CERTIFICATION IN ACCORDANCE WITH ISO 8178-1:2006

performed on behalf of

TECNOVA HT S.r.l.

Tribiano (Milan)

May 2015 – rev. 03

INDEX

All information about the description of the installation, operating conditions and the configuration of the automatic measurement system object of this document have been supplied by the customer.

Laboratory responsible
Order of Chemists Lazio – Umbria – Abruzzo – Molise
Registration n.2012
Digitally signed document in accordance with current regulations

Dr. Fernando Conti

INTRODUCTION

TECNOVA HT S.r.l. instructed **ECO CHIMICA ROMANA S.r.l.** to provide a verification, in accordance with ISO 8178-1:2006, of an automatic measurement system (hereafter called AMS) installed on exhaust flue gas stack coming from a DEUTZ test engine at Milantractor S.p.A. plant site in Tribiano (MI).

All sampling times below reported use the AMS clock.

The intervention has been performed between 18 – 21 May 2015.

In this document will be considered the equivalence test of NO_x parameter. However in the paper will be shows the samplings results (AMS and SRM) of all monitored parameters.

TECHNICAL SHEET 1 - DEFINITIONS AND ABBREVIATIONS

AMS: Automated Measuring System. Measurement system for continuous monitoring of emissions. (Candidate system).

SRM:Standard Reference Method. Method described and standardised to define quality characteristics, temporarily installed on site for verification purposes. (Reference system).

TECHNICAL SHEET 2 - CALCULATIONS - EQUIVALENCE DETERMINATION

The first part of ISO 8178:2006 specifies the measurement and evaluation methods for gaseous and particulate exhaust emissions from reciprocating internal combustion (RIC) engines under steady-state conditions on a test bed, necessary for determining one weighted value for each exhaust gas pollutant.

Systems or analyzers which do not meet the criteria described in ISO 8178 can still be used if they are equivalent as reported in Chapter 7. The determination of system equivalency shall be based on a seven-sample pair (or larger) correlation study between the system under consideration and one of the accepted systems of the first part of ISO 8178.

Results refers to the specific cycle weighted emissions value.

The equivalency of the sample pair averages shall be determined by *F*-test and *t*-test statistics (Annex D), with outliers excluded.

In this document will be considered the equivalence test of NO_x parameter.

The statistical method reported in the Annex D examines the hypothesis that the population standard deviation and mean value for an emission measured with the reference system do not differ from the standard deviation and population mean value for that emission measured with the candidate system.

The hypothesis shall be tested on the basis of a 5% significance level of the *F* and *t* values. The critical *F* and *t* values for 7 to 10 sample pairs are given in Table 1.

Sample size	*F*-test		*t*-test	
	df	F_{crit}	df	t_{crit}
7	6/6	4,284	12	2,179
8	7/7	3,787	14	2,145
9	8/8	3,438	16	2,120
10	9/9	3,179	18	2,101

Tab. 1

If the *F* and *t* values calculated according to the formula below are greater than the critical *F* and *t* values, the candidate system is not equivalent.

The following procedure shall be followed. The subscripts R and C refer to the reference and candidate system, respectively.

a) Conduct at least 7 tests with the candidate and reference systems preferably operated in parallel. The number of tests is referred to as n_R and n_C.

b) Calculate the mean values x_R and x_C and the standard deviations s_R and s_C, as follows:

Mean value

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

Standard deviation

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N-1}}$$

c) Calculate the *F* value, as follows:

$$F = \frac{s^2_{major}}{s^2_{\min or}}$$ (the greater standard deviation shall be in the numerator)

d) Calculate the *t* value, as follows:

$$t = \frac{|x_C - x_R|}{\sqrt{(n_C - 1)\times s_C^2 + (n_R - 1)\times s_R^2}} \times \sqrt{\frac{n_C \times n_R \times (n_C + n_R - 2)}{n_C + n_R}}$$

e) Compare the calculated *F* and *t* values with the Critical *F* and *t* values corresponding to the respective number of tests indicated in Table 1.

f) Determine the degrees of freedom (*df*), as follows:

$$df = \frac{n_R - 1}{n_C - 1}$$

$$df = n_C + n_R - 2$$

g) Determine the equivalence, as follows:

- if $F < F_{crit}$ and $t < t_{crit}$ then the candidate system is equivalent to the reference system;
- if $F \geq F_{crit}$ and $t \geq t_{crit}$ then the candidate system is different from the reference system.

TECHNICAL SHEET 3 - PLANT DESCRIPTION

PLANT GENERAL DATA	
Company name	TECNOVA HT S.r.l.
Plant	TECNOVA HT S.r.l. c/o MILANTRACTOR S.p.A.
Address	Via Pasubio, 2 20067 Tribiano - Milan

POINT OF EMISSION	
Technical Specifications	
Stack shape	Circular
Internal stack diameter	0,8 m
Outlet chimney height from the ground	11,3 m
Sample plain height	8,87 m
Fumes inlet height	4,87 m
Flow rate (process conditions)	5.500 ÷ 15.000 m³/h
Fumes temperature	200 ÷ 400 °C
Indicative fumes composition	
H_2O	4 ÷ 5 % (v/v)
$O_{2\ (dry\ gas)}$	10 ÷ 15 % (v/v)
$CO_{2\ (dry\ gas)}$	4 ÷ 7,7 % (v/v)
Indicative content of stack fumes major pollutants	
$CO_{\ (dry\ gas)}$	70 ÷ 500 ppm
$NO_{x\ (dry\ gas)}$	300 ÷ 1000 ppm
$SO_{2\ (dry\ gas)}$	4 ÷ 8 ppm
Dust	5 ÷ 28 mg/m³
$COT_{\ (dry\ gas)}$	230 ÷ 500 ppm
Abatement systems	
None	

FLANGES FEATURES	
Flanges number	4
Flanges type and size	n. 3 DN65 PN6, n.1 DN100 PN6

SAMPLING POINT ACCESSIBILITY
Step irons

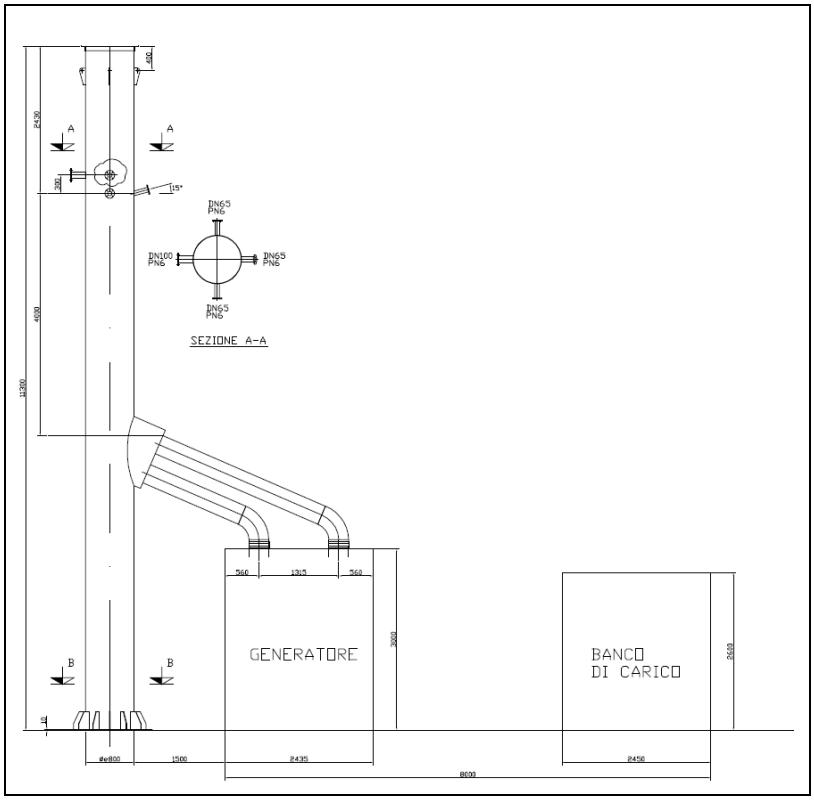

Fig. 1 - Stack layout

Fig. 2 - Working area

TECHNICAL SHEET 4 – COMPONENTS DATA SHEET

ENGINE	
Model	TBD620V16G3
Serial Number	2202756
Manufactured	DEUTZ
Rated speed	1500 / 1800 rpm
Prime Power	1844 / 2508 kW
Standby Power	1936 / 2633 kW
Fuel	Diesel
ALTERNATOR	
Model	LSA 51.2 L70
Serial Number	168870/001
Manufactured	LEROY SOMER
Prime Power	2150 kVA
Threephase Voltage	400 / 440 VAC
GENERATING SET	
Prime Power Iso 8528	2.150 / 2.365 kVA
Prime Power	1.720 / 1.892 kW
Standby Power Iso 8528	2.255 / 2.480 kVA
Standby Power	1.804 / 1.984 kW
Threephase Voltage	400 / 440 VAC
Frequency	50 / 60 Hz
Fuel Consumption 100% Load	409 lt/h
Fuel Tank Capacity	590 lt
Version	Container
Soundproofed	70 dB(A) a 7 m
Lenght	12.190 mm
Width	2.438 mm
Height	2.591 mm
Weight	26.000 kg

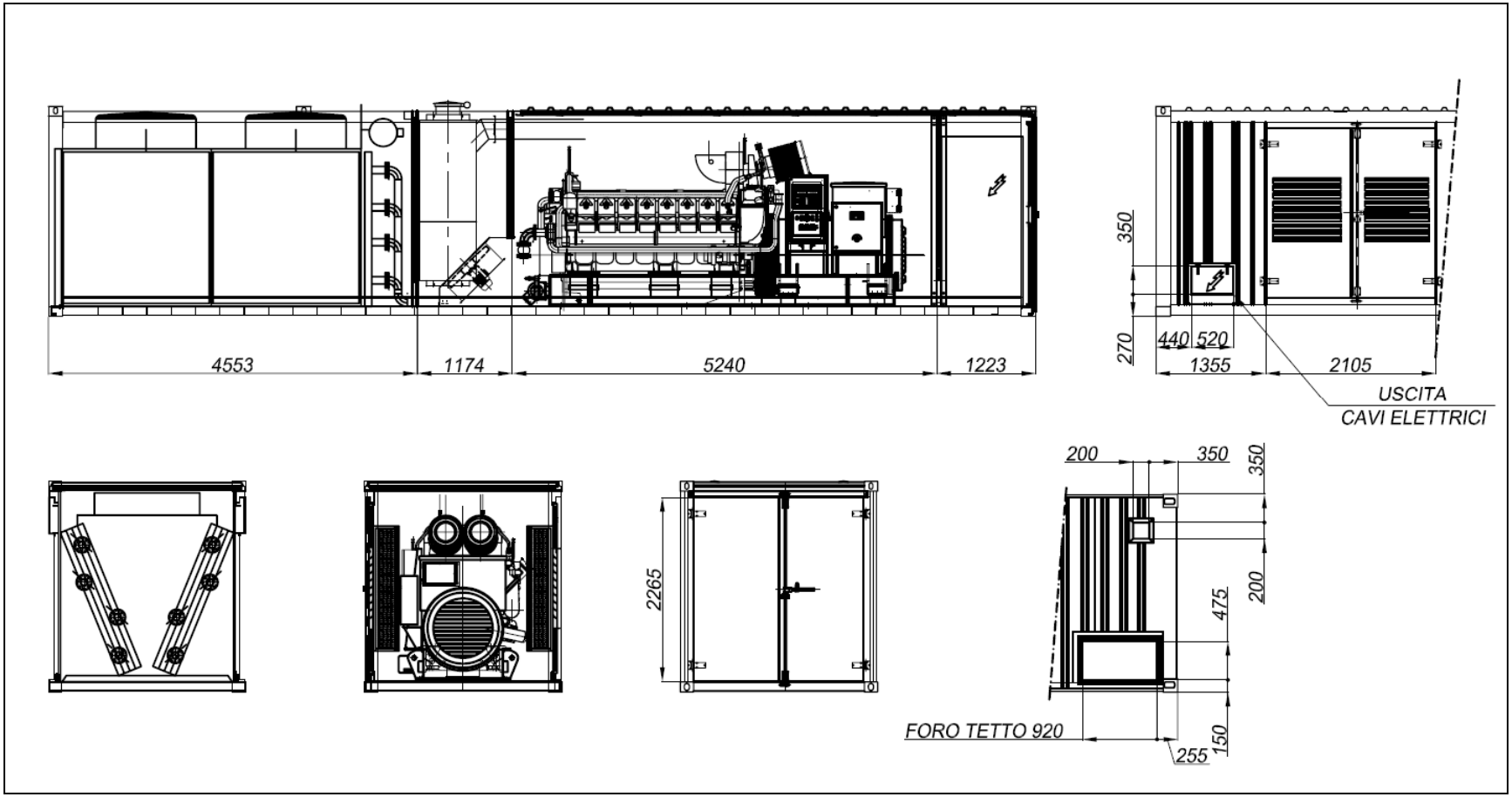

Fig. 3 - Container layout

Fig. 4 - Working area

TECHNICAL SHEET 5 - ANALYSIS LABORATORY AND STAFF

LABORATORY GENERAL DATA	
Company name	ECO CHIMICA ROMANA
Address	Via Morsasco,71
ZIP code	00166
Place	Roma (RM)

TECHNICIAN	
Technician in charge of the intervention	Daniele Cotroneo
Responsible	Daniele Cotroneo

TECHNICAL SHEET 6 - AUTOMATED MEASURING SYSTEM (AMS)

AUTOMATED MEASURING SYSTEM FEATURES (AMS)		
S-KEEPER7 - FULL supplied by TECNOVA HT		
SYSTEM SUPPLIER	**MODEL**	**DESCRIPTION**
FUJI ELECTRIC	ZPA	Extractive direct measurement multiparameter analyzer
	ZFK7	ZrO_2 - O_2 analyzer
---	THERMO FID – SK7	Extractive direct measurement THC analyzer
SINTROL	S710 Marine	Dust monitor

ACQUISITION DATA SOFTWARE		
Supplier	----	----
Frequency data availability	20 seconds	

SAMPLE LINE				
Plant	**Ø line [mm]**	**Length [m]**	**Temperature [°C]**	**Use**
DEUTZ ENGINE	4	15	190	CO, NO_x, CO_2, SO_2
				O_2
				COT

MONITORING CABINET	
Present/Absent	Present
Installation height	On the ground

CABINET INSTRUMENTS OPERATIVE CONDITIONS	
Internal conditioning system	Absent
Calibration system	Manual
Calibration cylinders	Present

AMS FEATURES						
Parameter	**Analyzer**	**In situ / extractive**	**Direct / indirect**	**Measuring principle**	**Units of measurement**	**Full scale**
Dust	SINTROL S710 Marine	In situ	I	Inductive electrification	raw	-
O_2	FUJI ELECTRIC ZFK7	E	D	ZrO_2	%(v/v)	25
NO_x	FUJI ELECTRIC ZPA	E	D	NDIR	ppm	2000
SO_2		E	D		ppm	2000
CO		E	D		ppm	2000
CO_2		E	D		%(v/v)	20
THC	--- THERMO FID – SK7	E	D	FID	ppm	2000

Fig. 5 - Measurement section

Fig. 6 - S-KEEPER7 AMS

Fig. 7 - S-KEEPER7 AMS

TECHNICAL SHEET - STANDARD REFERENCE METHOD (SRM)

Tested parameter	Test method
Dust	UNI EN 13284-1:2003
CO	UNI EN 15058:2006
CO_2	EPA 3A:2006
NO_x	UNI EN 14792:2006
COT	UNI EN 12619:2013
SO_2	UNI 10393:1995
Flow rate	UNI EN ISO 16911-1:2013
Temperature [1], Pressure [1]	UNI EN ISO 16911-1:2013
O_2 [1]	UNI EN 14789:2006
H_2O [1]	UNI EN 14790:2006
[1] although not directly covered by the tests, are necessary for the operations of standardization and reference procedure.	

STANDARD REFERENCE METHOD FEATURES (SRM)				
System supplier	**Model**	**Detected parameters**	**Measuring principle**	**Full scale**
RATFISCH	RS53T	COT	FID	1000 ppm
TECORA	Isostack Basic HV [2]	Dust and moisture	Isokinetism	Only sampling
		Flow rate	Differential pressure	3.556 Pa
		Temperature	Thermocouple K (Cr-Ni)	1.200°C
		Pressure	Piezoresistance	1.035 mbar
HORIBA	PG 250 [3]	O_2	Paramagnetic sensor	25 %(v/v)
		CO	NDIR	1000 ppm
		NO_x	Chemiluminescence	2500 ppm
		CO_2	NDIR	20 %(v/v)
		SO_2		200 ppm

[2] The mentioned devices are used only for the sampling, in particular under isokinetic conditions with regard to water and dust.

[3] The determination of the nitrogen oxides (NO_x) as the sum of of NO and NO_2, was carried out using a catalytic converter NO_2/NO, which transforms the nitrogen dioxide to nitric oxide, by placing it first of the NO analyzer, and allows the determination as NO.

Where necessary, heated lines (150 – 180 °C) of appropriate length, cooling and gas dehydration systems, catalytic conversion systems (NO2 → NO), gas dynamic dilution systems and everything else necessary to the correct application of the above descripted methods, have also been used. The full list of strumentation and accessories used during the test and the relative calibration reports, where applicable, is available at the laboratory.

TECHNICAL SHEET 8 - NORMATIVE REFERENCES

PARAMETER	NORMATIVE	DESCRIPTION
Measuring system	**ISO 8178-1:2006**	Reciprocating internal combustion engines – Exhaust emission measurement – Part 1: Test-bed measurement of gaseous and particulate exhaust emissions
Dust	**UNI EN 13284-1:2003**	Stationary source emissions – Determination of low range mass concentration of dust – Manual gravimetric method
Moisture (H_2O)	**UNI EN 14790:2006**	Stationary source emissions - Determination of the water vapour in ducts
Oxygen (O_2)	**UNI EN 14789:2006**	Stationary source emissions - Determination of volume concentration of oxygen (O2) - Reference method - Paramagnetism
Carbon dioxide (CO_2)	**EPA 3A:2006**	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions From Stationary Sources (Instrumental Analyzer Procedure)
Carbon monoxide (CO)	**UNI EN 15058:2006**	Stationary source emissions - Determination of the mass concentration of carbon monoxide (CO) - Reference method: Non-dispersive infrared spectrometry
Sulphur dioxide (SO_2)	**UNI 10393:1995**	Instrumental method with direct extractive sampling for sulfur dioxide determination in conveyed gas flow
Nitric oxides (NO_x)	**UNI EN 14792:2006**	Stationary source emissions - Determination of mass concentration of nitrogen oxides (NO_x) - Reference method: Chemiluminescence
Total organic carbon (COT)	**UNI EN 12619:2013**	Stationary source emissions – Determination of the mass concentration of total gaseous organic carbon – Continuous flame ionisation detector method.
Flow rate	**UNI EN ISO 16911:2013 - Annex A**	Stationary source emissions – Manual and automatic determination of velocity and volume flow rate in ducts – Part 1: Manual reference method
Temperature - Pressure	**UNI EN ISO 16911:2013 - Annex A**	Stationary source emissions – Manual and automatic determination of velocity and volume flow rate in ducts – Part 1: Manual reference method

STANDARD REFERENCE METHODS DETECTION LIMITS

As regards the detection limits of the reference methods (for a specific measurement method they are represented by the values below which the result can't be considered reliable due to the high degree of uncertainty), can be considered the values in the following table:

Parameter	Detection limit
O_2	0,08 % full scale
CO_2	0,01 % full scale
CO	0,52 % full scale
NO	0,08 % full scale
SO_2	0,11% full scale
Dust	Depends on the sampled volume
COT	0,16 mg/Nm^3

The application of the detection limit of continuous and manual methods is different.

Regarding the continuous methods, for which the 10 minutes average value is the mean value of the validated elementary data (minute), the detection limit vary depending on the number of the elementary data that form the mean value and which are below the detection limit.

In practical terms, for a specific parameter, if the i^{th} elementary data is below the detection limit, the 10 minutes average will be lower than the average determined by using, for the ith data, the detection limit.

With reference to manual methods the final result is determined as a ratio between a quantity (i.e. µg of Cl^- ion) and the sampled gas volume. Then the detection limit, expressed as a final result, may vary depending of sampled gas volume, although the laboratory analytical determination is characterized by a unique detection limit.

TECHNICAL SHEET 9 – EQUIVALENCE TESTS RESULTS

Following the detailed reports of the tests performed on the AMS Candidate system for NO_x parameter.

NOTICE TO THE READER

The following pages of the report are not made public because they contain confidential data owned by TECNOVA HT SrL

The full report is available only upon written request by the Customer or Certification Body