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ADDITIONAL REPORT No. 00260 2 2011 FOR TESTS AND MEASUREMENTS ON B.I. *0188/2009*

Boiler: ECO HORNET 100 kW HEATING UNIT operating on pelletized wood fuel, manufactured by S.C. HORNET GRUP S.R.L.

Testing

The tests were performed on the fully-equipped boiler.

The direct measurement of the fuel supply rate was made by weighing the wood fuel (pellets) for each testing mode.

Subject to these conditions, according to the provisions of SR EN 303-5, the boiler load is determined on the fuel side and on the hot water preparation side and the efficiency is determined by the direct method and the measurement errors are verified by calculating the indirect efficiency resulting from the measurement of all heat loss components.

Tests – synthetic results

The following testing conditions were applied, in accordance with the testing procedure for solid-fuel boilers of powers up to 300 kW, SREN 303-5:

Test at Qn+/-8%

- stabilized thermal regime
- te=70-80°c
- 8t = 15-25 K
- measurement of CO2, CO, COY, NOx levels – average values over the entire period
- measurement of dust level, 2 times – aspiration on filtering 30 minutes
- temperature on surfaces: min. 5 points on each surface
  separately on doors and handles

- The boiler was inspected.
- During the operation at nominal levels, the water temperature at the boiler output was maintained at 80 ±10 °C by assuring a proper flow rate and a dissipated heat load able to maintain the desired temperature range;
- During operation in the minimal mode, the thermostat was adjusted to 90°C and a proper water supply rate was provided so that to obtain for the estimated load a temperature difference of approx. 20 °C between the feed water and the return water;
- The boiler input temperature was automatically adjusted by the testing bench so that to maintain a temperature difference of 15-25 K inside the boiler.

TESTING MODE

- nominal power declared by manufacturer Pn = 111.7 kW
- nominal output declared by manufacturer Qn = 105 kW

The synthetic general results obtained in the testing modes applied to the ECO HORNET 100 kW boiler are presented in Table 1

Table 1: General synthetic results

BOILER	ECO HORNET 100 kW
MODE	NOMINAL
Declared thermal output [kW]	**105**
Declared efficiency [%]	**94**
Water throughput: g_{water} [kg/h]	5021
Water temperature at boiler intake: t_{wateri}[°C]	62.03
Water temperature at boiler discharge: t_{waterd}[°C]	80.00
Measured thermal output [kW]	104.93
Temperature of exhaust gases in the flue: t_{flue} [°C]	119.8
Hourly fuel consumption: B_{comb} [kg/h]	23.70
Fuel's calorific power: Hi [MJ/kq]	17
Direct/indirect efficiency: EFF [%]	93.58/94.06
Validation of declared output and efficiency	**YES**

The synthetic results of the measurements made in the flue are presented in Table 2.

Table 2: Synthetic results of flue measurements

No.	**CO** (ppm)	CO2 (%)	NOx (ppm)	O2 (%)	Tflue
1	153	17.57	107	4.10	119.3
2	116	18.19	105	4.10	118.8
3	163	17.82	105	4.00	118.8
4	352	18.05	104	4.10	119.1
5	160	18.50	107	4.00	118.6
6	237	16.84	104	3.50	119.2
7	122	17.35	111	3.10	119.1
8	112	17.98	113	4.50	118.8
9	240	17.66	113	4.30	119.0
10	124	18.08	111	4.10	118.6
11	240	17.91	105	4 40	118.8
12	186	17.70	104	4.70	1194
13	143	18.72	104	4.40	118.5
14	150	17.81	100	4.90	119.0
15	180	18.42	97	4.60	119.1
16	157	18.07	95	4.20	118.8
17	179	17 **44**	94	4 40	119.1

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The charts below show the values of the main parameters monitored during the maximum (nominal) load testing mode.

ECO HORNET 100 kW HEATING UNIT
Testing on nominal load operating mode
time [mm]

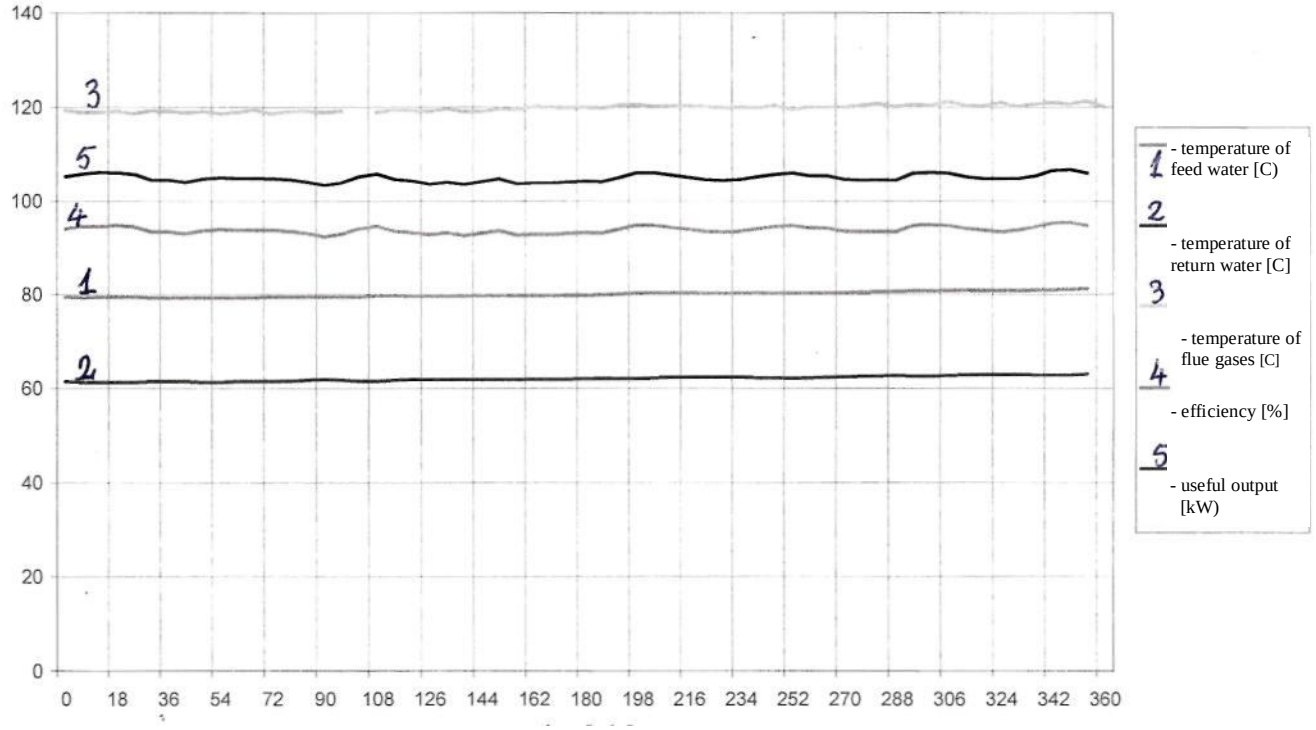

Table 3 presents the calculation of direct efficiency.

Table 4 presents the calculation of indirect efficiency.

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Table 3: CALCULATION OF DIRECT EFFICIENCY

MEASURED BOILER	HORNET100		
FUEL	PELLETS		
MODE	NOMINAL		
DATE	14.06.2011		
TIME	10:10-16:55		
	SYMBOL	M/U	AVERAGE VALUE
Water volume measured	Vwater	I	5021
Time	time	sec.	3600
Average water temperature at boiler loop intake per cycle	twater-i	C	62.03
Average water temperature at boiler discharge per cycle	twater-d	C	80.00
CALCULATION OF HEAT QUANTITIES			
Useful heat quantity per cycle			
Intake water density	ROwater	kg/me	997
Hourly water throughput	Gwater	kg/h	5006
Cycle time	Tcycle	mm	365
Water quantity per cycle	Gtot	kg	30453
Water temperature difference	del_t	K	17.97
Specific heat of water	Cp_{water}	kJ/kg/K	4.186
Useful heat generated by water per cycle	Qut	kJ	2290732
Useful heat generated by water per cycle	Qut kcal	kcal	547237
Quantity of heat generated by fuel per cycle			
Humidity	W	%	5
Calorific power Hiuse=18000 kJ/kg			
Hi=Hiusc*(100-W)/10O-24.4*W	Hi	kJ/kg	16978
Hi kcal/kg	Hikcal	kcal/kg	4056
Fuel quantity per cycle	Ball	kg	144.175
Heat generated by fuel per cycle	Qfuel	kJ	2447803
Heat generated by fuel per cycle	Qfuelkcal	kcal	584759
BOILER EFFICIENCY – DIRECT BALANCE			
EFFICIENCY (100*Qut/Qdat)	EFFdrr	%	93.58
Hourly fuel consumption	Bh	*kg/h*	23.70
Useful heat output	Qut	kW	104.62

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Table 4: CALCULATION OF INDIRECT EFFICIENCY

MEASURED BOILER	**HORNET100**		
FUEL	**PELLETS**		
MODE	**NOMINAL**		
DATE	**14.06.2011**		
TIME	**10:10-16:15**		
	SYMBOL	**M/U**	**AVERAGE VALUE**
Water volume measured	Vwater	I	**5021**
Time	time	sec	**3600**
Average water temperature at boiler loop intake per cycle	twater-**i**	C	**62.03**
Average water temperature at boiler discharge per cycle	twater-d	C	**80.00**
Flue temperature	Tflue	C	**119.8**
Ambient air temperature	Tair	C	**20**
Flue gas analysis	02	%	**4.20**
Flue gas analysis	CO2	%	**18.06**
Flue gas analysis	CO	ppm	**241**
Flue gas analysis	NOx	ppm	**104.6**
Excess air	Excess air		**1.251**
Intake water density	ROwater	kg/mc	**997**
Hourly water throughput	Gwater	kg/h	**5006**
Specific heat of water	cpa	kJ/kg/K	**4.186**
Useful heat	Out	kW	**104.60**
Useful heat	Out	kcal/h	**90017**
BOILER EFFICIENCY CALCULATION			
Humidity	W	%	5
Calorific power Hiusc = 88000 kJ/kg			
Hi=Hiusc*(100-W)/100-24.4*W	Hi	kJ/kg	**16978**
Hi kcal/kg	Hikcal	kcal/kg	**4055,9**
Minimum specific combustion air volume	Va	Nmc/kg	**4,111**
Minimum specific flue gas volume	Vga	Nmc/kg	**4,877**
Excess air	Excess air		**1,251**
Specific gas volume			
Vg=Vgo+(A-1)*Va	Vg	Nmc/kg	**5,91**
Specific H_2O volume in gases	VH20	Nmc/kg	**0,795**
Specific volume of dry gases	Vgdry	Nmc/kg	**5,114**
Specific loss due to gas enthalpy at the flue			
Flue gas temperature	tcas	C	**119,8**
Ambient temperature	to	C	**20**
Specific gas temperature	cpg	kJ/NmcKK	**1,364**
qflue=1/Hi*Vg***cpg*(tflue-to)*100**	qflue	%	**4,736**
Specific loss by incomplete mechanical burning			
Ash concentration in fuel	A	%	**1,8**
Carbon concentration in fuel	Ca	%	**4,5**
q inc.m=1/Hi*32657*(A/100)*(Ca1100ri00	qinc.m	%	**0,156**
Specific loss by incomplete chemical burning			
CO concentration in gases	CO	%	**0,0241**
qincc=1/Hi*126**.36*CO*Vgdry*100**	qinc.c	%	**0,092**
Specific loss through outer surfaces			
qex**t=Qext/Q*100**	qext	%	**0,956**
BOILER EFFICIENCY – INDIRECT BALANCE			
EFF**i**nd=100-qco**s-qinc.m-qinc.c-qext**	**EFFind**	%	91,06

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EMISSIONS OF SOLID PARTICLES:

Testing method: according to the European standard SR E**N** *13284-112008.*

EcoHORNET 105 kW heating unit flue

Physical parameters of source:

~ flue diameter: 0.12 m;

~ average temperature at measuring points: 104°C; 108°C;

~ average speed: 1.3 *m/s*; 3 *m/s*;

~ gas discharge rate: 21 *Nm*^{3}/h; 49 Nm^3/h;

~ isokinetic sampling (the sampling plane, with two sampling points, is located along the straight length of tube).

Sampling equipment parameters:

- **Screen sampling system outside the flue**
  1, Sampling nozzle: inside diameter = 6 mm;
  2, Aspiration tube (device mounted outside the flue);
  3, Filtering device: filter diameter = 47 mm;
  4, Aspiration unit and flue gas measurement devices;
  5, Anemometer for speed measurement.
- **Conditioning and weighing equipment**
  1. Desiccator
  2. Electronic scales
  3. Thermometer close to the scales
  4. Notebook for monitoring temperature in the scales room.

TEST RESULTS

Sequential dust emissions

Emission source	Sampling date	Sampling time	No. of tests	Sampling period, **minutes**	Sample volume L	Sampling flow rate, L/min	Temperature °C	Total dust weight on filter, mg	Total dust concentration, mg/Nm^3	Measurement error, mg/m^3
Dust discharge flue	16.06.2011	15.10-15.40 16.25-16.40	1 1	30 15	90 75	3,0 5,0	104 108	0, 3 0 ^	4,6 7,4	2
Measurement methods						SREN 13284-1: 20 08				

Sampling date: 16.06.2011

Prepared by: Verificat,

Nicolae ANTONESCU Paul Dan STANESCU

Illegible signature

The foregoing English translation is herewith certified to be a true and complete translation of the Romania text which has been submitted to me in the form of a photocopy.

Nasen Brigitte MÜLLER,

duly authorized by the Ministry of Justice of Romania [Romanian: Ministerul Justiţiei] under the registration number 23906/2009, to certify the accuracy and completeness of translations into the English language.

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