Auxiliary combustion values (solid fuels):

Burning period: Type of boiler: Date of testing: Test conditions:	I. ORLIGNO 200 40 kW 2008-04-16 rated capacity	II. ORLIGNO 200 40 kW 2008-04-16 rated capacity
Type of fuel:	wood/beech/45cm	wood/beech/45cm
Stoichiometric oxygen volume [m^3/kg]	0.867	0.867
Stoichiometric air volume [m^3/kg]	4.128	4.128
Stoichiometric volume of dry combustion products [m^3/kg]	4.057	4.057
Maximum CO_2 volume [%]	19.55	19.55
Stoichiometric air multiple [-]	1.30	1.25
Volume of dry combustion products [m^3/kg]	5.357	5.225
Volume of H_2O in the combustion air [m^3/kg]	0.066	0.066
Volume of H_2O in the combustion products [m^3/kg]	0.882	0.882

Calculated values - thermal summary:

Burning period: Type of boiler: Date of testing: Test conditions:	I. ORLIGNO 200 40 kW 2008-04-16 rated capacity	II. ORLIGNO 200 40 kW 2008-04-16 rated capacity
Type of fuel:	wood/beech/45cm	wood/beech/45cm
Loss of sensible heat of combustion products (chimney) [%]	6.4	6.9
Loss of gas underburning [%]	0.4	0.6
Loss of mechanical underburning [%]	0.2	0.2
Loss of heat transfer into the environ. [%]	1.9	1.8
Total loss [%]	8.9	9.6
Calorific efficiency - indirect method [%]	91.1	90.4
Heat input [kW]	38.2	41.7
Heating output [kW]	**34.7**	**37.7**
Uncertainty of determining heating output [kW]	1.5	1.6
Calorific efficiency – direct method [%]	**90.7**	**90.3**
Capacity / rated capacity [%]	86.6	94.1

Under the rated output, the boiler efficiency regarding wood burning meets the requirements applicable to category 3 according to ČSN EN 303-5:2000, figure 1.

Fuel analysis

Fuel type	wood			
Analytical indicator	Symbol	Unit	Value	Uncertainty
Heat of combustion	Q_s	[IU/kg]	17.06	0.14
Calorific value	Q_j	[IU/kg]	15.45	0.14
All water in original condition	W^r_t	[% by weight]	13.62 ± 0.01	
Ash	A	[% by weight]	0.51 ± 0.02	
Carbon	C	[% by weight]	43.01	0.25
Hydrogen	H	[% by weight]	5.83	0.10
Nitrogen	N	[% by weight]	0.23	0.10
Sulphur	S	[% by weight]	0.00	
Chlorine	Cl	[% by weight]	0.00	
Oxygen - recalculation for 100%	O	[% by weight]	36.80	
CO_2 max	CO_{2max}	[% by volume]	19.55	
Conversion factor f_{emis} for the conversion of [mg.m^3] emissions to [mg.IU]	f_{emis}	[-]	0.26334	
Min. required volume of O_2	$V_{O2\ min}$	[m^3/kg]	0.86862	
Min. required dry air volume	$V_{vz\ min}$	[m^3/kg]	4.13629	
Min. quantity of dry chimney gas	$V_{ks\ min}$	[m^3/kg]	4.06944	

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 the document EA 4/02."

Test evaluation:

The heating output 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 output equals the rated heating output, see the relevant data in the technical documentation.

Tested by: Milan Holomek Date: 10/2010 Signed:

Reviewed by: Ing. Stanislav Buchta Date: 10/10 Signed:

Accredited test number: **1004.1**

Test title: **Heating output, heating input and calorific efficiency test**
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 18 kW, ORLIGNO 200 40 kW

Measuring devices: see Report 39-8811/1

Date of test and ambient conditions - see the "Heating output and calorific efficiency" test						
Place of testing:	at SZÚ	x	at the manufacturer	☐	at the customer	☐	*other:*

Test result:

Requirement	Requirement specification	Test evaluation	Note
Deviation of type A			
A.1 Deviation for Austria			
Boiler efficiency for rated heating output and minimum heating output: *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 18 kW, rated output, fuel: wood**

Boiler output	Calorific efficiency required	Calorific efficiency measured
Rated – 1st burning period	75.0	90.8
Rated – 2nd burning period	75.0	90.2

Measurement results: **2. boiler: ORLIGNO 200 40 kW, rated output, fuel: wood**

Boiler output	Calorific efficiency required	Calorific efficiency measured
Rated – 1st burning period	77.6	90.7
Rated – 2nd burning period	77.6	90.3

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 18 kW, ORLIGNO 200 40 kW

Measuring devices: see Report 39-8811/1

Date of test and ambient conditions - see the "Heating output and calorific efficiency" test							
Place of testing:	at SZÚ	x	at the manufacturer	☐	at the customer	☐	*other:*

Test result:

Requirement	Requirement specification	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 heating output, or as regards boilers with a range of heating outputs operated under the rated heating output and the minimum heating output in accordance with 5.7, 5.9 and 5.10. The requirement regarding the limit values of dust emissions under the minimum heating output is fulfilled if the requirements concerned are fulfilled under the rated heating output.	ČSN EN 303-5 Art. 4.2.6	+	category 3

Measurement results: **1. boiler: ORLIGNO 200 18 kW, rated output, fuel: wood**

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

Boiler output	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 %
Rated	5.92	15.23	686	306	168	40	626	120	252	29

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.)	14^{10}-14^{40}	15^{05}-15^{35}	16^{15}-16^{45}	17^{05}-17^{35}
ambient temperature (°C)	23,2	21,3	20,4	20,0
number of measuring points ()	1	1	1	1
duration of consumption at the measuring point	30	30	30	30
flu gas temperature (°C)	164,1	151,8	155,9	164,7
negative (positive) pressure in the measurement	-10	-10	-10	-10
atmospheric air pressure (Pa)	98 498			
measurement cross-section (m^2)	0,00785			
fictitious humidity under standard conditions (kg/m^3)	0,1290			
dew point temperature (°C)	52,8			
relative flu gas humidity (%)	14,4			

humid flu gas density under stand. conditions (kg/m^3)	1,2850			
operating content of O_2 (%)	5,9			
flue gas volume flow rate (m^3/h)	47,4			
flu gas vol. flow rate under stand. conditions (m^3/h)	29,2			
dry flu gas volume flow rate under standard conditions (m^3/h)	25,0			
medium exhaust rate (m/s)	1,7	1,7	1,7	1,7
weight of solid pollutants (mg)	7,0	6,2	6,8	5,8
flu gas sample volume (m^3)	0,310	0,311	0,312	0,312
flu gas sample volume under stand. conditions (m^3)	0,188	0,194	0,193	0,189
dry flu gas sample volume under standard conditions (m^3)	0,161	0,166	0,165	0,162
medium weight concentration of solid pollutants (mg/m^3)	22,6	19,9	21,8	18,6
medium weight concentration of solid pollutants under standard conditions (mg/m^3)	37,2	32,0	35,2	30,7
medium weight concentration of solid pollutants in dry flu gas under standard conditions (mg/m^3)	43,5	37,3	41,2	35,8
mass flow rate of solid pollutants (g/h)	1,07	0,94	1,03	0,88
average medium weight concentration of solid pollutants (mg/m^3)	20,7			
average medium weight concentration of solid pollutants under standard conditions (mg/m^3)	33,8			
average medium weight concentration of solid pollutants in dry flu gas under standard conditions	39,5			
avg. medium weight concentration of solid pollutants in dry flu gas under standard conditions at 10% O_2	28,8			
average mass flow rate of solid pollutants (g/h)	1,00			
standard deviation for determination of medium weight concentration of solid pollutants (mg/m^3)	1,81			
standard deviation for determination of average mass flow rate of solid pollutants (g/h)	0,09			

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

Measurement results: **2. boiler: ORLIGNO 200 40 kW, rated output, fuel: wood**

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

Boiler output	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 %
Rated	4.65	14.89	1120	151	141	51	936	55	195	34

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.)	10^{48}-11^{18}	11^{38}-12^{08}	12^{48}-13^{18}	13^{38}-14^{08}
ambient temperature (°C)	21,3	21,3	21,8	22,1
number of measuring points ()	1	1	1	1

duration of consumption at the measuring point	30	30	30	30
flu gas temperature (°C)	130,2	138,9	145,4	142,6
negative (positive) pressure in the measurement	-24	-24	-31	-31
atmospheric air pressure (Pa)	98 312			
measurement cross-section (m^2)	0,00785			
fictitious humidity under standard conditions (kg/m^3)	0,1281			
dew point temperature (°C)	52,6			
relative flu gas humidity (%)	14,3			
humid flu gas density under stand. conditions (kg/m^3)	1,2814			
operating content of O_2 (%)	4,6			
flue gas volume flow rate (m^3/h)	88,5			
flu gas vol. flow rate under stand. conditions (m^3/h)	57,5			
dry flu gas volume flow rate under standard conditions (m^3/h)	49,3			
medium exhaust rate (m/s)	3,1	3,1	3,1	3,1
weight of solid pollutants (mg)	15,0	16,2	16,8	15,8
flu gas sample volume (m^3)	0,573	0,575	0,572	0,576
flu gas sample volume under stand. conditions (m^3)	0,376	0,370	0,362	0,367
dry flu gas sample volume under standard conditions (m^3)	0,322	0,317	0,310	0,315
medium weight concentration of solid pollutants (mg/m^3)	26,2	28,2	29,4	27,4
medium weight concentration of solid pollutants under standard conditions (mg/m^3)	39,9	43,8	46,4	43,1
medium weight concentration of solid pollutants in dry flu gas under standard conditions (mg/m^3)	46,6	51,1	54,2	50,2
mass flow rate of solid pollutants (g/h)	2,32	2,49	2,60	2,42
average medium weight concentration of solid pollutants (mg/m^3)	27,8			
average medium weight concentration of solid pollutants under standard conditions (mg/m^3)	43,3			
average medium weight concentration of solid pollutants in dry flu gas under standard conditions	50,5			
avg. medium weight concentration of solid pollutants in dry flu gas under standard conditions at 10% O_2	34,0			
average mass flow rate of solid pollutants (g/h)	2,50			
standard deviation for determination of medium weight concentration of solid pollutants (mg/m^3)	1,35			
standard deviation for determination of average mass flow rate of solid pollutants (g/h)	0,12			

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 18 kW, ORLIGNO 200 40 kW

Measuring devices: see Report 39-8811/1

Date of test and ambient conditions - see the "Heating output and calorific efficiency" test						
Place of testing:	at SZÚ	x	at the manufacturer	☐	at the customer	☐	*other:*

Test result:

Requirement						Requirement specification	Test evaluation	Note
A.1 Deviation for Austria								
Limit values of emissions						ČSN EN 303-5 Annex A Art. A 1.2	+	
	mg/IU[1)]	**CO**	**NO_x**	**OGC**	**Dust**			
Manual fuel supply	**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 calorific value of the fuel used **[2)] Limit values of NO_x apply for boilers burning wood only** **[3)] At 30% of the rated heating output, the limit value may be exceeded by 50%**								

Measurement results: **1. boiler: ORLIGNO 200 18 kW, rated output, fuel: wood**

Boiler output	Average emission values								
	Measured values					Converted values			
	O_2 [%]	CO [ppm]	NO_x [ppm]	OGC [ppm]	Dust [mg/m^3]	CO [mg/MJ]	NO_x [mg/MJ]	OGC [mg/MJ]	Dust [mg/MJ]
Rated	5.92	686	168	306	40	314	126	60	14

Measurement results: **2. boiler: ORLIGNO 200 40 kW, rated output, fuel: wood**

Boiler output	Average emission values								
	Measured values					Converted values			
	O_2 [%]	CO [ppm]	NO_x [ppm]	OGC [ppm]	Dust [mg/m^3]	CO [mg/MJ]	NO_x [mg/MJ]	OGC [mg/MJ]	Dust [mg/MJ]
Rated	4.65	1120	141	151	51	469	98	27	17

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 18 kW, ORLIGNO 200 40 kW

Measuring devices: see Report 39-8811/1

Date of test and ambient conditions - see the "Heating output and calorific efficiency" test						
Place of testing:	at SZÚ	x	at the manufacturer	☐	at the customer	☐ *other:*

Test result:

Requirement	Requirement specification	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 (lignite)	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 18 kW, rated output, fuel: wood**

Boiler output	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	5.92	686	306	40	626	120	29	0,455	0,021

Measurement results: **2. boiler: ORLIGNO 200 40 kW, rated output, fuel: wood**

Boiler output	Average emission values								
	Measured values				Converted values				
	O_2 [%]	CO [ppm]	OGC [ppm]	Dust [mg/m^3]	CO O_2 = 10 % [mg/m^3]	OGC O_2 = 10 % [mg/m^3]	Dust O_2 = 10 % [mg/m^3]	CO O_2 = 13% [g/m^3]	Dust O_2 = 13% [g/m^3]
Rated	4.65	1120	151	51	936	55	34	0,681	0,025

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 18 kW, ORLIGNO 200 40 kW

Measuring devices: see Report 39-8811/1

Date of test and ambient conditions - see the "Heating output and calorific efficiency" test							
Place of testing:	at SZÚ	x	at the manufacturer	☐	at the customer	☐	*other:*

Test result:

Requirement					Requirement specification	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/m#]**	**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 18 kW, rated output, fuel: wood**

Boiler output	Average emission values								
	Measured values				Converted values				
	O_2 [%]	CO [ppm]	OGC [ppm]	Dust [mg/m^3]	CO O_2 = 10 % [mg/m^3]	OGC O_2 = 10 % [mg/m^3]	Dust O_2 = 10 % [mg/m^3]	CO O_2 = 13 % [mg/m^3]	Dust O_2 = 13% [mg/m^3]
Rated	5.92	686	306	40	626	120	29	455	21

Measurement results: **2. boiler: ORLIGNO 200 40 kW, rated output, fuel: wood**

Boiler output	Average emission values								
	Measured values				Converted values				
	O_2 [%]	CO [ppm]	OGC [ppm]	Dust [mg/m^3]	CO O_2 = 10 % [mg/m^3]	OGC O_2 = 10 % [mg/m^3]	Dust O_2 = 10 % [mg/m^3]	CO O_2 = 13 % [mg/m^3]	Dust O_2 = 13% [mg/m^3]
Rated	4.65	1120	151	51	936	55	34	681	25

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 supply and max. rated heating capacity of 300 kW. Terminology, requirements, testing, and marking
- Instruction & Service Manual ORLIGNO 200
- Customer's declaration of 2010-12-27
- Source materials for Task No. 39-8811/1

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

Ing. Stanislav Buchta
Head of Boiler and Industrial Heat Equipment Team

STROJÍRENSKÝ ZKUŠEBNÍ ÚSTAV, s.p. CZ

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