Fuel analysis

Fuel type	Wood			
Analytical indicator	Symbol	Unit	Value	Uncertainty
Heat of combustion	Q_s	[MJ/kg]	16.46	0.14
Caloric value	Q_j	[MJ/kg]	14.75	0.14
All water in original condition	W^r_t	[% by weight]	17.35 ± 0.01	
Ash	A	[% by weight]	1.14 ± 0.02	
Carbon	C	[% by weight]	40.93	0.25
Hydrogen	H	[% by weight]	5.88	0.10
Nitrogen	N	[% by weight]	0.20	0.10
Sulphur	S	[% by weight]	0.044	
Chlorine	Cl	[% by weight]	0.022	
Oxygen – calculation for 100%	O	[% by weight]	34.44	
CO_2 max.	$CO_{2\,max.}$	[% by volume]	19.12	
Conversion factor f_{emis} for the conversion of emissions in [mg/m^3] to [mg/MJ]	f_{emis}	[-]	0.26843	
Min. required volume of O_2	$V_{O2\,min}$	[m^3/kg]	0.845	
Min. required dry air volume	$V_{vz\,min}$	[m^3/kg]	4.025	
Min. quantity of dry chimney gas	$V_{ks\,min}$	[m^3/kg]	3.934	

Note: Sample in the original condition

Measurement uncertainty: specified in the table of measurement results

The above-specified extended measurement uncertainties are calculated as a factor of the measurement uncertainty and the extension coefficient, k=2, corresponding to the coverage certainty of 95% as regards standard classification. The uncertainties do not reflect the impact of sample taking and lack of homogeneity. The standard uncertainty was determined in accordance with Document EA 4/02."

Test evaluation:

The heat capacity measured is within the tolerance of ±8%;
Boiler class 3;
The temperature of combustion products is lower than 160°C above the ambient temperature, see the respective data in the technical documentation;
The measured draught values do not exceed the maximum values according to figure 2;
The period of burning is more than 2 hours during wood burning;
The minimum heating capacity equals the rated heating capacity - see the follow-up data in the technical documentation.

Tested by: Milan Holomek Date: 2010-12-10 Signed:

Reviewed by: Ing. Stanislav Buchta Date: 2010-12-10 Signed:

Accredited test number: **1004.1** Test title: **Test of heat capacity, input and efficiency Deviation of type A.1.1**

Testing method: ČSN EN 303-5:2000, Art. 5.7, 5.8 and 5.10

Sample tested: ORLIGNO 200 60 kW

Measuring equipment used: See report 39-8811/3

Date of test and ambient conditions - see the "Heat capacity, input and efficiency" test							
Place of testing:	at the Engineering Test Institute	x	at the manufacturer	☐	at the customer	☐	*other:*

Test results:

Requirement	Specification of requirement	Test evaluation	Note
Type A deviations			
A.1 Deviation for Austria			
Boiler efficiency for rated heat capacity and minimum heat capacity: *a) Manual fuel supply* ≤ 10 kW 73 % > 10 kW ≤ 200 kW $(65.3 + 7.7 \log Q_N)$ % > 200 kW 83 % *b) Automatic fuel supply* ≤ 10 kW 76 % > 10 kW ≤ 200 kW $(68.3 + 7.7 \log Q_N)$ % > 200 kW 86 %	ČSN EN 303-5 Annex A Art. A 1.1	+	

Measurement results: **1. boiler: ORLIGNO 200 60 kW, rated output, fuel: wood**

Boiler capacity	Calorific efficiency required	Calorific efficiency measured
Rated – 1st burning period	79.0	89.2
Rated - 2nd burning period	79.0	88.6

Test evaluation: The measured efficiency is higher than the required minimum.

Tested by: Milan Holomek Date: 2010-12-10 Signed:

Reviewed by: Ing. Stanislav Buchta Date: 2010-12-10 Signed:

Accredited test number: **1005.1** Test title: **Combustion efficiency test - emissions**

Testing method: ČSN EN 303-5:2000, Art. 5.7, 5.9 and 5.10

Sample tested: ORLIGNO 200 60 kW

Measuring equipment used: See report 39-8811/3

Date of test and ambient conditions - see the "Heat capacity, input and efficiency" test							
Place of testing:	at the Engineering Test Institute	x	at the manufacturer	☐	at the customer	☐	*other:*

Test results:

Requirement	Specification of requirement	Test evaluation	Note
Limit values of emissions The emission values must be low during burning. This requirement is considered fulfilled if the emission values specified in table 7 are not exceeded, provided that the boiler is operated under rated heat capacity, or as regards boilers with a range of heat capacity operated under the rated heat capacity and the minimum heat capacity in accordance with 5.7, 5.9 and 5.10. The requirement regarding the limit values of dust emissions under the minimum heat capacity is fulfilled if the requirements concerned are fulfilled under the rated heat capacity.	ČSN EN 303-5 Art. 4.2.6	+	Class 3

Measurement results: **1. boiler: ORLIGNO 200 60 kW, rated output, fuel: wood**

Average values of gas emissions of O_2, CO_2, CO, OGC, NO_x and dust:

	O_2 [%]	CO_2 [%]	CO [ppm]	OGC [ppm]	NO_x [ppm]	Dust [mg/m^3]	CO [mg/m^3] O_2 = 10%	OGC [mg/m^3] O_2 = 10%	NO_x [mg/m^3] O_2 = 10 %	Dust [mg/m^3] O_2 = 10 %
Average values	**6.01**	**13.57**	**1056**	**141**	**119**	**48**	**969**	**56**	**179**	**35**

Measured and calculated values concerning the dust measurements:

Concentration of solid pollutants at the boiler output				
Measurement number	1	2	3	4
beginning – end of measurement (hour, min.)	11^{46}-12^{16}	12^{36}-13^{06}	13^{46}-14^{16}	14^{36}-15^{06}
ambient temperature (°C)	27,3	27,8	28,2	28,3
number of measuring points ()	1	1	1	1
duration of consumption at the measuring point	30	30	30	30
flu gas temperature (°C)	136,7	144,8	141,0	149,4
negative (positive) pressure in the measurement	-27	-27	-28	-28
atmospheric air pressure (Pa)	99 885			
measurement cross-section (m^2)	0,00785			

fictitious humidity under standard conditions (kg/m^3)	0,1331			
dew point temperature (°C)	52,9			
relative flu gas humidity (%)	14,8			
humid flu gas density under stand. conditions (kg/m^3)	1,2725			
operating content of O_2 (%)	6,0			
flue gas volume flow rate (m^3/h)	151,8			
flu gas vol. flow rate under stand. conditions (m^3/h)	98,7			
dry flu gas volume flow rate under standard conditions (m^3/h)	84,1			
medium exhaust rate (m/s)	5,4	5,4	5,4	5,4
weight of solid pollutants (mg)	15,8	14,7	15,6	14,8
flu gas sample volume (m^3)	0,574	0,571	0,570	0,572
flu gas sample volume under stand. conditions (m^3)	0,377	0,368	0,370	0,364
dry flu gas sample volume under standard conditions (m^3)	0,321	0,314	0,315	0,310
medium weight concentration of solid pollutants (mg/m^3)	27,5	25,7	27,4	25,9
medium weight concentration of solid pollutants under standard conditions (mg/m^3)	41,9	39,9	42,2	40,7
medium weight concentration of solid pollutants in dry flu gas under standard conditions (mg/m^3)	49,2	46,8	49,5	47,7
mass flow rate of solid pollutants (g/h)	4,17	3,90	4,16	3,93
average medium weight concentration of solid pollutants (mg/m^3)	26,6			
average medium weight concentration of solid pollutants under standard conditions (mg/m^3)	41,2			
average medium weight concentration of solid pollutants in dry flu gas under standard conditions	48,3			
avg. medium weight concentration of solid pollutants in dry flu gas under standard conditions at 10% O_2	35,4			
average mass flow rate of solid pollutants (g/h)	4,00			
standard deviation for determination of medium weight concentration of solid pollutants (mg/m^3)	0,96			
standard deviation for determination of average mass flow rate of solid pollutants (g/h)	0,14			

Note: standard conditions – temperature: 0 °C, pressure: 101.325 kPa

Test evaluation: Emissions – Category 3.

Tested by: Milan Holomek Date: 2010-12-10 Signed:

Reviewed by: Ing. Stanislav Buchta Date: 2010-12-10 Signed:

Accredited test number: **1005.1** Test title: **Combustion efficiency test - emissions**
Deviation of type A.1.2

Testing method: ČSN EN 303-5:2000, Art. 5.7, 5.9 and 5.10

Sample tested: ORLIGNO 200 60 kW

Measuring equipment used: See report 39-8811/3

Date of test and ambient conditions - see the "Heat capacity, input and efficiency" test						
Place of testing:	at the Engineering Test Institute	x	at the manufacturer	☐	at the customer	☐ *other:*

Test results:

Requirement						**Specification of requirement**	**Test evaluation**	**Note**
A.1 deviation for Austria								
Limit values of emissions						ČSN EN 303-5 Annex A Art. A 1.2	+	
	mg/MJ[1)]	**CO**	**NO_x**	**OGC**	**Dust**			
Manual fuel charging	**Biological fuels**	**1100**	**150[2)]**	**80**	**60**			
	Fossil fuels	**1100**	**100**	**80**	**60**			
Automatic fuel supply	**Biological fuels**	**500[3)]**	**150[2)]**	**40**	**60**			
	Fossil fuels	**500**	**100**	**40**	**40**			
[1)]With respect to the caloric value of the fuel used **[2)] Limit values of NO_x apply for boilers burning wood only** **[3)]At 30% of the rated heat capacity, the limit value may be exceeded by 50%**								

Measurement results: **1. boiler: ORLIGNO 200 60 kW, rated output, fuel: wood**

Boiler capacity	**Average emission values**								
	Measured values					**Converted values**			
	O_2 [%]	**CO [ppm]**	**NO_x [ppm]**	**OGC [ppm]**	**Dust [mg/m³]**	**CO [mg/MJ]**	**NO_X [mg/MJ]**	**OGC [mg/MJ]**	**Dust [mg/MJ]**
Rated	6.01	1056	119	141	48	494	91	28	18

Test evaluation: The measured emission values do not exceed the limit values.

Tested by: Milan Holomek Date: 2010-12-10 Signed:

Reviewed by: Ing. Stanislav Buchta Date: 2010-12-10 Signed:

Accredited test number: **1005.1** Test title: **Combustion efficiency test - emissions Deviation of type A.2**

Testing method: ČSN EN 303-5:2000, Art. 5.7, 5.9 and 5.10

Sample tested: ORLIGNO 200 60 kW

Measuring equipment used: See report 39-8811/3

Date of test and ambient conditions - see the "Heat capacity, input and efficiency" test							
Place of testing:	at the Engineering Test Institute	x	at the manufacturer	☐	at the customer	☐	*other:*

Test results:

Requirement				Specification of requirement	Test evaluation	Note
A.2 Deviation for Germany						
For Germany, only category 3 in accordance with table 7 is acceptable. Central heating boilers burning solid fuels with the rated heat capacity exceeding 15 kW must be constructed and operated so that the emissions meet the following requirements, depending on the fuel used:				ČSN EN 303-5 Annex A Art. A.2	+	
Fuel	**Emission values [g/m³]**	**CO**	**Dust**			
Black and brown coal	**reference content of O_2 = 8%**	**-**	**0.15**			
Wood in natural condition	**Reference content of O_2 = 13%**	**4 [1] 2 [2] 1 [3] 0.5 [4]**	**0.15**			
[1] 15 kW < O_N ≤ 50 kW [2] 50 kW < O_N ≤ 150 kW [3] 150 kW < O_N ≤ 500 kW [4] O_N > 500 kW						

Measurement results: **1. boiler: ORLIGNO 200 60 kW, rated output, fuel: wood**

Boiler capacity	Average emission values								
	Measured values				Converted values				
	O_2 [%]	CO [ppm]	OGC [ppm]	Dust [mg/m³]	CO O_2 = 10 % [mg/m³]	OGC O_2 = 10 % [mg/m³]	Dust O_2 = 10 % [mg/m³]	CO O_2 = 13% [g/m³]	Dust O_2 = 13% [g/m³]
Rated	6.01	1056	141	48	969	56	35	0.705	0.026

Test evaluation: The measured emission values do not exceed the limit values.

Tested by: Milan Holomek Date: 2010-12-10 Signed:

Reviewed by: Ing. Stanislav Buchta Date: 2010-12-10 Signed:

Accredited test number: **1005.1** Test title: **Combustion efficiency test - emissions Deviation of type A.5**

Testing method: ČSN EN 303-5:2000, Art. 5.7, 5.9 and 5.10

Sample tested: ORLIGNO 200 60 kW

Measuring equipment used: See report 39-8811/3

Date of test and ambient conditions - see the "Heat capacity, input and efficiency" test							
Place of testing:	at the Engineering Test Institute	x	at the manufacturer	☐	at the customer	☐	*other:*

Test results:

Requirement					Specification of requirement	Test evaluation	Note
A.5 Deviation for Switzerland							
For boilers burning wood in natural condition, only category 3 of Table 7 is acceptable. The use of coal, coal briquettes and coke with the specific content of sulphur > 1% is not permitted.					ČSN EN 303-5 Annex A Art. A.5	+	
Fuel	**Q_N [kW]**	**Emissions [mg/m³]**	**CO**	**Dust**			
Fossil	**$Q_N \leq 70$** **$70 < Q_N \leq 1000$**	**reference content of O_2 = 7%**	**4000** **1000**	**-** **150**			
Wood in natural condition	**$Q_N \leq 70$** **$70 < Q_N \leq 200$** **$200 < Q_N \leq 500$** **$500 < Q_N \leq 1000$**	**Reference content of O_2 = 13%**	**4000** **2000** **1000** **500**	**-** **150** **150** **150**			

Measurement results: **1. boiler: ORLIGNO 200 60 kW, rated output, fuel: wood**

Boiler capacity	Average emission values								
	Measured values				Converted values				
	O_2 [%]	CO [ppm]	OGC [ppm]	Dust [mg/m³]	CO O_2 = 10 % [mg/m³]	OGC O_2 = 10 % [mg/m³]	Dust O_2 = 10 % [mg/m³]	CO O_2 = 13 % [mg/m³]	Dust O_2 = 13% [mg/m³]
Rated	6.01	1056	141	48	969	56	35	705	-

Test evaluation: The measured emission values do not exceed the limit values.

Tested by: Milan Holomek Date: 2010-12-10 Signed:

Reviewed by: Ing. Stanislav Buchta Date: 2010-12-10 Signed:

The test methods in this Report were applied without deviations, additions or exceptions.

III. List of referenced documents

- Order B-38376 of 2010-09-01
- Contract B-38376/39 of 2010-09-15
- Contract Supplement No. 1 of 2011-02-02
- ČSN EN 303-5:2000 – Central heating boilers – Part 5: Central heating boilers burning solid fuels, with manual or automatic fuel supply and nominal heat capacity of up to 300 kW. Terminology, requirements, testing and marking.
- Instruction & Service Manual ORLIGNO 200
- Customer's declaration of 2010-12-27
- Source materials for Task No. 39-8811/3

The persons stated below are accountable for the accuracy of the above-specified data:

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