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- REPORT -

XMile Europe B.V.
Results of the emission measurements at the MS Catharina
January 16th 2013, baseline
August 27th 2014, with XMile additive

SGS registration	
Our reference	EZMO/11/0027-2_rap
Version no.	1
Report date	17 October 2016
Author	John van Middelkoop

Version history		
Version	**Date**	**Changes**
0	01-12-2014	
1	17-10-2016	Fuel consumption based on calculation
2		
3		

Whenever a new version is made, the prior version is cancelled.

Project details

General information

Company name	XMILE Europe B.V.
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Email address	marius@xmile.eu
Client reference number	MS Catharina
SGS reference number	EZMO/11/0027-2

Plant details

Location	MS Catharina
Plant	MAK 6Mu451 AK located Tolkamer, the Netherlands
Production details	E3 Test Cycle

Measurement details

Kind of measurement	Emission measurements, O_2, CO_2, CO, NO_x, PM
Measurement period	January 16, 2013 and August 27, 2014
Measuring staff	John van Middelkoop and Joop Kleverwal

Signatures

Project Manager	Technical Manager
John van Middelkoop	Charlotte Wösten

Quality

For a list of the accredited activities (RvA L092) of the SGS Nederland BV Environmental Services Department in Arnhem, The Netherlands, we refer to the last three pages of the Dutch Accreditation Council RvA website (http://www.rva.nl/?p=cins0200).

Disclaimer

Terminology

°C	degrees Celsius
% by weight	percentage by weight
h	hours
ind	in normal condition dry (101.3 kPa, 273 K)
inm	in normal condition moist (101.3 kPa, 273 K)
K	Kelvin
kg	kilogrammes
kPa	kilo Pascal
m	metres
vppm	volume parts per million
mg/m_0^3	milligrammes per normal cubic metre
m^3	cubic metres
mg	milligrammes
vol%	volume percentage
g	grammes
GJ	gigajoules
m^3/h	flow under normal operating conditions
m_0^3/h	normalized flow (273 K, 1013 hPa, current % O_2 and dry flue gas)
m_0^3/h @ x vol% O_2	normalized flow (273 K, 1013 hPa at X vol% O_2 and dry flue gas)
s_D	standard deviation of the differences D_i between the measurements being compared
D_i	difference between the i^{th} measured value of the SRM and the corresponding calibrated (corrected) value of the AMS
σ_o	uncertainty derived from the requirements of the law
AMS	Automatic Measuring System
JC / AST	Annual Check / Annual Surveillance Test
ELV	Emission Limit Value
QAL1	First Quality Assurance Level
QAL2	Second Quality Assurance Level
QAL3	Third Quality Assurance Level
SRM	Standard Reference Method
K_v	These are the measurement values from an x^2 test with a β value of 50%, a factor of 0.9161-0.9521 (depending on the number of measurements). Is a value from a table and depends on the number of measurements. Varies between 0.91 and 0.98.
$t_{0.95}$	Confidence interval of 95%
$t_{0.95}(N-1)$	Is a value from a table and depends on the number of measurements. Generally varies between 2.1 and 1.8.

Summary

Commissioned by XMile Europe B.V., SGS Nederland BV, Environmental Services, executed emission measurements on the propulsion engine of the MS Catharina.

XMile Europe B.V. wants to reduce the emission of engines. The product of XMile is an additive in the fuel. The Ms Catharina is using the product of XMile Europe BV since January 2013 after the base line measurements were performed.

Purpose of the measurements

The purpose of the measurements is to get information about the emissions of the engine during the use of the XMile product in the fuel. Therefore a base line measurement is executed 16 January 2013. On August 27th 2014 the measurements are repeated with the additive of XMile in the fuel.

A summary of the results of the emission measurements is given in the table below. The measurements are performed with the cycle E3 at different loads.

Table 0.1 Summary results

Engine			
Manufacturer		MAK	
Type		6Mu451 AK	
Number		24652	
Location		MS Catharina	
Cycle		E3: 882 kW @ 375 rpm	
Emissions		**Without fuel treatment**	**With XMILE additive**
NOx relative emisson	(g/kWh)	***17.7***	***16.7***
CO_2 relative emisson	(g/kWh)	***641***	***599***

Table of Contents

1 Introduction

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A short description of the supplier and the engine details are included in chapter 2. Chapter 3 describes the measuring equipment and measurement methods. The measurement program is given in chapter 4. The results of the measurements are presented in chapter 5. In chapter 6 the conclusion is given. The report concludes with a calculation of the degree of error for the measurements in chapter 7.

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2 Measurement object details

This chapter contains a short description of the site of the measurement location.

2.1 Xmile

XMILE is a fuel additive which unique characteristics are discovered by more and more companies and consumers. XMILE can be summarized as an advanced enzyme-based biological solution for increasing fuel efficiency and reliability. In fact, by adding XMILE the fuel quality improves so combustion is better and more complete.
By this:

- Lower fuel consumption
- Reduced emissions
- Improved engine performance
- Cleaner engine, less maintenance

These effects as a result of using XMILE have a positive effect on reducing costs and improve environmental performance.

2.2 Engine details

In table 2.1, the information of the engine is given

Table 2.1 Engine data

Components		Engine
Manufacturer		MAK
Type		6Mu451 AK
Serial number		24652
Emission class		CCNR
Number of cilinders		6
Line / V		Line
Charging		Turbo
Intercooler		Yes
Rated power	kW	882
Rated speed	rpm	375
Year of construction		1972
Cycle(s)		E3

Table 2.2 General Information

Principal representative(s)	M. Overbeeke
SGS Technician(s)	J. Kleverwal J.F. van Middelkoop
Test Location	MS Catharina

3 Description of measuring equipment and measurement methods

This chapter describes the measuring equipment and the measurement methods.

3.1 Measuring equipment

The following measuring equipment was used for the measurements.

Table 3.1 Measurement equipment

Component	Analyzer	Identification	Measuring principle	Standard
Oxygen	Testo 350 Maritime	SGS 13-276	Chemical cell	-
Carbon dioxide	Testo 350 Maritime	SGS 13-276	Infrared	-
Carbon monoxide	Testo 350 Maritime	SGS 13-276	Chemical cell	-
Nitrogen oxides	Testo 350 Maritime	SGS 13-276	Chemical cell	-
Particulate Matters*)	Dilution Method	SGS 11-033	Dilution method	ISO 8178

*) only during the base line measurement

3.2 Measurement methods

The following paragraphs describe the measurement methods. The measurements are performed using the procedures of the MARPOL 73/78 test cycle E3.

3.2.1 Gaseous flue gas components

The flue gas of the diesel engine was continuously sampled in the outlet. After filtration of the flue gas the sample flow is lead to a “testo 350-MARITIME portable flue gas analyzer “.The concentrations of O_2, CO_2, CO and NO_x in the filtered and dried flue gas sample flow was analyzed.

3.2.2 Determination of particulate matter (base line measurement)

A partial flue gas stream flow is taking out of the exhaust gas flow with a sample probe. The exhaust gas flow is going through a mixture housing with dry cool air. Before the flue gas/air mixture is reaching the glass fibre filter the exhaust gas temperature is below 54 degrees Celsius.
Because of this dilution method the existing condensable particles are catched inventially on the filter. The filter will be weighed at standard conditions before and after the measuring.

3.2.3 Determination of the flue gas temperature

The flue gas temperature was determined using a calibrated type K thermocouple and recording unit.

3.3 Suitability of the measurement plane

The measurement points for the emission measurements are located in a horizontal duct. The measurement points are located at a height of 1.5 meters. Before and after the measurement location more than 5 times the diameter of straight duct exists. The sample port has a 1 inch and a half inch opening with ball valves.

3.4 Fuel consumption numbers of the measurement

Fuel consumption numbers are given by XMILE, based on calculation.

4 Measurement Program and deviation from the standard

4.1 Measurement Program

The measurement objective is to determine the effect of XMile fuel additive on the emissions of the engine. In order to determine this effect, SGS is asked to determine the emission characteristics of the engine on the MS Catharina before and after adding XMile fuel additive. The test procedure of a test cycle E3 as defined in the MARPOL 73/78 is used to determine the emission characteristics.

The MARPOL states that for an E3 cycle the program below should be done:

Table 4.1 Test cycles type E3
Propeller-law heavy-duty engines for ship propulsion without limitation of length

Speed	100%	91%	80%	68%
Power	100%	75%	50%	25%
Weighting factor	0.20	0.50	0.15	0.15

4.2 Deviation from the standard

The emission measurements are done in compliance with the test procedure described in the MARPOL 73/78. The emissions measurements are done using a TESTO 350 maritime. According to Germanischer Lloyd (GL) the systems complies with the regulations MEPC 103(49) MARPOL Annex VI and he NOx technical code.

Fuel flow measurement is not present on the MS Catharina. Data sheets of the engine are used for the fuel use of both tests.

5 Results

In this chapter the summary of the measurements are given.

5.1 Emission characteristics

In this paragraph the results of the E3 cycle measurements with and without fuel treatment are presented.

Table 5.1 Summary results without fuel treatment

Engine				
Manufacturer		MAK		
Type		6Mu451 AK		
Number		24652		
Location		MS Catharina		
Cycle		E3: 882 kW @ 375 rpm		
Emissions		**Measured**	**Demand**	**Comply**
NOx relative emisson	(g/kWh)	***17.7***	***10.8***	***No***
CO relative emisson	(g/kWh)	***0.6***	***3.5***	***Yes***
Particle relative emission	(g/kWh)	***0.38***	***0.2***	***No***

Table 5.2 Summary results with fuel treatment

Engine				
Manufacturer		MAK		
Type		6Mu451 AK		
Number		24652		
Location		MS Catharina		
Cycle		E3: 882 kW @ 375 rpm		
Emissions		**Measured**	**Demand**	**Comply**
NOx relative emisson	(g/kWh)	***16.7***	***10.8***	***No***
CO relative emisson	(g/kWh)	***0.9***	***3.5***	***Yes***

5.2 Emission results

The results are summarised in table 5.3.

Table 5.3 Summary of measurements

Component	Without fuel treatment January 16, 2013 (g/kWh)	With fuel treatment August 27, 2014 (g/kWh)	Delta (%)
NO_x			
100%	16.8	15.1	- 10
75%	17.8	16.9	- 5
50%	18.9	18.6	- 2
25%	17.9	18.2	2
PM			
100%	0.56		
75%	0.29		
50%	0.38		
25%	0.49		
CO			
100%	0.80	0.97	21
75%	0.52	1.00	92
50%	0.47	0.40	- 15
25%	0.67	0.40	- 40
CO_2			
100%	626	573	-9
75%	630	589	-7
50%	645	606	-6
25%	663	628	-6

6 Conclusion

The results of the measurements are summarized in the following table.

Table 6.1 Summary of measurements

Component	Without fuel treatment January 16, 2013	With fuel treatment August 27, 2014	Delta (%)
Emissions			
NO_x g/kWh	17.7	16.7	- 6
CO g/kWh	0.6	0.9	50
CO_2 g/kWh	641	599	-7

Conclusion

The results of the emission measurements show that the MAK 6Mu451 AK engine with number 24652 has a decrease of 1 g/kWH NO_x emission, the CO reduction is increasing with the fuel additive and the CO_2 has a decrease of 7%.

As the PM is not measured with the official dilution set during the measurements on August 27, 2014, the results cannot be given.

7 Discussion of errors

7.1 Purpose of discussion of errors

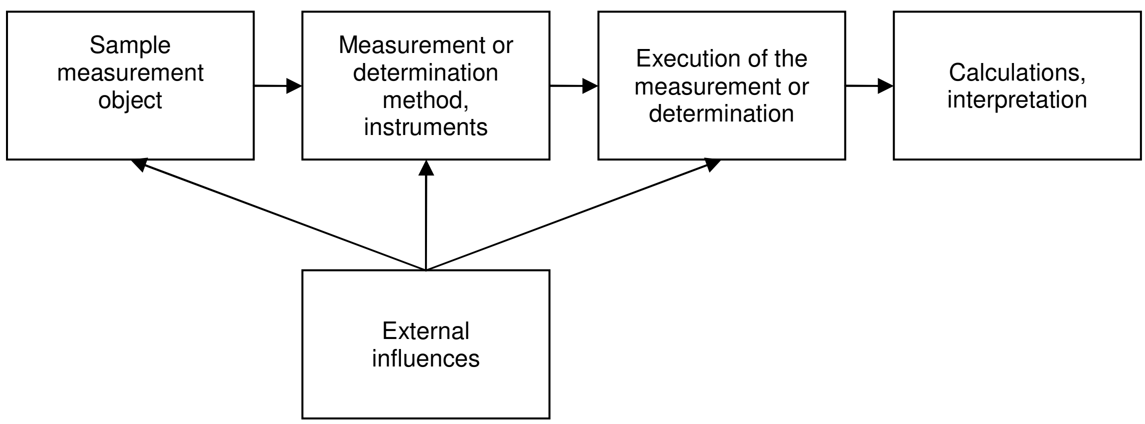
When carrying out a measurement one always needs to be aware that there will be errors in the final results. This is not only true for the measurements, errors may also occur in the calculations.
An 'error' is defined as every deviation from the actual value. By carrying out an *evaluation of errors*, the influence of the error can be determined. This evaluation must be carried out both before and after the measurement. Before the measurement it is called an errors prognosis and after the measurement it is called an errors calculation. The errors discussion serves the following purposes:

Determination of the accuracy of a result
A measurement result for which the accuracy is unknown, is useless. If one wants to express the result of a test as an objective number, one will also want to express the accuracy as an objective number. By doing so, we will discover the boundaries within which the *true* value of the result.

Selection of the method and the instruments
Using the desired accuracy and the measurement method, the carrying out of an errors prognosis can determine whether the measurement meets the required accuracy. If the desired accuracy is not achieved, sources of error will need to be removed or a completely different measurement method will need to be found.
By ensuring that the experiments are carried out in an efficient manner, and by mainly focusing on the element that is the greatest source of inaccuracy, better results can be obtained and less time is wasted.

7.2 Classification of errors

The following figure gives a schematic overview of a number of steps in which errors may occur.



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7.2.1 Errors related to measurement object

Sources of errors are often already present in the measurement object, for example:

- Lack of homogeneous composition of a gas.
- No long enough straight area for a volume measurement.
- A temperature measurement done on the ‘shade side’.

7.2.2 Errors in the measurement or determination method

These so-called *method errors* often lead to wrong measurement or analysis results. It is hidden in the way the work is done. The measurement influences the value to be measured. e.g. when doing a velocity measurement in a small pipe, the pitot tube blocks a large part of the pipe so that a wrong velocity is measured.

7.2.3 Instrument errors

These mistakes hide in the instruments used. They can be the result of calibration errors or adjustment errors. It is also quite common for the *zero point* or *reference point* of a measuring device to not be constant.

7.2.4 Errors that are created during the execution of the measurement

This type of error is mainly created by the person carrying out the measurement and can be avoided through correct and careful carrying out of the measurement.

7.2.5 Errors resulting from external influences

This type of error is created outside of the actual execution of the experiment, and yet influence the result, for example:

- magnetic fields around measuring equipment
- vibrations
- humidity
- weather conditions

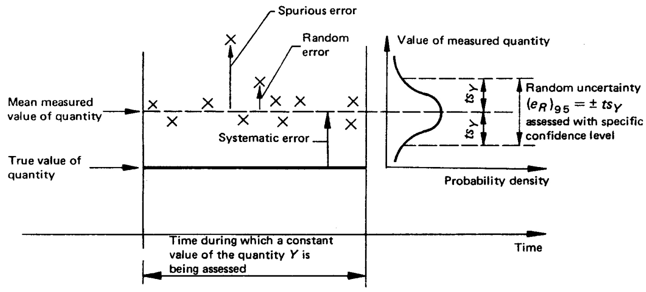
7.2.6 Errors in the interpretation of the errors

In this respect, one must ask oneself whether what one is measuring is actually what one thinks one is measuring. One must be certain that the method used is the correct one for what needs to be determined.

7.3 Kinds of errors that may occur

The errors that may occur during a measurement can be subdivided into the following categories:

- *Systematic errors*
- *Chance errors*
- *Parasitic errors*



7.3.1 Systematic errors

Systematic errors are errors that influence a measurement in the same way every time. They always result in a value that is either too high or too low. The error is not reduced by repeating the measurement many times.
The systematic errors are mainly errors in the measuring equipment and are the result of the wrong calibration of an instrument or by a null setting that is incorrect.
The systematic errors can be subdivided into two large groups:

a) <u>Constant systematic errors</u>
These are normal for all measurements executed under the same circumstances and are constant over time but, depending on the nature of the error, they can vary with the value resulting from the measurement.

b) <u>Variable systematic errors</u>
These can be the result of not keeping the conditions under which the measurement is being executed constant. For instance, if the temperature rises near a measuring instrument that has been calibrated for a certain temperature.
A second type of variable systematic error can result from measuring with a digital instrument on a continually varying value.

7.3.2 Chance errors, replicability

Chance errors are defined as errors for which the magnitude and direction are completely dependent on chance and which can therefore be different for each and every measurement. If many measurements are conducted, the errors can partially compensate each other.
Another term that is often used in this context is *replicability*: the correspondence between several measurements of the same value with the same method. If something is replicable, it does not automatically mean that there is no systematic error. A systematic error can only be tracked down by carrying out the measurement with a different method.
It won't always be possible to put an error into one of these two groups because, on the one hand, subjective criteria are used to classify the error and, on the other hand, the errors that occur are often partially systematic and partially due to chance.

7.3.3 Parasitic errors

Parasitic errors are errors like human error or errors that result from the temporary failure of a measuring instrument. The observations that suffer from this kind of error should not be included in the averaging of the measurement values because they can produce large deviations in the results.

7.4 Measurement uncertainties

The following measurement uncertainties have to be taken into account:

Table 7.1 Overview of measurement uncertainties

	Total unc.
NO_x	**10%**
O_2	**10%**
CO_2	**10%**
CO	**10%**
PM	**50%**

APPENDICES

Appendix A. Calculations performed as per MARPOL

Before Treatment

Table A.1 Results environmental measurements

Engine					
Type		6Mu451 AK			
Number		24652			
Location		MS Catharina			
Fuel 1 Oil					
Type		LFO			
Test					
Date		16-1-2013			
Start	(hh:mm)	10:05	10:19	10:33	10:51
End	(hh:mm)	10:15	10:29	10:43	11:01
Engine conditions					
P Load	(kW)	782	676	430	224
nd Number of revolutions	(rpm)	352	340	302	240
qmf Fuel consumption (oil)	(l/h)	188.00	165.00	108.00	58.00
Ta Suction air temperature	(°C)	13	13	14	14
LT cooling water before engine	(°C)	22	20	18	17
Ignition angle	(°)				
pc Charge air pressure	(bar)	0.90	0.74	0.42	0.15
Tsc Charge air temperature	(°C)	45	43	36	23
Ambient air					
Atmospheric pressure	(mbar)	1009	1009	1010	1009
Temperature	(°C)	14	14	14	15
Relative humidity	(%)	44	43	40	39
Results flue gas measurements					
Texh Temperature	(°C)	329	326	308	261
O2	(vol% dry flue gas)	14.5	14.5	14.5	15.5
CO2	(vol% dry flue gas)	4.7	4.7	4.6	3.9
CO	(vppm dry flue gas)	94	60	53	62
NOx	(vppm dry flue gas)	1,339	1,402	1,441	1,127
Particle measurement					
Filternumber		ME 488	ME 481	ME 482	ME 483
Tare weight	(g)	1.105	1.111	1.127	1.109
Gross weight	(g)	1.166	1.142	1.160	1.164
Sampling volume	(m03 dry flue gas)	0.87	0.85	0.71	1.11

Table A.2 Calculated air and combustion data

Engine					
Type		6Mu451 AK			
Number		24652			
Location		MS Catharina			
Air data					
Atmospheric pressure	(mbar)	1009.4	1009.4	1009.5	1009.4
Temperature	(°C)	14.0	13.8	14.0	14.5
Relative humidity	(%)	44.0	43.0	40.0	39.0
Absolute humidity	(vol%)	0.69	0.67	0.63	0.63
Absolute humidity (Ha)	(g/kg dry air)	4.34	4.18	3.94	3.97
Water saturation pressure at Rt	(mbar)	95	86	59	28
Absolute humidity Turbo (Hsc)	(g/kg dry air)	33	32	27	15
Fuel					
Oil type		LFO			
Identification code		EN-590			
Density at 15 °C	(kg/l)	0.840			
Net caloric value	(MJ/kg)	42.66			
Carbon-content	(% m/m)	86.00%			
Hydrogen-content	(% m/m)	13.00%			
Nitrogen-content	(% m/m)	0.10%			
Sulphur-content	(% m/m)	0.00%			
Calculated stoichiometric combustion data		Fuel 1			
Dry air demand	(m3/kg)	11.07			
Dry flue gas flow	(m3/kg)	10.35			
Wet flue gas flow	(m3/kg)	12.07			
Fuel 1 Oil consumption	(kg/h)	158	139	91	49
Calculated actual combustion data					
Air factor EAF		3.10	3.10	3.11	3.63
Dry flue gas flow	(m3/kg)	33.6	33.6	33.8	39.5
	(m3/h)	5299	4651	3063	1924
Wet flue gas flow	(m3/kg)	35.2	35.2	35.4	41.1
	(m3/h)	5557	4876	3210	2004
Water concentration	(vol% wet flue gas)	4.6	4.6	4.6	4.0

Table A.3 Correction factors

Testconditions					
Fa-factor (mechanically charged)		0.96	0.96	0.96	0.96
Fa-factor (turbo charged)		0.93	0.93	0.93	0.93
CCNR					
NOx correction for humidity and temperature KHDIES					
KHDIES	Applicable	0.901	0.900	0.899	0.899
Particle correction for humidity and fa					
Particle correction factor (Kp)		1.093	1.095	1.099	1.098
Particle correction factor (Kfa)		1.073	1.042	1.042	1.041
Aid factor Kfa 1		0.176	0.171	0.169	0.155
Aid factor Kfa 2		0.164	0.164	0.163	0.154
EAFref		2.886	2.970	2.990	3.487
Aid factor Kfa 3		1.075	1.040	1.038	1.004
Applicable correction factors					
NOx correction					
KHDIES applicable		0.901	0.900	0.899	0.899
Particle correction					
Kp		1.093	1.095	1.099	1.098
Kfa		1.073	1.042	1.042	1.041
PTcorr		0.000			

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Table A.4 Emission concentrations at standard conditions

Engine					
Type		6Mu451 AK			
Number		24652			
Location		MS Catharina			
Standard flue gas conditions					
Moisture	(vol %)	0.0			
Temperature	(°C)	0			
Pressure	(mbar)	1013			
Molar volume	(m3/kmol)	22.40			
Oxygen concentration	(vol% dry flue gas)	15			
Test					
Date		16-1-2013			
Start	(hh:mm)	10:05	10:19	10:33	10:51
End	(hh:mm)	10:15	10:29	10:43	11:01
Results in flue gas at standard conditions					
CO	(vppm)	86.6	55.3	48.7	67.2
NOx	(vppm)	1233	1291	1336	1221
Flue gas flow	(m3/h)	5754	5050	3305	1775
Relative emissions					
CO2	(g/kWh)	626	630	645	663
CO	(g/kWh)	0.80	0.52	0.47	0.67
NOx	(g/kWh)	18.63	19.81	21.08	19.88
Weighed relative emissions					
NOx	(g/h)	2914	6695	1360	668
NOx (Khdies corrected)	(g/h)	2627	6025	1222	600
Load	(kW)	156.40	338.00	64.50	33.60
E3	factor	0.20	0.50	0.15	0.15
Weighed relative emission per sample (corrected)	(g/kWh)	16.80	17.82	18.94	17.87
Weighed relative emission	(g/kWh)	19.64			
Weighed relative emission (corrected)	(g/kWh)	17.68			
CO	(g/h)	124.53	174.41	30.15	22.36
Load	(kW)	156.40	338.00	64.50	33.60
E3	factor	0.20	0.50	0.15	0.15
CO Weighed relative emission per sample	(g/kWh)	0.80	0.52	0.47	0.67
CO Weighed relative emission	(g/kWh)	0.59			
Particles					
Sample w eight	(mg)	61	31	33	55
Particles	(mg/m03 dry flue gas)	70	37	47	50
Particles (at standard conditions)	(mg/m03 dry flue gas)	65	34	44	54
Particle	(g/kWh)	0.48	0.25	0.34	0.43
Particle corrected Kp, Kfa	(g/kWh)	0.56	0.29	0.38	0.49
Particle	(g/h)	74.55	85.46	21.67	14.34
Particle (Corrected; Kp en Kfa)	(g/h)	87.39	97.54	24.80	16.40
Load	(kW)	156.40	338.00	64.50	33.60
E3	factor	0.20	0.50	0.15	0.15
Weighed relative emission	(g/kWh)	0.33			
Weighed relative emission (corrected)	(g/kWh)	0.38			

After Treatment

Table A.5 Results environmental measurements

Engine					
Type		6Mu451 AK			
Number		24652			
Location		MS Catharina			
Fuel 1 Oil					
Type		LFO			
Identification code		EN-590			
Test					
Date		27/08/14			
Start	(hh:mm)	8:47	9:05	9:28	9:58
End	(hh:mm)	8:57	9:15	9:38	10:08
Engine conditions					
P Load	(kW)	782	676	430	224
nd Number of revolutions	(rpm)	355	341	305	235
qmf Fuel consumption (oil)	(l/h)	188.00	165.00	108.00	58.00
Ta Suction air temperature	(°C)	24	25	25	27
LT cooling water before engine	(°C)	64	65	65	65
Ignition angle	(°)				
pc Charge air pressure	(bar)	0.95	0.80	0.45	0.14
Tsc Charge air temperature	(°C)	55	62	48	39
Ambient air					
Atmospheric pressure	(mbar)	1013	1013	1014	1014
Temperature	(°C)	21	22	23	23
Relative humidity	(%)	53	50	48	50
Results flue gas measurements					
Texh Temperature	(°C)	364	353	328	281
O2	(vol% dry flue gas)	13.8	14.1	14.3	15.3
CO2	(vol% dry flue gas)	4.8	4.6	4.5	3.8
CO	(vppm dry flue gas)	127	123	47	38
NOx	(vppm dry flue gas)	1,252	1,310	1,356	1,086

Table A.6 Calculated air and combustion data

Engine					
Type		6Mu451 AK			
Number		24652			
Location		MS Catharina			
Air data					
Atmospheric pressure	(mbar)	1013.4	1013.4	1013.6	1013.9
Temperature	(°C)	20.9	22.3	22.7	22.7
Relative humidity	(%)	52.7	49.6	48.0	50.0
Absolute humidity	(vol%)	1.28	1.31	1.30	1.35
Absolute humidity (Ha)	(g/kg dry air)	8.05	8.26	8.18	8.53
Water saturation pressure at Rt	(mbar)	157	218	111	70
Absolute humidity Turbo (Hsc)	(g/kg dry air)	54	85	51	40
Fuel					
Oil type		LFO			
Identification code		EN-590			
Density at 15 °C	(kg/l)	0.840			
Net caloric value	(MJ/kg)	42.66			
Carbon-content	(% m/m)	86.00%			
Hydrogen-content	(% m/m)	13.00%			
Nitrogen-content	(% m/m)	0.10%			
Sulphur-content	(% m/m)	0.00%			
Calculated stoichiometric combustion data		Fuel 1			
Dry air demand	(m3/kg)	11.07			
Dry flue gas flow	(m3/kg)	10.35			
Wet flue gas flow	(m3/kg)	12.07			
Fuel 1 Oil consumption	(kg/h)	158	139	91	49
Calculated actual combustion data					
Air factor EAF		2.79	2.92	3.01	3.52
Dry flue gas flow	(m3/kg)	30.1	31.6	32.6	38.3
	(m3/h)	4761	4386	2962	1866
Wet flue gas flow	(m3/kg)	31.9	33.5	34.5	40.2
	(m3/h)	5045	4639	3128	1960
Water concentration	(vol% wet flue gas)	5.6	5.5	5.3	4.8

Table A.7 Correction factors

Testconditions					
Fa-factor (mechanically charged)		0.99	0.99	0.99	0.99
Fa-factor (turbo charged)		0.99	0.99	0.99	1.00
CCNR					
NOx correction for humidity and temperature KHDIES					
KHDIES	Applicable	0.966	0.971	0.970	0.979
Particle correction for humidity and fa					
Particle correction factor (Kp)		1.037	1.034	1.035	1.030
Particle correction factor (Kfa)		1.000	1.000	1.011	1.006
Aid factor Kfa 1		0.188	0.176	0.170	0.154
Aid factor Kfa 2		0.185	0.174	0.168	0.154
EAFref		2.754	2.894	2.980	3.503
Aid factor Kfa 3		1.000	1.000	1.000	1.000
Applicable correction factors					
NOx correction					
KHDIES applicable		0.966	0.971	0.970	0.979
Particle correction					
Kp		1.037	1.034	1.035	1.030
Kfa		1.000	1.000	1.011	1.006
PTcorr		0.000			

Table A.8 Emission concentrations at standard conditions

Engine					
Type		6Mu451 AK			
Number		24652			
Location		MS Catharina			
Standard flue gas conditions					
Moisture	(vol %)	0.0			
Temperature	(°C)	0			
Pressure	(mbar)	1013			
Molar volume	(m3/kmol)	22.40			
Oxygen concentration	y flue gas)	15			
Test					
Date		27/08/14			
Start	(hh:mm)	8:47	9:05	9:28	9:58
End	(hh:mm)	8:57	9:15	9:38	10:08
Results in flue gas at standard conditions					
CO	(vppm)	105	107	42.1	39.9
NOx	(vppm)	1036	1138	1215	1142
Flue gas flow	(m3/h)	5754	5050	3305	1775
Relative emissions					
CO2	(g/kWh)	573	589	606	628
CO	(g/kWh)	0.97	1.00	0.40	0.40
NOx	(g/kWh)	15.65	17.46	19.18	18.58
Weighed relative emissions					
NOx	(g/h)	2448	5900	1237	624
NOx (Khdies corrected)	(g/h)	2366	5731	1199	611
Load	(kW)	156.40	338.00	64.50	33.60
E3	factor	0.20	0.50	0.15	0.15
Weighed relative emission per sample (	(g/kWh)	15.13	16.96	18.60	18.19
Weighed relative emission	(g/kWh)	17.23			
Weighed relative emission (corrected)	(g/kWh)	16.72			
CO	(g/h)	151.17	337.19	26.10	13.30
Load	(kW)	156.40	338.00	64.50	33.60
E3	factor	0.20	0.50	0.15	0.15
CO Weighed relative emission per sam	(g/kWh)	0.97	1.00	0.40	0.40
CO Weighed relative emission	(g/kWh)	0.89			

Appendix B. Zero and span check TESTO 350

					Projectnumber	EZMO-11-0027	
					Projectlocation	MS Catharina	
					Date	16-1-2013	
					Performer(s)	JMI	
Tagnumber(s)							
		O_2 vol%	CO_2 vol%	CO vppm	NO_x vppm	SO_2 vppm	C_xH_y vppm
Range analyser		25	20	1000	1000		
Spangasconcentration	40003362154	20.95	18	906	898		
Control gas conc.	identification						
Leaktest performed	Satisfies	Yes					
Calibration 1	**time Calibration**						
zero	9:35	0	0	0	0		
span	9:44		17.98	905	900		
control gas							
Calibration 2	**time Calibration**						
zero before calibration	11:22	0	0.1	1	3		
zero after calibration							
span before calibration	11:28	20.92	17.97	910	895		
span after calibration							
deviation in % zero		0.0	0.5	0.1	0.3		
deviation in % span		0.1	0.2	0.4	0.3		

SGS				Projectnumber	EZMO-11-0027		
				Projectlocation	MS Catharina		
				Date	27/8/2014		
				Performer(s)	JMI		
Tagnumber(s)							
		O_2 vol%	CO_2 vol%	CO vppm	NO_x vppm	SO_2 vppm	C_xH_y vppm
Range analyser		25	20	1000	1000		
Spangasconcentration	40004525368	20.95	18.19	894	904.8		
Control gas conc.	identification						
Leaktest performed	Satisfies	Yes					
Calibration 1	**time Calibration**						
zero	16:30	0	0	0	0		
span	16:45		17.88	901	901		
control gas							
	26-8-2014						
Calibration 2	**time Calibration**						
zero before calibration	15:15	0	0.1	1	3		
zero after calibration							
span before calibration	15:25	20.78	17.92	899	902		
span after calibration							
deviation in % zero		0.0	0.5	0.1	0.3		
deviation in % span		0.8	1.5	0.6	0.3		
	27-8-2014						

Appendix C. Calibration gas

AIR PRODUCTS

Analyse certificaat

Air Products SA/NV
1789 Waversesteenweg
Chaussee de Wavre
B-1160 BRUSSELS
Printdatum: 13 MRT 2013

Container Type: X50A - 50L Aluminum Fles
Type afsluiter: DIN14
Netto Gewicht: 9.935 kg
Vul Druk @ 15 °C: 141.0 bar-g
Vul Druk @ 15 °C: 143.780 kg/cm2
Inhoud @ 0°C, 1013 mbar: 7.290 Nm3

Materiaal **61385** Mélange gazeux	Fabrik Datum 11 MRT 2013	Analyse Datum 13 MRT 2013	Vervaldatum 11 MRT 2018
Inspectie Lot **040004525368**		Fabrik Lok 0234	

ONDER GRENS	BOVEN GRENS	NOMINALE WAARDE	GEMETEN WAARDE	EENHEID	ONZEKERHEID	NR REPET ST. DEV	ANALYSE FASE	ANALYSE FREQ	ANALYSE METHODE
NOx									
		900	901	ppm mo	± 1%rel			I	Ana - Chemiluminescentie (NOx)
Propaan									
		900	902	ppm mo	± 0.5 %rel			I	Grav
Koolstofmonoxide									
		900	900	ppm mo	± 0.5 %rel			I	Grav
Koolstofdioxide									
		18.00	18.02	% mole	± 0.1%rel			I	Grav
Stikstof oxide									
		900	900	ppm mo	± 1%rel			I	Ana - Chemiluminescentie (NOx)
Zwavel Dioxide									
		900	900	ppm mo	± 0.5 %rel			I	Grav
Stikstof									
			81.5	% mole	± 0.1%rel			I	Grav

Het certificaat is electronisch opgesteld en is geldig zonder handtekening.

OPMERKINGEN:
Methode : 1 = Certificatie methode , 2 = Analyse methode.#
Analyse freq : I = Individuele analyse , B = Batch (Lot) analyse, C = Berekende waarde , S= Oorsprong.#
De afkorting (m) in de meeteenheid refereert naar massa (gewicht).
Herleidbaar naar Internationale standaard : Gewicht Standaard N°. 986682.#
Herleidbaar naar internationale standaarden Standaard manometer N°. 405156 / 405157.#
#
Air Products is ISO 9001:2000 gecertificeerd.- Cert nr 01131-98-AQ-LDN-UKAS.#
#
Niet meer gebruiken bij een druk lager dan 3 bar (uitzonderd producten geleverd met een druk lager dan 10 bar).#
Te bewaren bij een temperatuur van -10° C tot +50° C.*

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☎ UK: 08457 020202 IRL: 01 463 4200 FR: 0800 480 030 BE: 078 15 52 02 NL: 020 206 17 01 DE: 069 380 789 355 PL: 0 801 100 107 CZ: 800 100 700 SK: 0800 100 700 ES: 902 13 02 02 PT: 00800 6231 4576

tell me more
www.airproducts.com

IJkgas controleformulier

RvA ijkgasfles

IJkgas flesnummer: 003108SG
RvA certificaatnummer: 3222191.01

IJkgasfles

Concentratie ijkgas: hoog
Leverancier: Air Products
IJkgasflesnummer: 040004525368
Houdbaarheidsdatum: 11-Mar-18

Resultaten		RvA [mol]	RvA [Vol]	Certificaat [mol]	Certificaat [Vol]	Controle
NO_x	ppm					
NO	ppm	913	914.3	901	902.2	**904.80**
C_xH_y	ppm	900	882.3	902	884.3	**880.34**
CO	ppm	901	902.3	900	901.3	**894.31**
CO_2	%	17.99	17.90	18.02	17.93	**18.19**
SO_2	ppm	904	886.8	900	882.8	**872.43**

Uitgevoerd door: T.Hermsen
Controle datum: 7/3/2013

Gecontroleerd KAM:
Controle datum: 7/31/2013

IJkgas controleformulier

RvA ijkgasfles

IJkgas flesnummer: 000323 SG

RvA certificaatnummer: 3220922

IJkgasfles

Concentratie ijkgas: hoog

Leverancier: Air Products

IJkgasflesnummer: 040003362154

Houdbaarheidsdatum: 2/25/2014

Resultaten		RvA [mol]	RvA [Vol]	Certificaat [mol]	Certificaat [Vol]	Controle
NO_x	ppm					
NO	ppm	899	900		0	**898**
C_xH_y	ppm	900	882		0	**898**
CO	ppm	907	908		0	**906**
CO_2	%	17.93	17.84		0.00	**18.00**
SO_2	ppm	894	877		0	**906**

Uitgevoerd door: J. Kleverwal

Gecontroleerd KAM: ________

Controle datum: 7/25/2012

Controle datum: ________