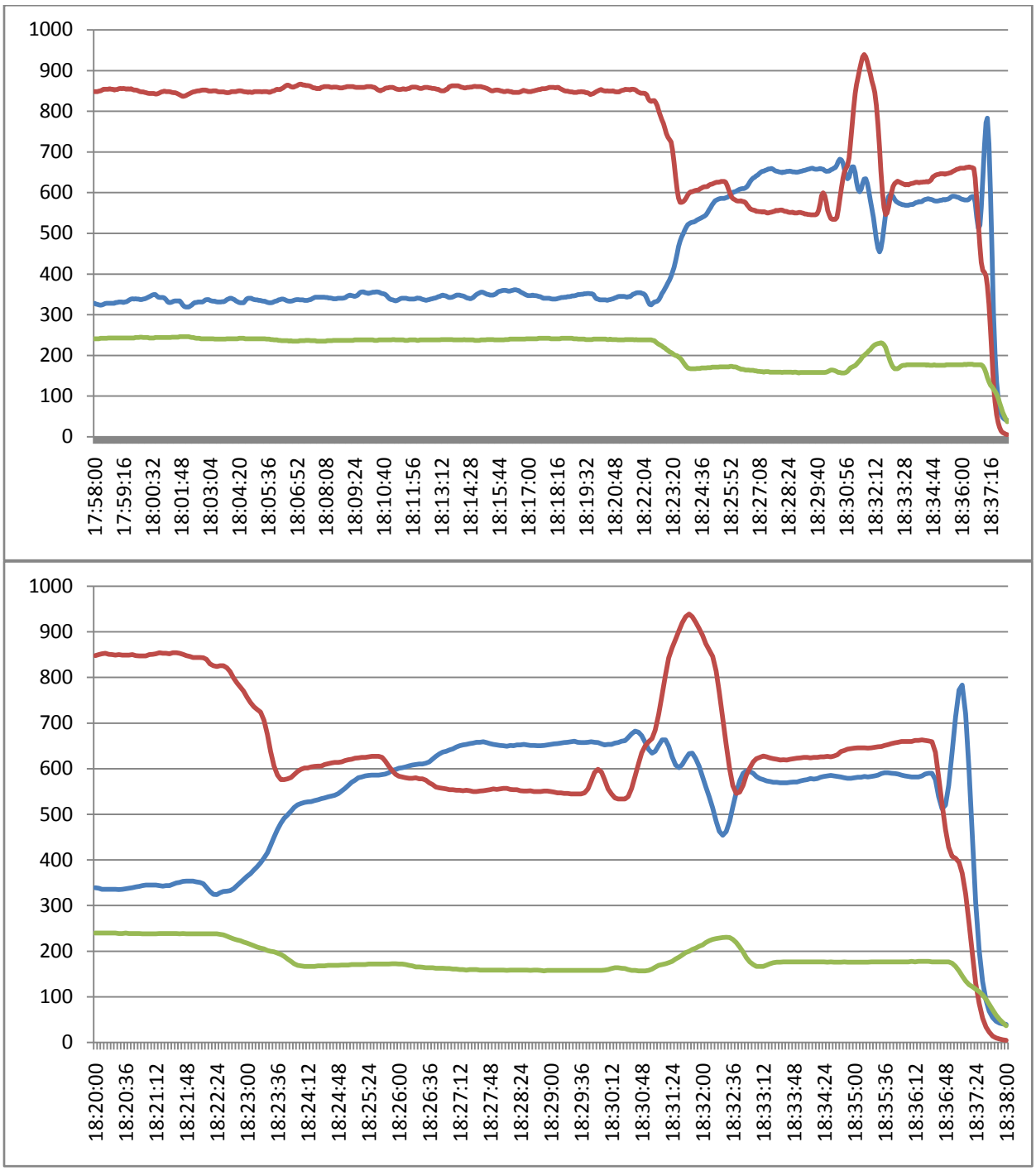
<u>Time Interval from 16.57 to 17.30 hrs was excluded</u> due to blows of strong stern winds.

Time Interval from 17.32 to 17.51 hrs



<u>Time Interval from 17.32 to 17.51 was excluded</u> due to strong blows of stern wind.

For more clear picture of situation, please see two Charts presenting the arrival of the ship in the port using Module TRGA on the buffer tank



The Module TRGA on the buffer tank was given following results:

CO = 361.48 (-6%)	**SO = 240.3 (+0.14)**	**NO = 861.78 (-4.2%)**
CO = 361.48 (-6%)	**SO = 240.3 (+0.14)**	**NO = 861.78 (-4.2%)**
CO = 357.15 (-7.13%)	**SO = 240.57 (+0.15)**	**NO = 861.4 (-4.1%)**
CO = 351.76 (-8.53%)	**SO = 239.96 (0)**	**NO = 863.16 (-4.07%)**
CO = 364.3 (- 5.27%)	**SO = 224.5 (-6.44)**	**NO = 865.7 (-3.8%)**
CO = 337.7 (-12.17%)	**SO = 243.15 (+0.4%)**	**NO = 853.8 (-5.1%)**

CONCLUSIONS

1. Use of the module TRGA for processing of heavy fuel on the buffer tank, having in mind same weather conditions, was lowered CO emissions as follows:

a) For the entire time Interval from -5.27% to -12.1%
b) The most authentic result from -5.27% to –6%

2. All mutual conditions are giving the conclusion on their comparability with testing of previous day.

3. The results obtained are comparable with the results obtained on 19 August 2012.

Below follows a brief photo report.

Unburned particles of soot, in continuing tearing off from the funnel wall.

Departure from the port of Oostende: smoke gases caused from still cold engine, malfunctioning of injectors, higher viscosity of fuel due to overflow of fuel

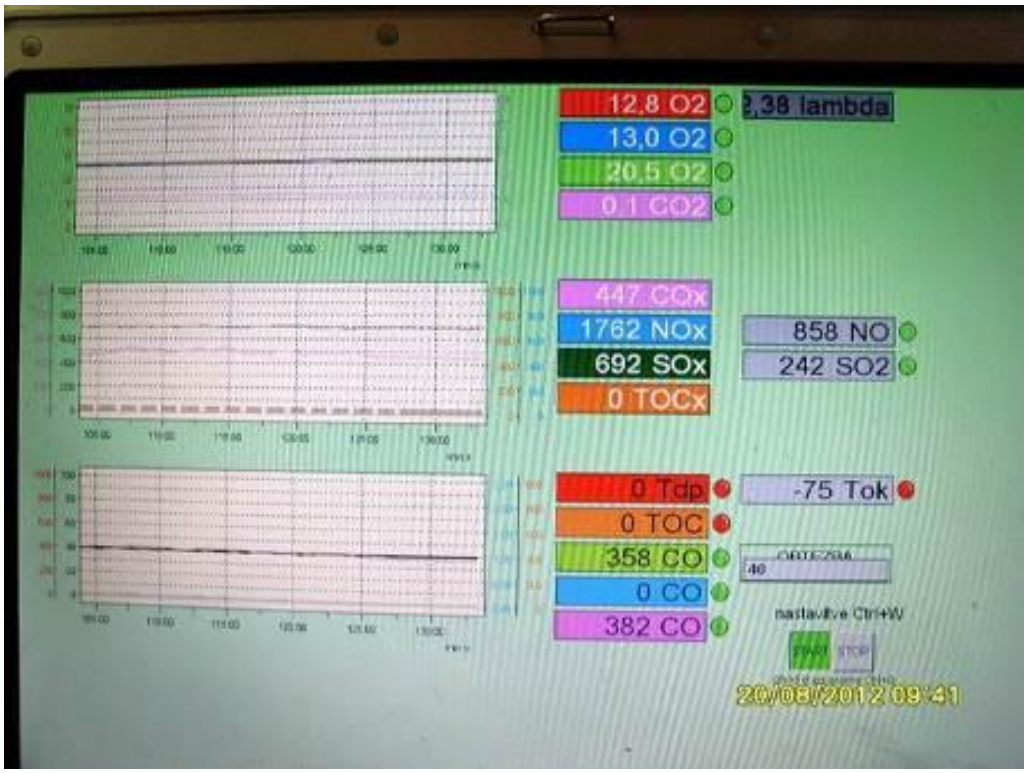

14,9 O2
13,8 O2
15,4 O2
4,4 CO2
845 COx
1229 NOx
485 SOx
0 TOCx
598 NO
170 SO2
0 Tdp
0 TOC
677 CO
649 CO
-75 To
40
20/08/2012 08:01
nastavitve Ctrl
START
STOP


20/08/2012 08:10


517 COx
1660 NOx
714 SOx
0 TOCx
808
250
0 Tdp
0 TOC
413 CO
0 CO
441 CO
-75
40
nastavitve
START
20/08/2012 08:13


13,1 O2
12,4 O2
12,9 O2
6,4 CO2
2,59 lambda
478 COx
1710 NOx
694 SOx
0 TOCx
832 NO
243 SO2
0 Tdp
0 TOC
383 CO
0 CO
396 CO
-75 Tok
40
nastavitve Ctrl+W
20/08/2012 08:19

Frontal wind


12,8 O2
13,0 O2
20,5 O2
0,1 CO2
447 COx
1762 NOx
692 SOx
0 TOCx
858 NO
242 SO2
0 Tdp
0 TOC
358 CO
0 CO
382 CO
-75 Tok
nastavitve Ctrl+W
20/08/2012 09:41


13,0 O2
12,5 O2
13,3 O2
6,0 CO2
428 COx
1809 NOx
684 SOx
0 TOCx
881 NO
239 SO2
0 Tdp
0 TOC
342 CO
0 CO
357 CO
-75 Tok
nastavitve Ctrl+W
20/08/2012 10:24

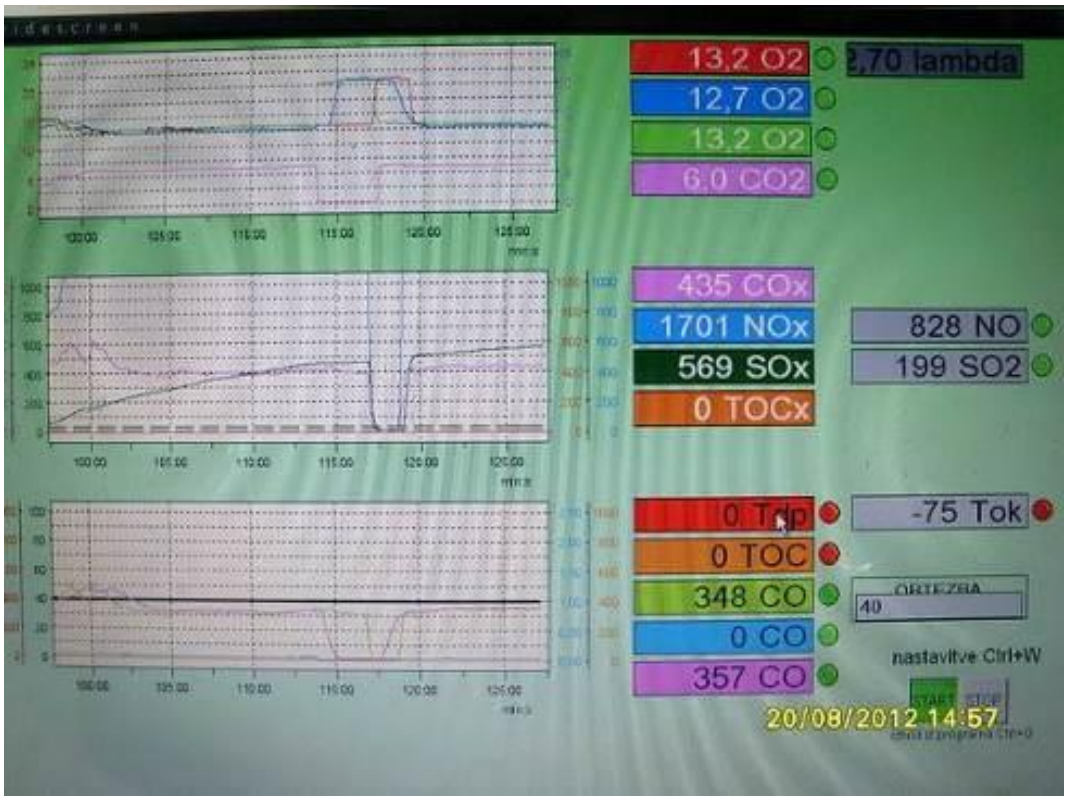

20/08/2012 10:45


20/08/2012 10:54


13,0 O2
12,6 O2
13,2 O2
6,1 CO2
2,69 lambda
432 COx
1803 NOx
686 SOx
0 TOCx
878 NO
240 SO2
0 Tdp
0 TOC
346 CO
0 CO
355 CO
-75 Tok
40
nastavitve Ctrl+W
START
STOP
20/08/2012 10:56

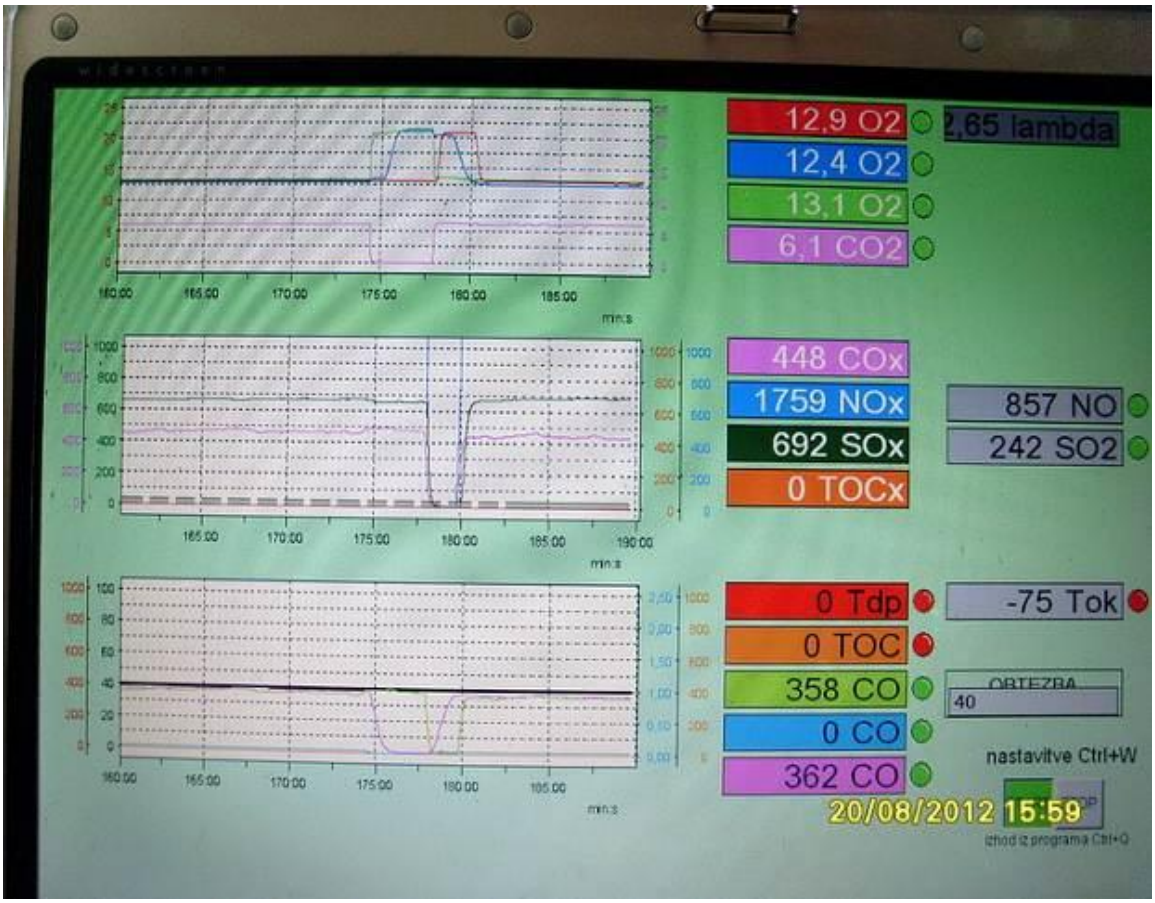

13,1 O2
12,7 O2
13,3 O2
5,9 CO2
2,73 lambda
417 COx
1423 NOx
428 SOx
0 TOCx
693 NO
150 SO2
0 Tdp
0 TOC
334 CO
0 CO
342 CO
-75 Tok
40
nastavitve Ctrl+W
START
STOP
20/08/2012 11:50

This are not traces of smoke but continuous »cleaning« of ship's funnel…



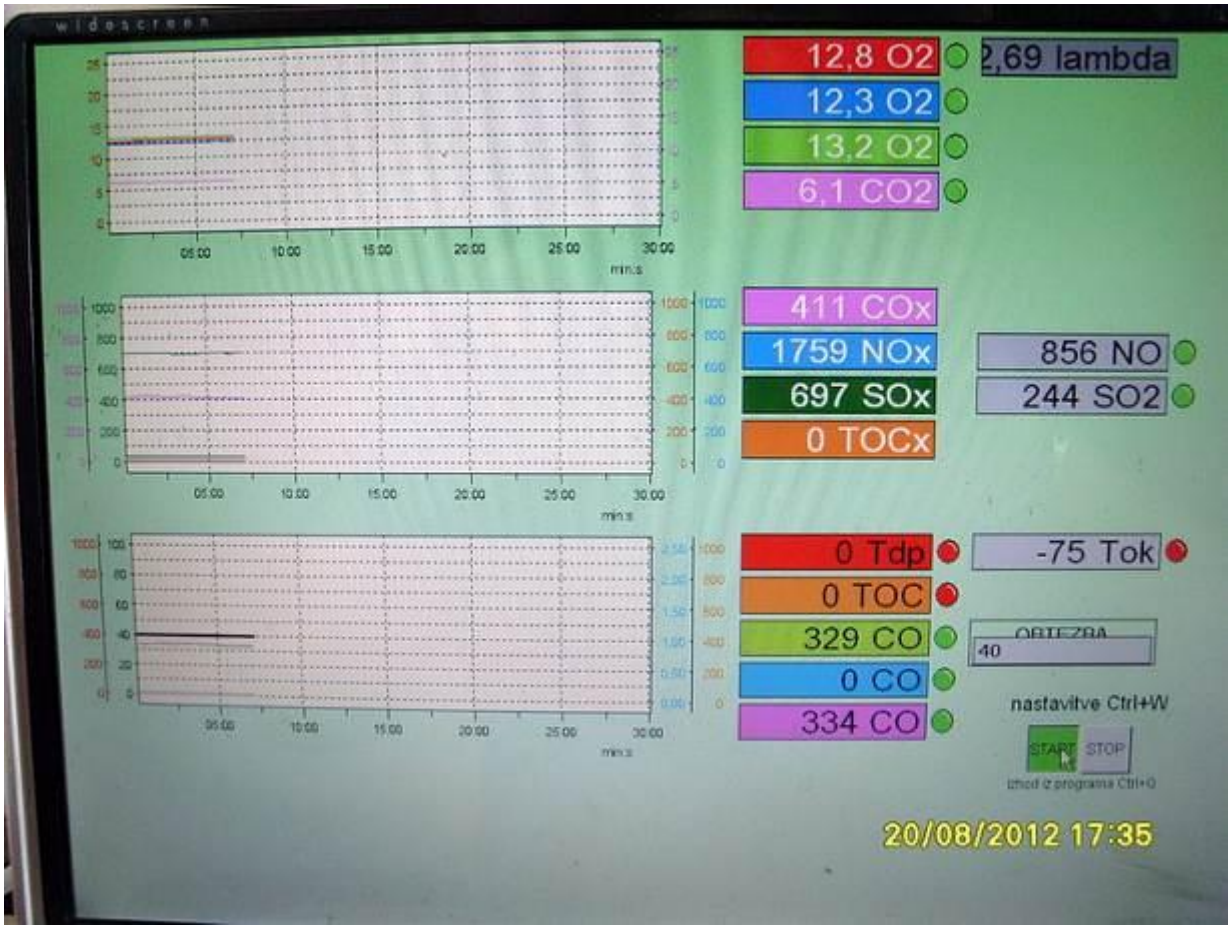
Smoke gases were less time to time: photos with working engine

Smoke gases were less time to time: photos with working engine


12,9 O2
12,4 O2
13,1 O2
6,1 CO2
2,65 lambda
448 COx
1759 NOx
692 SOx
0 TOCx
857 NO
242 SO2
0 Tdp
0 TOC
358 CO
0 CO
362 CO
-75 Tok
40
nastavitve Ctrl+W
20/08/2012 15:59


20/08/2012 16:16


12,8 O2
2,68 lambda
12,5 O2
13,2 O2
6,0 CO2
437 COx
1751 NOx
852 NO
692 SOx
242 SO2
0 TOCx
0 Tdp
-75 Tok
0 TOC
350 CO
40
0 CO
356 CO
nastavitve Ctrl+W
START
STOP
20/08/2012 16:23


12,8 O2
2,69 lambda
12,3 O2
13,2 O2
6,1 CO2
411 COx
1759 NOx
856 NO
697 SOx
244 SO2
0 TOCx
0 Tdp
-75 Tok
0 TOC
329 CO
40
0 CO
334 CO
nastavitve Ctrl+W
START
STOP
20/08/2012 17:35

At present time the Module TRGA was in function on the settling tank.


20/08/2012 18:37

F.4.7 The comparative results of emissions during using of treated fuel with module TRGA on the buffer tank and on the settling tank (21 August 2012)

	Data	***Notes***
Date	21 August 2012	
Place and event Measurements on the PORT side engine 21-test-1	Port of Oostende, B Navigation from Oostende to Ramsgate **Module TRGA on the buffer tank is switched ON.** **Module TRGA on the settling tank is swtiched ON.** Engine start: Leaving the Pear Arrival Oostende Data from the ship's bridge Log: 21 August 2012 Wind: Sea: Draft: Current: Cargo:	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

No any measurements were done in the navigation from Oostende to Ramsgate due to necessary full treatment of fuel with Module TRGA in the settlement tank.

	Data	***Notes***
Date	21 August 2012	
Place and event Measurements on the PORT side engine 21-test-2	Port of Ramsgate, UK. Navigation from Ramsgate to Oostende **Module TRGA on the buffer tank is switched ON.** **Module TRGA on the settling tank is switched ON.** Engine start: 14.20 hrs Leaving the Pear 14.30 hrs Arrival Oostende 18.25 hrs Data from the ship's bridge Log: 21 August 2012 Wind: NE, force 8 Sea: 2 Draft: 4,6 m Current: speed 0,1 Nm/h Cargo: 365,0 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

Engine functioning on the treated fuel:

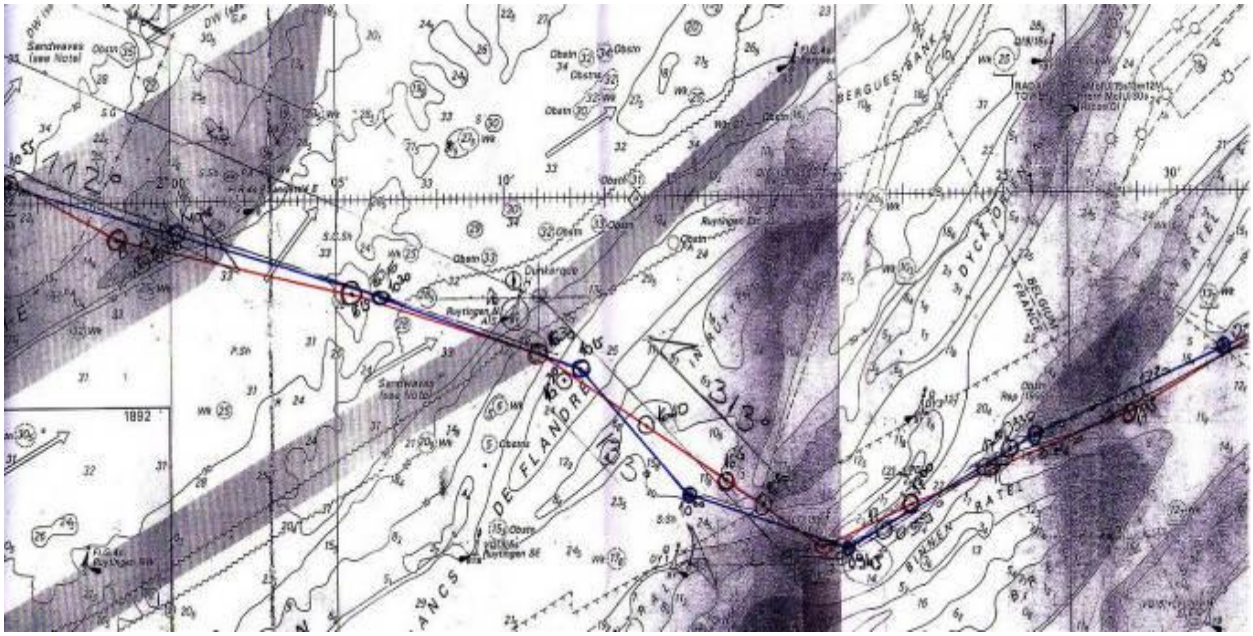
First Module TRGA works on preparatory tank,
Second module TRGA works on settlement tank.

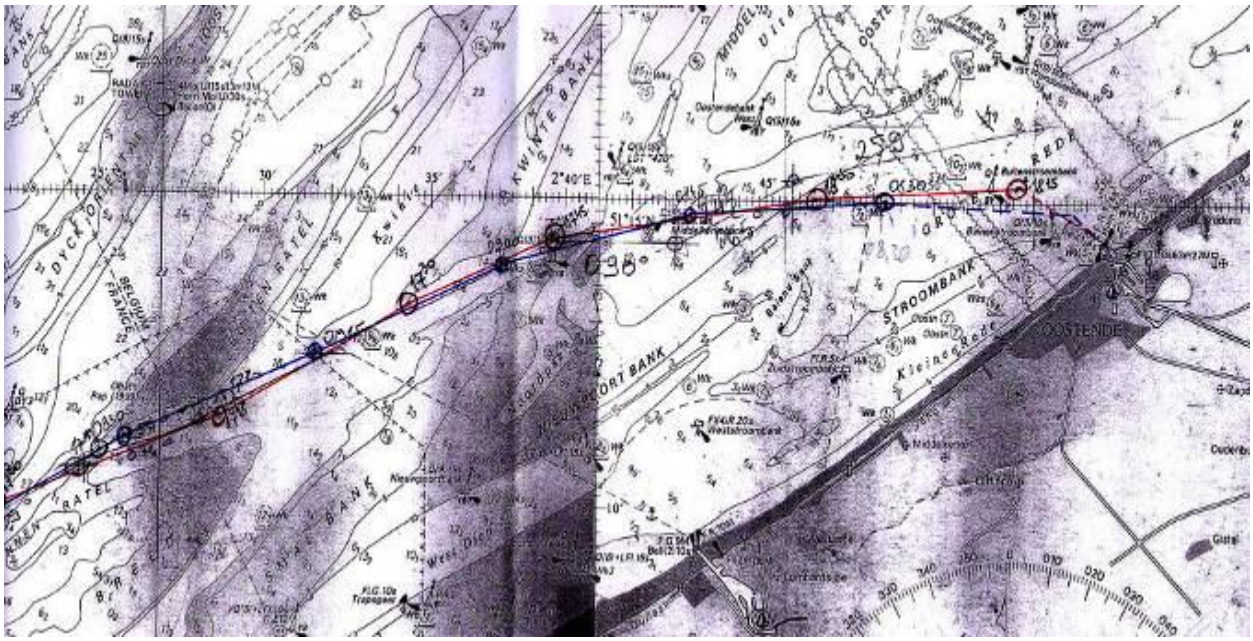
Time correction of routes/tracking: none.

The selection of a credible intervals for measurement was based on the following factors:

1. Stable regime of engine operation,
2. Stable regime of measuring devices,
3. Same wind direction during the intervals,
4. The assumption that the engine load was at least same as on 19 August 2012.

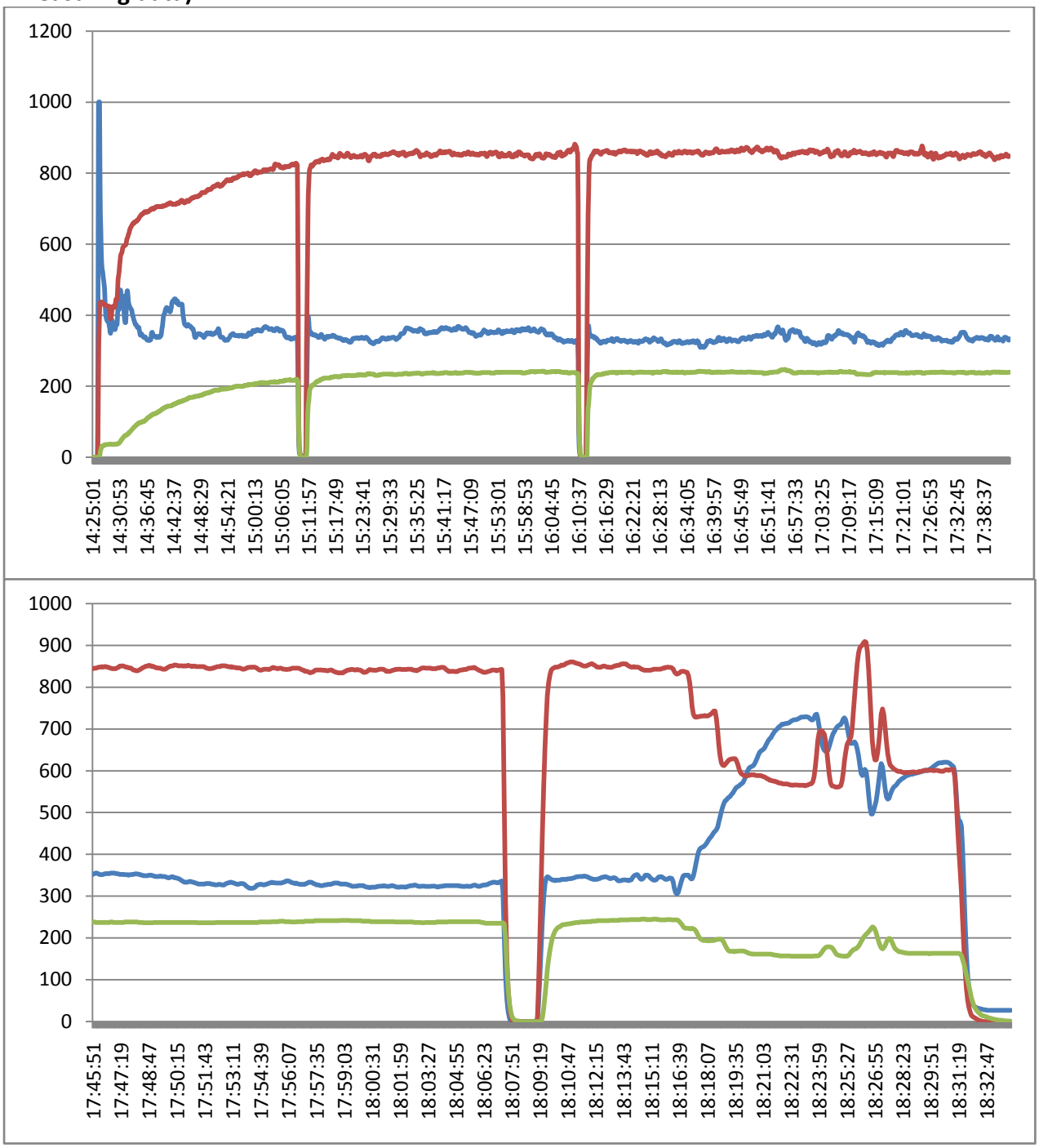
The actual facts were: ship's draft 4,6 meters, NE wind from the side before 17.30 hrs, then frontal (side) wind on the angle of 40° on the course of the ship. Wind speed was 8 Nm/h, the wave height was 2 (0,5 meters).





The best time interval for measurements was from 16.50 hrs forward.

Integral chart (in two parts due to automatic exchange of electronic mapping for saving measuring data)



Prior analyzing of the results ref. to the emission in some regions, it is necessary to analyze the areas of emissions changes on departure from the Port of Ramsgate, using standard fuel (Chart 1), then using the fuel treated with the Module TRGA on the buffer tank (Chart 2) and during operation of the entire system, where two modules TRGA were working at the same time, on the buffer tank and on the settling tank (Chart 3).

Chart 1. 19 August 2012 standard fuel

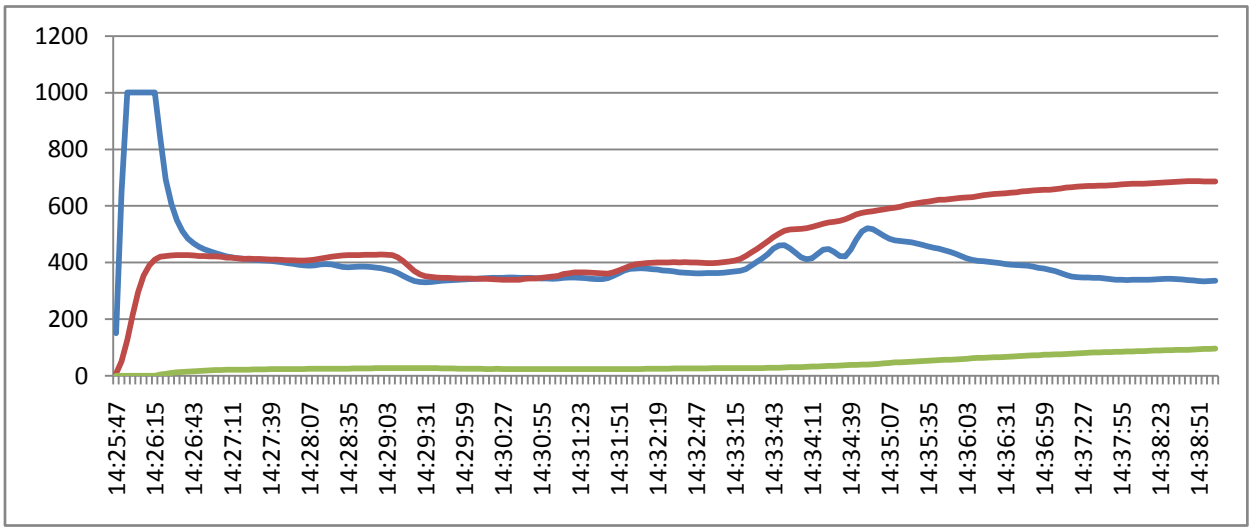


Chart 2. 20 August 2012 Fuel treated on the buffer tank

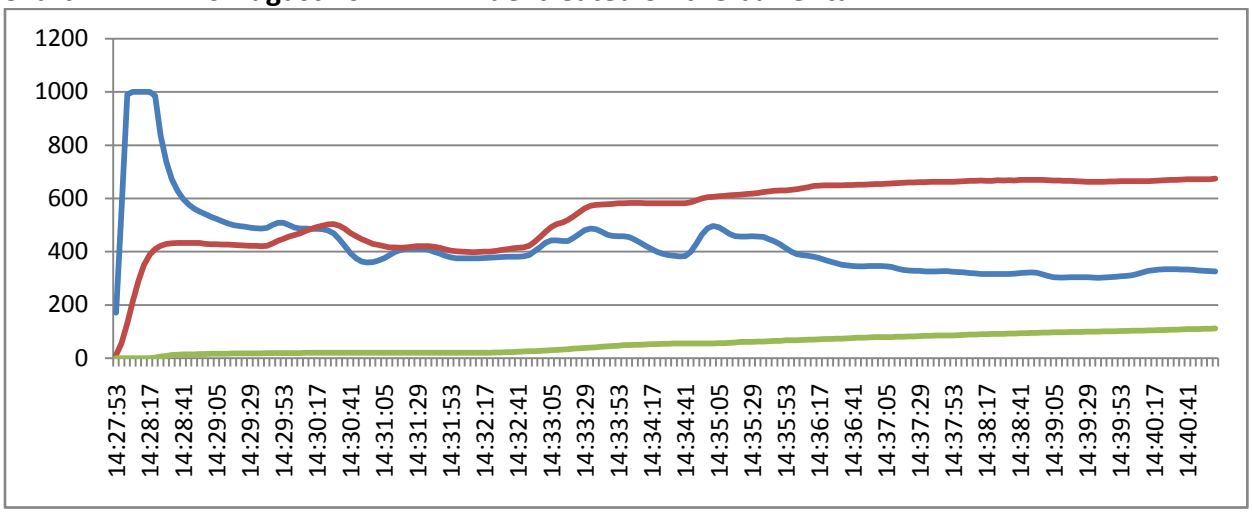
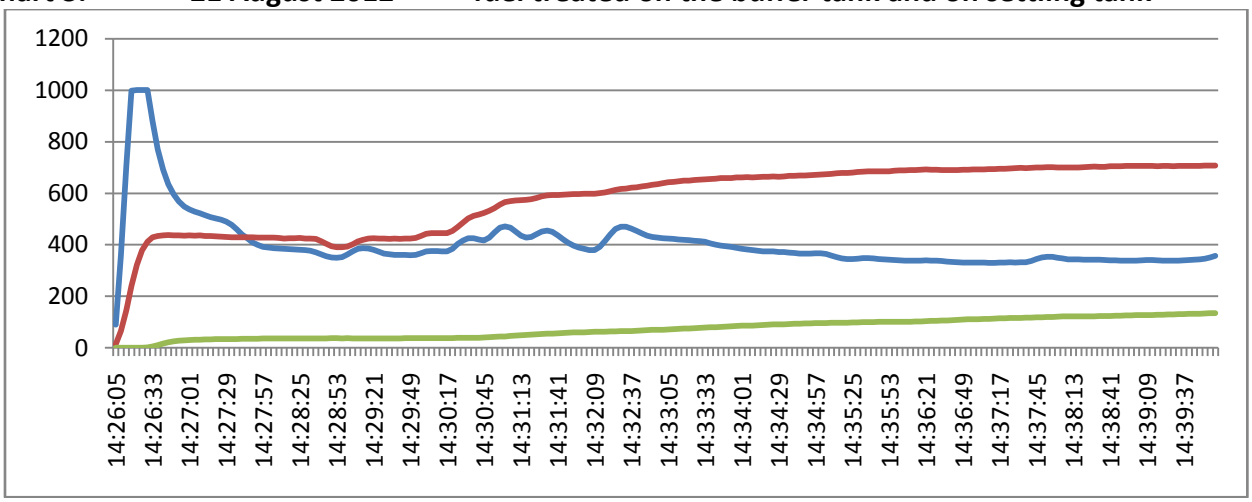


Chart 3. 21 August 2012 fuel treated on the buffer tank and on settling tank

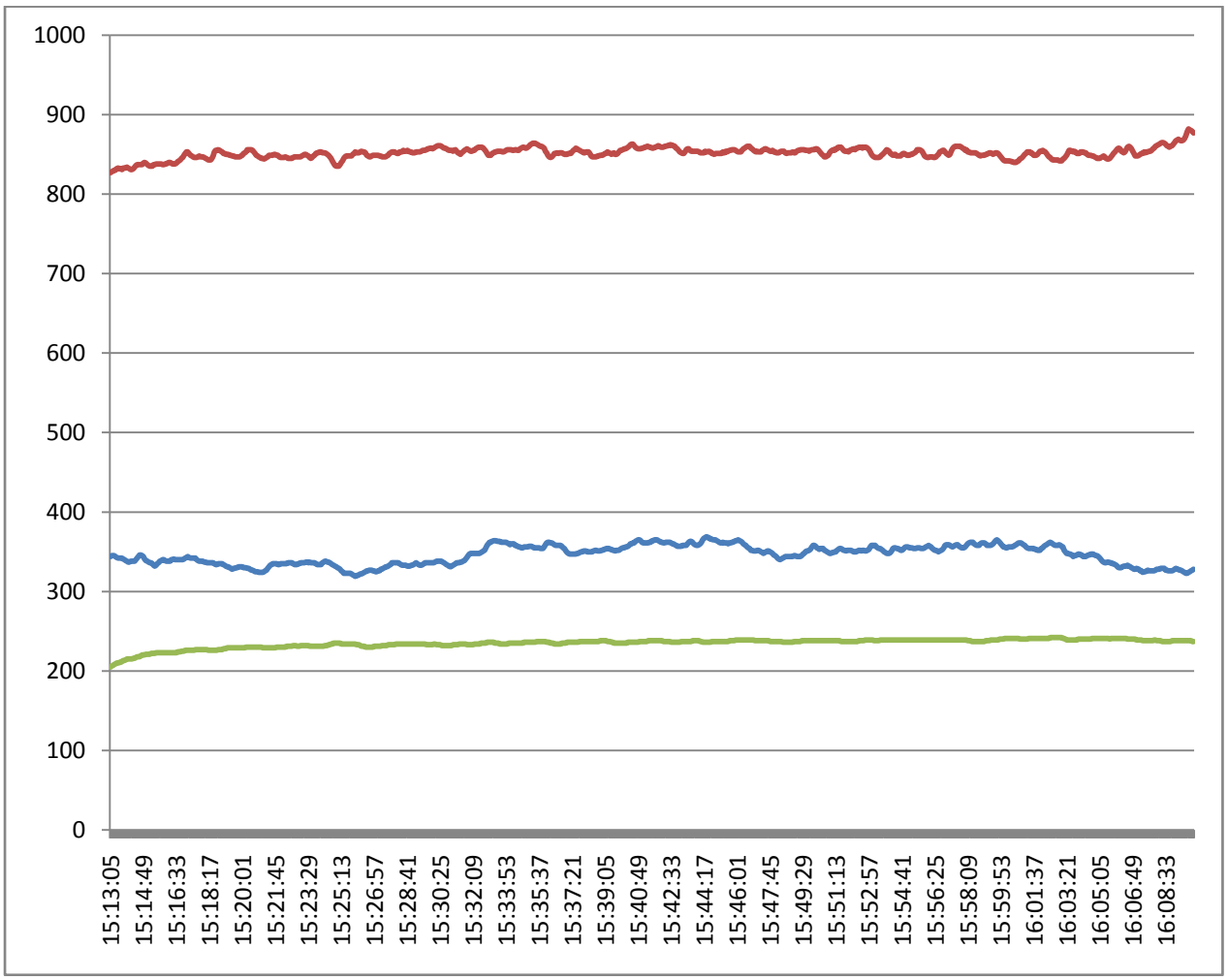


The Charts are showing the shortness of the time intervals of engine start in stable regime, due to higher level of fuel treatment.

Let's go back to the selection and analysis of credible time intervals for measurements.

Time Interval between 14.25 and 15.15 hrs was not considered due to for transitional engine arrangements and preparation of measuring devices.

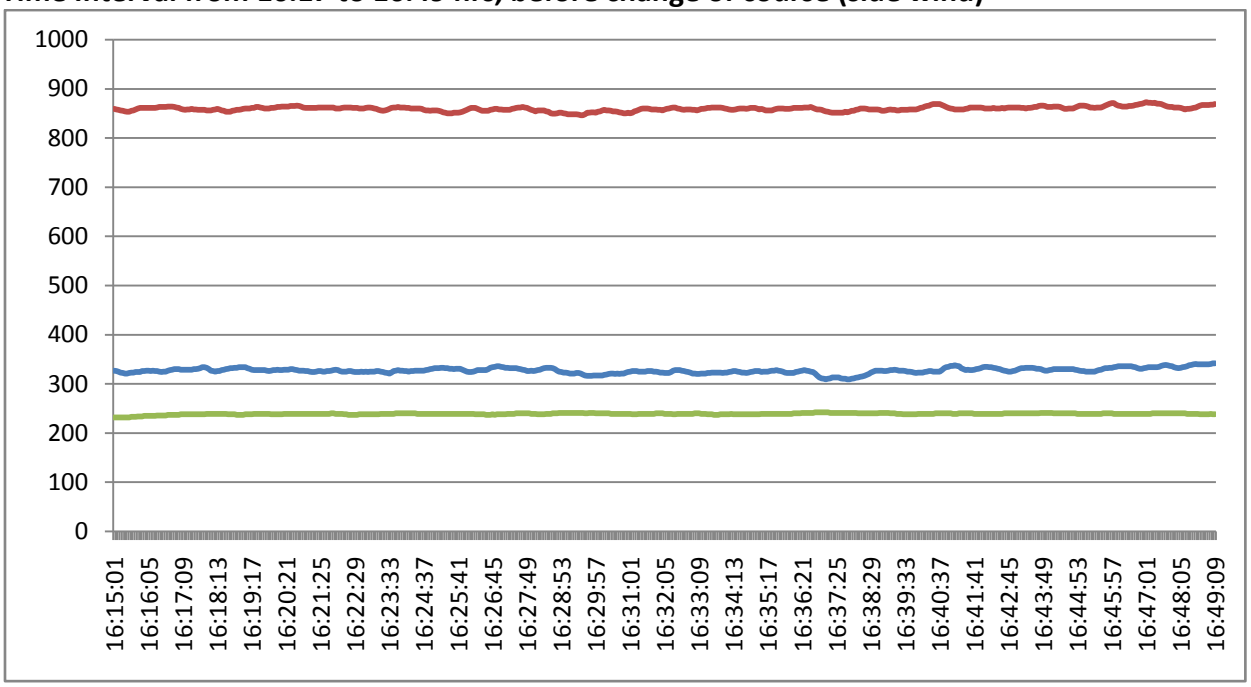
The time interval between 15.15 and 16.10hrs is consisting of 2 very strong intervals (20 minutes and 30 minutes), which closely corresponds to the shallow water areas (see nautical chart), and affecting the load of the engine. Sizes of the emissions in each of them are stable, but not showing the whole picture. However, look at the charts and average values...



Average values of smoke gases:
CO = 346 (-10%) SO = 234.7 (-0.2%) NO = 851.56 (-5.36)
(using standard fuel CO = 384.58 SO = 234.96 NO = 899.84)

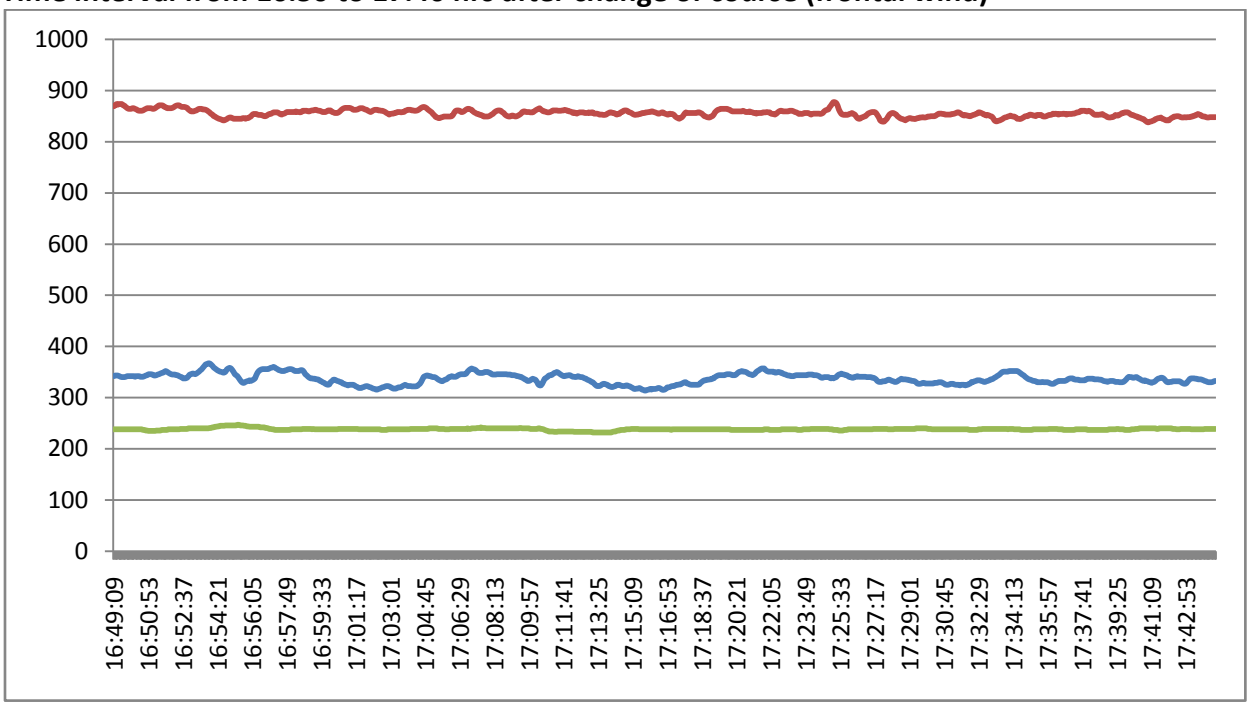
Next time interval was between the moderation of measuring devices also have two intervals, first from 16.17 and 16.49 hrs before the change of the course of navigation (side wind), and second from 16.50 to 17.40 hrs when frontal wind was blown, force 8 Nm/h.

Time Interval from 16.17 to 16.49 hrs, before change of course (side wind)

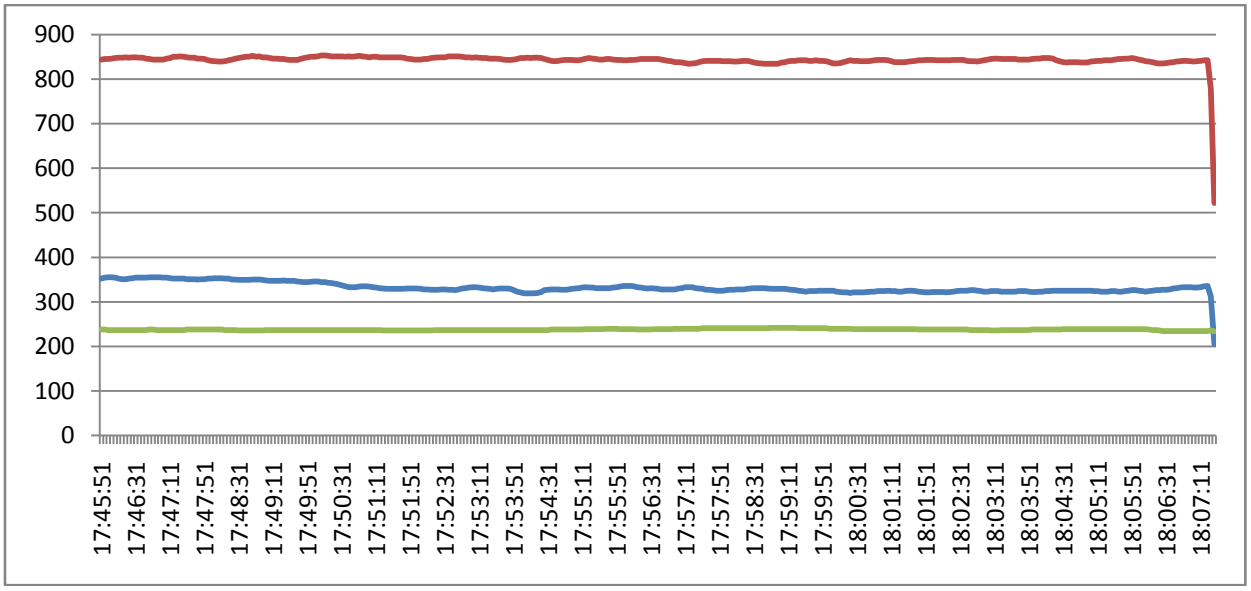


Average values of smoke gases:
CO = 327 (-14.97%) SO = 238.9 (+1.67%) NO = 859.4 (-4.49%)
(using standard fuel CO = 384.58 SO = 234.96 NO = 899.84)

Time interval from 16.50 to 17.40 hrs after change of course (frontal wind)



Average values of smoke gases:
CO = 337.1 (-12.34%) SO = 238.3 (+1.65%) NO = 855.18 (-4.96%)
(using standard fuel CO = 384.58 SO = 234.96 NO = 899.84)



Average values of smoke gases:
CO = 332 (-13.67%) SO = 238 (+1.7%) NO = 843.6 (-6.25%)
(using standard fuel CO = 384.58 SO = 234.96 NO = 899.84)

Use of two Modules TRGA, one on the buffer tank and second on the settling tank were given following results:

CO = 346 (-10%)	**SO = 234.7 (-0.2%)**	**NO = 851.56 (-5.36)**
CO = 327 (-14.97%)	**SO = 238.9 (+1.67%)**	**NO = 859.4 (-4.49%)**
CO = 337.1 (-12.34%)	**SO = 238.3 (+1.65%)**	**NO = 855.18 (-4.96%)**
CO = 332 (-13.67%)	**SO = 238 (+1.7%)**	**NO = 843.6 (-6.25%)**

CONCLUSIONS

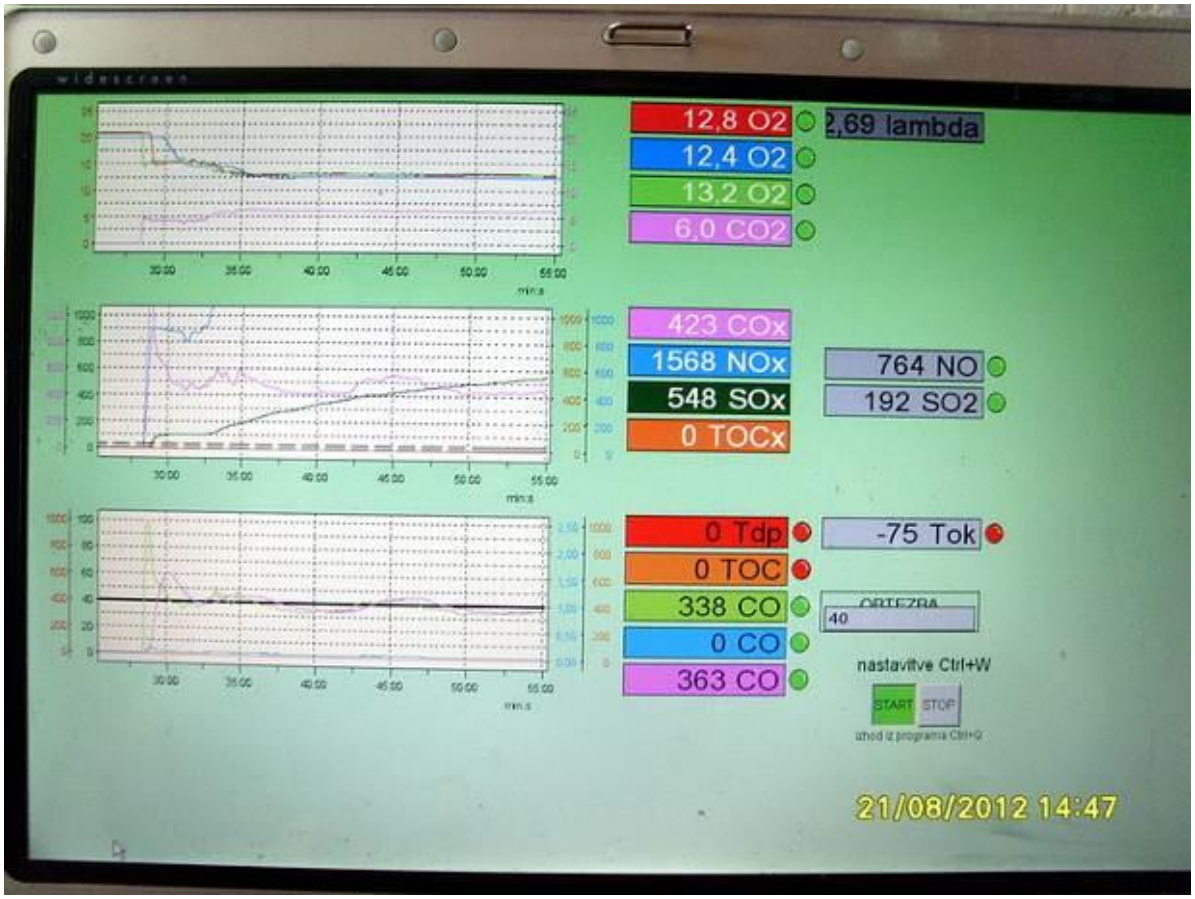
1. Use of both Modules TRGA for processing of heavy fuel on the buffer tank and on the settling tank, having in mind same weather conditions, was lowered CO emissions as follows:

a) For the entire time Interval from -10% to -14,97%
b) The most authentic result from -12,34% to –13,67%

2. All mutual conditions are giving the conclusion on their comparability with testing of previous day.

3. The results obtained were comparable with the results obtained on 19 August 2012 and 20 August 2012.

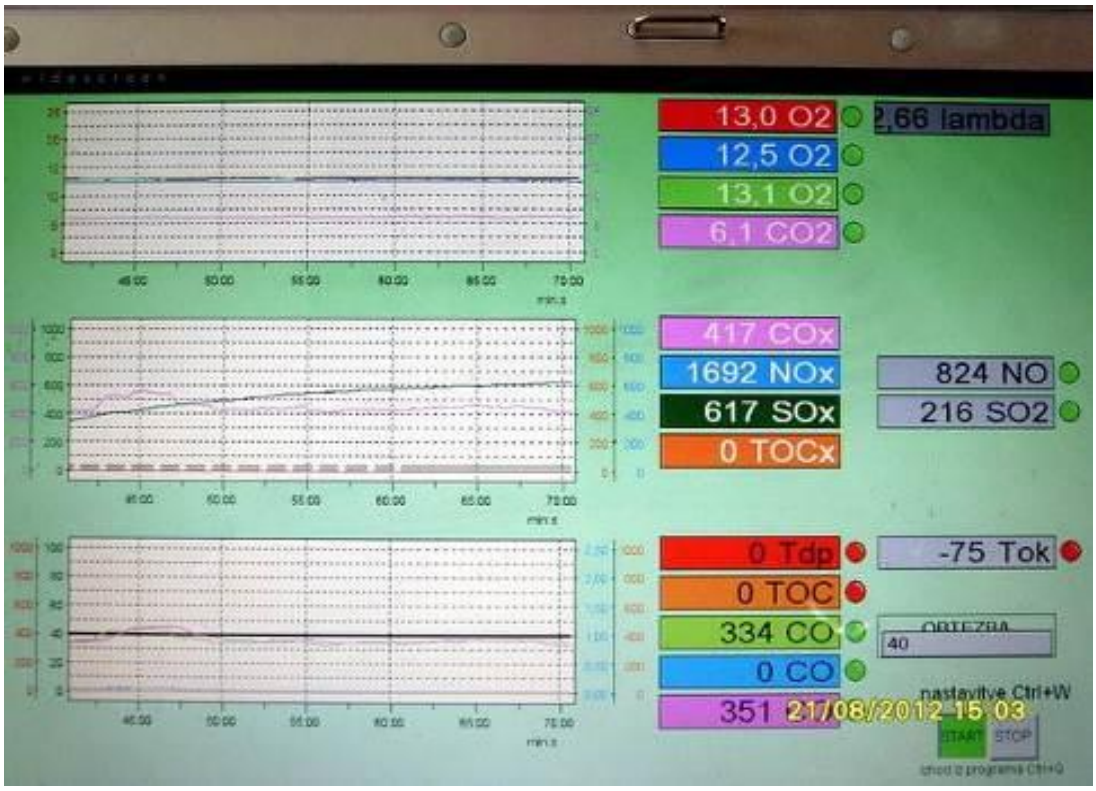
Below follows a brief photo report.

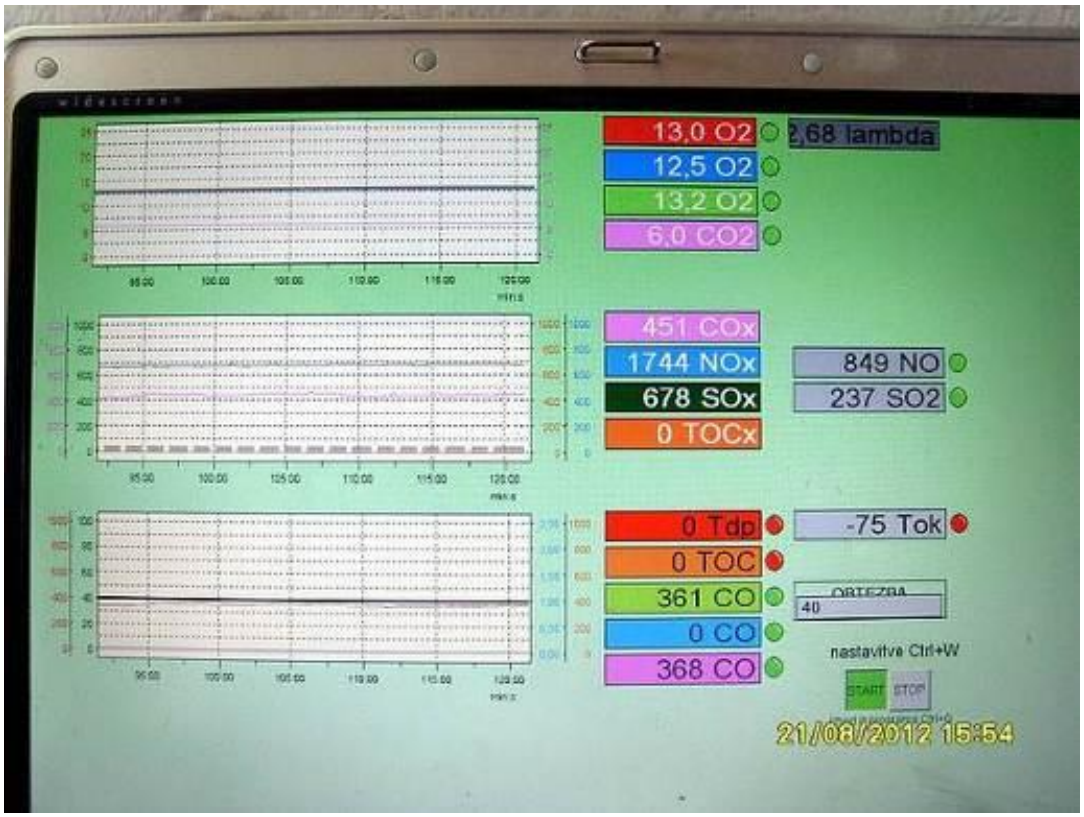

12,8 O2
2,69 lambda
12,4 O2
13,2 O2
6,0 CO2
423 COx
1568 NOx
764 NO
548 SOx
192 SO2
0 TOCx
0 Tdp
-75 Tok
0 TOC
338 CO
40
0 CO
363 CO
nastavitve Ctrl+W
START
STOP
21/08/2012 14:47


21/08/2012 14:22


21/08/2012 14:52


21/08/2012 15:01


13,0 O2
2,66 lambda
12,5 O2
13,1 O2
6,1 CO2
417 COx
1692 NOx
824 NO
617 SOx
216 SO2
0 TOCx
0 Tdp
-75 Tok
0 TOC
334 CO
ORTEZBA
40
0 CO
351
nastavitve Ctrl+W
21/08/2012 15:03
START
STOP


13,0 O2
2,68 lambda
12,5 O2
13,2 O2
6,0 CO2
451 COx
1744 NOx
849 NO
678 SOx
237 SO2
0 TOCx
0 Tdp
-75 Tok
0 TOC
361 CO
ORTEZBA
40
0 CO
368 CO
nastavitve Ctrl+W
START
STOP
21/08/2012 15:54

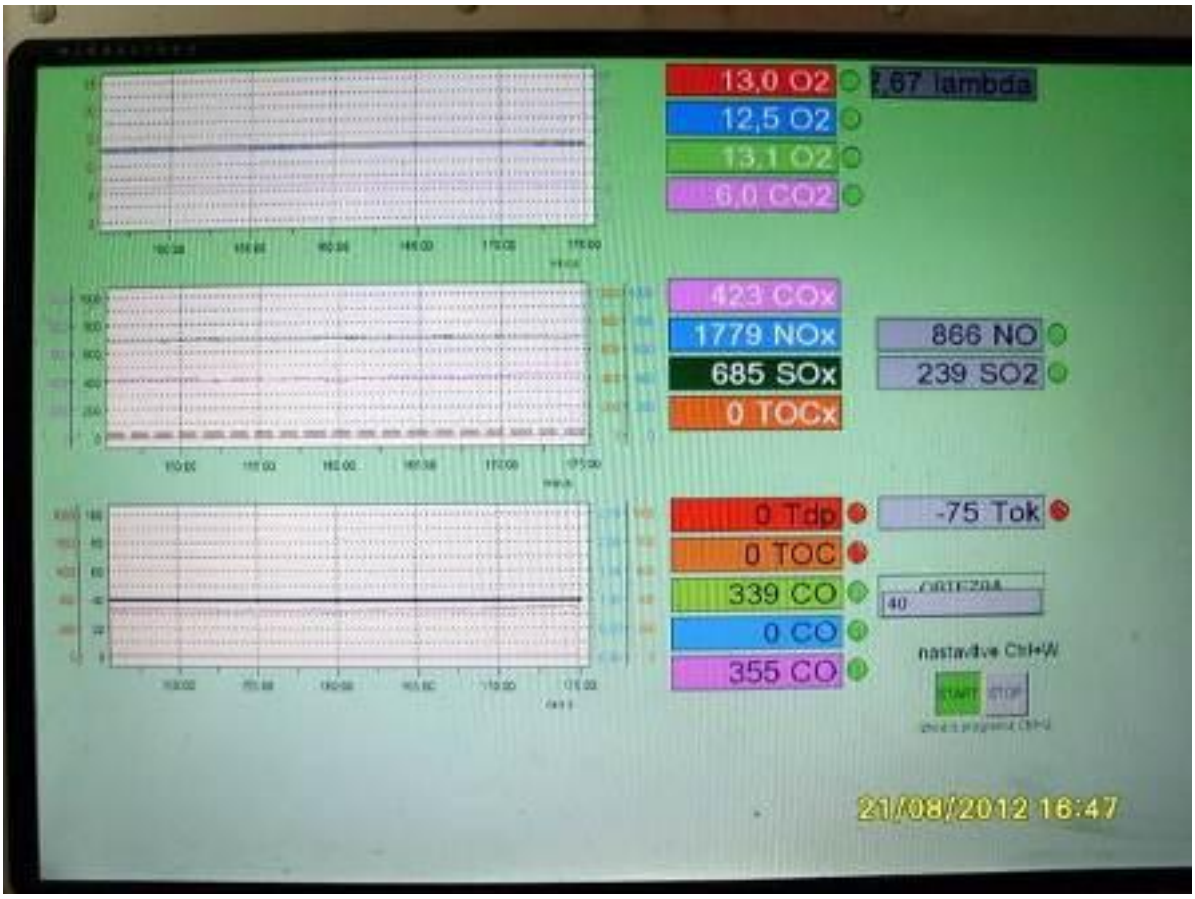
RO-RO vessel »Gardenia », on the route between Ramsgate to Oostende, the photos were done in navigation, passing »Larkspur«, the main reason was to show smoke gases from the both engine's funnels and to compare them with smoke gases observed on the port side engine onboard RO-RO vessel »Larkspur«

RO-RO vessel »Gardenia«

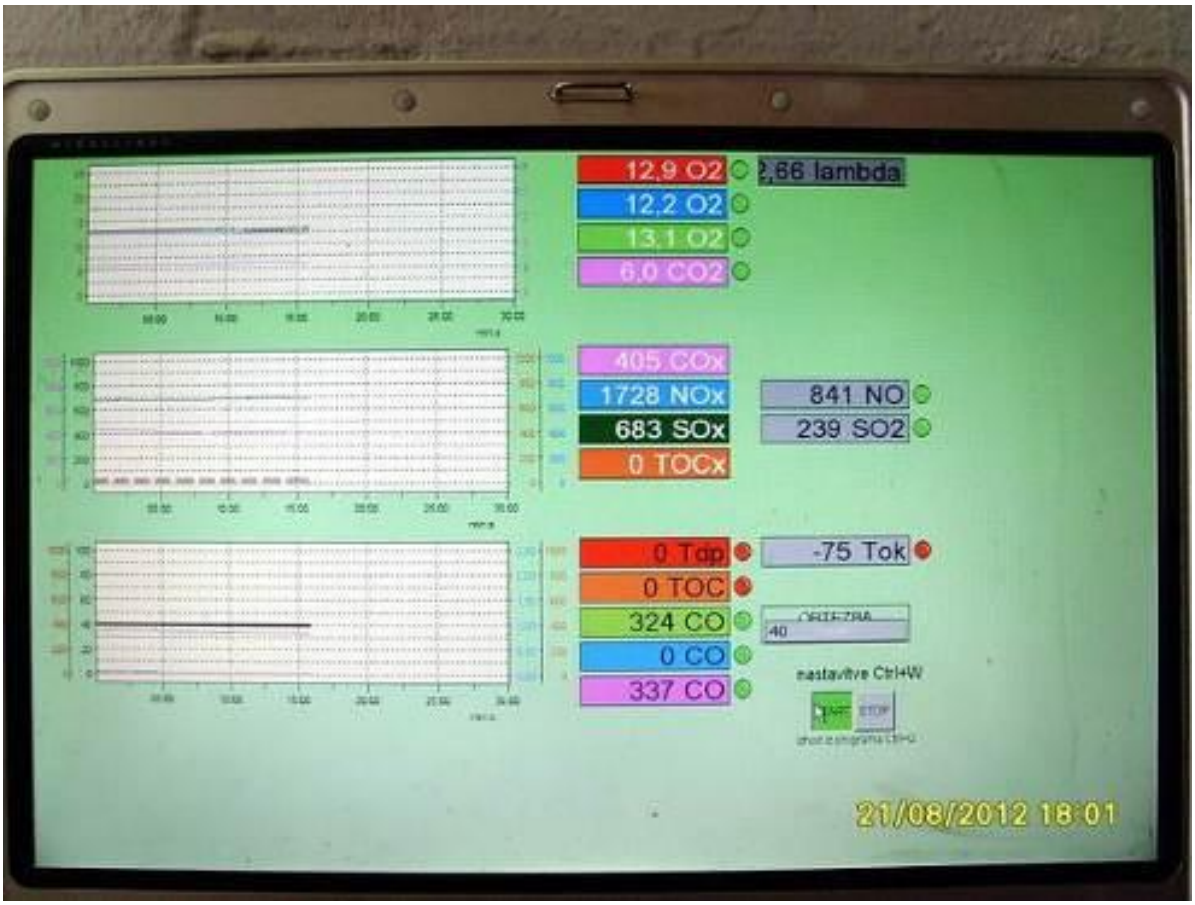
RO-RO vessel »Gardenia«

Smoke from the port side funnel onboard RO-RO vessel »Larkspur«


20/08/2012 16:16


13,0 O2
12,5 O2
13,1 O2
6,0 CO2
67 lambda
423 COx
1779 NOx
685 SOx
0 TOCx
866 NO
239 SO2
0 Tdp
0 TOC
339 CO
0 CO
355 CO
-75 Tok
40
nastavitve Ctrl+W
START
STOP
21/08/2012 16:47


12,9 O2
12,4 O2
13,2 O2
5,9 CO2
68 lambda
407 COx
1749 NOx
680 SOx
0 TOCx
851 NO
238 SO2
0 Tdp
0 TOC
325 CO
0 CO
340 CO
-75 Tok
40
nastavitve Ctrl+W
START
STOP
21/08/2012 17:27


12,9 O2
2,66 lambda
12,2 O2
13,1 O2
6,0 CO2
405 COx
1728 NOx
683 SOx
0 TOCx
841 NO
239 SO2
0 Tdp
0 TOC
324 CO
0 CO
337 CO
-75 Tok
40
nastavitve Ctrl+W
21/08/2012 18:01


20,0 O2
20,9 O2
0,0 CO2
31 COx
0 NOx
0 SOx
0 TOCx
0 NO
0 SO2
0 Tdp
0 TOC
25 CO
0 CO
27 CO
-75 Tok
40
START
STOP
21/08/2012 18:35

Smoke from the port side funnel of »Larkspur«

F.4.8 The comparative results of emissions during operation on the treated fuel with the module TRGA on the buffer tank and on the settling tank (22 August 2012)

	Data	*Notes*
Date	22 August 2012	
Place and event Measurements on the PORT side engine 22-test-1	Port of Oostende, Belgium Navigation from Oostende to Ramsgate **Module TRGA on the buffer tank is switched OFF.** **Module TRGA on the settling tank is switched ON.** Engine start: 07.40 hrs Leaving the Pear 07.50 hrs Arrival Ramsgate 12.03 hrs Data from the ship's bridge Log: 22 August 2012 Wind: W, force 5 Sea: 3 Draft: 4,7 m Current: speed 0,5 to 1,25 Nm/h Cargo: 596,5 tons	Air turbine of port side engine is in excellent technical condition. Air turbine of stbd' side engine is NOT in the excellent technical condition. There is water vapor in the smoke gases. Wear of fuel injectors on both engines.

Functioning of engine on the treated fuel:

First Module TRGA switched OFF on buffer tank,
Second module TRGA working on settlement tank.

Time correction of routes/tracking: 15 minutes.

On 19 August 2012 departure from the Port of Oostende at 08.15 hrs, arrival in the Port of Ramsgate at 12.48 hrs (navigation time 04.38 hrs).

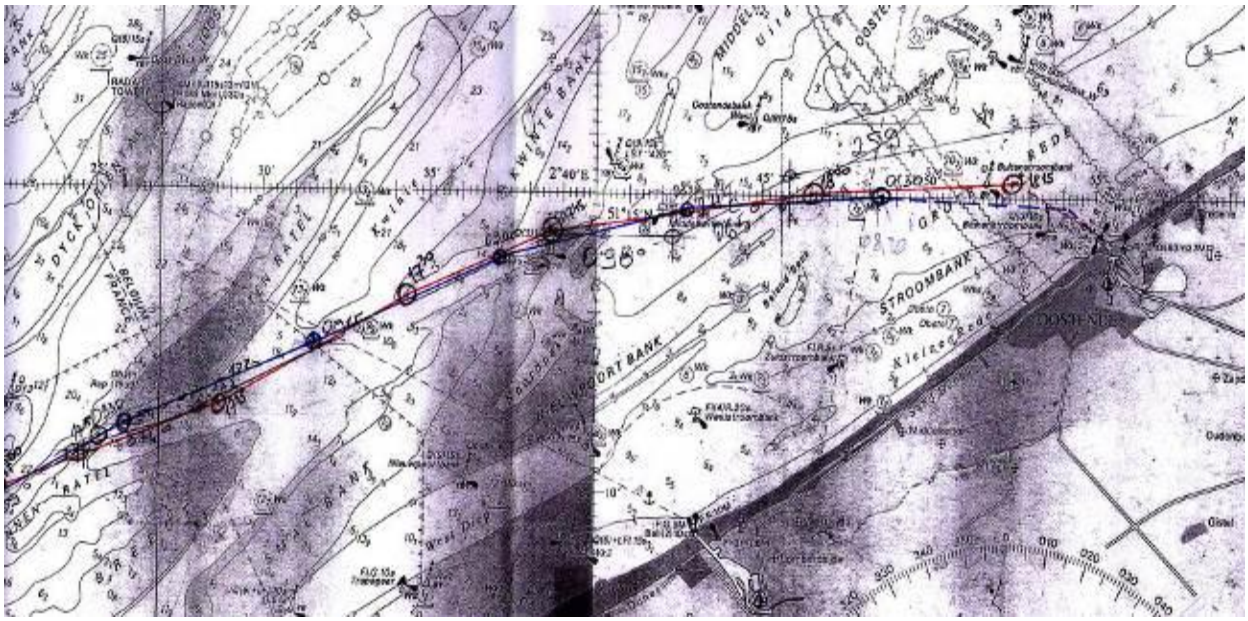
On 22 August 2012 departure from the Port of Oostende at 08.00 hrs, arrival in the Port of Ramsgate at 12.03 hrs (navigation time 04.03 hrs).

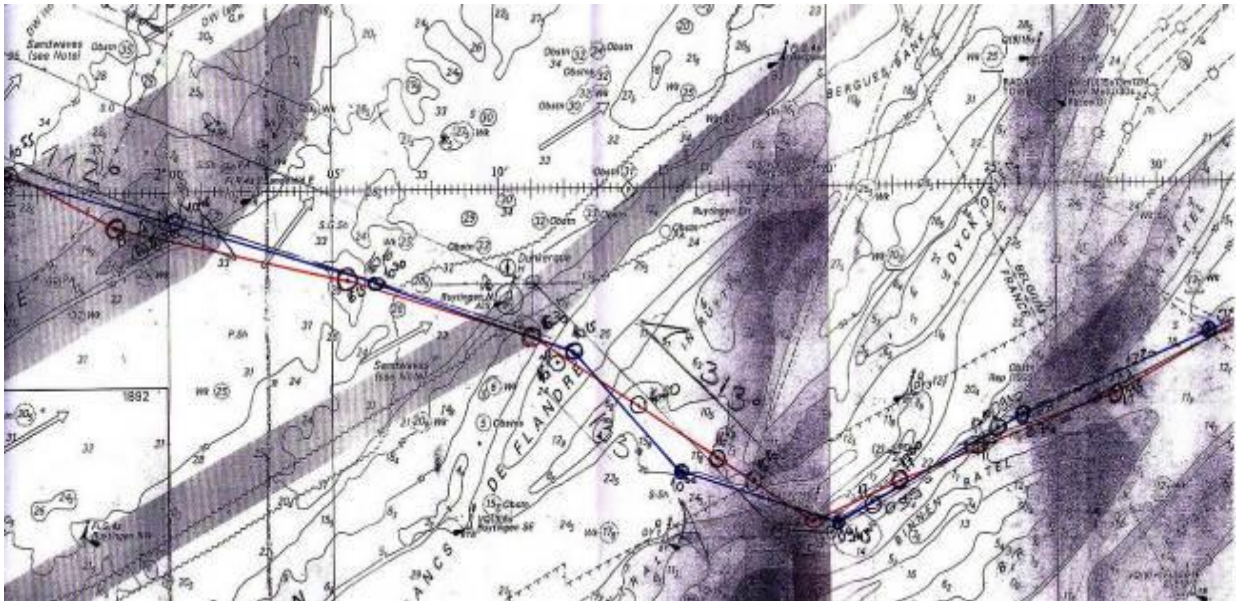
Having in mind that the ship's speed was constant, precedent navigational chart should be used, including time marks on the chart with remark »minus 15 minutes«.

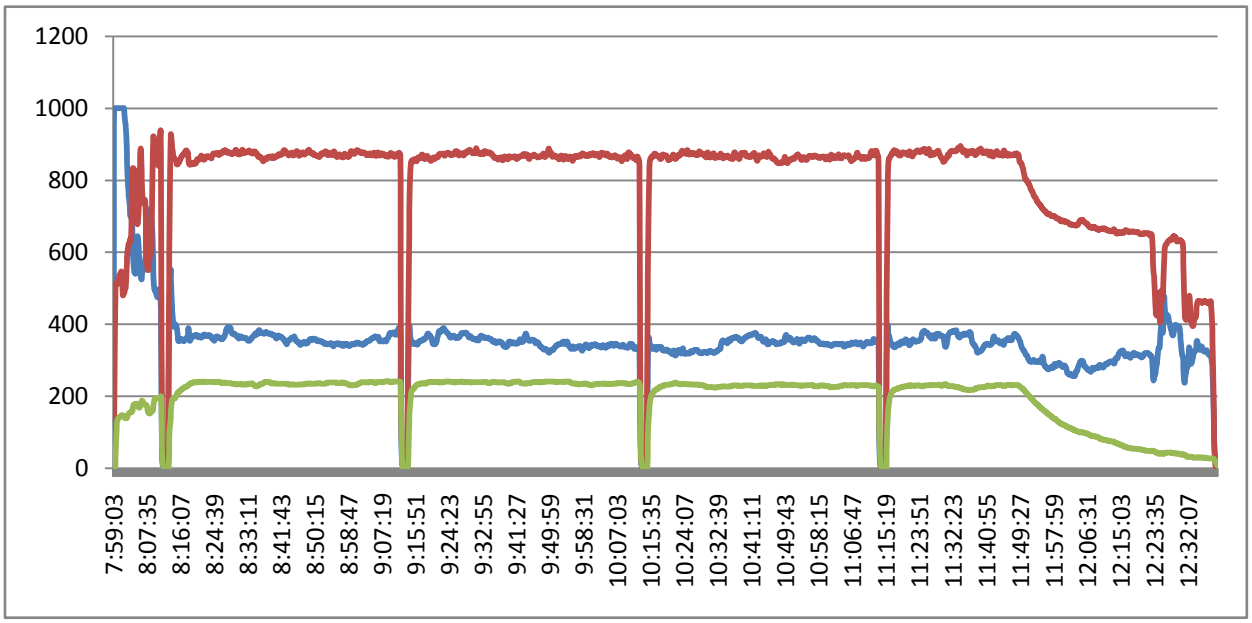
The selection of a credible intervals for measurement was based on the following factors:

1. Stable regime of engine operation,
2. Stable regime of measuring devices,
3. Same wind direction during the intervals,
4. The assumption that the engine load was at least same as on 19 August 2012.

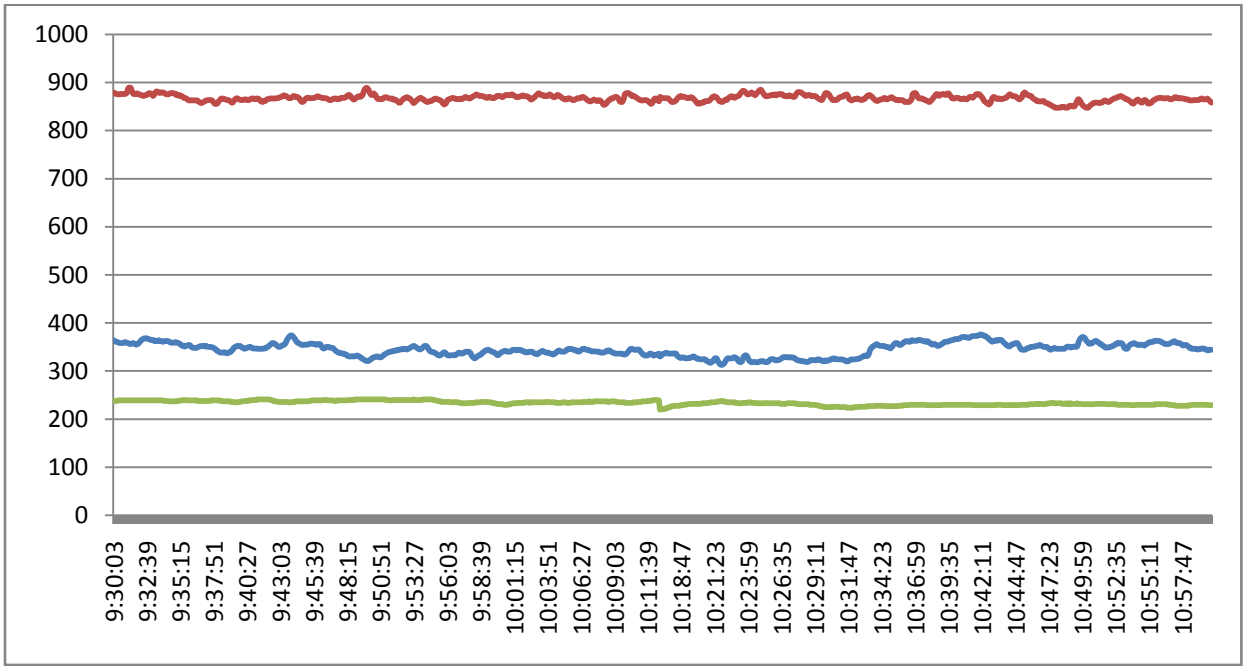
The actual facts were: ship's draft 4,7 meters, W frontal (side) wind on the angle of 40° on the course of the ship. Wind speed was 8 Nm/h, the wave height was 3 (0,5 to 0,75 meters). Low sea current from stern direction.





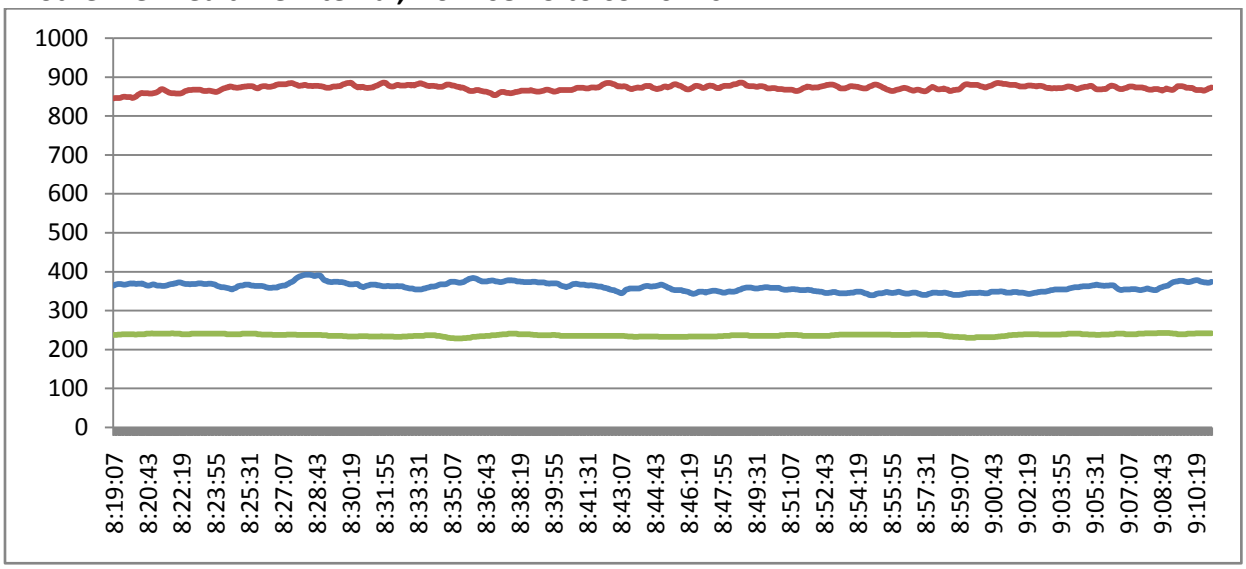

1200
1000
800
600
400
200
0
7:59:03
8:07:35
8:16:07
8:24:39
8:33:11
8:41:43
8:50:15
8:58:47
9:07:19
9:15:51
9:24:23
9:32:55
9:41:27
9:49:59
9:58:31
10:07:03
10:15:35
10:24:07
10:32:39
10:41:11
10:49:43
10:58:15
11:06:47
11:15:19
11:23:51
11:32:23
11:40:55
11:49:27
11:57:59
12:06:31
12:15:03
12:23:35
12:32:07

Time interval before 08.27hrs: different speed and frontal wind.
Time interval from 08.32 to 09.15 hrs: frontal wind under angle.
Time interval from 09.20 to 09.30 hrs: course change due to frontal wind.
Time interval from 09.30 to 10.30 hrs: permanent course with frontal wind under angle.
Time interval from 10.30 to 11.45 hrs: passing the area of shallow waters and course change to the frontal wind.
Excluded from Charts the moderation of measuring devices and verified time interval was used from 09.30 to 11.00 hrs, entire time interval was of 90 minutes.



Average values of smoke gases:
CO = 344.62 (-10.39%) SO = 230.1 (-2.06%) NO = 865.8 (-3.78%)
(using standard fuel CO = 384.58 SO = 234.96 NO = 899.84)

Another verified time interval, from 08.19 to 09.10 hrs



Average values of smoke gases:
CO = 359.68 (-6.47%) SO = 236.35 (+0.6%) NO = 871.46 (-3.15%)
(using standard fuel CO = 384.58 SO = 234.96 NO = 899.84)

CONCLUSIONS

1. Use of one Module TRGA for processing of heavy fuel on the settling, having in mind same weather conditions, was lowered CO emissions as follows:

CO = 344.62 (-10.39%) **SO = 230.1 (-2.06%)** **NO = 865.8 (-3.78%)**
CO = 359.68 (-6.47%) **SO = 236.35 (+0.6%)** **NO = 871.46 (-3.15%)**

Entire time Interval was from -6,47% to -10,39%.

2. All mutual conditions are giving the conclusion on their comparability with testing of previous day.

3. The results obtained are comparable with the results obtained on 19 August 2012, 20 August 2012 and 21 August 2012.

The analysis of photos are showing that engine revolutions in the time of using treated fuel were higher than engine revolutions in the time using standard fuel – please see the comparison.

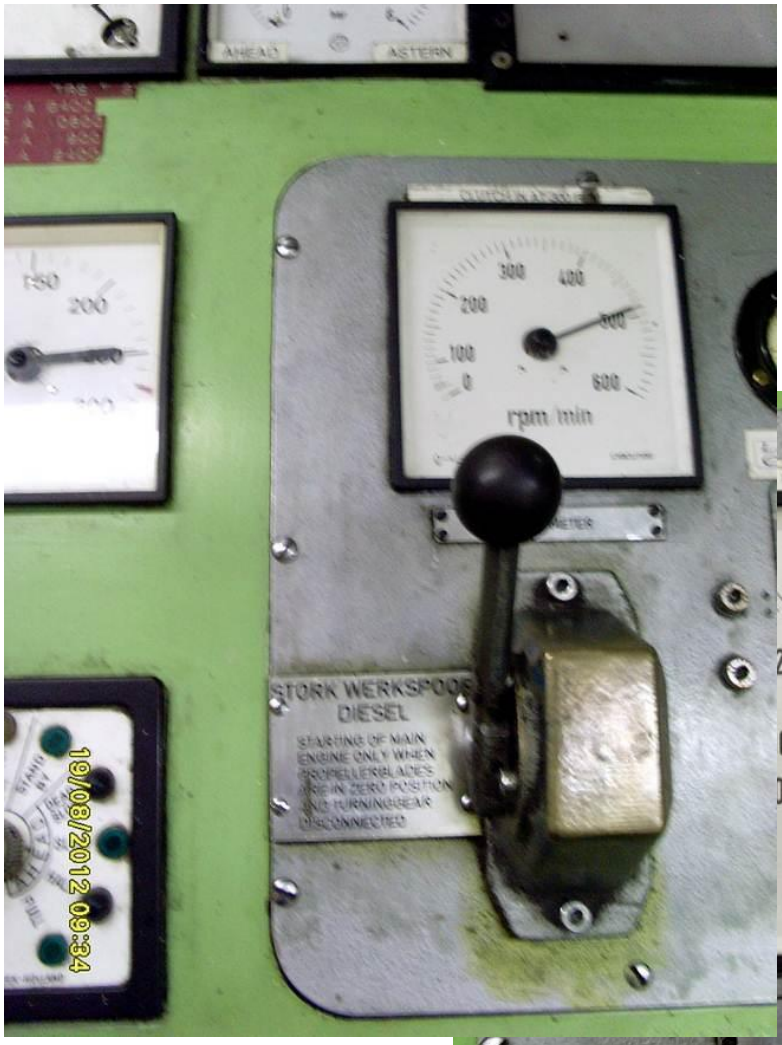
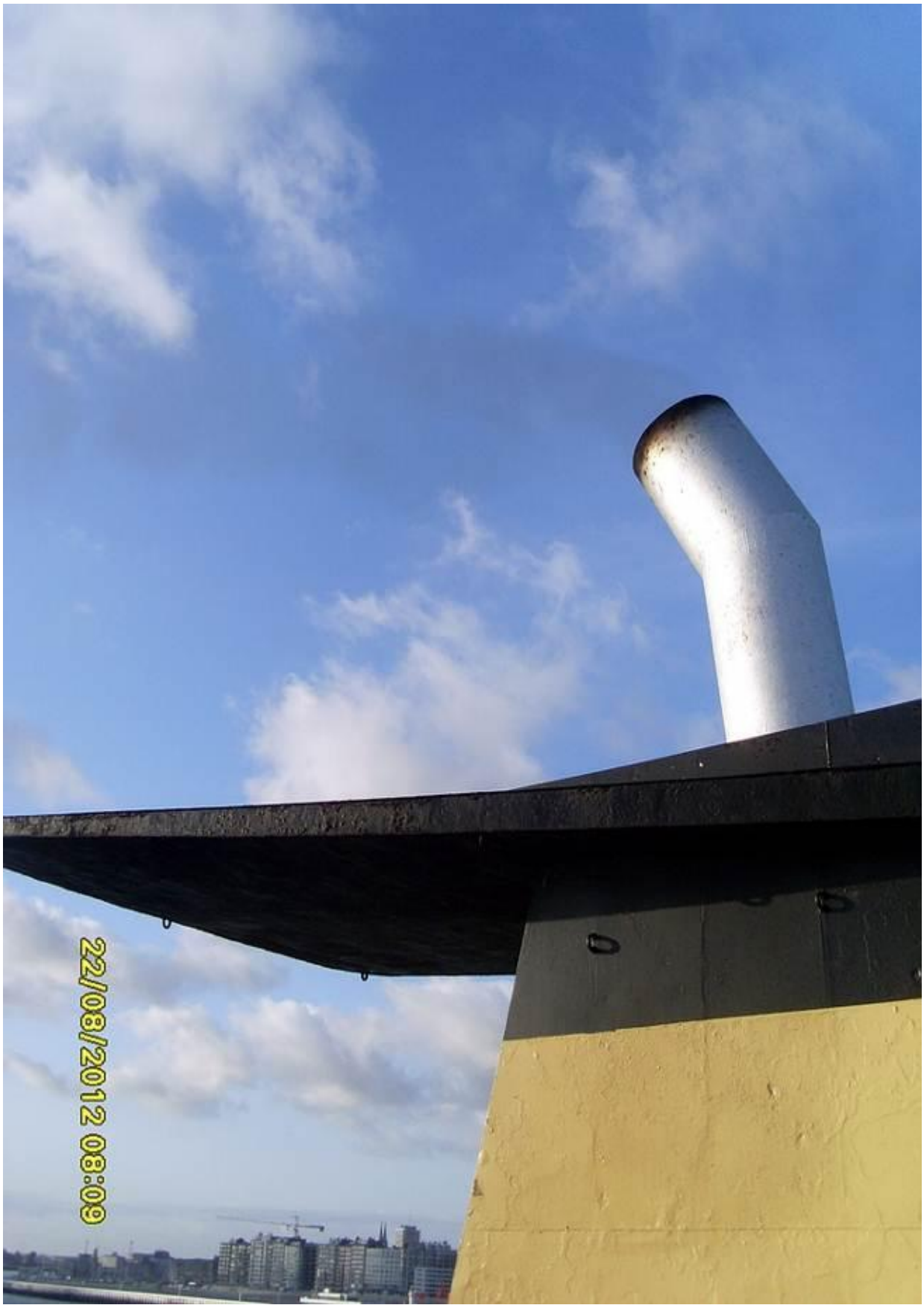


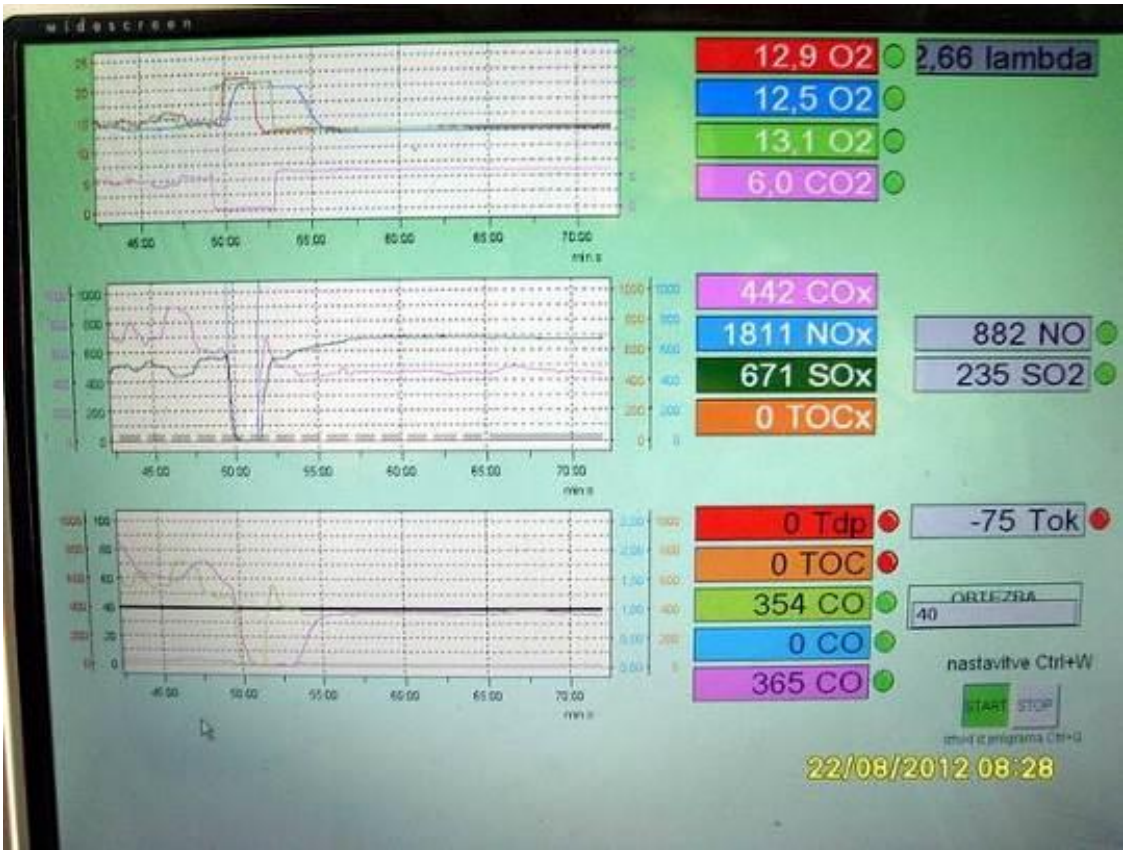
Photo of Tachometer onboard m/v »Larkspur« on 19 August 2012

The Module TRGA switched OFF on the buffer tank

Decreasing of smoke gases on departure from the Port using heavy fuel

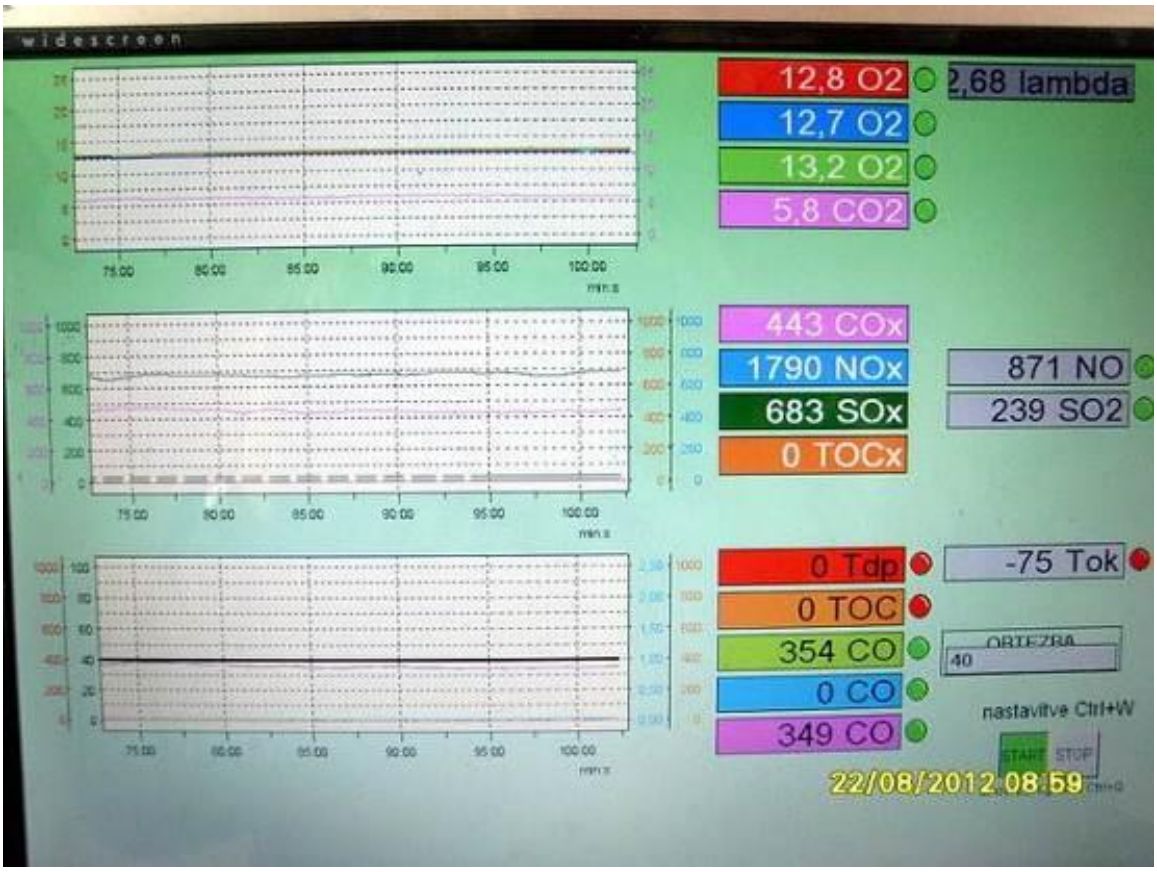

22/08/2012 08:09


22/08/2012 08:11

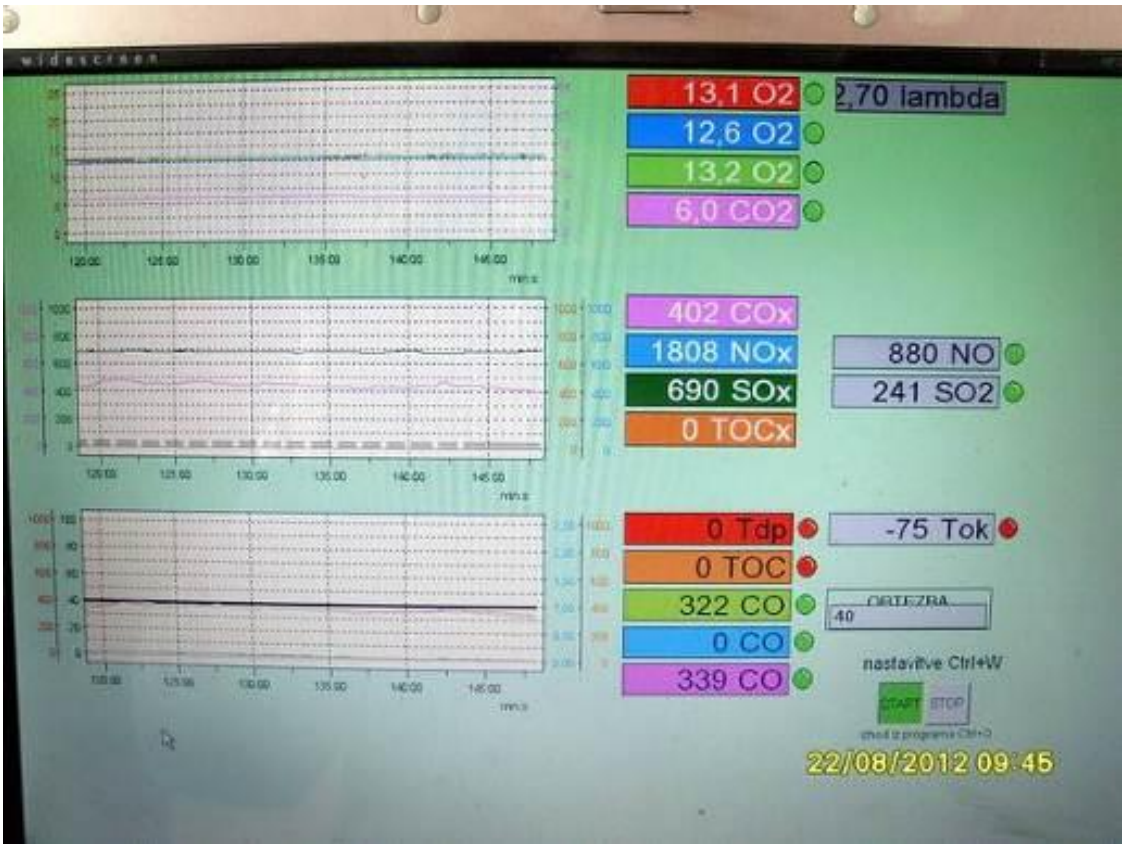

12,9 O2
2,66 lambda
12,5 O2
13,1 O2
6,0 CO2
442 COx
1811 NOx
882 NO
671 SOx
235 SO2
0 TOCx
0 Tdp
-75 Tok
0 TOC
354 CO
0 CO
365 CO
40
nastavitve Ctrl+W
START
STOP
22/08/2012 08:28


22/08/2012 08:32

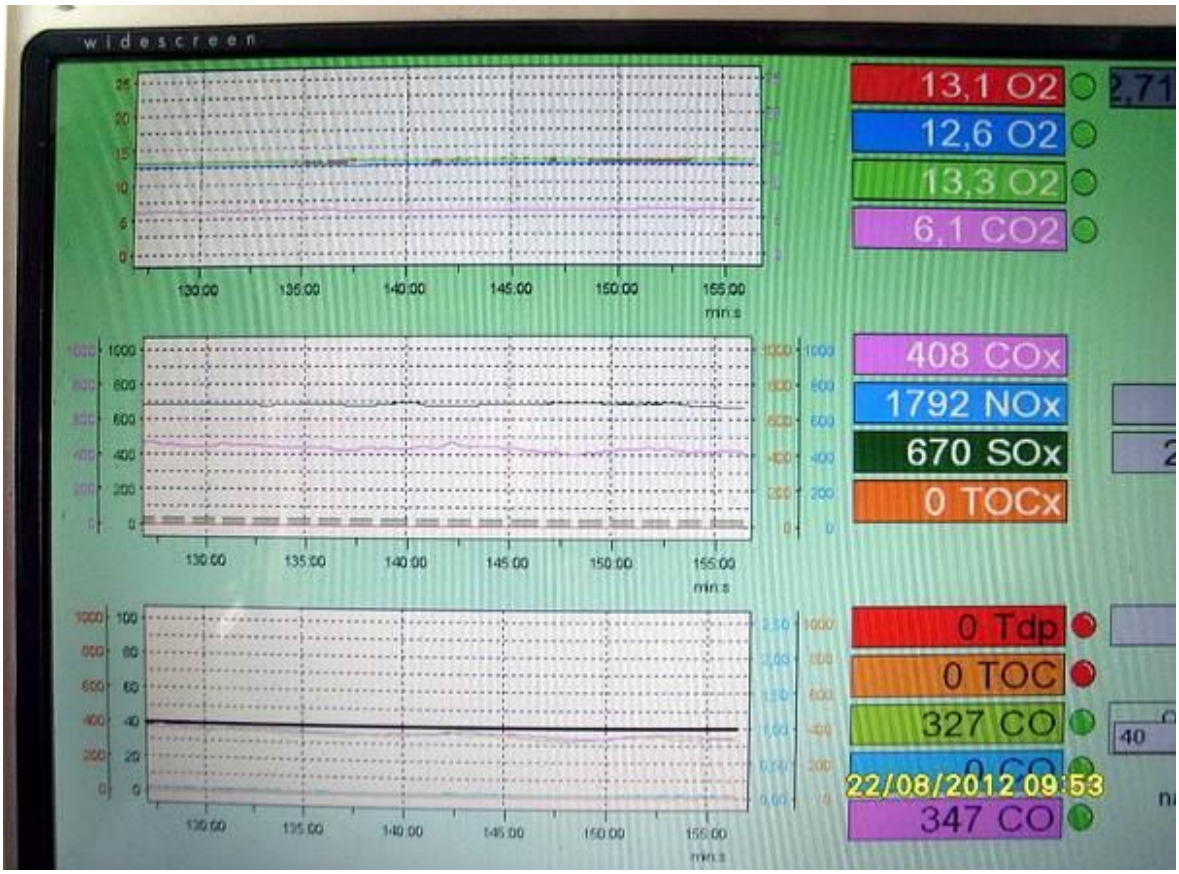

22/08/2012 08:33


widescreen
12,8 O2
12,7 O2
13,2 O2
5,8 CO2
2,68 lambda
443 COx
1790 NOx
683 SOx
0 TOCx
871 NO
239 SO2
0 Tdp
0 TOC
354 CO
0 CO
349 CO
-75 Tok
40
nastavitve Ctrl+W
START STOP
22/08/2012 08:59


22/08/2012 09:38


13,1 O2
12,6 O2
13,2 O2
6,0 CO2
2,70 lambda
402 COx
1808 NOx
690 SOx
0 TOCx
880 NO
241 SO2
0 Tdp
0 TOC
322 CO
0 CO
339 CO
-75 Tok
40
nastavitve Ctrl+W
START
STOP
22/08/2012 09:45


22/08/2012 09:52



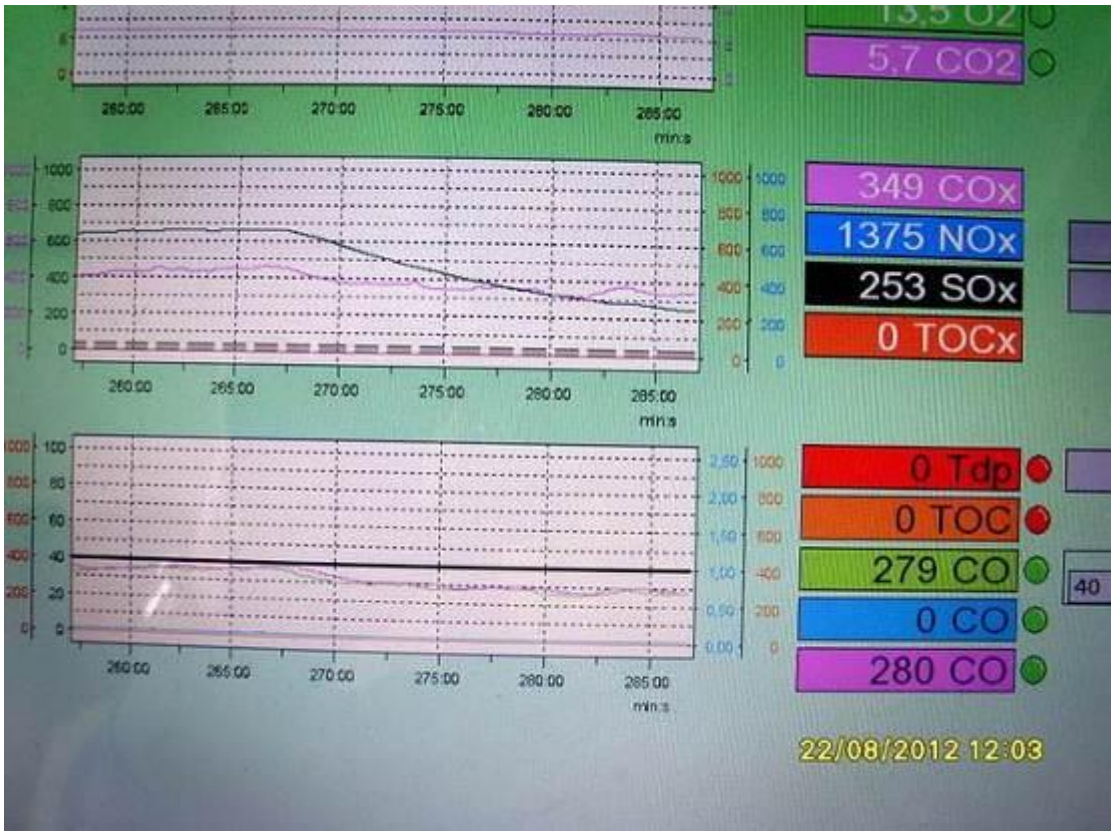
Smoke gases detection onboard sister ship »Gardenia« without module TRGA


TRANSEUROPA FERRIES


OPA FERRIES

Comparison of smoke gases detection on both ships at same time


5,9 CO2
403 COx
1807 NOx
663 SOx
0 TOCx
0 Tdp
0 TOC
322 CO
0 CO
334 CO
22/08/2012 10:23


5,7 CO2
349 COx
1375 NOx
253 SOx
0 TOCx
0 Tdp
0 TOC
279 CO
0 CO
280 CO
22/08/2012 12:03

EU Certificate No. IZV-PED-A1-06-810-11-01 for Module TRGA

CERTIFIKAT

Notranja proizvodna preverjanja z nadzorom končne presoje skladna s členom 3.2 in Prilogo I (Modul A1) po Direktivi 97/23/ES

Internal manufacturing checks with monitoring of the final assessment in according to article 3.2 and Anex I, (Module A1) according to Directive 97/23/EC

Št. certifikata : IZV-PED-A1-06-810-11-01
Certificate No.:

Institut za varilstvo d.o.o. kot priglašen organ potrjuje ustreznost postopkov izvedenih s strani proizvajalca tlačnega sklopa, v obsegu določil priloge III, modul A1 in člena 3.2 direktive o tlačni opremi 97/23/ES. Proizvajalcu je odobreno označevanje tlačne opreme z našo identifikacijsko številko 2042, v okviru področja veljavnosti.
Institut za varilstvo, d.o.o. as a notified body confirms herewith the adequacy of the procedures carried out by the manufacturer of pressure equipment within the provisions of Annex III, ModuleA1 and article 3.2 Pressure Equipment Directive 97/23/EC. The manufacturer is authorized to provide his pressure equipment manufactured within the scope of the examination with our indentification number 2042

Proizvajalec : **BIMONT d.o.o., Senčna ulica 19, SI-6310 Izola,**
Manufacturer:

Naslov proizvodnega obrata : **BIMONT d.o.o., Senčna ulica 19, SI-6310 Izola,**
Production site :

Področje veljavnosti : **Tlačni cevovod TRGA-3G**
Scope of examination No.: **tip: -03, -04, -05, -08, -10, -15, -20, -50**

Št. načrta : **TRGA-3G - 03,04,05; TRGA-3G - 08,10; TRGA-3G - 15**
Drawing No.: **TRGA-3G - 20; TRGA-3G – 50**

Poročilo št.: **P1277-A1-06-810-1101**
Test report No.:

Odobritev velja pod pogojem, da se izvajajo nadzorne presoje, preskusi in verifikacije s strani Instituta za varilstvo d.o.o., glede na zahteve določene v medsebojni pogodbi
The approval is valid provided that surveillance audits, tests and verifications are performed by Institut za varilstvo d.o.o. in accordance with the requirements stated in the mutual contract.

notified body 2042 2 INSTITUT ZA VARILSTVO

Andrej Smonkar IWI-C
Priglašen organ za tlačno opremo št. 2042
Notified Body, No.2042

Ljubljana, 20.06.2011
Place, date.:

INSTITUT ZA VARILSTVO
Welding Institute

notified body

Institut za varilstvo d.o.o., Ptujska ulica 19, SI-1000 Ljubljana,
tel.:+386 1 280 94 00, fax:+386 1 280 94 22, www.i-var.si
Obr. št. / Form Nr. DP-500/06

Statement of RACI Ltd. Ljubljana, R Slovenia, official performer of measuring and testing

RACI Rationalization of Combustion Processes d.o.o.
Company in Ljubljana Technology Park
Address: Tehnološki park 24
SI-1000 LJUBLJANA, SLOVENIA
Phone: +386 1 620 33 80 Fax: +386 1 620 33 90
Bank Account: NLB, IBAN: SI56 0208 5001 6765 554
or BANKA KOPER, IBAN: SI56 1010 0004 3925 378
VAT No.: SI80268170 Registration No.: 5865425
E-mail: info@raci.si URL: http://www.raci.si

BIMONT d.o.o.
Senčna ulica 19

SI-6310 IZOLA

Ljubljana, 29.10.2012

The undersigned Aleš Škufca, B. Sc., employee of RACI d.o.o., as the performer of testing, confirm that the data from report RACI No. 2012092A from 07.09.2012, written in both Slovenian and English language, related to measurements of emission into the air, performed at the left engine of the ro-ro ship »Larkspur«, which the customer, company Bimont d.o.o. from Izola, used in their report on pilot project, are reliable.

The purpose of measurements, performed from August 19th 2012 to August 22nd 2012 was to compare emissions of substances into the air from the engine firing fuel oil with mounted pressure pipe TRGA-3G on buffer tank and settling tank and without them.

Report RACI No. 2012092A from September 7th 2012 represents an integral part of the report from company Bimont d.o.o. on pilot project and it shall not be used partially without consent of RACI d.o.o.

This statement has been written on request of the customer, company Bimont d.o.o., in Slovenian and English language.

RACI d.o.o.
Manager

Dr. Jurij ČRETNIK

RACI racionalizacija sistov zgorevanja d.o.o.

Measurements performed by

Aleš ŠKUFCA, B. Sc.

Statement of Ship owner of RO-RO vessel »Larkspur«, Messrs. Transeuropa Ferries Ltd. Koper, R Slovenia

The overall results of the use of ship's modules TRGA testing on ro-ro ship Larkspur "from 19 to 22 08. 2012

	Operation on the standard fuel	**Using module TRGA only on the buffer tank**	**Using module TRGA only on the settling tank**	**Using module TRGA on the buffer tank and on the settling tank**
The main observed effects				
Flue gas temperature St. (C)	325 326 337	356 356 357	353 347 353	**368** **370** **370**
Level CO	100%	- 3.8 – 6.4 % -5.27 – 6%	-6.47 – 10.39%	**-10 – 14.97 %** **-12.34 – 13.67**
Visual amount of smoke **length in meters of water followed**	100% at startup – a lot of smoke during the driving 30-80 meters	at startup – less for 30% during the driving 5-40 meters	**at startup – less for 40%** **during the driving 5 - 10 meters**	at startup – less for 30% during the driving 5 - 20 meters
The amount of fuel sludge from the separator	0.692 tonnes per day Of which the fuek is 415 kg	0.692 tonnes per day Of which the fuel is 415 kg	0	**0**
	1	2	3	4

Additional effects of the installation of ship modules TRGA

1. Additional heating fuel. **TRGA modul provides heating fuel in a buffer tank on the temperature of 85-90 degrees**, what reduces the viscosity of the fuel, using fuel or high binding in the case of poor fuel heaters lining the resin, which is the build-up. **TRGA module provides heating fuel in settling tank so that the fuel is heated to 5 ° C in a streaming through the module.**
2. Reducing the amount and size of solid particles in the fuel directly affects the speed and reduce the amount of fuel sludge to collection tanks for fuel mud tank and, in addition to direct fuel saving, provides cost generated by the fuel acquisition sludge by the port services.
3. Reducing the amount and size of solid particles in the fuel has a direct impact on the reduction of wear separator and saving in the cost of its repair and maintenance.

4. Reducing the amount and size of solid particles in the fuel has an indirect impact on reducing pollution **settling tank** and the costs incurred in cleaning.
5. Using a modul TRGA back to the **buffer tank** provides a softer transition from a heavy fuel engine and vice versa, which, in addition to reducing the heat load allow to start the transition process in less fuel earlier, which also saves on diesel.

Reliable operation of modul TRGA

Module TRGA on the buffer tank has worked continuously from 28. 11. 2011 to 15. 8. 2012, which means for 9 months. TRGA module did not require continuous monitoring or any maintenance. TRGA module did not require any cleaning, adjustment, or replacement of any parts or regulation. TRGA module was turned off before testing in August 2012, and after the test is still working. Reviewof TRGA module during testing showed that the module is in an excellent and perfect mechanical condition and has no traces of wear.

Module TRGA in a settling tank has worked continuously from 19. 8. 2011 to 18. 10. 2012. The module did not require continuous monitoring or any maintenance. The TRGA module did not require cleaning, adjustment, replacement of any parts or regulation.

Marine Company Transeuropa Shipping Lines d.o.o.
(Transeuropa Ferries) Koper Slovenija
www.transeuropaferries.com
Direktor – ing. Rihard Stergulc

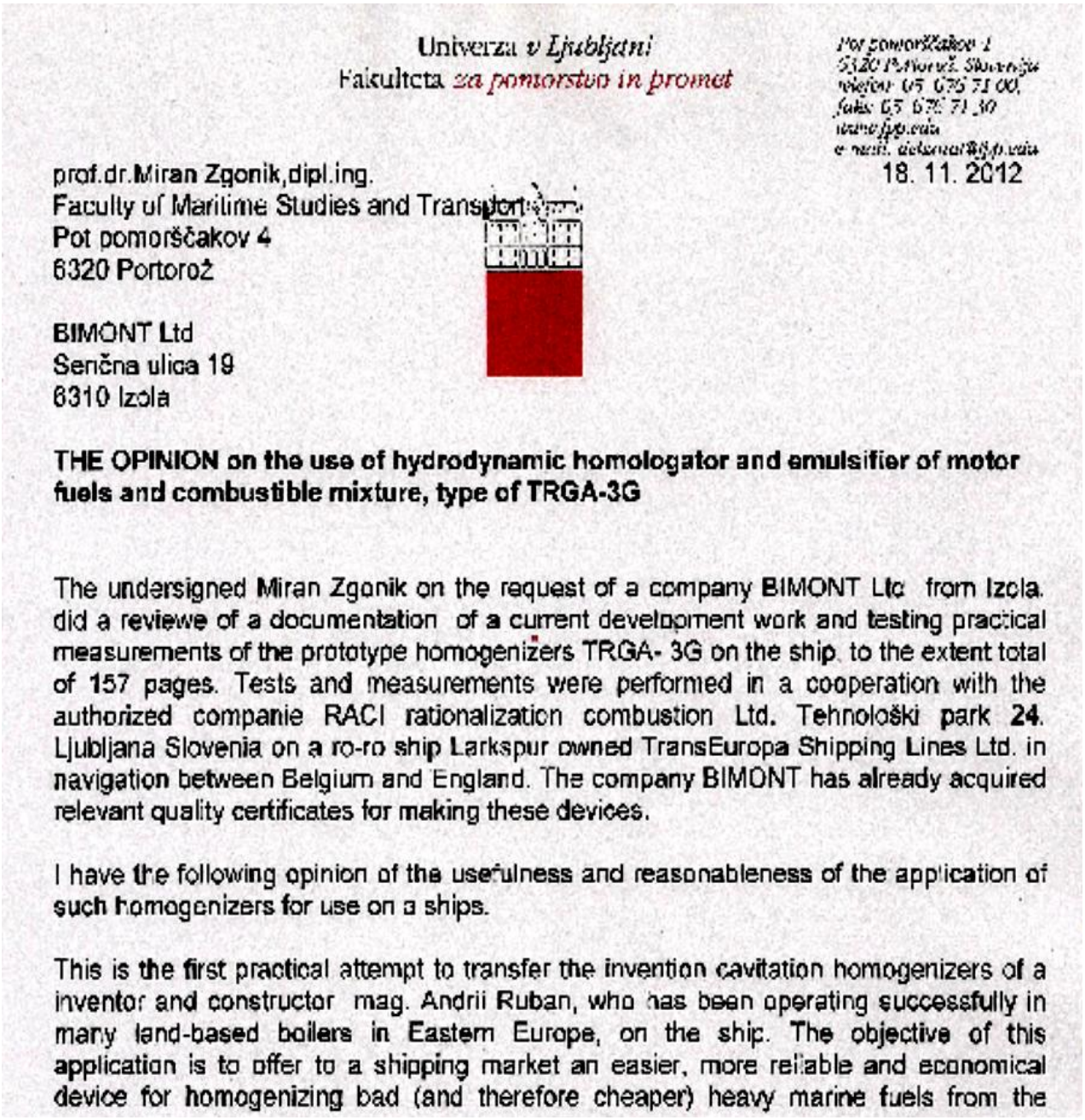
TRANSEUROPA SHIPPING LINES d.o.o. RIHARD STERGULC FLEET MANAGER Signature

LIST OF ATTACHMENTS TO THIS PILOT PROJECT

Other available documentation (as attachments to this Pilot Project, in PDF form)

1. Monitoring report of emissions to atmosphere; object: Left exhaust of RO-RO ship Larkspur [RACI Report emissions Sept 2012 ENG.pdf]

2. RACI measuring data m/v Larkspur.pdf



Univerza v Ljubljani
Fakulteta za pomorstvo in promet

Pot pomorščakov 4
6320 Portorož
telefon: 05 676 71 00
faks: 05 676 71 30
www.fpp.edu
e-mail: dekanat@fpp.edu

18. 11. 2012

prof.dr.Miran Zgonik,dipl.ing.
Faculty of Maritime Studies and Transport
Pot pomorščakov 4
6320 Portorož

BIMONT Ltd
Senčna ulica 19
6310 Izola

THE OPINION on the use of hydrodynamic homologator and emulsifier of motor fuels and combustible mixture, type of TRGA-3G

The undersigned Miran Zgonik on the request of a company BIMONT Ltd from Izola. did a reviewe of a documentation of a current development work and testing practical measurements of the prototype homogenizers TRGA- 3G on the ship. to the extent total of 157 pages. Tests and measurements were performed in a cooperation with the authorized companie RACI rationalization combustion Ltd. Tehnološki park 24. Ljubljana Slovenia on a ro-ro ship Larkspur owned TransEuropa Shipping Lines Ltd. in navigation between Belgium and England. The company BIMONT has already acquired relevant quality certificates for making these devices.

I have the following opinion of the usefulness and reasonableness of the application of such homogenizers for use on a ships.

This is the first practical attempt to transfer the invention cavitation homogenizers of a inventor and constructor mag. Andrii Ruban, who has been operating successfully in many land-based boilers in Eastern Europe, on the ship. The objective of this application is to offer to a shipping market an easier, more reliable and economical device for homogenizing bad (and therefore cheaper) heavy marine fuels from the

of 157 pages. Tests and measurements were performed in a cooperation with the authorized companie RACI rationalization combustion Ltd. Tehnološki park 24. Ljubljana Slovenia on a ro-ro ship Larkspur owned TransEuropa Shipping Lines Ltd. in navigation between Belgium and England. The company BIMONT has already acquired relevant quality certificates for making these devices.

I have the following opinion of the usefulness and reasonableness of the application of such homogenizers for use on a ships.

This is the first practical attempt to transfer the invention cavitation homogenizers of a inventor and constructor mag. Andrii Ruban, who has been operating successfully in many land-based boilers in Eastern Europe, on the ship. The objective of this application is to offer to a shipping market an easier, more reliable and economical device for homogenizing bad (and therefore cheaper) heavy marine fuels from the current mechanical devices for this purpose.The traditional rotary homogenizator, which are usually mounted on the ships, the ship owners doesn't like because of the frequent maintenance problems, although it is known that the homogenised heavy fuel engine however works better than without this procedure.

The manner of operation a device TRGA- 3G is based on effects of a cavitation which with the "microexplosion" "shredded" (depolarization) a long hydrocarbon molecules of heavy fuel, than they reduce a viscosity of the fuel and also break a solid inclusions in the fuel at much smaller particles, so that improve a combustion and internal roller wear less. With a device TRGA- 3G the treated heavy fuel combustion behaves as it would be easier, less viscous and seemingly increasing cetane number. Probably because of even nicer dispersed. Since the manner of cavitation compared to traditional rotary versions without moving parts, the maintenance of such homogenizer is hardly need,and also the energy consumption for the operation of the machine is less.

In the transfer of TRGA- 3G from land to sea (on the ship), it was necessary to determine the following conclusions:

1. it will the cavitation homogenizer, built in a shipping plant, work just as well as in land-based boiler rooms, with a view that takes place in the combustion engine in a different, much more severe conditions as in the boiler stokers the time and

8. for how long the effect of homogenization is visible, after the fuel is returned into the tank.
9. what kind of savings of the power can be expected in comparasion with a conventional rotary homogenizers

Measurements of the pilot project were carefully performed, they tried to catch as more similar sea conditions in the comparison between the normal and the treated fuel. With some reasoning we can answer at questions as follows:

1. The homogenizer was operated perfectly the pressure and temperature differences were expected in the required limits. When you switch to the homogenized fuel the engine and the whole system were warm faster and achieved sooner a stable state, which indicates a higher effective power.
2. They were not able to measure directly a fuel consumption, because this would require the installation of flow meters supplied and return fuel to the plant. Also effective engine power or torque on the shaft could not be measured directly and therefore, is needed a different conclusion about the specific fuel consumption: the increase in the rotational speed of the propeller in the same quantity of fuel injected (index = const.) From 490 to 510 min-1, 4 %. From the square propeller characteristics (typical graph in the appendix) shows that this means at least 8% more power and therefore 8% lower specific fuel consumption. If the direct measurement of fuel consumption and the effective power of this has been confirmed, this is an extremely positive result.
3. Measurement of exhaust emissions have shown that contrary to expectation, despite the intense combustion and more power oxides of nitrogen do not increase but even slightly reduced. Similarly is with the monoxide.
4. Measurements of smoke directly in these experiments, on the ship has not been measured, but the comparative photographs were includede in the report, which are showing us the significantly less black smoke in the homogenised fuel. Similarly, as was also found in boiler rooms (they were included in the report a comparison of smoke after Bosch similar procedure).
5. The sulfur in the fuel can not disappear, because it is a basic element. Can be only binded differently. In the emissions with TRGA- 3G treated fuels are measured at slightly lower levels, but this can only be attributed to measurement methods, which detect less of them. It may be somewhat easier to sulfur

compounds bind (hidden) in the small solid particles such as in a big one. (Total area of smaller particles may be greater than if the same or even greater weight to large particles). For the shipowner this is better. Because of some higher power of course the specific values (g / kwh), would be smaller ones.

6. Attached microscopic image comparison between the original and with TRGA-3G homogenised fuel shows that a cavitation reduced to a few fragments, approximately below 4 microns, which is two to three times less than what pass through a mechanical homogenizers and at least 10-20 times less than the particles were in untreated fuel. Small pieces of tier 4 microns to wear rings do have no effect.
7. For a good operation of TRGA -3G is sufficient a previously built supply pump if the pressure in the system is 6 or more bars, if not you need to install an additional pump.
8. In the fuel which is returned back into a buffer tankaf after the homogenization the effect remained for several hours.
9. Savings of drive power pumps with TRGA- 3G compared to a traditional homogeniser in the shown experiment were not measured. At the University of Tallinn were measured two to three times the difference in favor of TRGA -3G. The most important was a low power consumption.

Conclusion:

The use of homogenizers type TRGA- 3G, which has been operating successfully in the boiler house on the land identified by the current pilot project looks promising also for the ship and it does not appear to be any hidden problems.

Miran Zgonik

space is enough. in the engine the time for a combustion is only a few hundredths or tenths of seconds, hardly any space, the floors are significantly higher and a lower excess air.

2. it will be reduce the specific fuel consumption as the same. less or even more than was observed in the boiler.
3. it will the concentration of nitrogen oxides and carbon monoxide increased or decreased because of a more intensive combustion
4. how it will be with the smoke in the exhaust gases, as it shipowners particularly interested in, because in the ports under control, the smoke is noticeable and seen from far away.
5. what happens to the sulfur in the fuel.
6. about how much the size of solid particles (mainly silicon and sand) were reduced in such treated marine fuel and if they will be enough small that we could houpe for a less wear rings in the cylinder,
7. it will be sufficient a standard pup for fuel which is already in the system for a good functioning of TRGA -3G
8. for how long the effect of homogenization is visible, after the fuel is returned into the tank.
9. what kind of savings of the power can be expected in comparasion with a conventional rotary homogenizers

Measurements of the pilot project were carefully performed, they tried to catch as more similar sea conditions in the comparison between the normal and the treated fuel. With some reasoning we can answer at questions as follows:

1. The homogenizer was operated perfectly the pressure and temperature differences were expected in the required limits. When you switch to the homogenized fuel the engine and the whole system were warm faster and achieved sooner a stable state, which indicates a higher effective power.
2. They were not able to measure directly a fuel consumption, because this would require the installation of flow meters supplied and return fuel to the plant. Also effective engine power or torque on the shaft could not be measured directly and therefore, is needed a different conclusion about the specific fuel consumption: the increase in the rotational speed of the propeller in the same quantity of fuel injected (index = const.) From 490 to 510 min-1, 4 %. From the square propeller