Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

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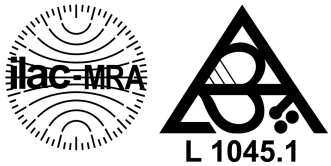

Non-Confidential Business Information (Non-CBI)

TEST REPORT
32-10198/4-3/T

Product:	Solid Fuel-Fired Hydronic Heating Appliances
Type designation	P4 Pellet 60
Customer:	Fröling Heizkessel- und Behälterbau Ges.m.b.H. Industriestraße 12 A-4710 Grieskirchen Austria
Manufacturer:	Fröling Heizkessel- und Behälterbau Ges.m.b.H. Industriestraße 12 A-4710 Grieskirchen Austria
Employee responsible:	Milan Holomek
5th revision issue date:	2022-07-08
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Distribution list:	1 copy to the Customer 1 copy to the Engineering Test Institute

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Annex A*
Annex B*
Annex C*

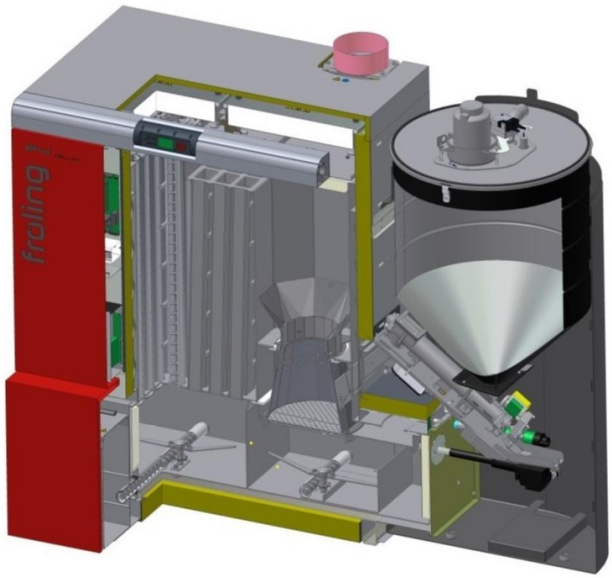
*Note: Annex A, Annex B and Annex C are integral parts of this document.

The tests were performed based on these documents:
- Order B-66546 dated 2019-05-10 (received on 2019-05-10)
- Contract B-66546/32 dated 2019-03-13
- Amendment D1 of Contract B-66546/32
- This test report is a revision of test report 32-10198/4-3/T of 2022-03-19 and fully replaces it

I. Product description, intended use and mode of application

The P4 Pellet 60 boiler is a hydronic heater (with automatic fuel supply). The P4 Pellet boiler is a boiler that produces useful heat for heating space and preparing hot water. The boiler uses wood pellets for fuel. The pellets are transported by the suction turbine via the suction hoses from the fuel store into the large hopper. Either suction probes or pellet screws are used as a discharge system. The pellets are transported to the downpipe with the stoker screw and fall in a metered quantity through the burn back flap onto the combustion grate of the sturdy steel combustion chamber. Hot air is added by the automatic ignition to ignite the pellets. Together with the speed-controlled induced draft fan and the stoker screw, the broadband Lambda probe ensures optimum combustion. Heat generated during combustion moves through the steel combustion chamber to the heat exchanger, where it is used for heating the hot water. Ash contained in the flue gas is deposited in the heat exchanger. An efficiency optimization system in the heat exchanger ensures automatic cleaning by means of turbulators (spiral springs) and the ash falls downwards.

Operating instructions and further detailed descriptions of individual assembly groups are provided in the enclosed technical documentation to Task 32-10198 (Annex A).



Firebox volume

0.34 ft^3

P4 Pellet 60:
Combustion chamber:
D1= 250 mm
D2= 175 mm
H= 268,5 mm
Volume= 9,62 dm³

II. Sample tested

Boiler output versions that are the subject of the proceedings:

Boiler output version	Heat output	Sample number	Place of testing
P4 Pellet 60	58.5 kW 199 500 Btu/h	0211.20.33009.001	SZÚ Brno Hudcova 424/56b 621 00 BRNO

Visual inspection, testing and verification were carried out by Ing. Vladimír Foit, Ing. Michal Havlů, Test Engineers, at SZU Brno, Hudcova 424/56b, 621 00 BRNO in 08/2020.

- Number of samples: 1
- Date of submission or sampling: 2020-08-01
- Reg. number: 0211.20.33009.001

III. Measuring and test equipment

No.	Description	Inventory number	Calibration valid until	Accuracy
1.	Combustion product analyser, Horiba, type ENDA-680P	022394	calibration prior to each measurement	
2.	Prandtl tube 0,3m	ME 485	-	5012-KL-RS091-09
3.	Induction flow meter	022389-C/1	10/2021	KL 6015-KL-P0696-17
4.	Temperature measurement set	022399-D/8	11/2020	KL-T-0116-18
5.	Thermometer, Moisture meter	116258	11/2021	KL 10595/2018
6.	Barometer	111985	05/2024	KL 6013-KL-K0005-19
7.	Draught gauge	MaR11-Tah	06/2021	KL 6013-KL-C0465-19
8.	Electronic stop watch	990760	11/2022	KL 2955E-17
9.	Analytic weighing machine Sartorius	021682	04/2021	KL 14/KA-19
10.	Electronic thermometer	022320/7	09/2021	KL-T-0115-18
11.	Electrometer	022389-A/4	05/2025	KL039/15/E
12.	Induction water meter	116320	04/2024	KLQ0191/2018
13.	Weighing machine	022151	02/2021	KL 6051-KL-H0187-19
14.	Weighing machine	022211	02/2021	KL 6051-KL-H0190-19
15.	Weighing machine	022331	03/2021	KL 6051-KL-H0243-19
16.	Tape measure	ME 477	10/2022	seKL 8800/2017
17.	Membrane gas meter 1	ME 552	07/2023	5012-KL-P1484-18
18.	Membrane gas meter 2	ME 553	07/2023	5012-KL-P1483-18
19.	Membrane gas meter 3	ME 554	07/2023	5012-KL-P1485-18
20.	A kit for temperature measurement 1	ME 555	08/2021	KL-T-0107-18
21.	A kit for temperature measurement 2	ME 556	08/2021	KL-T-0106-18
22.	A kit for temperature measurement 3	ME 557	08/2021	KL-T-0108-18
23.	Draught gauge 1	MaR08_Tah	06/2021	6013-KL-C0467-19
24.	Draught gauge 2	MaR09_Tah	06/2021	6013-KL-C0466-19
25.	Draught gauge 3	MaR10_Tah	06/2021	6013-KL-C0464-19
26.	Anemometer	117888	07/2023	6015-KL-P0404-20

* Calibration certificates are included in this test report in Annex B

Measurement uncertainty

Parameter measured	Measurement uncertainty
Combustion product analysis	
CO	up to 6% of the value measured
CO_2	up to 2% of the value measured
Temperature	
of the combustion products	up to 5 K
of the ambient in the room	up to 1.5 K
of the surface	up to 2 K
of the parts making contact	up to 2 K
Weight	
of the fuel consumption	± 20 g
of the solid combustion residues	± 5 g
of the fuel supply ≤ 7.5 kg	± 5 g
> 7.5 kg	± 10 g

“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% for 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.”

IV. Photographs

Fröling

V. Test description

The P4 Pellet 60 boiler was tested in accordance with the U.S. EPA 40 CFR Part 60, Subpart QQQQ – Standards of Performance for New Residential Wood Heaters using ASTM E2515 and ASTM E2618. Testing proceeded in accordance with requirements for the wood pellets alternative compliance option. Particulate emissions were measured using sampling trains consisting of two filters (front and back).

The model P4 Pellet 60 was tested for thermal efficiency and carbon monoxide (CO) emissions in accordance with CSA B415.1-10. Schematic of equipment test setup is described at figure 1.

The **conditioning** process was carried out at Fröling laboratory in Grieskirchen, based of the U.S. EPA 40 CFR Part 60, *art.11 Conditioning*. The Fröling company perfomed several tests at medium heat draw rate (Cat II and III) that were included in the conditioning time. This pre-test phase was declared by Fröling company (Annex A).

Run 1 was a **category IV** maximum output test. The target output rate was the manufacturer's specified rating of 199 500 BTU/hr. **Run 2** was a **category I** test with a target heat output below 15% of maximum. **Run 3** was a **category II** test with a target heat output below 25% of maximum. **Run 4** was a **category III** test with a target heat output below 50% of maximum.

The test fuel used was the Wood Pellet and was classified as EN plus. The fuel was delivered in 15 kg plastic bags.

Every test results apply only to the specific appliance tested.

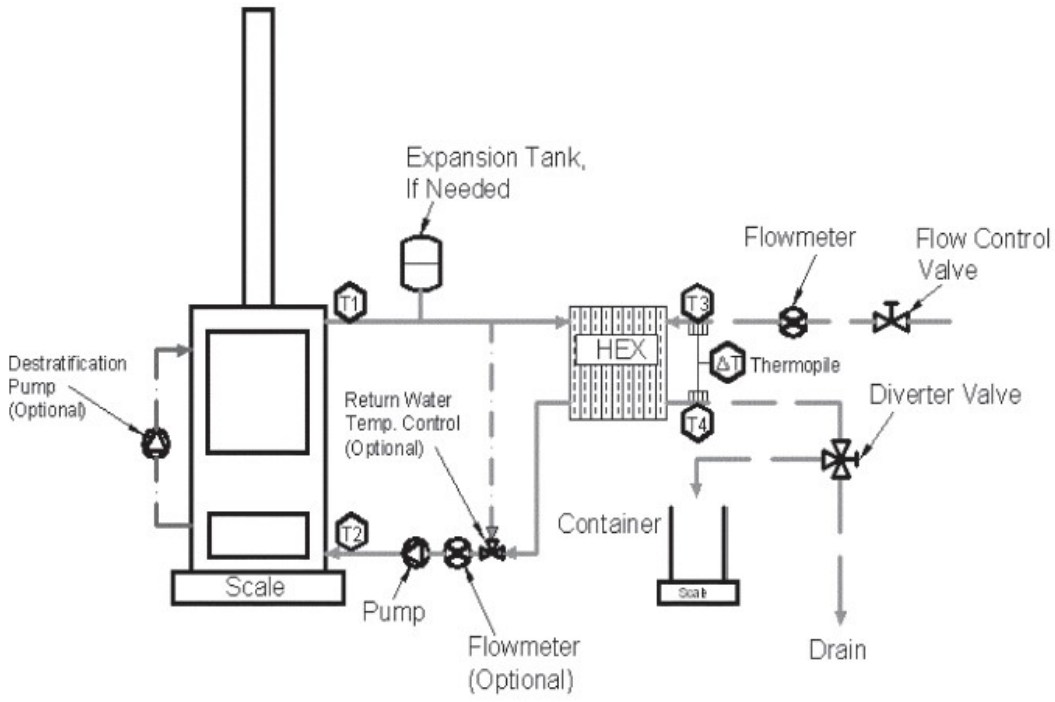


Figure 1 Schematic of equipment test setup (ASTM 2618-13)

T3 - temperature of cooling water at the inlet to the load side of the heat exchanger
T4 - temperature of cooling water at the outlet of the load side of the heat exchanger
T1 - temperature of the hot water supply as it leaves the boiler
T2 - temperature of return water as it enters the boiler

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VI. Test discussion on run appropriateness

Run 1 was a **category IV** maximum output test. The target output rate was the manufacturer's specified rating of 199 500 BTU/hr. During the IV category test were reached 203 584 Btu/hr nominal heat output. The specified nominal heat output was reached with permitted tolerance. Emission rate was 0.022 lb/mmBtu output and delivered efficiency 87.7 %
All acceptance criteria for a category IV test were met by this run, so its results are valid. No anomalies were observed during this run.

Run 2 was a test of **category I** < 15%. During test were reached load heat output rate 27 730. That is 13.9 % of nominal output rate. Emission rate was 0.096 lb/mmBtu output and delivered efficiency 78.4 %
All acceptance criteria for a category I test were met by this run, so its results are valid. No anomalies were observed during this run.

Run 3 was a test of **category II** test with a target heat output below 25% of maximum. During this run were reached 42 428 Btu/hr which is a 21.5 % of nominal heat output. Emission rate was 0.082 lb/mmBtu output and delivered efficiency 80.1 %
All acceptance criteria for a category I test were met by this run, so its results are valid. No anomalies were observed during this run.

Run 4 was a test of **category III** test with a target heat output below 50% of maximum. During this run were reached 84 578 Btu/hr which is a 42.6 % of nominal heat output. Emission rate was 0.032 lb/mmBtu output and delivered efficiency 83.6 %
All acceptance criteria for a category I test were met by this run, so its results are valid. No anomalies were observed during this run.

VII. Sumary of results

Measurement results: P4 Pellet 60

Burn rate categories, particulate emissions and delivered output				
Boiler type	P4 Pellet 60			
Fuel type	Wood Pellets			
Nominal heat output (Btu/hr)	199 500			
Test run	**1**	**2**	**3**	**4**
Load heat output* (Btu/hr)	203 584	27 730	43 428	84 578
Load percentage (% of max)	102.1	13.9	21.5	42.6
Burn rate category	**IV**	**I**	**II**	**III**
ambient temperature (°F) humidity (%) air pressure (Inch Hg)	81 50.7 28.9	81 43.9 28.9	82 42.7 29.0	80 38.8 29.2
Length of test (min)	240	240	240	240
Heat input (Btu/hr)	232 169	35 373	54 199	101 207
Delivered heat output** (Btu/hr)	203 667	27 75	42 822	84 572
Delivered efficiency (%)	87.7	78.4	80.1	83.6
Emissions (ASTM E2515) (g/hr)	2.07	1.20	1.61	1.25
Emission rate (lb/mm Btu output)	**0.022**	**0.096**	**0.082**	**0.032**

**Including load water, appliance steel and water and storage system steel and water
*load water only

Emissions (ASTM E2515) (g/hr) – First hour	1.88	0.85	0.96	0.73
Emissions (ASTM E2515) (g/kg dry fuel) – First hour	0.14	0.38	0.31	0.13

The P4 Pellet 60 boiler meets the requirements of 40 CFR 60 Subpart QQQQ Step 2 emissions limit of 0.10 lb/mm Btu heat output for each burn rate, using the cord wood alternative compliance option. The proportionality results for all four test runs were acceptable.

Manufacturer:		**Fröling Heizkessel- und Behälterbau Ges.m.b.H.**	
Model:		**P4 Pellet 60**	
Maximum output rating:	Q_{MAX}	199 500	BTU/HR
Annual efficiency rating:	η_{avg}	80.8	(Using higher heating value)
Particle emissions:	E_{AVG}	1.359	Grams/hr (annual average)
		0.072	Lbs/Milion BTU output
Carbon monoxide:	CO_g/min	0.17	Grams/minute (annual average)

Measurement results: P4 Pellet 60

Efficency and CO Emissions (B415.1)				
Boiler type	P4 Pellet 60			
Fuel type	Wood Pellets			
Nominal heat output (Btu/hr)	199 500			
Test run	**1**	**2**	**3**	**4**
Burn rate category	**IV**	**I**	**II**	**III**
Heat output (Btu/hr)	212 443	31 808	49 471	93 307
HHV efficiency (%)	86.7%	86.2%	87.4%	87.8%
LHV efficiency (%)	93.0%	92.5%	93.7%	94.2%
CO emissions (g/MJ output)	0.00	0.50	0.27	0.02
CO emissions (g/kg dry fuel)	0.07	8.54	4.71	0.30
CO emissions (g/min)	0.01	0.26	0.22	0.03

Measurement results: P4 Pellet 60

Dilution tunnel gas measurement				
Boiler type	P4 Pellet 60			
Fuel type	Wood Pellets			
Nominal heat output (Btu/hr)	199 500			
Test run	**1**	**2**	**3**	**4**
ambient temperature (°F) humidity (%) air pressure (Inch Hg) Room air velocity (start) (ft/min) Room air velocity (end) (ft/min)	81 50.7 28.9 13.8 11.8	81 43.9 28.9 3.9 3.9	82 42.7 29.0 9.8 19.7	80 38.8 29.2 17.7 5.9
Length of test (min)	240	240	240	240
Velocity (ft/s)	18.19	17.79	18.03	18.35
Flow rate (dscf/min)	176.4	186.7	188.4	190.9
Temperature (°F)	128	83	87	93

VIII. Particulate emissions results

Measurement results: P4 Pellet 60

Manufacturer		Fröling Heizkessel- und Behälterbau Ges.m.b.H.			
Model		P4 Pellet 60			
Run		**1**	**2**	**3**	**4**
Test date		03.08.2020	04.08.2020	04.08.2020	05.08.2020
Burn rate	kg/hr dry	12.24	1.85	2.84	5.33
Average gas temperature	°F	240	149	159	175
Average tunnel temperature	°F	128	83	87	93
Average gas velocity in dilution tunnel	Ft/s	18.3	17.9	18.1	18.4
Average gas flow rate in dilution tunnel	dscf/min	177.0	187.5	189.1	191.6
Average delta p	inch H_2O	0.086	0.086	0.088	0.086
Average delta H	inch H_2O	0.070	0.070	0.072	0.070
Total time of test	min	240	240	240	240
Sample train 1					
Total sample volume	Ft^3	48.275	52.054	54.349	53.007
Average gas meter temperature	°F	75	75	77	75
Total sample volume (standard conditions)	dscf	45.642	49.208	51.367	50.641
Total particulates	mg	9.3	5.5	7.8	5.2
Particulate concentration (dry-standard)	g/dscf	0.000204	0.000112	0.000152	0.000103
Particulate emissions	g	8.62	5.01	6.87	4.70
Difference from average	g	0.34	0.20	0.41	0.28
Sample train 2					
Total sample volume	Ft^3	49.582	50.818	55.479	51.277
Average gas meter temperature	°F	76	76	78	75
Total sample volume (standard conditions)	dscf	47.473	48.547	53.088	49.598
Total particulates	mg	8.9	5.0	7.1	5.7
Particulate concentration (dry-standard)	g/dscf	0.000187	0.000103	0.000134	0.000115
Particulate emissions	g	7.93	4.61	6.05	5.27
Difference from average	g	0.34	0.20	0.41	0.28
Ambient sample train					
Total sample volume	Ft^3	50.959	49.546	50.535	50.853
Average gas meter temperature	°F	81	77	78	76
Total sample volume (standard conditions)	dscf	47.776	46.751	47.785	48.600
Total particulates	mg	0.0	0.0	0.0	0.0
Particulate concentration (dry-standard)	g/dscf	0.000000	0.000000	0.000000	0.000000

Average	Total sample volume	Ft^3	48.928	51.436	54.914	52.142
	Average gas meter temperature	°F	75	76	77	75
	Total sample volume (standard conditions)	dscf	46.558	48.878	52.227	50.119
	Total particulates	mg	9.1	5.2	7.5	5.5
	Particulate concentration (dry-standard)	g/dscf	0.000196	0.000107	0.000143	0.000109
	Particulate emissions	**g**	**8.28**	**4.81**	**6.46**	**4.98**
	Maximum difference from average	g	0.62	0.36	0.48	0.37

Additional acceptance criteria					
Boiler water return temperature > 120 °F	yes	yes	yes	yes	
Proportional rate variation > 80%	yes	yes	yes	yes	
90% of PR values between 90 - 100 %	yes	yes	yes	yes	

First hour (1)	Total sample volume	Ft^3	11.336	11.195	13.702	13.066
	Average gas meter temperature	°F	76	74	74	73
	Total sample volume (standard conditions)	dscf	10.704	10.580	12.991	12.510
	Total particulates	mg	1.9	0.8	1.1	0.8
	Particulate concentration	g/dscf	0.000178	0.000076	0.000085	0.000064
	Particulate emissions	g	1.88	0.85	0.96	0.73

After first hour phase (1)	Total sample volume	Ft^3	40.082	40.859	40.647	39.941
	Average gas meter temperature	°F	75	75	77	75
	Total sample volume (standard conditions)	dscf	37.906	38.553	38.376	38.131
	Total particulates	mg	6.8	4.1	6.3	4.4
	Particulate concentration	g/dscf	0.000179	0.000106	0.000164	0.000115
	Particulate emissions	g	5.69	3.57	5.57	3.96

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Emissions sampling data (ASTM E2515-11)

Run	**1**	
Manufacturer	Fröling Heizkessel	
Project No.	32-10198	
Model	**P4 Pellet 60**	
Test date	03.08.2020	
Technician	Foit	
Test time	11:43 – 15:43	
Total sampling time [min]	240	
Barometric pressure	"Hg	28.92
Molecular weight (wet)	lb/lbmol	29.00
DIlution tunnel moisture	%	2.00
Dilution tunnel static pressure	"H_2O	-0.183
Pitot tube Cp	-	0.99
Tunnel velocity	ft/s	18.19
Average tunnel flow	dscf/min	176.4
Tunnel area	ft^2	0.190

Velocity traverse data									
	X1	X2	X3	X4	Y1	Y2	Y3	Y4	Center
Initial dP "H2O	0.067	0.082	0.082	0.067	0.067	0.082	0.082	0.070	0.086
Initial temp. °F	128	128	128	128	128	128	128	128	128

Air velocity initial	ft/min	13.8
Air velocity final	ft/min	11.8
% smoke capture	%	100
Induced draft	Pa	0
V_{strav}	ft/s	19.54
V_{scent}	ft/s	20.98
F_p	-	0.93
Meter factor Y(1)		0.992
Meter factor Y(2)		1.006
Meter factor Y(amb)		0.995

Total particulate (1) (first hour)	mg	**1.9**
Total particulate (1) (Post first hour)	mg	**6.8**
Total particulate (1)	mg	**9.3**
Total particulate (2)	mg	**8.9**

El. time	Particulate sampling data																		
	Gas meter cubic feet			Sample rate cfm			Orifice dH			Temperature gas meter °F			Temperature filter °F			Ambient	Dil. tunnel temp.	Dil. tunnel dP	PR 1	PR 2
	Train 1	Train 2	Amb.	Train 1	Train 2	Amb	Train 1	Train 2	Amb	Train 1	Train 2	Amb	Train 1	Train 2	Amb	°F	°F	" H2O		
0	0.000	0.000	0.000				0.03	0.04	0.04	75	75	82	79	77	82	82	125	0.086		
1	0.201	0.207	0.212	0.201	0.207	0.212	0.06	0.06	0.07	75	75	82	80	77	82	82	125	0.086	100	100
2	0.402	0.413	0.425	0.201	0.207	0.212	0.10	0.08	0.10	75	75	82	84	79	82	82	126	0.086	100	100
3	0.603	0.620	0.637	0.201	0.207	0.212	0.09	0.08	0.10	75	75	82	85	80	81	81	126	0.086	100	100
4	0.805	0.826	0.849	0.201	0.207	0.212	0.08	0.08	0.10	75	75	82	85	81	81	81	126	0.086	100	100
5	1.006	1.033	1.062	0.201	0.207	0.212	0.09	0.08	0.10	75	75	82	86	81	81	81	126	0.086	100	100
6	1.207	1.240	1.274	0.201	0.207	0.212	0.09	0.08	0.10	75	75	81	87	82	81	81	126	0.086	100	100
7	1.408	1.446	1.486	0.201	0.207	0.212	0.09	0.08	0.10	75	75	81	88	83	81	81	126	0.086	100	100

8	1.609	1.653	1.699	0.201	0.207	0.212	0.09	0.08	0.10	75	75	81	88	83	81	81	126	0.086	100	100
9	1.810	1.859	1.911	0.201	0.207	0.212	0.09	0.08	0.10	75	75	81	89	83	81	81	126	0.086	100	100
10	2.011	2.066	2.123	0.201	0.207	0.212	0.07	0.07	0.10	75	75	81	89	84	81	81	126	0.086	100	100
11	2.213	2.272	2.336	0.201	0.207	0.212	0.09	0.08	0.10	75	75	81	89	84	81	81	126	0.086	100	100
12	2.414	2.479	2.548	0.201	0.207	0.212	0.09	0.08	0.10	75	75	81	90	84	81	81	126	0.086	100	100
13	2.615	2.686	2.760	0.201	0.207	0.212	0.09	0.08	0.10	75	75	81	90	84	81	81	125	0.086	99	99
14	2.816	2.892	2.973	0.201	0.207	0.212	0.08	0.07	0.10	75	75	81	90	85	81	81	126	0.086	100	100
15	3.017	3.099	3.185	0.201	0.207	0.212	0.08	0.08	0.10	75	75	81	90	85	81	81	126	0.086	100	100
16	3.218	3.305	3.397	0.201	0.207	0.212	0.07	0.08	0.10	75	75	81	90	85	81	81	125	0.086	100	100
17	3.419	3.512	3.610	0.201	0.207	0.212	0.06	0.07	0.10	75	75	82	90	85	81	81	125	0.086	100	99
18	3.621	3.719	3.822	0.201	0.207	0.212	0.07	0.07	0.10	75	75	82	90	85	82	82	126	0.086	100	100
19	3.822	3.925	4.034	0.201	0.207	0.212	0.07	0.08	0.10	75	75	82	90	85	82	82	125	0.086	100	100
20	4.023	4.132	4.247	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	86	82	82	126	0.086	100	100
21	4.224	4.338	4.459	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	86	82	82	126	0.086	100	100
22	4.425	4.545	4.671	0.201	0.207	0.212	0.07	0.07	0.10	76	76	82	90	86	82	82	126	0.086	100	100
23	4.626	4.752	4.884	0.201	0.207	0.212	0.06	0.08	0.10	76	76	82	90	86	82	82	126	0.086	100	100
24	4.828	4.958	5.096	0.201	0.207	0.212	0.05	0.07	0.10	76	76	82	90	86	82	82	127	0.086	100	100
25	5.029	5.165	5.308	0.201	0.207	0.212	0.07	0.07	0.10	76	76	82	90	86	81	81	126	0.086	100	100
26	5.230	5.371	5.521	0.201	0.207	0.212	0.07	0.07	0.10	76	76	82	90	86	82	82	126	0.086	100	100
27	5.431	5.578	5.733	0.201	0.207	0.212	0.07	0.07	0.10	76	76	82	89	86	82	82	126	0.086	100	100
28	5.632	5.785	5.945	0.201	0.207	0.212	0.07	0.08	0.10	76	76	82	90	86	82	82	126	0.086	100	100
29	5.833	5.991	6.158	0.201	0.207	0.212	0.08	0.07	0.10	76	76	82	90	86	82	82	126	0.086	100	100
30	6.034	6.198	6.370	0.201	0.207	0.212	0.07	0.08	0.10	76	76	82	90	86	82	82	126	0.086	100	100
31	6.236	6.404	6.582	0.201	0.207	0.212	0.07	0.07	0.10	76	76	82	89	86	82	82	126	0.086	100	99
32	6.437	6.611	6.795	0.201	0.207	0.212	0.07	0.07	0.10	76	76	82	90	86	82	82	126	0.086	100	99
33	6.638	6.817	7.007	0.201	0.207	0.212	0.07	0.08	0.10	76	76	82	90	86	82	82	127	0.086	100	100
34	6.839	7.024	7.219	0.201	0.207	0.212	0.07	0.07	0.10	76	77	82	90	86	81	81	127	0.086	100	100
35	7.040	7.231	7.432	0.201	0.207	0.212	0.06	0.07	0.10	76	77	82	90	86	81	81	126	0.086	100	99
36	7.241	7.437	7.644	0.201	0.207	0.212	0.07	0.07	0.10	76	77	82	89	86	81	81	126	0.086	100	99
37	7.442	7.644	7.856	0.201	0.207	0.212	0.07	0.07	0.10	76	77	82	89	85	81	81	126	0.086	100	99
38	7.644	7.850	8.069	0.201	0.207	0.212	0.07	0.07	0.10	76	77	82	90	85	82	82	126	0.086	99	99
39	7.845	8.057	8.281	0.201	0.207	0.212	0.06	0.07	0.10	76	77	82	90	85	82	82	125	0.086	99	99
40	8.046	8.264	8.493	0.201	0.207	0.212	0.07	0.08	0.10	76	77	82	90	85	82	82	126	0.086	100	99
41	8.247	8.470	8.706	0.201	0.207	0.212	0.07	0.07	0.10	76	77	82	89	85	82	82	126	0.086	100	99
42	8.448	8.677	8.918	0.201	0.207	0.212	0.06	0.07	0.10	76	77	82	89	85	82	82	126	0.086	99	99
43	8.649	8.883	9.130	0.201	0.207	0.212	0.07	0.08	0.10	76	77	82	89	85	82	82	126	0.086	100	99
44	8.850	9.090	9.342	0.201	0.207	0.212	0.06	0.07	0.10	76	77	82	89	85	82	82	126	0.086	100	99

45	9.052	9.297	9.555	0.201	0.207	0.212	0.07	0.07	0.10	77	77	82	89	84	82	82	126	0.086	99	99
46	9.253	9.503	9.767	0.201	0.207	0.212	0.07	0.07	0.10	76	77	82	89	84	81	81	127	0.086	100	99
47	9.454	9.710	9.979	0.201	0.207	0.212	0.06	0.07	0.10	76	77	82	89	84	81	81	127	0.086	100	99
48	9.655	9.916	10.192	0.201	0.207	0.212	0.07	0.07	0.10	76	77	82	89	84	81	81	127	0.086	100	100
49	9.856	10.123	10.404	0.201	0.207	0.212	0.06	0.07	0.10	76	77	81	89	84	81	81	127	0.086	100	100
50	10.057	10.330	10.616	0.201	0.207	0.212	0.07	0.07	0.10	76	77	81	89	84	81	81	127	0.086	100	100
51	10.258	10.536	10.829	0.201	0.207	0.212	0.07	0.07	0.10	76	77	81	89	84	81	81	128	0.086	100	100
52	10.460	10.743	11.041	0.201	0.207	0.212	0.07	0.07	0.10	76	77	81	89	84	81	81	127	0.086	100	99
53	10.661	10.949	11.253	0.201	0.207	0.212	0.06	0.07	0.09	76	77	81	89	84	81	81	127	0.086	100	100
54	10.862	11.156	11.466	0.201	0.207	0.212	0.06	0.08	0.09	76	77	81	89	84	81	81	127	0.086	100	99
55	11.063	11.362	11.678	0.201	0.207	0.212	0.07	0.07	0.10	76	77	81	89	84	81	81	128	0.086	100	100
56	11.264	11.569	11.890	0.201	0.207	0.212	0.07	0.08	0.10	76	77	81	90	84	81	81	128	0.086	100	100
57	11.465	11.776	12.103	0.201	0.207	0.212	0.06	0.08	0.10	76	77	81	90	84	81	81	128	0.086	100	100
58	11.666	11.982	12.315	0.201	0.207	0.212	0.07	0.08	0.10	76	77	81	90	84	81	81	127	0.086	100	100
59	11.868	12.189	12.527	0.201	0.207	0.212	0.07	0.08	0.10	76	77	81	90	84	81	81	128	0.086	100	100
60	12.069	12.395	12.740	0.201	0.207	0.212	0.08	0.08	0.10	76	77	81	90	84	81	81	128	0.086	100	100
61	12.270	12.602	12.952	0.201	0.207	0.212	0.05	0.07	0.10	76	77	81	88	84	81	81	128	0.086	100	100
62	12.471	12.809	13.164	0.201	0.207	0.212	0.03	0.07	0.10	76	77	81	88	84	81	81	128	0.086	100	100
63	12.672	13.015	13.377	0.201	0.207	0.212	0.07	0.08	0.10	75	77	81	87	84	81	81	127	0.086	100	100
64	12.873	13.222	13.589	0.201	0.207	0.212	0.07	0.08	0.10	75	77	81	88	84	80	80	128	0.086	100	100
65	13.075	13.428	13.801	0.201	0.207	0.212	0.07	0.07	0.10	75	77	81	89	84	81	81	128	0.086	100	100
66	13.276	13.635	14.014	0.201	0.207	0.212	0.07	0.07	0.10	75	76	81	89	83	81	81	128	0.086	100	100
67	13.477	13.842	14.226	0.201	0.207	0.212	0.07	0.08	0.10	75	76	81	89	83	81	81	128	0.086	100	100
68	13.678	14.048	14.438	0.201	0.207	0.212	0.08	0.07	0.10	75	76	81	89	83	81	81	128	0.086	100	100
69	13.879	14.255	14.651	0.201	0.207	0.212	0.07	0.07	0.10	75	76	81	89	83	81	81	128	0.086	100	100
70	14.080	14.461	14.863	0.201	0.207	0.212	0.07	0.08	0.10	75	76	81	89	83	81	81	129	0.086	100	100
71	14.281	14.668	15.075	0.201	0.207	0.212	0.07	0.07	0.10	75	76	81	89	83	81	81	129	0.086	100	100
72	14.483	14.875	15.288	0.201	0.207	0.212	0.07	0.08	0.10	75	76	81	89	83	81	81	128	0.086	100	100
73	14.684	15.081	15.500	0.201	0.207	0.212	0.06	0.08	0.10	75	76	81	89	83	81	81	128	0.086	100	100
74	14.885	15.288	15.712	0.201	0.207	0.212	0.06	0.07	0.10	75	76	81	89	83	81	81	128	0.086	100	100
75	15.086	15.494	15.925	0.201	0.207	0.212	0.07	0.08	0.10	75	76	81	89	83	81	81	129	0.086	100	100
76	15.287	15.701	16.137	0.201	0.207	0.212	0.06	0.07	0.10	75	76	81	89	83	81	81	127	0.086	100	100
77	15.488	15.907	16.349	0.201	0.207	0.212	0.06	0.07	0.10	75	76	81	89	83	80	80	127	0.086	100	100
78	15.689	16.114	16.562	0.201	0.207	0.212	0.08	0.08	0.10	75	76	81	89	83	80	80	127	0.086	100	100
79	15.891	16.321	16.774	0.201	0.207	0.212	0.07	0.07	0.10	75	76	81	89	83	80	80	128	0.086	100	100
80	16.092	16.527	16.986	0.201	0.207	0.212	0.07	0.07	0.10	75	76	80	89	83	80	80	128	0.086	100	100
81	16.293	16.734	17.199	0.201	0.207	0.212	0.08	0.07	0.10	75	76	80	89	83	80	80	128	0.086	100	100

82	16.494	16.940	17.411	0.201	0.207	0.212	0.07	0.07	0.10	75	76	80	89	83	80	80	128	0.086	100	100
83	16.695	17.147	17.623	0.201	0.207	0.212	0.07	0.08	0.09	75	76	80	89	82	80	80	128	0.086	100	100
84	16.896	17.354	17.836	0.201	0.207	0.212	0.07	0.08	0.10	75	76	80	89	82	80	80	128	0.086	100	100
85	17.097	17.560	18.048	0.201	0.207	0.212	0.07	0.07	0.10	74	76	80	89	82	80	80	128	0.086	100	100
86	17.299	17.767	18.260	0.201	0.207	0.212	0.06	0.07	0.09	74	76	80	89	81	80	80	128	0.086	100	100
87	17.500	17.973	18.473	0.201	0.207	0.212	0.07	0.07	0.09	74	76	80	89	81	80	80	128	0.086	100	100
88	17.701	18.180	18.685	0.201	0.207	0.212	0.07	0.07	0.10	74	76	80	89	81	80	80	128	0.086	100	100
89	17.902	18.387	18.897	0.201	0.207	0.212	0.07	0.07	0.10	74	76	80	89	81	80	80	128	0.086	100	100
90	18.103	18.593	19.110	0.201	0.207	0.212	0.07	0.08	0.10	74	76	80	89	81	80	80	128	0.086	100	100
91	18.304	18.800	19.322	0.201	0.207	0.212	0.06	0.08	0.10	74	76	81	89	81	80	80	128	0.086	100	100
92	18.505	19.006	19.534	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	81	80	80	128	0.086	100	100
93	18.707	19.213	19.747	0.201	0.207	0.212	0.07	0.08	0.10	74	75	80	89	80	80	80	128	0.086	100	100
94	18.908	19.420	19.959	0.201	0.207	0.212	0.07	0.07	0.09	74	75	81	89	80	80	80	128	0.086	100	100
95	19.109	19.626	20.171	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	80	80	80	128	0.086	100	100
96	19.310	19.833	20.384	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	80	80	80	128	0.086	100	100
97	19.511	20.039	20.596	0.201	0.207	0.212	0.06	0.08	0.10	74	75	81	89	80	80	80	129	0.086	100	100
98	19.712	20.246	20.808	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	80	80	80	129	0.086	100	100
99	19.914	20.452	21.021	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	80	80	80	128	0.086	100	100
100	20.115	20.659	21.233	0.201	0.207	0.212	0.07	0.08	0.10	74	75	81	89	80	80	80	128	0.086	100	100
101	20.316	20.866	21.445	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	79	80	80	128	0.086	100	100
102	20.517	21.072	21.658	0.201	0.207	0.212	0.06	0.08	0.10	74	75	80	89	79	80	80	128	0.086	100	100
103	20.718	21.279	21.870	0.201	0.207	0.212	0.07	0.08	0.10	74	75	81	89	79	80	80	128	0.086	100	100
104	20.919	21.485	22.082	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	79	80	80	128	0.086	100	100
105	21.120	21.692	22.295	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	90	79	80	80	128	0.086	100	100
106	21.322	21.899	22.507	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	79	80	80	128	0.086	100	100
107	21.523	22.105	22.719	0.201	0.207	0.212	0.06	0.08	0.10	74	75	81	89	79	80	80	128	0.086	100	100
108	21.724	22.312	22.932	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	79	81	81	129	0.086	100	100
109	21.925	22.518	23.144	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	79	81	81	128	0.086	100	100
110	22.126	22.725	23.356	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	79	80	80	128	0.086	100	100
111	22.327	22.932	23.569	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	79	81	81	129	0.086	100	100
112	22.528	23.138	23.781	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	79	81	81	129	0.086	100	100
113	22.730	23.345	23.993	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	78	81	81	128	0.086	100	100
114	22.931	23.551	24.206	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	78	81	81	129	0.086	100	100
115	23.132	23.758	24.418	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	78	81	81	128	0.086	100	100
116	23.333	23.965	24.630	0.201	0.207	0.212	0.07	0.08	0.10	74	75	81	89	78	81	81	128	0.086	100	100
117	23.534	24.171	24.843	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	78	81	81	128	0.086	100	100
118	23.735	24.378	25.055	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100

119	23.936	24.584	25.267	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	78	81	81	128	0.086	100	100
120	24.138	24.791	25.480	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	78	81	81	128	0.086	100	100
121	24.339	24.997	25.692	0.201	0.207	0.212	0.08	0.07	0.10	74	75	81	89	78	81	81	128	0.086	100	100
122	24.540	25.204	25.904	0.201	0.207	0.212	0.08	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100
123	24.741	25.411	26.117	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100
124	24.942	25.617	26.329	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100
125	25.143	25.824	26.541	0.201	0.207	0.212	0.07	0.08	0.10	74	75	81	89	78	80	80	128	0.086	100	100
126	25.344	26.030	26.754	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100
127	25.546	26.237	26.966	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100
128	25.747	26.444	27.178	0.201	0.207	0.212	0.05	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100
129	25.948	26.650	27.390	0.201	0.207	0.212	0.06	0.08	0.10	74	75	81	89	78	80	80	129	0.086	100	100
130	26.149	26.857	27.603	0.201	0.207	0.212	0.08	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100
131	26.350	27.063	27.815	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	78	80	80	128	0.086	100	100
132	26.551	27.270	28.027	0.201	0.207	0.212	0.08	0.07	0.10	74	75	81	89	78	80	80	129	0.086	100	100
133	26.752	27.477	28.240	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	89	77	80	80	129	0.086	100	100
134	26.954	27.683	28.452	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	89	77	80	80	129	0.086	100	100
135	27.155	27.890	28.664	0.201	0.207	0.212	0.07	0.08	0.10	74	75	81	89	77	80	80	129	0.086	100	100
136	27.356	28.096	28.877	0.201	0.207	0.212	0.06	0.08	0.10	74	75	81	89	77	80	80	128	0.086	100	100
137	27.557	28.303	29.089	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	89	77	80	80	129	0.086	100	100
138	27.758	28.510	29.301	0.201	0.207	0.212	0.05	0.07	0.10	74	75	80	89	77	80	80	129	0.086	100	100
139	27.959	28.716	29.514	0.201	0.207	0.212	0.07	0.08	0.10	74	75	80	89	77	80	80	128	0.086	100	100
140	28.161	28.923	29.726	0.201	0.207	0.212	0.06	0.07	0.10	74	75	80	89	77	80	80	128	0.086	100	100
141	28.362	29.129	29.938	0.201	0.207	0.212	0.07	0.08	0.10	74	75	80	89	77	80	80	128	0.086	100	100
142	28.563	29.336	30.151	0.201	0.207	0.212	0.06	0.07	0.10	74	75	80	89	77	80	80	128	0.086	100	100
143	28.764	29.542	30.363	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	89	77	80	80	128	0.086	100	100
144	28.965	29.749	30.575	0.201	0.207	0.212	0.06	0.07	0.10	74	75	80	89	77	80	80	128	0.086	100	100
145	29.166	29.956	30.788	0.201	0.207	0.212	0.06	0.08	0.10	74	75	80	89	77	80	80	128	0.086	100	100
146	29.367	30.162	31.000	0.201	0.207	0.212	0.06	0.07	0.10	74	75	80	89	77	80	80	128	0.086	100	100
147	29.569	30.369	31.212	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	89	77	80	80	128	0.086	100	100
148	29.770	30.575	31.425	0.201	0.207	0.212	0.06	0.07	0.10	74	75	80	89	77	80	80	128	0.086	100	100
149	29.971	30.782	31.637	0.201	0.207	0.212	0.06	0.07	0.10	74	75	80	89	77	80	80	129	0.086	100	100
150	30.172	30.989	31.849	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	88	77	80	80	128	0.086	100	100
151	30.373	31.195	32.062	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	88	77	80	80	128	0.086	100	100
152	30.574	31.402	32.274	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	88	77	80	80	129	0.086	100	100
153	30.775	31.608	32.486	0.201	0.207	0.212	0.07	0.07	0.09	74	75	80	88	77	80	80	129	0.086	100	100
154	30.977	31.815	32.699	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	88	77	80	80	128	0.086	100	100
155	31.178	32.022	32.911	0.201	0.207	0.212	0.06	0.07	0.10	74	75	80	88	77	80	80	128	0.086	100	100

156	31.379	32.228	33.123	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	88	77	80	80	128	0.086	100	100
157	31.580	32.435	33.336	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	88	77	80	80	129	0.086	100	100
158	31.781	32.641	33.548	0.201	0.207	0.212	0.06	0.08	0.10	74	75	80	88	77	80	80	129	0.086	100	100
159	31.982	32.848	33.760	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	88	77	80	80	129	0.086	100	100
160	32.183	33.055	33.973	0.201	0.207	0.212	0.07	0.07	0.10	74	75	80	88	77	80	80	128	0.086	100	100
161	32.385	33.261	34.185	0.201	0.207	0.212	0.06	0.08	0.10	74	75	80	88	77	80	80	129	0.086	100	100
162	32.586	33.468	34.397	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	80	80	128	0.086	100	100
163	32.787	33.674	34.610	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	80	80	129	0.086	100	100
164	32.988	33.881	34.822	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	80	80	129	0.086	100	100
165	33.189	34.087	35.034	0.201	0.207	0.212	0.07	0.08	0.10	74	75	81	88	77	80	80	128	0.086	100	100
166	33.390	34.294	35.247	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	81	81	129	0.086	100	100
167	33.591	34.501	35.459	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	80	80	129	0.086	100	100
168	33.793	34.707	35.671	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	80	80	130	0.086	101	100
169	33.994	34.914	35.884	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	81	81	130	0.086	101	100
170	34.195	35.120	36.096	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	81	81	130	0.086	101	100
171	34.396	35.327	36.308	0.201	0.207	0.212	0.06	0.08	0.10	74	75	81	88	77	81	81	130	0.086	101	100
172	34.597	35.534	36.521	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	81	81	130	0.086	101	100
173	34.798	35.740	36.733	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	81	81	129	0.086	101	100
174	34.999	35.947	36.945	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	81	81	130	0.086	101	100
175	35.201	36.153	37.158	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	81	81	130	0.086	101	100
176	35.402	36.360	37.370	0.201	0.207	0.212	0.06	0.08	0.10	74	75	81	88	77	81	81	130	0.086	101	100
177	35.603	36.567	37.582	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	81	81	130	0.086	101	100
178	35.804	36.773	37.795	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	81	81	130	0.086	101	100
179	36.005	36.980	38.007	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	81	81	131	0.086	101	100
180	36.206	37.186	38.219	0.201	0.207	0.212	0.07	0.07	0.10	74	75	81	88	77	81	81	131	0.086	101	100
181	36.408	37.393	38.432	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	81	81	130	0.086	101	100
182	36.609	37.600	38.644	0.201	0.207	0.212	0.06	0.07	0.10	74	75	81	88	77	81	81	130	0.086	100	100
183	36.810	37.806	38.856	0.201	0.207	0.212	0.07	0.07	0.10	75	76	81	88	77	81	81	129	0.086	100	100
184	37.011	38.013	39.069	0.201	0.207	0.212	0.06	0.07	0.10	75	76	81	89	77	81	81	129	0.086	100	100
185	37.212	38.219	39.281	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	89	77	81	81	130	0.086	100	100
186	37.413	38.426	39.493	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	89	77	81	81	130	0.086	101	100
187	37.614	38.632	39.706	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	89	77	81	81	131	0.086	101	100
188	37.816	38.839	39.918	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	89	77	81	81	131	0.086	101	100
189	38.017	39.046	40.130	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	89	77	81	81	131	0.086	101	100
190	38.218	39.252	40.343	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	89	77	81	81	130	0.086	100	100
191	38.419	39.459	40.555	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	89	77	81	81	130	0.086	100	100
192	38.620	39.665	40.767	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	89	77	81	81	130	0.086	100	100

193	38.821	39.872	40.980	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	89	77	81	81	130	0.086	100	100
194	39.022	40.079	41.192	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
195	39.224	40.285	41.404	0.201	0.207	0.212	0.07	0.08	0.10	75	76	82	89	77	81	81	131	0.086	101	100
196	39.425	40.492	41.617	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	89	77	81	81	131	0.086	101	100
197	39.626	40.698	41.829	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	81	81	131	0.086	101	100
198	39.827	40.905	42.041	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	131	0.086	101	100
199	40.028	41.112	42.254	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	82	82	131	0.086	101	100
200	40.229	41.318	42.466	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	82	82	131	0.086	101	100
201	40.430	41.525	42.678	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	82	82	130	0.086	100	100
202	40.632	41.731	42.891	0.201	0.207	0.212	0.06	0.08	0.10	75	76	82	90	77	81	81	130	0.086	100	100
203	40.833	41.938	43.103	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
204	41.034	42.145	43.315	0.201	0.207	0.212	0.06	0.07	0.09	75	76	82	90	77	81	81	130	0.086	100	100
205	41.235	42.351	43.528	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
206	41.436	42.558	43.740	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	82	82	130	0.086	100	100
207	41.637	42.764	43.952	0.201	0.207	0.212	0.06	0.08	0.10	75	76	82	90	77	82	82	130	0.086	100	100
208	41.838	42.971	44.165	0.201	0.207	0.212	0.08	0.07	0.10	75	76	82	90	77	82	82	130	0.086	100	100
209	42.040	43.177	44.377	0.201	0.207	0.212	0.06	0.08	0.10	75	76	82	90	77	82	82	130	0.086	100	100
210	42.241	43.384	44.589	0.201	0.207	0.212	0.07	0.08	0.10	75	76	82	90	77	82	82	130	0.086	100	100
211	42.442	43.591	44.802	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	82	82	130	0.086	100	100
212	42.643	43.797	45.014	0.201	0.207	0.212	0.07	0.08	0.10	75	76	82	90	77	82	82	130	0.086	100	100
213	42.844	44.004	45.226	0.201	0.207	0.212	0.06	0.08	0.10	75	76	82	90	77	81	81	129	0.086	100	100
214	43.045	44.210	45.439	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
215	43.246	44.417	45.651	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	82	82	130	0.086	100	100
216	43.448	44.624	45.863	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	129	0.086	100	100
217	43.649	44.830	46.075	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	82	82	130	0.086	100	100
218	43.850	45.037	46.288	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
219	44.051	45.243	46.500	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
220	44.252	45.450	46.712	0.201	0.207	0.212	0.07	0.08	0.10	75	76	82	90	77	81	81	130	0.086	100	100
221	44.453	45.657	46.925	0.201	0.207	0.212	0.07	0.07	0.09	75	76	82	90	77	81	81	129	0.086	100	100
222	44.655	45.863	47.137	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
223	44.856	46.070	47.349	0.201	0.207	0.212	0.08	0.08	0.10	75	76	82	90	77	81	81	130	0.086	100	100
224	45.057	46.276	47.562	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	82	82	130	0.086	100	100
225	45.258	46.483	47.774	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
226	45.459	46.690	47.986	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	129	0.086	100	100
227	45.660	46.896	48.199	0.201	0.207	0.212	0.08	0.07	0.10	75	76	82	90	77	81	81	129	0.086	100	100
228	45.861	47.103	48.411	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	81	81	129	0.086	100	100
229	46.063	47.309	48.623	0.201	0.207	0.212	0.07	0.08	0.10	75	76	82	90	77	81	81	130	0.086	100	100

230	46.264	47.516	48.836	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
231	46.465	47.722	49.048	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
232	46.666	47.929	49.260	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	130	0.086	100	100
233	46.867	48.136	49.473	0.201	0.207	0.212	0.07	0.07	0.10	75	76	81	90	77	81	81	130	0.086	100	100
234	47.068	48.342	49.685	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	129	0.086	100	100
235	47.269	48.549	49.897	0.201	0.207	0.212	0.06	0.07	0.10	75	76	82	90	77	81	81	129	0.086	100	100
236	47.471	48.755	50.110	0.201	0.207	0.212	0.07	0.08	0.10	75	76	82	90	77	81	81	127	0.086	100	100
237	47.672	48.962	50.322	0.201	0.207	0.212	0.07	0.07	0.10	75	76	82	90	77	81	81	125	0.086	99	99
238	47.873	49.169	50.534	0.201	0.207	0.212	0.07	0.08	0.10	75	76	82	90	77	81	81	130	0.086	100	100
239	48.074	49.375	50.747	0.201	0.207	0.212	0.07	0.08	0.10	76	76	82	90	77	81	81	130	0.086	100	100
240	48.275	49.582	50.959	0.201	0.207	0.212	0.06	0.07	0.10	76	76	82	90	77	81	81	130	0.086	100	100
	48.275	**49.582**	**50.959**				**0.07**	**0.07**	**0.10**	**75**	**76**	**81**	**89**	**80**	**81**	**81**	**128**	**0.086**		

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

Emissions sampling data (ASTM E2515-11)

Run	**2**	
Manufacturer	Fröling Heizkessel	
Project No.	32-10198	
Model	**P4 Pellet 60**	
Test date	04.08.2020	
Technician	Foit	
Test time	8:32 – 12:32	
Total sampling time [min]	240	
Barometric pressure	"Hg	28.88
Molecular weight (wet)	lb/lbmol	29.00
DIlution tunnel moisture	%	2.00
Dilution tunnel static pressure	"H_2O	-0.186
Pitot tube Cp	-	0.99
Tunnel velocity	ft/s	17.79
Average tunnel flow	dscf/min	186.7
Tunnel area	ft^2	0.190

Velocity traverse data									
	X1	X2	X3	X4	Y1	Y2	Y3	Y4	Center
Initial dP "H2O	0.070	0.082	0.086	0.070	0.074	0.076	0.084	0.070	0.086
Initial temp. °F	83	83	83	83	83	83	83	83	83

Air velocity initial	ft/min	3.9
Air velocity final	ft/min	3.9
% smoke capture	%	100
Induced draft	Pa	0
V_{strav}	ft/s	19.68
V_{scent}	ft/s	20.98
F_p	-	0.94
Meter factor Y(1)		0.992
Meter factor Y(2)		1.006
Meter factor Y(amb)		0.995

Total particulate (1) (first hour)	mg	**0.8**
Total particulate (1) (Post first hour)	mg	**4.1**
Total particulate (1)	mg	**5.5**
Total particulate (2)	mg	**5.0**

El. time	Particulate sampling data																		
	Gas meter cubic feet			Sample rate cfm			Orifice dH			Temperature gas meter °F			Temperature filter °F			Ambient temperature	Dil. tunnel temp.	Dil. tunnel dP	PR 1	PR 2
	Train 1	Train 2	Amb.	Train 1	Train 2	Amb.	Train 1	Train 2	Amb.	Train 1	Train 2	Amb.	Train 1	Train 2	Amb.	°F	°F	" H2O		
0	0.000	0.000	0.000				0.00	0.00	0.01	73	74	74	74	74	80	80	82	0.086		
1	0.217	0.212	0.206	0.217	0.212	0.206	0.02	0.03	0.04	73	74	74	73	73	80	80	82	0.086	100	100
2	0.434	0.423	0.413	0.217	0.212	0.206	0.06	0.08	0.10	73	74	74	73	74	80	80	82	0.086	100	100
3	0.651	0.635	0.619	0.217	0.212	0.206	0.07	0.08	0.11	73	74	75	73	74	80	80	82	0.086	100	100
4	0.868	0.847	0.826	0.217	0.212	0.206	0.07	0.08	0.10	73	74	75	73	74	80	80	82	0.086	100	100
5	1.084	1.059	1.032	0.217	0.212	0.206	0.07	0.07	0.10	73	74	75	74	74	80	80	82	0.086	100	100
6	1.301	1.270	1.239	0.217	0.212	0.206	0.06	0.08	0.10	73	74	75	74	74	80	80	82	0.086	100	100

7	1.518	1.482	1.445	0.217	0.212	0.206	0.07	0.08	0.10	73	74	75	74	74	80	80	82	0.086	100	100
8	1.735	1.694	1.652	0.217	0.212	0.206	0.06	0.08	0.10	73	74	75	74	74	80	80	82	0.086	100	100
9	1.952	1.906	1.858	0.217	0.212	0.206	0.07	0.08	0.10	73	74	75	74	74	80	80	82	0.086	100	100
10	2.169	2.117	2.064	0.217	0.212	0.206	0.06	0.07	0.10	74	74	75	74	74	80	80	82	0.086	100	100
11	2.386	2.329	2.271	0.217	0.212	0.206	0.07	0.08	0.09	74	74	75	74	74	80	80	82	0.086	100	100
12	2.603	2.541	2.477	0.217	0.212	0.206	0.07	0.08	0.10	74	74	75	74	74	80	80	82	0.086	100	100
13	2.820	2.753	2.684	0.217	0.212	0.206	0.06	0.08	0.10	74	74	75	74	74	80	80	82	0.086	100	100
14	3.036	2.964	2.890	0.217	0.212	0.206	0.07	0.07	0.10	74	74	75	74	74	80	80	82	0.086	100	100
15	3.253	3.176	3.097	0.217	0.212	0.206	0.07	0.08	0.10	74	74	75	74	74	80	80	82	0.086	100	100
16	3.470	3.388	3.303	0.217	0.212	0.206	0.07	0.07	0.10	74	74	75	74	74	80	80	82	0.086	100	100
17	3.687	3.600	3.510	0.217	0.212	0.206	0.06	0.08	0.10	74	74	75	74	74	80	80	82	0.086	100	100
18	3.904	3.811	3.716	0.217	0.212	0.206	0.07	0.08	0.10	74	74	75	74	74	80	80	82	0.086	100	100
19	4.121	4.023	3.922	0.217	0.212	0.206	0.06	0.08	0.10	74	74	75	74	74	81	81	82	0.086	100	100
20	4.338	4.235	4.129	0.217	0.212	0.206	0.06	0.08	0.09	74	74	75	74	74	81	81	82	0.086	100	100
21	4.555	4.447	4.335	0.217	0.212	0.206	0.07	0.08	0.10	74	74	75	74	74	81	81	82	0.086	100	100
22	4.772	4.658	4.542	0.217	0.212	0.206	0.06	0.08	0.09	74	74	75	74	74	81	81	82	0.086	100	100
23	4.988	4.870	4.748	0.217	0.212	0.206	0.06	0.08	0.10	74	74	75	74	74	81	81	82	0.086	100	100
24	5.205	5.082	4.955	0.217	0.212	0.206	0.06	0.08	0.10	74	74	75	74	74	81	81	82	0.086	100	100
25	5.422	5.294	5.161	0.217	0.212	0.206	0.07	0.08	0.10	74	75	75	74	75	81	81	82	0.086	100	100
26	5.639	5.505	5.368	0.217	0.212	0.206	0.08	0.07	0.09	74	75	75	74	75	81	81	82	0.086	100	100
27	5.856	5.717	5.574	0.217	0.212	0.206	0.07	0.07	0.10	74	75	75	74	75	80	80	82	0.086	100	100
28	6.073	5.929	5.780	0.217	0.212	0.206	0.06	0.08	0.10	74	75	75	74	75	81	81	82	0.086	100	100
29	6.290	6.140	5.987	0.217	0.212	0.206	0.07	0.07	0.10	74	75	75	74	75	81	81	82	0.086	100	100
30	6.507	6.352	6.193	0.217	0.212	0.206	0.07	0.07	0.10	74	75	76	74	75	81	81	82	0.086	100	100
31	6.724	6.564	6.400	0.217	0.212	0.206	0.06	0.08	0.10	74	75	76	74	75	81	81	82	0.086	100	100
32	6.941	6.776	6.606	0.217	0.212	0.206	0.07	0.08	0.09	74	75	76	74	75	81	81	82	0.086	100	100
33	7.157	6.987	6.813	0.217	0.212	0.206	0.07	0.07	0.10	74	75	76	74	75	80	80	82	0.086	100	100
34	7.374	7.199	7.019	0.217	0.212	0.206	0.06	0.08	0.09	74	75	76	74	75	81	81	82	0.086	100	100
35	7.591	7.411	7.226	0.217	0.212	0.206	0.07	0.08	0.10	74	75	76	74	75	81	81	82	0.086	100	100

36	7.808	7.623	7.432	0.217	0.212	0.206	0.07	0.08	0.10	74	75	76	74	75	81	81	82	0.086	100	100
37	8.025	7.834	7.638	0.217	0.212	0.206	0.07	0.07	0.09	74	75	76	74	75	81	81	82	0.086	100	100
38	8.242	8.046	7.845	0.217	0.212	0.206	0.06	0.08	0.10	74	75	76	74	75	81	81	82	0.086	100	100
39	8.459	8.258	8.051	0.217	0.212	0.206	0.07	0.08	0.10	74	75	76	74	75	81	81	82	0.086	100	100
40	8.676	8.470	8.258	0.217	0.212	0.206	0.06	0.08	0.10	74	75	76	74	75	81	81	82	0.086	100	100
41	8.893	8.681	8.464	0.217	0.212	0.206	0.07	0.07	0.10	74	75	76	74	75	81	81	82	0.086	100	100
42	9.109	8.893	8.671	0.217	0.212	0.206	0.07	0.08	0.10	74	75	76	74	75	81	81	82	0.086	100	100
43	9.326	9.105	8.877	0.217	0.212	0.206	0.07	0.08	0.10	74	75	76	74	75	81	81	82	0.086	100	100
44	9.543	9.317	9.084	0.217	0.212	0.206	0.06	0.08	0.09	74	75	76	74	76	81	81	82	0.086	100	100
45	9.760	9.528	9.290	0.217	0.212	0.206	0.06	0.08	0.10	74	75	76	74	76	81	81	82	0.086	100	100
46	9.977	9.740	9.496	0.217	0.212	0.206	0.07	0.08	0.10	74	75	76	74	76	81	81	82	0.086	100	100
47	10.194	9.952	9.703	0.217	0.212	0.206	0.07	0.07	0.10	74	75	76	74	76	81	81	82	0.086	100	100
48	10.411	10.164	9.909	0.217	0.212	0.206	0.06	0.08	0.10	74	76	76	74	76	81	81	82	0.086	100	100
49	10.628	10.375	10.116	0.217	0.212	0.206	0.07	0.08	0.10	74	76	76	74	76	81	81	82	0.086	100	100
50	10.845	10.587	10.322	0.217	0.212	0.206	0.07	0.08	0.10	74	76	76	74	76	81	81	82	0.086	100	100
51	11.061	10.799	10.529	0.217	0.212	0.206	0.07	0.08	0.10	74	76	76	74	76	81	81	82	0.086	100	100
52	11.278	11.011	10.735	0.217	0.212	0.206	0.07	0.07	0.10	74	76	76	74	76	81	81	82	0.086	100	100
53	11.495	11.222	10.942	0.217	0.212	0.206	0.06	0.08	0.10	74	76	77	75	76	81	81	82	0.086	100	100
54	11.712	11.434	11.148	0.217	0.212	0.206	0.06	0.07	0.10	74	76	77	75	76	81	81	82	0.086	100	100
55	11.929	11.646	11.354	0.217	0.212	0.206	0.07	0.08	0.10	74	76	77	75	76	81	81	82	0.086	100	100
56	12.146	11.857	11.561	0.217	0.212	0.206	0.06	0.08	0.10	74	76	77	75	76	81	81	82	0.086	100	100
57	12.363	12.069	11.767	0.217	0.212	0.206	0.07	0.08	0.09	74	76	77	75	76	81	81	82	0.086	100	100
58	12.580	12.281	11.974	0.217	0.212	0.206	0.07	0.08	0.10	74	76	77	75	76	82	82	82	0.086	100	100
59	12.797	12.493	12.180	0.217	0.212	0.206	0.07	0.07	0.10	75	76	77	75	76	81	81	82	0.086	100	100
60	13.013	12.704	12.387	0.217	0.212	0.206	0.07	0.08	0.10	75	76	77	75	76	81	81	82	0.086	100	100
61	13.230	12.916	12.593	0.217	0.212	0.206	0.07	0.07	0.10	75	76	77	75	76	82	82	82	0.086	100	100
62	13.447	13.128	12.800	0.217	0.212	0.206	0.07	0.08	0.10	75	76	77	75	76	82	82	82	0.086	100	100
63	13.664	13.340	13.006	0.217	0.212	0.206	0.05	0.07	0.10	75	76	77	75	76	82	82	82	0.086	100	100
64	13.881	13.551	13.212	0.217	0.212	0.206	0.02	0.07	0.10	75	76	77	75	76	82	82	82	0.086	100	100

65	14.098	13.763	13.419	0.217	0.212	0.206	0.04	0.08	0.09	75	76	77	75	76	82	82	82	0.086	100	100
66	14.315	13.975	13.625	0.217	0.212	0.206	0.08	0.07	0.10	75	77	77	76	76	82	82	83	0.086	100	100
67	14.532	14.187	13.832	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	76	76	82	82	83	0.086	100	100
68	14.749	14.398	14.038	0.217	0.212	0.206	0.07	0.07	0.11	75	77	77	76	76	82	82	82	0.086	100	100
69	14.965	14.610	14.245	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	76	76	82	82	82	0.086	100	100
70	15.182	14.822	14.451	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	82	82	82	0.086	100	100
71	15.399	15.034	14.658	0.217	0.212	0.206	0.08	0.08	0.10	75	77	77	75	76	82	82	83	0.086	100	100
72	15.616	15.245	14.864	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	75	76	81	81	83	0.086	100	100
73	15.833	15.457	15.070	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	75	76	81	81	82	0.086	100	100
74	16.050	15.669	15.277	0.217	0.212	0.206	0.08	0.08	0.10	75	77	77	75	76	81	81	83	0.086	100	100
75	16.267	15.881	15.483	0.217	0.212	0.206	0.07	0.08	0.09	75	77	77	75	76	81	81	83	0.086	100	100
76	16.484	16.092	15.690	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	81	81	83	0.086	100	100
77	16.701	16.304	15.896	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	81	81	83	0.086	100	100
78	16.917	16.516	16.103	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
79	17.134	16.728	16.309	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	75	76	81	81	82	0.086	100	100
80	17.351	16.939	16.515	0.217	0.212	0.206	0.08	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
81	17.568	17.151	16.722	0.217	0.212	0.206	0.08	0.08	0.09	75	77	77	75	76	81	81	82	0.086	100	100
82	17.785	17.363	16.928	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	75	76	81	81	82	0.086	100	100
83	18.002	17.574	17.135	0.217	0.212	0.206	0.07	0.08	0.09	75	77	77	75	76	81	81	82	0.086	100	100
84	18.219	17.786	17.341	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	75	76	81	81	82	0.086	100	100
85	18.436	17.998	17.548	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	75	76	81	81	82	0.086	100	100
86	18.653	18.210	17.754	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
87	18.870	18.421	17.961	0.217	0.212	0.206	0.05	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
88	19.086	18.633	18.167	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
89	19.303	18.845	18.373	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
90	19.520	19.057	18.580	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
91	19.737	19.268	18.786	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
92	19.954	19.480	18.993	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	75	76	81	81	82	0.086	100	100
93	20.171	19.692	19.199	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100

94	20.388	19.904	19.406	0.217	0.212	0.206	0.08	0.07	0.10	75	77	77	75	76	81	81	82	0.086	100	100
95	20.605	20.115	19.612	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
96	20.822	20.327	19.819	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	75	76	81	81	82	0.086	100	100
97	21.038	20.539	20.025	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	75	76	82	82	82	0.086	100	100
98	21.255	20.751	20.231	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	76	76	82	82	82	0.086	100	100
99	21.472	20.962	20.438	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	76	76	81	81	82	0.086	100	100
100	21.689	21.174	20.644	0.217	0.212	0.206	0.06	0.07	0.10	75	77	77	76	76	81	81	82	0.086	100	100
101	21.906	21.386	20.851	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	76	76	81	81	82	0.086	100	100
102	22.123	21.598	21.057	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	76	76	81	81	82	0.086	100	100
103	22.340	21.809	21.264	0.217	0.212	0.206	0.08	0.07	0.10	75	77	77	76	76	81	81	82	0.086	100	100
104	22.557	22.021	21.470	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	76	76	82	82	82	0.086	100	100
105	22.774	22.233	21.677	0.217	0.212	0.206	0.06	0.07	0.10	75	77	77	76	76	82	82	82	0.086	100	100
106	22.990	22.445	21.883	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	76	76	82	82	82	0.086	100	100
107	23.207	22.656	22.089	0.217	0.212	0.206	0.06	0.07	0.10	75	77	77	76	76	82	82	83	0.086	100	100
108	23.424	22.868	22.296	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	76	76	81	81	82	0.086	100	100
109	23.641	23.080	22.502	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	76	76	81	81	82	0.086	100	100
110	23.858	23.291	22.709	0.217	0.212	0.206	0.06	0.07	0.09	75	77	77	76	76	81	81	82	0.086	100	100
111	24.075	23.503	22.915	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	76	76	81	81	82	0.086	100	100
112	24.292	23.715	23.122	0.217	0.212	0.206	0.08	0.07	0.10	75	77	78	76	76	82	82	82	0.086	100	100
113	24.509	23.927	23.328	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	76	82	82	82	0.086	100	100
114	24.726	24.138	23.535	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	76	76	82	82	83	0.086	100	100
115	24.942	24.350	23.741	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	77	81	81	82	0.086	100	100
116	25.159	24.562	23.947	0.217	0.212	0.206	0.08	0.07	0.10	75	77	78	76	77	81	81	82	0.086	100	100
117	25.376	24.774	24.154	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	77	81	81	83	0.086	100	100
118	25.593	24.985	24.360	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	76	77	81	81	83	0.086	100	100
119	25.810	25.197	24.567	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	76	77	81	81	82	0.086	100	100
120	26.027	25.409	24.773	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	76	77	81	81	82	0.086	100	100
121	26.244	25.621	24.980	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	77	82	82	82	0.086	100	100
122	26.461	25.832	25.186	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	77	81	81	83	0.086	100	100

123	26.678	26.044	25.393	0.217	0.212	0.206	0.06	0.07	0.10	75	77	78	76	77	81	81	83	0.086	100	100
124	26.894	26.256	25.599	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	76	77	82	82	82	0.086	100	100
125	27.111	26.468	25.805	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	76	77	82	82	82	0.086	100	100
126	27.328	26.679	26.012	0.217	0.212	0.206	0.07	0.07	0.09	75	77	78	76	77	82	82	83	0.086	100	100
127	27.545	26.891	26.218	0.217	0.212	0.206	0.08	0.08	0.10	75	77	78	76	77	81	81	82	0.086	100	100
128	27.762	27.103	26.425	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	77	81	81	82	0.086	100	100
129	27.979	27.315	26.631	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	77	81	81	82	0.086	100	100
130	28.196	27.526	26.838	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	77	82	82	83	0.086	100	100
131	28.413	27.738	27.044	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	76	77	82	82	82	0.086	100	100
132	28.630	27.950	27.251	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	76	77	82	82	83	0.086	100	100
133	28.846	28.162	27.457	0.217	0.212	0.206	0.08	0.07	0.10	75	77	78	76	77	82	82	83	0.086	100	100
134	29.063	28.373	27.663	0.217	0.212	0.206	0.08	0.07	0.10	75	77	78	76	77	81	81	83	0.086	100	100
135	29.280	28.585	27.870	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	76	77	81	81	83	0.086	100	100
136	29.497	28.797	28.076	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	76	77	81	81	83	0.086	100	100
137	29.714	29.008	28.283	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	76	77	81	81	83	0.086	100	100
138	29.931	29.220	28.489	0.217	0.212	0.206	0.08	0.07	0.10	75	77	78	76	77	81	81	83	0.086	100	100
139	30.148	29.432	28.696	0.217	0.212	0.206	0.08	0.08	0.10	75	77	78	76	77	81	81	83	0.086	100	100
140	30.365	29.644	28.902	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	76	77	81	81	83	0.086	100	100
141	30.582	29.855	29.109	0.217	0.212	0.206	0.08	0.08	0.10	75	77	78	76	77	81	81	83	0.086	100	100
142	30.799	30.067	29.315	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
143	31.015	30.279	29.521	0.217	0.212	0.206	0.06	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
144	31.232	30.491	29.728	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	77	77	81	81	83	0.086	100	100
145	31.449	30.702	29.934	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	77	77	81	81	83	0.086	100	100
146	31.666	30.914	30.141	0.217	0.212	0.206	0.08	0.07	0.10	75	77	78	77	77	80	80	83	0.086	100	100
147	31.883	31.126	30.347	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	77	77	81	81	83	0.086	100	100
148	32.100	31.338	30.554	0.217	0.212	0.206	0.08	0.07	0.09	75	77	78	77	77	81	81	83	0.086	100	100
149	32.317	31.549	30.760	0.217	0.212	0.206	0.08	0.08	0.10	75	77	78	77	77	81	81	83	0.086	100	100
150	32.534	31.761	30.967	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	77	77	81	81	83	0.086	100	100
151	32.751	31.973	31.173	0.217	0.212	0.206	0.06	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100

152	32.967	32.185	31.379	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	77	77	81	81	83	0.086	100	100
153	33.184	32.396	31.586	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	77	77	81	81	83	0.086	100	100
154	33.401	32.608	31.792	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
155	33.618	32.820	31.999	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
156	33.835	33.032	32.205	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
157	34.052	33.243	32.412	0.217	0.212	0.206	0.06	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
158	34.269	33.455	32.618	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
159	34.486	33.667	32.825	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
160	34.703	33.879	33.031	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	77	81	81	83	0.086	100	100
161	34.919	34.090	33.237	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	77	77	81	81	83	0.086	100	100
162	35.136	34.302	33.444	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	77	77	81	81	83	0.086	100	100
163	35.353	34.514	33.650	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	77	77	81	81	83	0.086	100	100
164	35.570	34.726	33.857	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	77	77	81	81	83	0.086	100	100
165	35.787	34.937	34.063	0.217	0.212	0.206	0.06	0.07	0.10	75	77	77	77	77	81	81	84	0.086	100	100
166	36.004	35.149	34.270	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	77	77	81	81	83	0.086	100	100
167	36.221	35.361	34.476	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	77	77	81	81	83	0.086	100	100
168	36.438	35.572	34.683	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	77	78	81	81	83	0.086	100	100
169	36.655	35.784	34.889	0.217	0.212	0.206	0.07	0.08	0.10	75	77	77	77	78	81	81	83	0.086	100	100
170	36.871	35.996	35.095	0.217	0.212	0.206	0.06	0.08	0.10	75	77	77	77	78	81	81	83	0.086	100	100
171	37.088	36.208	35.302	0.217	0.212	0.206	0.07	0.07	0.10	75	77	77	77	78	81	81	83	0.086	100	100
172	37.305	36.419	35.508	0.217	0.212	0.206	0.08	0.08	0.10	75	77	78	77	78	81	81	83	0.086	100	100
173	37.522	36.631	35.715	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	78	81	81	83	0.086	100	100
174	37.739	36.843	35.921	0.217	0.212	0.206	0.05	0.08	0.10	75	77	78	77	78	81	81	83	0.086	100	100
175	37.956	37.055	36.128	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	78	81	81	83	0.086	100	100
176	38.173	37.266	36.334	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	78	81	81	83	0.086	100	100
177	38.390	37.478	36.541	0.217	0.212	0.206	0.06	0.07	0.10	75	77	78	77	78	81	81	83	0.086	100	100
178	38.607	37.690	36.747	0.217	0.212	0.206	0.06	0.08	0.10	75	77	78	77	78	81	81	83	0.086	100	100
179	38.823	37.902	36.953	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	77	78	81	81	83	0.086	100	100
180	39.040	38.113	37.160	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	77	78	81	81	83	0.086	100	100

181	39.257	38.325	37.366	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	78	81	81	84	0.086	100	100
182	39.474	38.537	37.573	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	77	78	81	81	83	0.086	100	100
183	39.691	38.749	37.779	0.217	0.212	0.206	0.08	0.07	0.10	75	77	78	77	78	81	81	84	0.086	100	100
184	39.908	38.960	37.986	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	78	81	81	83	0.086	100	100
185	40.125	39.172	38.192	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	77	78	81	81	83	0.086	100	100
186	40.342	39.384	38.399	0.217	0.212	0.206	0.05	0.07	0.10	75	77	78	77	78	81	81	83	0.086	100	100
187	40.559	39.596	38.605	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	78	78	81	81	84	0.086	100	100
188	40.775	39.807	38.811	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	78	78	81	81	83	0.086	100	100
189	40.992	40.019	39.018	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	83	0.086	100	100
190	41.209	40.231	39.224	0.217	0.212	0.206	0.05	0.07	0.10	75	77	78	78	78	81	81	84	0.086	100	100
191	41.426	40.443	39.431	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	78	78	81	81	83	0.086	100	100
192	41.643	40.654	39.637	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	78	78	81	81	84	0.086	100	100
193	41.860	40.866	39.844	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	83	0.086	100	100
194	42.077	41.078	40.050	0.217	0.212	0.206	0.07	0.08	0.10	75	77	78	78	78	81	81	83	0.086	100	100
195	42.294	41.289	40.257	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	83	0.086	100	100
196	42.511	41.501	40.463	0.217	0.212	0.206	0.08	0.08	0.09	75	77	78	78	78	81	81	83	0.086	100	100
197	42.728	41.713	40.669	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	83	0.086	100	100
198	42.944	41.925	40.876	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	83	0.086	100	100
199	43.161	42.136	41.082	0.217	0.212	0.206	0.08	0.07	0.10	75	77	78	78	78	81	81	83	0.086	100	100
200	43.378	42.348	41.289	0.217	0.212	0.206	0.06	0.07	0.10	75	77	78	78	78	81	81	84	0.086	100	100
201	43.595	42.560	41.495	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	84	0.086	100	100
202	43.812	42.772	41.702	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	84	0.086	100	100
203	44.029	42.983	41.908	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	84	0.086	100	100
204	44.246	43.195	42.115	0.217	0.212	0.206	0.08	0.08	0.09	75	77	78	78	78	81	81	84	0.086	100	100
205	44.463	43.407	42.321	0.217	0.212	0.206	0.07	0.07	0.10	75	77	78	78	78	81	81	83	0.086	100	100
206	44.680	43.619	42.527	0.217	0.212	0.206	0.06	0.08	0.10	76	77	78	78	78	81	81	83	0.086	100	100
207	44.896	43.830	42.734	0.217	0.212	0.206	0.08	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
208	45.113	44.042	42.940	0.217	0.212	0.206	0.07	0.07	0.10	76	77	78	78	78	81	81	83	0.086	100	100
209	45.330	44.254	43.147	0.217	0.212	0.206	0.08	0.08	0.10	76	77	78	78	78	81	81	83	0.086	100	100

210	45.547	44.466	43.353	0.217	0.212	0.206	0.06	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
211	45.764	44.677	43.560	0.217	0.212	0.206	0.07	0.08	0.10	76	77	78	78	78	81	81	84	0.086	100	100
212	45.981	44.889	43.766	0.217	0.212	0.206	0.06	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
213	46.198	45.101	43.973	0.217	0.212	0.206	0.06	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
214	46.415	45.313	44.179	0.217	0.212	0.206	0.07	0.08	0.10	76	77	78	78	78	81	81	83	0.086	100	100
215	46.632	45.524	44.385	0.217	0.212	0.206	0.06	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
216	46.848	45.736	44.592	0.217	0.212	0.206	0.07	0.08	0.10	76	77	78	78	78	81	81	84	0.086	100	100
217	47.065	45.948	44.798	0.217	0.212	0.206	0.07	0.08	0.09	76	77	78	78	78	81	81	84	0.086	100	100
218	47.282	46.160	45.005	0.217	0.212	0.206	0.07	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
219	47.499	46.371	45.211	0.217	0.212	0.206	0.06	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
220	47.716	46.583	45.418	0.217	0.212	0.206	0.08	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
221	47.933	46.795	45.624	0.217	0.212	0.206	0.07	0.08	0.10	76	77	78	78	78	81	81	84	0.086	100	100
222	48.150	47.006	45.830	0.217	0.212	0.206	0.07	0.08	0.10	76	77	78	78	78	81	81	83	0.086	100	100
223	48.367	47.218	46.037	0.217	0.212	0.206	0.07	0.07	0.09	76	77	78	78	78	81	81	83	0.086	100	100
224	48.584	47.430	46.243	0.217	0.212	0.206	0.08	0.07	0.10	76	77	78	78	78	81	81	84	0.086	100	100
225	48.800	47.642	46.450	0.217	0.212	0.206	0.07	0.08	0.10	76	77	77	78	78	81	81	83	0.086	100	100
226	49.017	47.853	46.656	0.217	0.212	0.206	0.06	0.07	0.10	76	77	77	78	78	81	81	84	0.086	100	100
227	49.234	48.065	46.863	0.217	0.212	0.206	0.07	0.07	0.10	76	77	77	78	78	81	81	84	0.086	100	100
228	49.451	48.277	47.069	0.217	0.212	0.206	0.07	0.08	0.10	76	77	77	78	78	81	81	84	0.086	100	100
229	49.668	48.489	47.276	0.217	0.212	0.206	0.07	0.08	0.10	76	77	77	78	78	81	81	84	0.086	100	100
230	49.885	48.700	47.482	0.217	0.212	0.206	0.07	0.08	0.10	76	77	77	78	78	81	81	84	0.086	100	100
231	50.102	48.912	47.688	0.217	0.212	0.206	0.08	0.08	0.10	76	77	77	78	78	81	81	84	0.086	100	100
232	50.319	49.124	47.895	0.217	0.212	0.206	0.08	0.07	0.10	76	77	77	78	78	81	81	84	0.086	100	100
233	50.536	49.336	48.101	0.217	0.212	0.206	0.07	0.08	0.09	76	77	77	78	78	81	81	84	0.086	100	100
234	50.752	49.547	48.308	0.217	0.212	0.206	0.07	0.07	0.09	76	77	77	78	78	81	81	83	0.086	100	100
235	50.969	49.759	48.514	0.217	0.212	0.206	0.07	0.08	0.10	76	77	77	78	78	81	81	84	0.086	100	100
236	51.186	49.971	48.721	0.217	0.212	0.206	0.07	0.08	0.10	76	77	77	78	78	81	81	84	0.086	100	100
237	51.403	50.183	48.927	0.217	0.212	0.206	0.06	0.07	0.10	76	77	77	78	78	81	81	84	0.086	100	100
238	51.620	50.394	49.134	0.217	0.212	0.206	0.07	0.07	0.10	76	77	77	78	78	81	81	83	0.086	100	100

239	51.837	50.606	49.340	0.217	0.212	0.206	0.06	0.07	0.10	76	77	77	78	78	81	81	83	0.086	100	100
240	52.054	50.818	49.546	0.217	0.212	0.206	0.08	0.08	0.09	76	77	78	78	78	81	81	86	0.086	101	100
	52.054	**50.818**	**49.546**				**0.07**	**0.07**	**0.10**	**75**	**76**	**77**	**76**	**77**	**81**	**81**	**83**	**0.086**		

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

Emissions sampling data (ASTM E2515-11)

Run	**3**	
Manufacturer	Fröling Heizkessel	
Project No.	32-10198	
Model	**P4 Pellet 60**	
Test date	04.08.2020	
Technician	Foit	
Test time	14:08 – 18:08	
Total sampling time [min]	240	
Barometric pressure	"Hg	29.00
Molecular weight (wet)	lb/lbmol	29.00
DIlution tunnel moisture	%	2.00
Dilution tunnel static pressure	"H_2O	-0.186
Pitot tube Cp	-	0.99
Tunnel velocity	ft/s	18.03
Average tunnel flow	dscf/min	188.4
Tunnel area	ft^2	0.190

Velocity traverse data									
	X1	X2	X3	X4	Y1	Y2	Y3	Y4	Center
Initial dP "H2O	0.072	0.084	0.082	0.074	0.074	0.078	0.084	0.074	0.088
Initial temp. °F	87	87	87	87	87	87	87	87	87

Air velocity initial	ft/min	9.8
Air velocity final	ft/min	19.7
% smoke capture	%	100
Induced draft	Pa	0
V_{strav}	ft/s	19.00
V_{scent}	ft/s	20.20
F_p	-	0.94
Meter factor Y(1)		0.992
Meter factor Y(2)		1.006
Meter factor Y(amb)		0.995

Total particulate (1) (first hour)	mg	**1.1**
Total particulate (1) (Post first hour)	mg	**6.3**
Total particulate (1)	mg	**7.8**
Total particulate (2)	mg	**7.1**

Elapsed time	Particulate sampling data																		
	Gas meter cubic feet			Sample rate cfm			Orifice dH			Temperature gas meter °F			Temperature filter °F			Ambient temperature	Dil. tunnel temp.	Dil. tunnel dP	PR 1	PR 2
	Train 1	Train 2	Ambient	Train 1	Train 2	Ambient	Train 1	Train 2	Ambient	Train 1	Train 2	Ambient	Train 1	Train 2	Ambient	°F	°F	" H2O		
0	0.000	0.000	0.000				0.01	0.00	0.00	72	73	74	74	74	78	78	85	0.088		
1	0.226	0.231	0.211	0.226	0.231	0.211	0.03	0.04	0.05	72	73	74	74	74	78	78	85	0.088	101	100
2	0.453	0.462	0.421	0.226	0.231	0.211	0.06	0.08	0.10	72	73	74	74	75	78	78	85	0.088	101	100
3	0.679	0.693	0.632	0.226	0.231	0.211	0.06	0.08	0.10	72	73	74	74	75	78	78	85	0.088	100	100
4	0.906	0.925	0.842	0.226	0.231	0.211	0.06	0.08	0.10	72	73	74	74	75	78	78	85	0.088	100	100
5	1.132	1.156	1.053	0.226	0.231	0.211	0.06	0.08	0.10	72	73	74	74	75	78	78	85	0.088	100	100
6	1.359	1.387	1.263	0.226	0.231	0.211	0.06	0.08	0.10	72	73	74	74	75	77	77	85	0.088	101	100

7	1.585	1.618	1.474	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	74	75	77	77	85	0.088	101	100
8	1.812	1.849	1.685	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	74	75	77	77	85	0.088	101	100
9	2.038	2.080	1.895	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	74	75	77	77	85	0.088	101	100
10	2.265	2.312	2.106	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	74	75	77	77	85	0.088	101	100
11	2.491	2.543	2.316	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	74	75	77	77	85	0.088	101	100
12	2.717	2.774	2.527	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	78	78	85	0.088	101	100
13	2.944	3.005	2.737	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	78	78	85	0.088	101	100
14	3.170	3.236	2.948	0.226	0.231	0.211	0.06	0.08	0.10	72	73	74	75	75	78	78	85	0.088	101	100
15	3.397	3.467	3.158	0.226	0.231	0.211	0.06	0.08	0.10	72	73	74	75	75	79	79	85	0.088	101	100
16	3.623	3.699	3.369	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	79	79	85	0.088	101	100
17	3.850	3.930	3.580	0.226	0.231	0.211	0.07	0.07	0.10	72	73	74	75	75	80	80	86	0.088	101	100
18	4.076	4.161	3.790	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	80	80	85	0.088	101	100
19	4.303	4.392	4.001	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	80	80	86	0.088	101	100
20	4.529	4.623	4.211	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	80	80	86	0.088	101	101
21	4.756	4.854	4.422	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	80	80	86	0.088	101	101
22	4.982	5.086	4.632	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	81	81	86	0.088	101	101
23	5.208	5.317	4.843	0.226	0.231	0.211	0.07	0.08	0.10	72	73	74	75	75	81	81	86	0.088	101	101
24	5.435	5.548	5.054	0.226	0.231	0.211	0.07	0.07	0.10	72	73	74	75	75	81	81	86	0.088	101	101
25	5.661	5.779	5.264	0.226	0.231	0.211	0.07	0.08	0.10	73	73	74	75	75	81	81	86	0.088	101	101
26	5.888	6.010	5.475	0.226	0.231	0.211	0.06	0.08	0.10	73	73	74	75	75	81	81	86	0.088	101	101
27	6.114	6.241	5.685	0.226	0.231	0.211	0.06	0.08	0.10	73	73	74	75	75	82	82	86	0.088	101	100
28	6.341	6.473	5.896	0.226	0.231	0.211	0.06	0.07	0.10	73	73	74	75	75	82	82	86	0.088	101	100
29	6.567	6.704	6.106	0.226	0.231	0.211	0.06	0.07	0.10	73	73	74	75	75	82	82	86	0.088	101	100
30	6.794	6.935	6.317	0.226	0.231	0.211	0.07	0.07	0.10	73	74	74	75	75	82	82	86	0.088	101	101
31	7.020	7.166	6.527	0.226	0.231	0.211	0.07	0.08	0.10	73	74	74	75	75	82	82	86	0.088	101	101
32	7.247	7.397	6.738	0.226	0.231	0.211	0.08	0.07	0.10	73	74	75	75	75	82	82	86	0.088	101	101
33	7.473	7.628	6.949	0.226	0.231	0.211	0.07	0.07	0.10	73	74	75	76	76	82	82	86	0.088	101	100
34	7.699	7.860	7.159	0.226	0.231	0.211	0.06	0.08	0.10	73	74	75	76	76	82	82	86	0.088	101	100
35	7.926	8.091	7.370	0.226	0.231	0.211	0.07	0.08	0.10	73	74	75	76	76	82	82	86	0.088	101	100

36	8.152	8.322	7.580	0.226	0.231	0.211	0.06	0.08	0.10	73	74	75	76	76	82	82	86	0.088	101	100
37	8.379	8.553	7.791	0.226	0.231	0.211	0.06	0.08	0.10	73	74	75	76	76	82	82	86	0.088	101	100
38	8.605	8.784	8.001	0.226	0.231	0.211	0.05	0.08	0.10	73	74	75	76	76	82	82	86	0.088	101	100
39	8.832	9.015	8.212	0.226	0.231	0.211	0.06	0.07	0.10	73	74	75	76	76	82	82	86	0.088	101	100
40	9.058	9.247	8.423	0.226	0.231	0.211	0.06	0.08	0.10	73	74	75	76	76	82	82	86	0.088	101	100
41	9.285	9.478	8.633	0.226	0.231	0.211	0.06	0.08	0.10	73	74	75	76	76	82	82	87	0.088	101	100
42	9.511	9.709	8.844	0.226	0.231	0.211	0.07	0.07	0.10	73	74	75	76	76	82	82	87	0.088	101	100
43	9.738	9.940	9.054	0.226	0.231	0.211	0.08	0.07	0.10	74	74	75	76	76	82	82	87	0.088	101	100
44	9.964	10.171	9.265	0.226	0.231	0.211	0.07	0.07	0.10	74	74	75	76	76	82	82	86	0.088	101	100
45	10.190	10.402	9.475	0.226	0.231	0.211	0.07	0.07	0.10	74	74	75	76	76	82	82	86	0.088	100	100
46	10.417	10.634	9.686	0.226	0.231	0.211	0.07	0.07	0.10	74	74	75	76	76	82	82	87	0.088	101	100
47	10.643	10.865	9.896	0.226	0.231	0.211	0.07	0.07	0.10	74	75	75	76	76	82	82	87	0.088	101	100
48	10.870	11.096	10.107	0.226	0.231	0.211	0.07	0.07	0.10	74	75	75	76	76	82	82	87	0.088	101	100
49	11.096	11.327	10.318	0.226	0.231	0.211	0.07	0.08	0.10	74	75	75	76	76	82	82	87	0.088	101	100
50	11.323	11.558	10.528	0.226	0.231	0.211	0.07	0.08	0.10	74	75	75	76	76	82	82	87	0.088	101	100
51	11.549	11.789	10.739	0.226	0.231	0.211	0.07	0.08	0.10	74	75	75	76	76	82	82	87	0.088	101	100
52	11.776	12.021	10.949	0.226	0.231	0.211	0.07	0.08	0.10	74	75	75	76	76	82	82	87	0.088	101	100
53	12.002	12.252	11.160	0.226	0.231	0.211	0.07	0.08	0.10	74	75	76	76	76	82	82	87	0.088	101	100
54	12.229	12.483	11.370	0.226	0.231	0.211	0.07	0.08	0.10	74	75	76	76	76	82	82	87	0.088	101	100
55	12.455	12.714	11.581	0.226	0.231	0.211	0.07	0.07	0.09	74	75	76	77	76	82	82	87	0.088	101	100
56	12.681	12.945	11.792	0.226	0.231	0.211	0.07	0.07	0.09	74	75	76	77	76	82	82	87	0.088	101	100
57	12.908	13.176	12.002	0.226	0.231	0.211	0.07	0.08	0.10	74	75	76	77	76	83	83	87	0.088	100	100
58	13.134	13.408	12.213	0.226	0.231	0.211	0.07	0.08	0.09	74	75	76	77	76	83	83	87	0.088	100	100
59	13.361	13.639	12.423	0.226	0.231	0.211	0.06	0.07	0.10	74	75	76	77	76	83	83	87	0.088	100	100
60	13.587	13.870	12.634	0.226	0.231	0.211	0.06	0.07	0.10	74	75	76	77	77	83	83	87	0.088	100	100
61	13.814	14.101	12.844	0.226	0.231	0.211	0.06	0.07	0.10	75	75	76	77	77	83	83	87	0.088	100	100
62	14.040	14.332	13.055	0.226	0.231	0.211	0.06	0.08	0.10	75	75	76	77	77	83	83	87	0.088	100	100
63	14.267	14.563	13.266	0.226	0.231	0.211	0.06	0.08	0.10	75	75	76	77	77	83	83	87	0.088	100	100
64	14.493	14.794	13.476	0.226	0.231	0.211	0.06	0.08	0.10	75	75	76	77	77	83	83	87	0.088	100	100

65	14.720	15.026	13.687	0.226	0.231	0.211	0.06	0.08	0.10	75	75	76	77	77	83	83	87	0.088	100	100
66	14.946	15.257	13.897	0.226	0.231	0.211	0.06	0.07	0.10	75	76	76	77	77	83	83	87	0.088	100	100
67	15.173	15.488	14.108	0.226	0.231	0.211	0.06	0.08	0.09	75	76	76	77	77	83	83	87	0.088	100	100
68	15.399	15.719	14.318	0.226	0.231	0.211	0.07	0.07	0.09	75	76	76	77	77	83	83	86	0.088	100	100
69	15.625	15.950	14.529	0.226	0.231	0.211	0.07	0.07	0.09	75	76	76	77	77	83	83	87	0.088	100	100
70	15.852	16.181	14.739	0.226	0.231	0.211	0.06	0.07	0.10	75	76	76	77	77	83	83	87	0.088	100	100
71	16.078	16.413	14.950	0.226	0.231	0.211	0.08	0.07	0.10	75	76	76	77	77	83	83	87	0.088	100	100
72	16.305	16.644	15.161	0.226	0.231	0.211	0.08	0.07	0.10	75	76	76	77	77	83	83	87	0.088	100	100
73	16.531	16.875	15.371	0.226	0.231	0.211	0.07	0.07	0.10	75	76	76	77	77	83	83	87	0.088	100	100
74	16.758	17.106	15.582	0.226	0.231	0.211	0.07	0.07	0.10	75	76	76	77	77	83	83	87	0.088	100	100
75	16.984	17.337	15.792	0.226	0.231	0.211	0.08	0.07	0.10	75	76	76	77	77	82	82	88	0.088	100	100
76	17.211	17.568	16.003	0.226	0.231	0.211	0.07	0.07	0.10	75	76	76	77	77	82	82	88	0.088	100	100
77	17.437	17.800	16.213	0.226	0.231	0.211	0.07	0.08	0.10	75	76	77	77	77	82	82	88	0.088	100	100
78	17.664	18.031	16.424	0.226	0.231	0.211	0.07	0.08	0.10	75	76	77	77	77	82	82	88	0.088	101	100
79	17.890	18.262	16.635	0.226	0.231	0.211	0.07	0.07	0.10	75	76	77	77	77	82	82	88	0.088	100	100
80	18.116	18.493	16.845	0.226	0.231	0.211	0.06	0.07	0.10	75	76	77	77	77	82	82	88	0.088	100	100
81	18.343	18.724	17.056	0.226	0.231	0.211	0.06	0.08	0.10	75	76	77	77	77	82	82	88	0.088	100	100
82	18.569	18.955	17.266	0.226	0.231	0.211	0.07	0.08	0.10	75	76	77	77	77	82	82	88	0.088	100	100
83	18.796	19.187	17.477	0.226	0.231	0.211	0.08	0.08	0.10	75	76	77	77	77	82	82	88	0.088	100	100
84	19.022	19.418	17.687	0.226	0.231	0.211	0.08	0.08	0.10	76	76	77	77	77	83	83	87	0.088	100	100
85	19.249	19.649	17.898	0.226	0.231	0.211	0.07	0.08	0.10	76	76	77	77	77	83	83	87	0.088	100	100
86	19.475	19.880	18.108	0.226	0.231	0.211	0.06	0.08	0.10	76	76	77	77	77	82	82	88	0.088	100	100
87	19.702	20.111	18.319	0.226	0.231	0.211	0.07	0.08	0.10	76	76	77	78	77	82	82	88	0.088	100	100
88	19.928	20.342	18.530	0.226	0.231	0.211	0.08	0.07	0.10	76	76	77	78	77	82	82	88	0.088	100	100
89	20.155	20.574	18.740	0.226	0.231	0.211	0.08	0.07	0.10	76	76	77	78	77	82	82	88	0.088	100	100
90	20.381	20.805	18.951	0.226	0.231	0.211	0.08	0.08	0.10	76	76	77	78	77	82	82	87	0.088	100	100
91	20.607	21.036	19.161	0.226	0.231	0.211	0.07	0.08	0.10	76	77	77	78	77	82	82	87	0.088	100	100
92	20.834	21.267	19.372	0.226	0.231	0.211	0.07	0.08	0.10	76	77	77	78	77	82	82	87	0.088	100	100
93	21.060	21.498	19.582	0.226	0.231	0.211	0.07	0.07	0.10	76	77	77	78	77	82	82	87	0.088	100	100

94	21.287	21.729	19.793	0.226	0.231	0.211	0.07	0.08	0.10	76	77	77	78	77	83	83	88	0.088	100	100
95	21.513	21.961	20.004	0.226	0.231	0.211	0.07	0.08	0.10	76	77	77	78	77	83	83	88	0.088	100	100
96	21.740	22.192	20.214	0.226	0.231	0.211	0.07	0.08	0.10	76	77	77	78	77	83	83	87	0.088	100	100
97	21.966	22.423	20.425	0.226	0.231	0.211	0.07	0.08	0.10	76	77	77	78	77	83	83	87	0.088	100	100
98	22.193	22.654	20.635	0.226	0.231	0.211	0.06	0.08	0.10	76	77	77	78	77	83	83	88	0.088	100	100
99	22.419	22.885	20.846	0.226	0.231	0.211	0.06	0.08	0.10	76	77	77	78	77	84	84	87	0.088	100	100
100	22.646	23.116	21.056	0.226	0.231	0.211	0.06	0.08	0.11	76	77	77	78	77	84	84	87	0.088	100	100
101	22.872	23.348	21.267	0.226	0.231	0.211	0.07	0.08	0.11	76	77	77	78	77	84	84	87	0.088	100	100
102	23.098	23.579	21.477	0.226	0.231	0.211	0.06	0.07	0.10	76	77	77	78	77	84	84	87	0.088	100	100
103	23.325	23.810	21.688	0.226	0.231	0.211	0.06	0.07	0.10	76	77	77	78	77	84	84	87	0.088	100	100
104	23.551	24.041	21.899	0.226	0.231	0.211	0.07	0.07	0.10	76	77	77	78	77	84	84	87	0.088	100	100
105	23.778	24.272	22.109	0.226	0.231	0.211	0.08	0.07	0.09	76	77	77	78	77	84	84	88	0.088	100	100
106	24.004	24.503	22.320	0.226	0.231	0.211	0.08	0.07	0.10	76	77	77	78	77	84	84	88	0.088	100	100
107	24.231	24.735	22.530	0.226	0.231	0.211	0.08	0.07	0.10	76	77	77	78	78	84	84	88	0.088	100	100
108	24.457	24.966	22.741	0.226	0.231	0.211	0.07	0.08	0.10	76	77	78	78	78	84	84	87	0.088	100	100
109	24.684	25.197	22.951	0.226	0.231	0.211	0.06	0.08	0.10	76	77	78	78	78	84	84	87	0.088	100	100
110	24.910	25.428	23.162	0.226	0.231	0.211	0.06	0.07	0.10	76	77	78	78	78	84	84	87	0.088	100	100
111	25.137	25.659	23.373	0.226	0.231	0.211	0.07	0.07	0.09	76	77	78	78	78	84	84	87	0.088	100	100
112	25.363	25.890	23.583	0.226	0.231	0.211	0.07	0.07	0.09	76	77	78	78	78	85	85	87	0.088	100	100
113	25.589	26.122	23.794	0.226	0.231	0.211	0.06	0.08	0.09	76	77	78	78	78	85	85	87	0.088	100	100
114	25.816	26.353	24.004	0.226	0.231	0.211	0.07	0.08	0.09	76	77	78	78	78	85	85	87	0.088	100	100
115	26.042	26.584	24.215	0.226	0.231	0.211	0.07	0.08	0.10	76	77	78	78	78	84	84	88	0.088	100	100
116	26.269	26.815	24.425	0.226	0.231	0.211	0.07	0.07	0.10	76	77	78	78	78	84	84	88	0.088	100	100
117	26.495	27.046	24.636	0.226	0.231	0.211	0.08	0.08	0.10	77	77	78	78	78	84	84	88	0.088	100	100
118	26.722	27.277	24.847	0.226	0.231	0.211	0.08	0.08	0.10	77	77	78	78	78	84	84	88	0.088	100	100
119	26.948	27.509	25.057	0.226	0.231	0.211	0.07	0.07	0.10	77	77	78	78	78	84	84	88	0.088	100	100
120	27.175	27.740	25.268	0.226	0.231	0.211	0.07	0.07	0.10	77	77	78	78	78	83	83	88	0.088	100	100
121	27.401	27.971	25.478	0.226	0.231	0.211	0.06	0.08	0.10	77	77	78	78	78	83	83	87	0.088	100	100
122	27.628	28.202	25.689	0.226	0.231	0.211	0.04	0.08	0.09	77	78	78	78	78	83	83	87	0.088	100	100

123	27.854	28.433	25.899	0.226	0.231	0.211	0.04	0.08	0.09	77	78	78	78	78	84	84	88	0.088	100	100
124	28.080	28.664	26.110	0.226	0.231	0.211	0.03	0.07	0.09	77	78	78	78	78	84	84	88	0.088	100	100
125	28.307	28.895	26.320	0.226	0.231	0.211	0.05	0.07	0.09	77	78	78	79	78	84	84	88	0.088	100	100
126	28.533	29.127	26.531	0.226	0.231	0.211	0.08	0.08	0.10	77	78	78	79	78	84	84	87	0.088	100	100
127	28.760	29.358	26.742	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	84	84	87	0.088	100	100
128	28.986	29.589	26.952	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	84	84	87	0.088	100	100
129	29.213	29.820	27.163	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	84	84	87	0.088	100	100
130	29.439	30.051	27.373	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	84	84	88	0.088	100	100
131	29.666	30.282	27.584	0.226	0.231	0.211	0.07	0.08	0.09	77	78	78	79	78	85	85	87	0.088	100	100
132	29.892	30.514	27.794	0.226	0.231	0.211	0.07	0.07	0.09	77	78	78	79	78	85	85	87	0.088	100	100
133	30.119	30.745	28.005	0.226	0.231	0.211	0.08	0.08	0.10	77	78	78	79	78	85	85	87	0.088	100	100
134	30.345	30.976	28.216	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	85	85	87	0.088	100	100
135	30.571	31.207	28.426	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	84	84	88	0.088	100	100
136	30.798	31.438	28.637	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	84	84	88	0.088	100	100
137	31.024	31.669	28.847	0.226	0.231	0.211	0.07	0.07	0.10	77	78	78	79	78	85	85	88	0.088	100	100
138	31.251	31.901	29.058	0.226	0.231	0.211	0.06	0.08	0.10	77	78	78	79	78	85	85	88	0.088	100	100
139	31.477	32.132	29.268	0.226	0.231	0.211	0.07	0.07	0.10	77	78	78	79	78	85	85	87	0.088	100	100
140	31.704	32.363	29.479	0.226	0.231	0.211	0.07	0.07	0.10	77	78	78	79	78	85	85	87	0.088	100	100
141	31.930	32.594	29.689	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	85	85	88	0.088	100	100
142	32.157	32.825	29.900	0.226	0.231	0.211	0.08	0.08	0.10	77	78	78	79	78	84	84	87	0.088	100	100
143	32.383	33.056	30.111	0.226	0.231	0.211	0.08	0.07	0.10	77	78	78	79	78	84	84	87	0.088	100	100
144	32.610	33.288	30.321	0.226	0.231	0.211	0.07	0.07	0.10	77	78	78	79	78	84	84	88	0.088	100	100
145	32.836	33.519	30.532	0.226	0.231	0.211	0.07	0.07	0.09	77	78	78	79	78	84	84	88	0.088	100	100
146	33.062	33.750	30.742	0.226	0.231	0.211	0.06	0.07	0.09	77	78	78	79	78	84	84	87	0.088	100	100
147	33.289	33.981	30.953	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	83	83	87	0.088	100	100
148	33.515	34.212	31.163	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	83	83	87	0.088	100	100
149	33.742	34.443	31.374	0.226	0.231	0.211	0.08	0.07	0.10	77	78	78	79	78	83	83	87	0.088	100	100
150	33.968	34.675	31.585	0.226	0.231	0.211	0.07	0.07	0.10	77	78	78	79	78	84	84	87	0.088	100	100
151	34.195	34.906	31.795	0.226	0.231	0.211	0.06	0.07	0.10	77	78	78	79	78	84	84	88	0.088	100	100

152	34.421	35.137	32.006	0.226	0.231	0.211	0.07	0.07	0.10	77	78	78	79	78	84	84	88	0.088	100	100
153	34.648	35.368	32.216	0.226	0.231	0.211	0.07	0.07	0.10	77	78	78	79	78	84	84	87	0.088	100	100
154	34.874	35.599	32.427	0.226	0.231	0.211	0.07	0.08	0.10	77	78	78	79	78	84	84	87	0.088	100	100
155	35.101	35.830	32.637	0.226	0.231	0.211	0.06	0.08	0.10	77	78	78	79	78	84	84	87	0.088	100	100
156	35.327	36.062	32.848	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
157	35.553	36.293	33.059	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
158	35.780	36.524	33.269	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
159	36.006	36.755	33.480	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
160	36.233	36.986	33.690	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
161	36.459	37.217	33.901	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
162	36.686	37.449	34.111	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	85	85	87	0.088	100	100
163	36.912	37.680	34.322	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	85	85	87	0.088	100	100
164	37.139	37.911	34.532	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	85	85	88	0.088	100	100
165	37.365	38.142	34.743	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
166	37.592	38.373	34.954	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
167	37.818	38.604	35.164	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
168	38.044	38.836	35.375	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
169	38.271	39.067	35.585	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
170	38.497	39.298	35.796	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	83	83	87	0.088	100	100
171	38.724	39.529	36.006	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	83	83	87	0.088	100	100
172	38.950	39.760	36.217	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	83	83	87	0.088	100	100
173	39.177	39.991	36.428	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	83	83	87	0.088	100	100
174	39.403	40.223	36.638	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
175	39.630	40.454	36.849	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
176	39.856	40.685	37.059	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	83	83	87	0.088	100	100
177	40.083	40.916	37.270	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
178	40.309	41.147	37.480	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
179	40.536	41.378	37.691	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
180	40.762	41.610	37.901	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100

181	40.988	41.841	38.112	0.226	0.231	0.211	0.06	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100
182	41.215	42.072	38.323	0.226	0.231	0.211	0.06	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100
183	41.441	42.303	38.533	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100
184	41.668	42.534	38.744	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100
185	41.894	42.765	38.954	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
186	42.121	42.996	39.165	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
187	42.347	43.228	39.375	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
188	42.574	43.459	39.586	0.226	0.231	0.211	0.06	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
189	42.800	43.690	39.797	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	86	0.088	100	100
190	43.027	43.921	40.007	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
191	43.253	44.152	40.218	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
192	43.479	44.383	40.428	0.226	0.231	0.211	0.08	0.08	0.11	77	78	79	79	78	84	84	87	0.088	100	100
193	43.706	44.615	40.639	0.226	0.231	0.211	0.07	0.08	0.11	77	78	79	79	78	84	84	87	0.088	100	100
194	43.932	44.846	40.849	0.226	0.231	0.211	0.06	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
195	44.159	45.077	41.060	0.226	0.231	0.211	0.06	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100
196	44.385	45.308	41.270	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100
197	44.612	45.539	41.481	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	83	83	87	0.088	100	100
198	44.838	45.770	41.692	0.226	0.231	0.211	0.07	0.07	0.09	77	78	79	79	78	83	83	87	0.088	100	100
199	45.065	46.002	41.902	0.226	0.231	0.211	0.07	0.07	0.09	77	78	79	79	78	83	83	87	0.088	100	100
200	45.291	46.233	42.113	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	83	83	87	0.088	100	100
201	45.518	46.464	42.323	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	83	83	87	0.088	100	100
202	45.744	46.695	42.534	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	83	83	88	0.088	100	100
203	45.970	46.926	42.744	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100
204	46.197	47.157	42.955	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
205	46.423	47.389	43.166	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
206	46.650	47.620	43.376	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
207	46.876	47.851	43.587	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
208	47.103	48.082	43.797	0.226	0.231	0.211	0.09	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100
209	47.329	48.313	44.008	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	84	84	88	0.088	100	100

210	47.556	48.544	44.218	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
211	47.782	48.776	44.429	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
212	48.009	49.007	44.640	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
213	48.235	49.238	44.850	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	85	85	87	0.088	100	100
214	48.461	49.469	45.061	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	85	85	87	0.088	100	100
215	48.688	49.700	45.271	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
216	48.914	49.931	45.482	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
217	49.141	50.163	45.692	0.226	0.231	0.211	0.08	0.07	0.09	77	78	79	79	78	84	84	88	0.088	100	100
218	49.367	50.394	45.903	0.226	0.231	0.211	0.08	0.07	0.09	77	78	79	79	78	84	84	88	0.088	100	100
219	49.594	50.625	46.113	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
220	49.820	50.856	46.324	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
221	50.047	51.087	46.535	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	83	83	88	0.088	100	100
222	50.273	51.318	46.745	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	83	83	88	0.088	100	100
223	50.500	51.550	46.956	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	83	83	87	0.088	100	100
224	50.726	51.781	47.166	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	83	83	88	0.088	100	100
225	50.952	52.012	47.377	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
226	51.179	52.243	47.587	0.226	0.231	0.211	0.08	0.08	0.10	77	78	79	79	78	83	83	88	0.088	100	100
227	51.405	52.474	47.798	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	83	83	88	0.088	100	100
228	51.632	52.705	48.009	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	83	83	88	0.088	100	100
229	51.858	52.937	48.219	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	83	83	88	0.088	100	100
230	52.085	53.168	48.430	0.226	0.231	0.211	0.07	0.07	0.10	77	78	79	79	78	83	83	88	0.088	100	100
231	52.311	53.399	48.640	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	83	83	88	0.088	100	100
232	52.538	53.630	48.851	0.226	0.231	0.211	0.08	0.07	0.09	77	78	79	79	78	84	84	88	0.088	100	100
233	52.764	53.861	49.061	0.226	0.231	0.211	0.08	0.07	0.09	77	78	79	79	78	84	84	87	0.088	100	100
234	52.991	54.092	49.272	0.226	0.231	0.211	0.08	0.07	0.10	77	78	79	79	78	84	84	87	0.088	100	100
235	53.217	54.324	49.482	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	88	0.088	100	100
236	53.443	54.555	49.693	0.226	0.231	0.211	0.07	0.08	0.11	77	78	79	79	78	84	84	88	0.088	100	100
237	53.670	54.786	49.904	0.226	0.231	0.211	0.07	0.07	0.11	77	78	79	79	78	84	84	88	0.088	100	100
238	53.896	55.017	50.114	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100

239	54.123	55.248	50.325	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
240	54.349	55.479	50.535	0.226	0.231	0.211	0.07	0.08	0.10	77	78	79	79	78	84	84	87	0.088	100	100
	54.349	**55.479**	**50.535**				**0.07**	**0.07**	**0.10**	**76**	**77**	**77**	**78**	**77**	**83**	**83**	**87**	**0.088**		

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

Emissions sampling data (ASTM E2515-11)

Run	**4**	
Manufacturer	Fröling Heizkessel	
Project No.	32-10198	
Model	**P4 Pellet 60**	
Test date	05.08.2020	
Technician	Foit	
Test time	7:55 – 11:55	
Total sampling time [min]	240	
Barometric pressure	"Hg	29.20
Molecular weight (wet)	lb/lbmol	29.00
DIlution tunnel moisture	%	2.00
Dilution tunnel static pressure	"H_2O	-0.183
Pitot tube Cp	-	0.99
Tunnel velocity	ft/s	18.35
Average tunnel flow	dscf/min	190.9
Tunnel area	ft^2	0.190

Velocity traverse data									
	X1	X2	X3	X4	Y1	Y2	Y3	Y4	Center
Initial dP "H2O	0.075	0.082	0.082	0.078	0.074	0.078	0.081	0.077	0.086
Initial temp. °F	93	93	93	93	93	93	93	93	93

Air velocity initial	ft/min	17.7
Air velocity final	ft/min	5.9
% smoke capture	%	100
Induced draft	Pa	0
V_{strav}	ft/s	19.13
V_{scent}	ft/s	20.04
F_p	-	0.95
Meter factor Y(1)		0.992
Meter factor Y(2)		1.006
Meter factor Y(amb)		0.995

Total particulate (1) (first hour)	mg	**0.8**
Total particulate (1) (Post first hour)	mg	**4.4**
Total particulate (1)	mg	**5.2**
Total particulate (2)	mg	**5.7**

Elapsed time	Particulate sampling data																		
	Gas meter cubic feet			Sample rate cfm			Orifice dH			Temperature gas meter °F			Temperature filter °F			Ambient temperature	Dil. tunnel temp.	Dil. tunnel dP	PR 1	PR 2
	Train 1	Train 2	Ambient	Train 1	Train 2	Ambient	Train 1	Train 2	Ambient	Train 1	Train 2	Ambient	Train 1	Train 2	Ambient	°F	°F	" H2O		
0	0.000	0.000	0.000				0.00	0.00	0.01	72	73	73	73	74	80	80	92	0.086		
1	0.221	0.214	0.212	0.221	0.214	0.212	0.03	0.04	0.05	72	73	73	74	75	80	80	92	0.086	100	100
2	0.442	0.427	0.424	0.221	0.214	0.212	0.07	0.08	0.09	72	73	73	74	75	80	80	92	0.086	100	100
3	0.663	0.641	0.636	0.221	0.214	0.212	0.06	0.08	0.10	72	73	73	75	75	80	80	92	0.086	100	100
4	0.883	0.855	0.848	0.221	0.214	0.212	0.07	0.08	0.10	72	73	73	75	75	80	80	92	0.086	100	100
5	1.104	1.068	1.059	0.221	0.214	0.212	0.07	0.08	0.10	72	73	73	75	75	81	81	92	0.086	100	100
6	1.325	1.282	1.271	0.221	0.214	0.212	0.06	0.08	0.10	72	73	73	75	75	81	81	92	0.086	100	100
7	1.546	1.496	1.483	0.221	0.214	0.212	0.07	0.08	0.10	72	73	74	75	75	81	81	92	0.086	100	100

8	1.767	1.709	1.695	0.221	0.214	0.212	0.07	0.08	0.10	72	73	73	75	75	81	81	92	0.086	100	100
9	1.988	1.923	1.907	0.221	0.214	0.212	0.07	0.08	0.10	72	73	73	75	75	81	81	92	0.086	100	100
10	2.209	2.137	2.119	0.221	0.214	0.212	0.06	0.08	0.10	72	73	74	75	76	81	81	92	0.086	100	100
11	2.430	2.350	2.331	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	75	76	81	81	92	0.086	100	100
12	2.650	2.564	2.543	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	75	76	80	80	92	0.086	100	100
13	2.871	2.777	2.755	0.221	0.214	0.212	0.06	0.08	0.10	73	73	74	75	76	80	80	92	0.086	100	100
14	3.092	2.991	2.966	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	75	76	80	80	92	0.086	100	100
15	3.313	3.205	3.178	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	75	76	80	80	93	0.086	100	100
16	3.534	3.418	3.390	0.221	0.214	0.212	0.08	0.08	0.10	73	73	74	75	76	80	80	93	0.086	100	100
17	3.755	3.632	3.602	0.221	0.214	0.212	0.08	0.08	0.09	73	73	74	76	76	80	80	93	0.086	100	100
18	3.976	3.846	3.814	0.221	0.214	0.212	0.08	0.08	0.10	73	73	74	76	76	80	80	93	0.086	100	100
19	4.196	4.059	4.026	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	76	81	81	93	0.086	100	100
20	4.417	4.273	4.238	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	76	81	81	93	0.086	100	100
21	4.638	4.487	4.450	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	76	81	81	93	0.086	100	100
22	4.859	4.700	4.662	0.221	0.214	0.212	0.06	0.07	0.10	73	73	74	76	76	81	81	93	0.086	100	100
23	5.080	4.914	4.873	0.221	0.214	0.212	0.06	0.07	0.10	73	73	74	76	76	81	81	93	0.086	100	100
24	5.301	5.128	5.085	0.221	0.214	0.212	0.06	0.08	0.10	73	73	74	76	76	81	81	93	0.086	100	100
25	5.522	5.341	5.297	0.221	0.214	0.212	0.07	0.07	0.10	73	73	74	76	76	81	81	92	0.086	100	100
26	5.742	5.555	5.509	0.221	0.214	0.212	0.07	0.07	0.10	73	73	74	76	76	81	81	93	0.086	100	100
27	5.963	5.769	5.721	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	76	81	81	93	0.086	100	100
28	6.184	5.982	5.933	0.221	0.214	0.212	0.06	0.08	0.10	73	73	74	76	76	81	81	93	0.086	100	100
29	6.405	6.196	6.145	0.221	0.214	0.212	0.08	0.08	0.10	73	73	74	76	76	81	81	92	0.086	100	100
30	6.626	6.410	6.357	0.221	0.214	0.212	0.07	0.07	0.10	73	73	74	76	76	81	81	92	0.086	100	100
31	6.847	6.623	6.569	0.221	0.214	0.212	0.07	0.07	0.10	73	73	74	76	76	81	81	92	0.086	100	100
32	7.068	6.837	6.780	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	76	81	81	93	0.086	100	100
33	7.289	7.051	6.992	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	76	81	81	93	0.086	100	100
34	7.509	7.264	7.204	0.221	0.214	0.212	0.06	0.07	0.10	73	73	74	76	76	80	80	93	0.086	100	100
35	7.730	7.478	7.416	0.221	0.214	0.212	0.06	0.07	0.10	73	73	74	76	76	81	81	93	0.086	100	100
36	7.951	7.692	7.628	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	76	81	81	92	0.086	100	100

37	8.172	7.905	7.840	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	77	81	81	92	0.086	100	100
38	8.393	8.119	8.052	0.221	0.214	0.212	0.06	0.08	0.10	73	73	74	76	77	81	81	92	0.086	100	100
39	8.614	8.332	8.264	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	76	77	81	81	92	0.086	100	100
40	8.835	8.546	8.476	0.221	0.214	0.212	0.08	0.07	0.10	73	73	74	76	77	81	81	92	0.086	100	100
41	9.055	8.760	8.687	0.221	0.214	0.212	0.06	0.07	0.10	73	73	74	76	77	81	81	92	0.086	100	100
42	9.276	8.973	8.899	0.221	0.214	0.212	0.06	0.08	0.10	73	73	74	76	77	81	81	92	0.086	100	100
43	9.497	9.187	9.111	0.221	0.214	0.212	0.06	0.08	0.09	73	73	74	77	77	81	81	92	0.086	100	100
44	9.718	9.401	9.323	0.221	0.214	0.212	0.07	0.08	0.09	73	73	74	77	77	81	81	92	0.086	100	100
45	9.939	9.614	9.535	0.221	0.214	0.212	0.07	0.08	0.10	73	73	74	77	77	81	81	93	0.086	100	100
46	10.160	9.828	9.747	0.221	0.214	0.212	0.07	0.08	0.09	73	73	74	77	77	81	81	93	0.086	100	100
47	10.381	10.042	9.959	0.221	0.214	0.212	0.06	0.08	0.10	73	73	74	77	77	81	81	93	0.086	100	100
48	10.601	10.255	10.171	0.221	0.214	0.212	0.06	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
49	10.822	10.469	10.383	0.221	0.214	0.212	0.07	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
50	11.043	10.683	10.594	0.221	0.214	0.212	0.07	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
51	11.264	10.896	10.806	0.221	0.214	0.212	0.07	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
52	11.485	11.110	11.018	0.221	0.214	0.212	0.07	0.08	0.10	73	74	74	77	77	81	81	93	0.086	100	100
53	11.706	11.324	11.230	0.221	0.214	0.212	0.07	0.08	0.10	73	74	74	77	77	81	81	93	0.086	100	100
54	11.927	11.537	11.442	0.221	0.214	0.212	0.07	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
55	12.148	11.751	11.654	0.221	0.214	0.212	0.07	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
56	12.368	11.965	11.866	0.221	0.214	0.212	0.06	0.07	0.09	73	74	74	77	77	81	81	93	0.086	100	100
57	12.589	12.178	12.078	0.221	0.214	0.212	0.05	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
58	12.810	12.392	12.290	0.221	0.214	0.212	0.06	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
59	13.031	12.606	12.501	0.221	0.214	0.212	0.07	0.07	0.10	73	74	74	77	77	81	81	93	0.086	100	100
60	13.252	12.819	12.713	0.221	0.214	0.212	0.06	0.07	0.10	73	74	74	77	77	80	80	93	0.086	100	100
61	13.473	13.033	12.925	0.221	0.214	0.212	0.07	0.07	0.10	73	74	74	77	77	80	80	93	0.086	100	100
62	13.694	13.247	13.137	0.221	0.214	0.212	0.08	0.07	0.10	73	74	75	77	77	80	80	93	0.086	100	100
63	13.914	13.460	13.349	0.221	0.214	0.212	0.08	0.07	0.10	73	74	75	77	77	80	80	93	0.086	100	100
64	14.135	13.674	13.561	0.221	0.214	0.212	0.07	0.08	0.10	73	74	75	77	77	80	80	93	0.086	100	100
65	14.356	13.887	13.773	0.221	0.214	0.212	0.07	0.07	0.10	73	74	75	77	77	80	80	93	0.086	100	100

66	14.577	14.101	13.985	0.221	0.214	0.212	0.06	0.07	0.10	73	74	75	77	77	80	80	93	0.086	100	100
67	14.798	14.315	14.196	0.221	0.214	0.212	0.07	0.08	0.09	73	74	75	77	77	80	80	93	0.086	100	100
68	15.019	14.528	14.408	0.221	0.214	0.212	0.07	0.08	0.10	73	74	75	77	77	80	80	93	0.086	100	100
69	15.240	14.742	14.620	0.221	0.214	0.212	0.06	0.08	0.10	73	74	75	77	77	80	80	93	0.086	100	100
70	15.460	14.956	14.832	0.221	0.214	0.212	0.06	0.08	0.10	73	74	75	77	77	80	80	93	0.086	100	100
71	15.681	15.169	15.044	0.221	0.214	0.212	0.07	0.08	0.10	73	74	75	77	77	80	80	93	0.086	100	100
72	15.902	15.383	15.256	0.221	0.214	0.212	0.07	0.08	0.10	73	74	75	77	77	80	80	93	0.086	100	100
73	16.123	15.597	15.468	0.221	0.214	0.212	0.07	0.08	0.10	73	74	75	77	77	80	80	93	0.086	100	100
74	16.344	15.810	15.680	0.221	0.214	0.212	0.07	0.07	0.10	73	74	75	77	77	80	80	93	0.086	100	100
75	16.565	16.024	15.892	0.221	0.214	0.212	0.07	0.07	0.10	73	74	75	77	77	80	80	93	0.086	100	100
76	16.786	16.238	16.103	0.221	0.214	0.212	0.07	0.07	0.10	73	74	75	77	77	80	80	93	0.086	100	100
77	17.007	16.451	16.315	0.221	0.214	0.212	0.07	0.08	0.10	73	74	75	77	77	79	79	93	0.086	100	100
78	17.227	16.665	16.527	0.221	0.214	0.212	0.08	0.08	0.10	73	74	75	77	77	79	79	93	0.086	100	100
79	17.448	16.879	16.739	0.221	0.214	0.212	0.08	0.08	0.10	74	74	75	77	77	79	79	93	0.086	100	100
80	17.669	17.092	16.951	0.221	0.214	0.212	0.07	0.08	0.10	74	74	75	77	77	79	79	93	0.086	100	100
81	17.890	17.306	17.163	0.221	0.214	0.212	0.08	0.08	0.10	74	74	75	77	77	79	79	93	0.086	100	100
82	18.111	17.520	17.375	0.221	0.214	0.212	0.08	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
83	18.332	17.733	17.587	0.221	0.214	0.212	0.07	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
84	18.553	17.947	17.799	0.221	0.214	0.212	0.07	0.08	0.10	74	74	75	77	77	79	79	93	0.086	100	100
85	18.773	18.161	18.010	0.221	0.214	0.212	0.07	0.08	0.10	74	74	75	77	77	79	79	93	0.086	100	100
86	18.994	18.374	18.222	0.221	0.214	0.212	0.07	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
87	19.215	18.588	18.434	0.221	0.214	0.212	0.07	0.08	0.10	74	74	75	77	77	79	79	93	0.086	100	100
88	19.436	18.802	18.646	0.221	0.214	0.212	0.06	0.08	0.10	74	74	75	77	77	79	79	93	0.086	100	100
89	19.657	19.015	18.858	0.221	0.214	0.212	0.07	0.08	0.10	74	74	75	77	77	79	79	93	0.086	100	100
90	19.878	19.229	19.070	0.221	0.214	0.212	0.08	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
91	20.099	19.442	19.282	0.221	0.214	0.212	0.07	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
92	20.319	19.656	19.494	0.221	0.214	0.212	0.06	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
93	20.540	19.870	19.706	0.221	0.214	0.212	0.06	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
94	20.761	20.083	19.917	0.221	0.214	0.212	0.07	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100

95	20.982	20.297	20.129	0.221	0.214	0.212	0.07	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
96	21.203	20.511	20.341	0.221	0.214	0.212	0.07	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
97	21.424	20.724	20.553	0.221	0.214	0.212	0.07	0.07	0.10	74	74	75	77	77	79	79	93	0.086	100	100
98	21.645	20.938	20.765	0.221	0.214	0.212	0.07	0.07	0.10	74	75	75	77	77	79	79	93	0.086	100	100
99	21.866	21.152	20.977	0.221	0.214	0.212	0.07	0.08	0.10	74	75	75	77	77	79	79	93	0.086	100	100
100	22.086	21.365	21.189	0.221	0.214	0.212	0.08	0.08	0.10	74	75	75	77	78	79	79	93	0.086	100	100
101	22.307	21.579	21.401	0.221	0.214	0.212	0.08	0.08	0.10	74	75	75	77	78	79	79	93	0.086	100	100
102	22.528	21.793	21.613	0.221	0.214	0.212	0.06	0.08	0.10	74	75	75	77	78	79	79	93	0.086	100	100
103	22.749	22.006	21.824	0.221	0.214	0.212	0.06	0.07	0.10	74	75	75	77	78	79	79	93	0.086	100	100
104	22.970	22.220	22.036	0.221	0.214	0.212	0.07	0.08	0.10	74	75	75	78	78	79	79	93	0.086	100	100
105	23.191	22.434	22.248	0.221	0.214	0.212	0.08	0.08	0.10	74	75	75	78	78	79	79	93	0.086	100	100
106	23.412	22.647	22.460	0.221	0.214	0.212	0.07	0.08	0.10	74	75	75	78	78	79	79	93	0.086	100	100
107	23.632	22.861	22.672	0.221	0.214	0.212	0.07	0.07	0.10	74	75	75	78	78	79	79	93	0.086	100	100
108	23.853	23.075	22.884	0.221	0.214	0.212	0.07	0.07	0.10	74	75	75	78	78	80	80	93	0.086	100	100
109	24.074	23.288	23.096	0.221	0.214	0.212	0.07	0.07	0.10	74	75	75	78	78	80	80	93	0.086	100	100
110	24.295	23.502	23.308	0.221	0.214	0.212	0.07	0.07	0.10	74	75	75	78	78	80	80	93	0.086	100	100
111	24.516	23.716	23.520	0.221	0.214	0.212	0.07	0.08	0.10	74	75	75	78	78	80	80	93	0.086	100	100
112	24.737	23.929	23.731	0.221	0.214	0.212	0.07	0.08	0.10	74	75	76	78	78	80	80	93	0.086	100	100
113	24.958	24.143	23.943	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
114	25.178	24.357	24.155	0.221	0.214	0.212	0.06	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
115	25.399	24.570	24.367	0.221	0.214	0.212	0.06	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
116	25.620	24.784	24.579	0.221	0.214	0.212	0.06	0.08	0.10	74	75	76	78	78	80	80	93	0.086	100	100
117	25.841	24.997	24.791	0.221	0.214	0.212	0.06	0.08	0.10	74	75	76	78	78	80	80	93	0.086	100	100
118	26.062	25.211	25.003	0.221	0.214	0.212	0.06	0.07	0.09	74	75	76	78	78	80	80	93	0.086	100	100
119	26.283	25.425	25.215	0.221	0.214	0.212	0.06	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
120	26.504	25.638	25.427	0.221	0.214	0.212	0.06	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
121	26.725	25.852	25.638	0.221	0.214	0.212	0.05	0.07	0.10	74	75	76	77	78	80	80	93	0.086	100	100
122	26.945	26.066	25.850	0.221	0.214	0.212	0.02	0.07	0.10	74	75	76	77	78	80	80	93	0.086	100	100
123	27.166	26.279	26.062	0.221	0.214	0.212	0.00	0.07	0.09	74	75	76	78	78	80	80	93	0.086	100	100

124	27.387	26.493	26.274	0.221	0.214	0.212	0.03	0.07	0.09	74	75	76	78	78	80	80	93	0.086	100	100
125	27.608	26.707	26.486	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
126	27.829	26.920	26.698	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
127	28.050	27.134	26.910	0.221	0.214	0.212	0.07	0.08	0.10	74	75	76	78	78	80	80	93	0.086	100	100
128	28.271	27.348	27.122	0.221	0.214	0.212	0.07	0.08	0.10	74	75	76	78	78	80	80	93	0.086	100	100
129	28.491	27.561	27.334	0.221	0.214	0.212	0.07	0.07	0.09	74	75	76	78	78	80	80	93	0.086	100	100
130	28.712	27.775	27.545	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
131	28.933	27.989	27.757	0.221	0.214	0.212	0.08	0.08	0.10	74	75	76	78	78	80	80	93	0.086	100	100
132	29.154	28.202	27.969	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
133	29.375	28.416	28.181	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
134	29.596	28.630	28.393	0.221	0.214	0.212	0.08	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
135	29.817	28.843	28.605	0.221	0.214	0.212	0.08	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
136	30.037	29.057	28.817	0.221	0.214	0.212	0.08	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
137	30.258	29.271	29.029	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
138	30.479	29.484	29.241	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
139	30.700	29.698	29.452	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
140	30.921	29.912	29.664	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
141	31.142	30.125	29.876	0.221	0.214	0.212	0.08	0.07	0.10	74	75	76	78	78	80	80	93	0.086	100	100
142	31.363	30.339	30.088	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
143	31.584	30.552	30.300	0.221	0.214	0.212	0.06	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
144	31.804	30.766	30.512	0.221	0.214	0.212	0.06	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100
145	32.025	30.980	30.724	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
146	32.246	31.193	30.936	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
147	32.467	31.407	31.148	0.221	0.214	0.212	0.06	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
148	32.688	31.621	31.359	0.221	0.214	0.212	0.06	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
149	32.909	31.834	31.571	0.221	0.214	0.212	0.06	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
150	33.130	32.048	31.783	0.221	0.214	0.212	0.07	0.07	0.09	74	75	76	78	78	79	79	93	0.086	100	100
151	33.350	32.262	31.995	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
152	33.571	32.475	32.207	0.221	0.214	0.212	0.07	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100

153	33.792	32.689	32.419	0.221	0.214	0.212	0.07	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100
154	34.013	32.903	32.631	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
155	34.234	33.116	32.843	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
156	34.455	33.330	33.055	0.221	0.214	0.212	0.08	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
157	34.676	33.544	33.266	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
158	34.896	33.757	33.478	0.221	0.214	0.212	0.05	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
159	35.117	33.971	33.690	0.221	0.214	0.212	0.05	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
160	35.338	34.185	33.902	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
161	35.559	34.398	34.114	0.221	0.214	0.212	0.08	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
162	35.780	34.612	34.326	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
163	36.001	34.826	34.538	0.221	0.214	0.212	0.06	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
164	36.222	35.039	34.750	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
165	36.443	35.253	34.962	0.221	0.214	0.212	0.07	0.07	0.09	74	76	76	78	78	79	79	93	0.086	100	100
166	36.663	35.467	35.173	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
167	36.884	35.680	35.385	0.221	0.214	0.212	0.07	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100
168	37.105	35.894	35.597	0.221	0.214	0.212	0.07	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100
169	37.326	36.107	35.809	0.221	0.214	0.212	0.07	0.07	0.11	74	75	76	78	78	79	79	93	0.086	100	100
170	37.547	36.321	36.021	0.221	0.214	0.212	0.07	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100
171	37.768	36.535	36.233	0.221	0.214	0.212	0.06	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100
172	37.989	36.748	36.445	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
173	38.209	36.962	36.657	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
174	38.430	37.176	36.869	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
175	38.651	37.389	37.080	0.221	0.214	0.212	0.07	0.07	0.10	74	75	76	78	78	79	79	93	0.086	100	100
176	38.872	37.603	37.292	0.221	0.214	0.212	0.07	0.08	0.09	74	75	76	78	78	79	79	93	0.086	100	100
177	39.093	37.817	37.504	0.221	0.214	0.212	0.06	0.08	0.09	74	75	76	78	78	79	79	93	0.086	100	100
178	39.314	38.030	37.716	0.221	0.214	0.212	0.06	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100
179	39.535	38.244	37.928	0.221	0.214	0.212	0.06	0.08	0.10	74	75	76	78	78	79	79	93	0.086	100	100
180	39.755	38.458	38.140	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
181	39.976	38.671	38.352	0.221	0.214	0.212	0.06	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100

182	40.197	38.885	38.564	0.221	0.214	0.212	0.06	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
183	40.418	39.099	38.776	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
184	40.639	39.312	38.987	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
185	40.860	39.526	39.199	0.221	0.214	0.212	0.07	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
186	41.081	39.740	39.411	0.221	0.214	0.212	0.07	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
187	41.302	39.953	39.623	0.221	0.214	0.212	0.08	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
188	41.522	40.167	39.835	0.221	0.214	0.212	0.08	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
189	41.743	40.381	40.047	0.221	0.214	0.212	0.07	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
190	41.964	40.594	40.259	0.221	0.214	0.212	0.06	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
191	42.185	40.808	40.471	0.221	0.214	0.212	0.06	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
192	42.406	41.022	40.682	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
193	42.627	41.235	40.894	0.221	0.214	0.212	0.06	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
194	42.848	41.449	41.106	0.221	0.214	0.212	0.07	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
195	43.068	41.662	41.318	0.221	0.214	0.212	0.07	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
196	43.289	41.876	41.530	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
197	43.510	42.090	41.742	0.221	0.214	0.212	0.07	0.07	0.09	74	76	76	78	78	79	79	93	0.086	100	100
198	43.731	42.303	41.954	0.221	0.214	0.212	0.07	0.08	0.09	74	76	76	78	78	79	79	93	0.086	100	100
199	43.952	42.517	42.166	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
200	44.173	42.731	42.378	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
201	44.394	42.944	42.589	0.221	0.214	0.212	0.08	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
202	44.614	43.158	42.801	0.221	0.214	0.212	0.08	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
203	44.835	43.372	43.013	0.221	0.214	0.212	0.08	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
204	45.056	43.585	43.225	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
205	45.277	43.799	43.437	0.221	0.214	0.212	0.07	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
206	45.498	44.013	43.649	0.221	0.214	0.212	0.07	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
207	45.719	44.226	43.861	0.221	0.214	0.212	0.07	0.08	0.10	74	76	76	78	78	79	79	93	0.086	100	100
208	45.940	44.440	44.073	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	78	78	79	79	93	0.086	100	100
209	46.161	44.654	44.285	0.221	0.214	0.212	0.07	0.07	0.11	74	76	76	78	78	79	79	93	0.086	100	100
210	46.381	44.867	44.496	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	79	78	80	80	93	0.086	100	100

211	46.602	45.081	44.708	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	79	78	80	80	93	0.086	100	100
212	46.823	45.295	44.920	0.221	0.214	0.212	0.07	0.07	0.10	74	76	76	79	78	80	80	93	0.086	100	100
213	47.044	45.508	45.132	0.221	0.214	0.212	0.08	0.07	0.10	75	76	76	79	78	80	80	93	0.086	100	100
214	47.265	45.722	45.344	0.221	0.214	0.212	0.08	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
215	47.486	45.936	45.556	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
216	47.707	46.149	45.768	0.221	0.214	0.212	0.06	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
217	47.927	46.363	45.980	0.221	0.214	0.212	0.06	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
218	48.148	46.577	46.192	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
219	48.369	46.790	46.403	0.221	0.214	0.212	0.07	0.07	0.10	75	76	76	79	78	80	80	93	0.086	100	100
220	48.590	47.004	46.615	0.221	0.214	0.212	0.06	0.08	0.09	75	76	76	79	78	80	80	93	0.086	100	100
221	48.811	47.217	46.827	0.221	0.214	0.212	0.06	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
222	49.032	47.431	47.039	0.221	0.214	0.212	0.06	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
223	49.253	47.645	47.251	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
224	49.473	47.858	47.463	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
225	49.694	48.072	47.675	0.221	0.214	0.212	0.07	0.08	0.10	75	75	76	79	78	80	80	93	0.086	100	100
226	49.915	48.286	47.887	0.221	0.214	0.212	0.08	0.07	0.10	75	75	76	79	78	80	80	93	0.086	100	100
227	50.136	48.499	48.099	0.221	0.214	0.212	0.08	0.07	0.10	75	76	76	79	78	80	80	93	0.086	100	100
228	50.357	48.713	48.310	0.221	0.214	0.212	0.08	0.07	0.10	75	76	76	79	78	80	80	93	0.086	100	100
229	50.578	48.927	48.522	0.221	0.214	0.212	0.07	0.07	0.10	75	76	76	79	78	80	80	93	0.086	100	100
230	50.799	49.140	48.734	0.221	0.214	0.212	0.07	0.07	0.10	75	76	76	79	78	80	80	93	0.086	100	100
231	51.020	49.354	48.946	0.221	0.214	0.212	0.07	0.08	0.10	75	75	76	79	78	80	80	93	0.086	100	100
232	51.240	49.568	49.158	0.221	0.214	0.212	0.07	0.07	0.10	75	75	76	79	78	80	80	93	0.086	100	100
233	51.461	49.781	49.370	0.221	0.214	0.212	0.06	0.07	0.09	75	75	76	79	78	80	80	93	0.086	100	100
234	51.682	49.995	49.582	0.221	0.214	0.212	0.06	0.07	0.10	75	75	76	79	78	80	80	93	0.086	100	100
235	51.903	50.209	49.794	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
236	52.124	50.422	50.006	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
237	52.345	50.636	50.217	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
238	52.566	50.850	50.429	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
239	52.786	51.063	50.641	0.221	0.214	0.212	0.07	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100

240	53.007	51.277	50.853	0.221	0.214	0.212	0.06	0.08	0.10	75	76	76	79	78	80	80	93	0.086	100	100
	53.007	**51.277**	**50.853**				**0.07**	**0.07**	**0.10**	**74**	**75**	**75**	**77**	**77**	**80**	**80**	**93**	**0.086**		

Test method ASTM E2515-11 – Lab results

Run	**1**
Manufacturer	Fröling Heizkessel
Project No.	32-10198
Model	**P4 Pellet 60**
Test date	03.08.2020

Particulate emissions

	Run	1				
	Date of testing	03.08.2020				
		ID	Final weight	Tare weight	Particulate	Total particulate
			[g]	[g]	[mg]	[mg]
Train 1	Front filter – First hr	5.2-3532	59.8297	59.8278	1.9	**9.3**
	Front filter - After first hr	5.2-3533	59.9482	59.9414	6.8	
	Rear filter	5.2-3766	9.9563	9.9557	0.6	
Train 2	Front filter	5.2-3031	58.2447	58.2364	8.3	**8.9**
	Rear filter	5.2-2540	9.3653	9.3647	0.6	
Amb.	Rear filter	4.2-2630	9.7735	9.7735	0.0	**0.0**

Filter train

Run		1					
Date of testing		03.08.2020					
Date in desicator		03.08.2020		16:00			
Date Time		04.08. 16:30	05.08. 7:00	05.08. 16:30	06.08. 8:00	07.08. 8:20	
Humidity [%] Temperature [°C]		42 20	37 22	33 23	37 20	41 19	
Filters (47 mm)	5.2-3532	59.8301	59.8297	59.8297			
	5.2-3533	59.9490	59.9481	59.9482			
	5.2-3766	9.9564	9.9563				
	5.2-3031	58.2462	58.2457	58.2452	58.2447	58.2447	
	5.2-2540	9.3652	9.3653				
	4.2-2630	9.7735	9.7735				

Test method ASTM E2515-11 – Lab results

Run	**2**
Manufacturer	Fröling Heizkessel
Project No.	32-10198
Model	**P4 Pellet 60**
Test date	04.08.2020

Particulate emissions

	Run	2				
	Date of testing	04.08.2020				
		ID	Final weight	Tare weight	Particulate	Total particulate
			[g]	[g]	[mg]	[mg]
Train 1	Front filter – First hr	5.2-3000	58.4510	58.4502	0.8	**5.5**
	Front filter - After first hr	5.2-3695	60.2982	60.2941	4.1	
	Rear filter	4.2-213	9.8821	9.8815	0.6	
Train 2	Front filter	11.5-216	59.1351	59.1302	4.9	**5.0**
	Rear filter	4.2-2616	9.6740	9.6739	0.1	
Amb.	Rear filter	5.2-3211	9.4648	9.4648	0.0	**0.0**

Filter train

Run		2					
Date of testing		04.08.2020					
Date in desicator		04.08.2020		16:00			
Date Time		05.08. 16:30	06.08. 8:00	06.08. 16:30	07.08. 8:20		
Humidity [%] Temperature [°C]		33 23	37 20	44 24	41 19		
Filters (47 mm)	5.2-3000	58.4519	58.4515	58.4511	58.4510		
	5.2-3695	60.2993	60.2989	60.2982	60.2982		
	4.2-213	9.8824	9.8821	9.8821			
	11.5-216	59.1360	59.1354	59.1350	59.1351		
	4.2-2616	9.6740	9.6740				
	5.2-3211	9.4647	9.4648				

Test method ASTM E2515-11 – Lab results

Run	**3**
Manufacturer	Fröling Heizkessel
Project No.	32-10198
Model	**P4 Pellet 60**
Test date	04.08.2020

Particulate emissions

	Run	3				
	Date of testing	04.08.2020				
		ID	Final weight	Tare weight	Particulate	Total particulate
			[g]	[g]	[mg]	[mg]
Train 1	Front filter – First hr	10.0-214	60.0349	60.0338	1.1	**7.8**
	Front filter - After first hr	5.2-214	60.2843	60.2780	6.3	
	Rear filter	4.2-2202	9.8825	9.8821	0.4	
Train 2	Front filter	6.4-3135	59.8097	59.8030	6.7	**7.1**
	Rear filter	4.2-2413	9.4526	9.4522	0.4	
					0.0	
Amb.	Rear filter	6.4-3314	10.1165	10.1165	0.0	**0.0**

Filter train

Run		3					
Date of testing		04.08.2020					
Date in desicator		04.08.2020		16:00			
Date Time		05.08. 16:30	06.08. 8:00	06.08. 16:30	07.08. 8:20		
Humidity [%] Temperature [°C]		33 23	37 20	44 24	41 19		
Filters (47 mm)	10.0-214	60.0350	60.0349				
	5.2-214	60.2849	60.2846	60.2843	60.2843		
	4.2-2202	9.8826	9.8825				
	6.4-3135	59.8103	59.8097	59.8097			
	4.2-2413	9.4526	9.4526				
	6.4-3314	10.1165	10.1165				

Test method ASTM E2515-11 – Lab results

Run	**4**
Manufacturer	Fröling Heizkessel
Project No.	32-10198
Model	**P4 Pellet 60**
Test date	05.08.2020

Particulate emissions

	Run	4				
	Date of testing	05.08.2020				
		ID	Final weight	Tare weight	Particulate	Total particulate
			[g]	[g]	[mg]	[mg]
Train 1	Front filter – First hr	10.0-215	58.7241	58.7233	0.8	**5.2**
	Front filter - After first hr	5.2-3244	59.5257	59.5213	4.4	
	Rear filter	5.2-2598	9.7079	9.7079	0.0	
Train 2	Front filter	4.2-215	60.3992	60.3938	5.4	**5.7**
	Rear filter	6.4-3253	10.1917	10.1914	0.3	
Amb.	Rear filter	6.4-3343	10.0218	10.0218	0.0	**0.0**

Filter train

Run		4					
Date of testing		05.08.2020					
Date in desicator		05.08.2020		16:00			
Date Time		06.08. 16:30	07.08. 8:20	07.08. 16:00	08.08. 16:00		
Humidity [%] Temperature [°C]		44 24	41 19	52 24	42 25		
Filters (47 mm)	10.0-215	58.7252	58.7244	58.7241	58.7241		
	5.2-3244	59.5260	59.5256	59.5257			
	5.2-2598	9.7079	9.7079				
	4.2-215	60.3998	60.3992	60.3992			
	6.4-3253	10.1917	10.1917				
	6.4-3343	10.0217	10.0218				

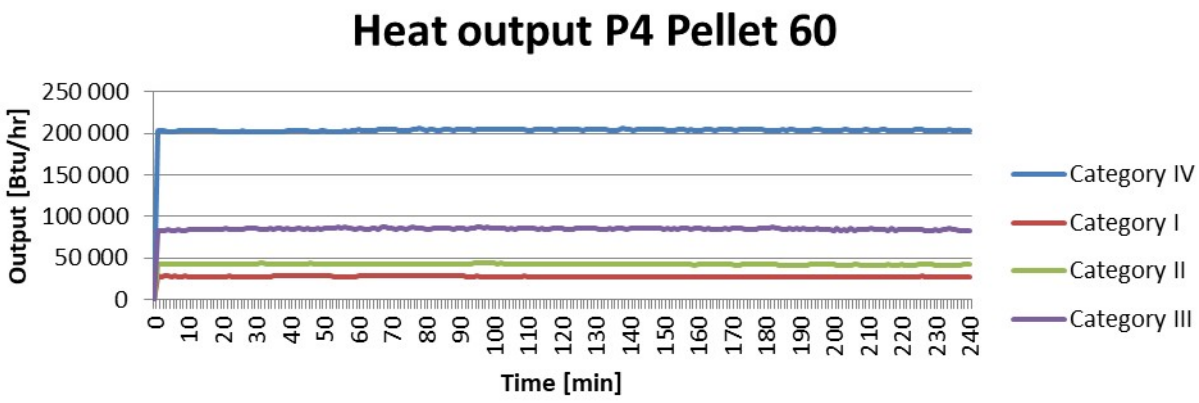
Filter tares

Date of testing		3. 8. – 5. 8. 2020			
Date in desicator		28.7.2020		8:00	
Date Time	29.7. 16:00	31.7. 6:50	1.8. 17:00	2.8. 12:30	4.8. 17:00
Humidity [%] Temperature [°C]	49 20	32 19	39 24	53 22	44 21
ID (47 mm)					
5.2-3532	59.8282	59.8278	59.8278		
5.2-3533	59.9415	59.9414			
5.2-3766	9.9560	9.9557	9.9557		
5.2-3031	58.2372	58.2367	58.2364	58.2364	
5.2-2540	9.3646	9.3647			
4.2-2630	9.7735	9.7735			
5.2-3000	58.4503	58.4502			
5.2-3695	60.2944	60.2940	60.2941		
4.2-213	9.8815	9.8815			
11.5-216	59.1302	59.1302			
4.2-2616	9.6740	9.6739			
5.2-3211	9.4648	9.4648			
10.0-214	60.0342	60.0339	60.0338		
5.2-214	60.2786	60.2781	60.2780		
4.2-2202	9.8821	9.8821			
6.4-3135	59.8033	59.8030	59.8030		
4.2-2413	9.4522	9.4522			
6.4-3314	10.1168	10.1165	10.1165		
10.0-215	58.7237	58.7233	58.7233		58.7233
5.2-3244	59.5214	59.5213			59.5213
5.2-2598	9.7079	9.7079			9.7079
4.2-215	60.3952	60.3947	60.3939	60.3938	60.3938
6.4-3253	10.1914	10.1914			10.1914
6.4-3343	10.0218	10.0218			10.0218

IX. Heat output results

ASTME2618-13 Heat output results

Manufacturer		**Fröling Heizkessel- und Behälterbau Ges.m.b.H.**			
Model		**P4 Pellet 60**			
Run		**1**	**2**	**3**	**4**
Test date		**03.08.2020**	**04.08.2020**	**04.08.2020**	**05.08.2020**
Burn Rate Category		**IV**	**I**	**II**	**III**
Time interval	min	240	240	240	240
Total fuel weight (wet)	lb	114.9	17.4	26.7	50.1
Average moisture of fuel	% dry	6.41	6.41	6.41	6.41
Average moisture of fuel	% wet	6.02	6.02	6.02	6.02
Average temperature of appliance water at start of test	°F	151	147	143	140
Average temperature of appliance water at end of test	°F	151	147	147	140
Average thermopile reading	°F	93	91	93	87
Average load side liquid flow rate	gal/min	4.39	0.61	0.91	1.95
Burn rate	lb/hr	26.98	4.08	6.26	11.75
Emissions	g	8.31	4.83	6.48	5.00
Fuel HHV	Btu/lb	8 600	8 600	8 600	8 600
Fuel LHV	Btu/lb	7 983	7 983	7 983	7 983
HHV Heat Input	Btu	928 677	140 941	215 955	404 826
LHV Heat Input	Btu	862 008	130 823	200 452	375 764
Appliance water specific heat	Btu/lb°F	1.001	1.001	1.001	1.001
Tank water Specific Heat	Btu/lb°F	1.001	1.001	1.001	1.001
Q - unit	Btu	-329	-92	2 414	22
Q - load	Btu	814 667	110 579	170 624	338 289
Q - storage	Btu	0	0	0	0
Total heat output	Btu	814 337	110 487	173 038	338 312
Total heat output rate	Btu/hr	203 584	27 730	43 428	84 578
Load output rate	Btu/hr	203 667	27 753	42 822	84 572
Emissions factor	g/kg	0.169	0.647	0.567	0.233
Total particulate emissions rate	g/MJ	0.0096	0.0413	0.0354	0.0139
Total particulate emissions rate	**lb/MM Btu**	**0.022**	**0.096**	**0.082**	**0.032**
Total particulate emissions	g/hr	2.07	1.21	1.62	1.25
Delivered efficency, HHV	%	87.7	78.4	80.1	83.6


Heat output P4 Pellet 60
Output [Btu/hr]
250 000
200 000
150 000
100 000
50 000
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
Time [min]
Category IV
Category I
Category II
Category III

Testing Laboratory
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Hydronic heating appliances – test method ASTM E2618-13 Annex A2 Water test data

Manufacturer:		Fröling Heizkessel- und Behälterbau Ges.m.b.H.
Model:		P4 Pellet 60
Project No.:		31-31313
Run No.:		1
Test date:		03.08.2020
Technician:		Foit
Beginning clock time:		11:43:00
Recording interval:	[min]	1
Total sampling time:	[min]	240

Boiler dry weight:	[lbs]	1676
Boiler water weight:	[lbs]	375

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
0	50.2	81	28.92	235	0.0007	12.88	4.412	11.351	93	134	169	76	78	62	155	1.001	36.745		0.0
1	50.0	81	28.92	235	0.0008	12.01	4.402	11.347	93	134	169	76	78	62	155	1.001	36.664	3 398	0.5
2	49.0	82	28.92	235	0.0007	12.07	4.387	11.356	92	134	168	76	78	62	155	1.001	36.537	3 378	1.0
3	48.5	82	28.92	234	0.0008	11.62	4.397	11.349	92	133	168	76	78	62	155	1.001	36.622	3 374	1.4
4	48.7	82	28.92	235	0.0008	12.19	4.402	11.341	92	133	168	76	79	62	154	1.001	36.664	3 362	1.9
5	48.8	82	28.92	235	0.0006	12.40	4.404	11.352	92	133	168	76	79	62	154	1.001	36.683	3 372	2.4
6	48.9	82	28.92	235	0.0006	12.68	4.386	11.333	92	133	168	76	79	62	155	1.001	36.532	3 369	2.9
7	49.2	81	28.92	235	0.0006	12.51	4.397	11.329	92	133	168	76	78	62	155	1.001	36.620	3 385	3.4
8	49.3	81	28.92	235	0.0008	11.81	4.404	11.345	92	133	168	76	78	62	155	1.001	36.681	3 388	3.8
9	49.6	81	28.92	235	0.0008	12.22	4.404	11.330	92	133	168	76	78	62	154	1.001	36.681	3 378	4.3
10	49.9	81	28.92	235	0.0007	12.37	4.401	11.317	92	133	168	76	78	62	155	1.001	36.657	3 378	4.8

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El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
11	49.9	81	28.92	236	0.0007	12.64	4.403	11.327	92	133	169	76	78	62	155	1.001	36.674	3 383	5.3
12	49.8	81	28.92	236	0.0007	12.42	4.388	11.329	92	134	169	76	78	62	155	1.001	36.549	3 383	5.7
13	49.9	81	28.92	235	0.0008	11.97	4.397	11.340	92	134	168	76	78	62	155	1.001	36.620	3 386	6.2
14	50.2	81	28.92	236	0.0007	12.35	4.397	11.326	92	133	168	75	78	62	155	1.001	36.620	3 379	6.7
15	50.1	81	28.92	235	0.0008	12.35	4.401	11.339	92	133	168	75	78	62	155	1.001	36.654	3 383	7.2
16	50.4	81	28.92	236	0.0008	11.94	4.400	11.331	92	133	168	75	78	62	155	1.001	36.645	3 381	7.7
17	50.3	81	28.92	236	0.0008	12.19	4.403	11.327	92	133	168	76	78	62	155	1.001	36.671	3 380	8.1
18	50.2	81	28.92	236	0.0007	12.18	4.405	11.321	92	133	168	76	78	62	155	1.001	36.691	3 382	8.6
19	50.1	81	28.92	236	0.0007	12.17	4.400	11.320	92	133	168	76	78	62	154	1.001	36.647	3 372	9.1
20	49.8	81	28.92	236	0.0007	12.58	4.400	11.319	92	133	168	76	78	62	154	1.001	36.647	3 372	9.6
21	49.5	81	28.92	236	0.0007	12.11	4.394	11.326	92	133	168	76	79	62	154	1.001	36.598	3 369	10.1
22	48.8	82	28.92	235	0.0008	11.78	4.391	11.317	92	133	168	76	79	62	154	1.001	36.571	3 360	10.5
23	48.6	82	28.92	236	0.0008	12.34	4.395	11.319	92	133	168	77	79	62	154	1.001	36.606	3 357	11.0
24	48.8	82	28.92	235	0.0008	11.87	4.398	11.315	92	133	168	77	79	62	154	1.001	36.635	3 363	11.5
25	48.5	82	28.92	236	0.0008	12.67	4.406	11.312	92	133	168	76	79	62	154	1.001	36.699	3 366	12.0
26	48.3	82	28.92	236	0.0008	12.28	4.412	11.314	92	133	168	77	79	62	154	1.001	36.748	3 383	12.4
27	48.4	82	28.92	236	0.0009	11.82	4.401	11.315	92	133	168	77	79	62	154	1.001	36.652	3 367	12.9
28	48.5	82	28.92	236	0.0008	12.15	4.407	11.316	92	133	168	77	79	62	154	1.001	36.704	3 366	13.4
29	48.8	81	28.92	237	0.0008	12.66	4.398	11.310	92	133	168	76	79	62	154	1.001	36.633	3 365	13.9
30	48.6	82	28.92	236	0.0008	11.77	4.391	11.304	92	133	168	76	79	62	154	1.001	36.576	3 365	14.4
31	48.5	82	28.92	236	0.0011	11.36	4.403	11.308	91	133	167	76	79	62	154	1.001	36.669	3 357	14.8
32	48.6	82	28.92	236	0.0007	12.81	4.396	11.309	91	133	168	77	79	62	154	1.001	36.616	3 350	15.3
33	48.4	82	28.92	236	0.0007	12.21	4.398	11.313	92	133	168	77	79	62	154	1.001	36.630	3 367	15.8
34	48.6	82	28.92	237	0.0007	12.54	4.396	11.304	92	133	168	77	79	62	154	1.001	36.613	3 369	16.3
35	48.5	82	28.92	236	0.0008	12.14	4.394	11.312	92	133	168	77	79	62	154	1.001	36.598	3 372	16.8
36	48.7	82	28.92	236	0.0008	11.74	4.393	11.316	92	133	168	77	79	62	154	1.001	36.594	3 364	17.2
37	48.5	82	28.92	236	0.0009	12.06	4.397	11.303	92	133	168	77	79	62	154	1.001	36.620	3 356	17.7

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El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
38	48.6	81	28.92	237	0.0007	12.61	4.400	11.297	92	133	168	77	79	62	154	1.001	36.650	3 362	18.2
39	48.8	81	28.92	237	0.0007	13.23	4.398	11.311	92	133	169	77	79	62	154	1.001	36.633	3 377	18.7
40	48.8	81	28.92	237	0.0007	11.94	4.403	11.312	93	134	169	77	79	62	155	1.001	36.672	3 398	19.2
41	49.0	81	28.92	237	0.0008	12.20	4.397	11.302	92	133	168	77	79	62	154	1.001	36.623	3 378	19.6
42	48.8	82	28.92	237	0.0007	12.11	4.390	11.302	92	133	168	77	79	62	155	1.001	36.567	3 375	20.1
43	48.4	82	28.92	237	0.0008	12.16	4.397	11.304	92	133	168	77	79	62	154	1.001	36.621	3 374	20.6
44	48.4	82	28.92	237	0.0007	11.96	4.403	11.297	92	133	168	77	79	62	154	1.001	36.672	3 375	21.1
45	48.6	82	28.92	237	0.0007	12.47	4.409	11.303	92	133	168	77	79	62	154	1.001	36.726	3 378	21.5
46	48.8	82	28.92	237	0.0007	11.82	4.393	11.292	92	133	168	77	79	62	154	1.001	36.587	3 370	22.0
47	48.4	82	28.92	237	0.0009	11.91	4.393	11.287	92	133	168	77	79	62	154	1.001	36.594	3 362	22.5
48	48.5	82	28.92	237	0.0008	12.74	4.401	11.280	92	133	168	77	79	62	154	1.001	36.652	3 371	23.0
49	48.9	82	28.92	237	0.0008	12.41	4.403	11.292	92	133	168	76	79	62	154	1.001	36.672	3 379	23.5
50	49.0	81	28.92	237	0.0009	12.08	4.395	11.291	92	133	168	76	79	62	154	1.001	36.606	3 375	23.9
51	49.1	81	28.93	237	0.0007	12.34	4.390	11.289	92	133	168	76	79	62	154	1.001	36.562	3 371	24.4
52	49.3	81	28.93	237	0.0009	11.83	4.397	11.295	92	133	168	76	79	62	154	1.001	36.623	3 372	24.9
53	49.6	81	28.93	238	0.0008	12.18	4.396	11.293	92	133	168	75	78	62	154	1.001	36.618	3 365	25.4
54	49.8	81	28.93	238	0.0008	11.80	4.401	11.291	92	133	168	75	78	62	154	1.001	36.653	3 372	25.9
55	49.8	81	28.93	238	0.0007	12.00	4.407	11.279	92	133	168	75	78	62	154	1.001	36.709	3 371	26.3
56	50.1	81	28.93	238	0.0007	12.23	4.406	11.276	92	133	168	75	78	62	154	1.001	36.694	3 373	26.8
57	50.0	81	28.93	238	0.0007	12.28	4.391	11.281	92	133	168	75	78	62	154	1.001	36.570	3 369	27.3
58	50.1	81	28.93	239	0.0008	12.10	4.394	11.280	92	133	168	75	78	62	154	1.001	36.599	3 377	27.8
59	50.1	81	28.93	239	0.0008	12.47	4.405	11.287	92	133	168	75	78	62	154	1.001	36.687	3 386	28.2
60	50.1	81	28.93	239	0.0007	12.82	4.406	11.286	93	134	169	75	78	62	155	1.001	36.699	3 402	28.7
61	50.1	81	28.93	239	0.0008	12.08	4.389	11.297	93	134	169	75	78	62	155	1.001	36.560	3 398	29.2
62	50.2	81	28.93	239	0.0009	11.71	4.392	11.279	93	134	169	75	78	62	155	1.001	36.584	3 395	29.7
63	50.2	81	28.93	239	0.0008	11.91	4.400	11.281	92	133	169	75	78	62	155	1.001	36.648	3 389	30.2
64	50.2	81	28.93	239	0.0007	12.25	4.408	11.300	92	133	169	75	78	62	155	1.001	36.712	3 393	30.6

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El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
65	50.3	81	28.93	240	0.0007	12.52	4.401	11.296	93	134	169	75	78	62	155	1.001	36.655	3 396	31.1
66	50.5	81	28.93	240	0.0007	12.59	4.405	11.290	93	134	169	75	78	62	155	1.001	36.687	3 409	31.6
67	50.8	81	28.93	240	0.0008	12.15	4.399	11.284	93	134	169	75	78	62	155	1.001	36.638	3 411	32.1
68	50.7	80	28.93	239	0.0008	12.03	4.399	11.301	93	134	169	75	78	62	155	1.001	36.643	3 408	32.6
69	50.6	81	28.93	240	0.0007	12.13	4.408	11.287	93	134	169	76	78	62	155	1.001	36.714	3 408	33.0
70	50.7	81	28.93	239	0.0008	12.02	4.401	11.282	93	134	169	76	78	62	155	1.001	36.653	3 400	33.5
71	50.7	81	28.93	240	0.0008	12.04	4.403	11.287	93	134	169	76	78	62	155	1.001	36.672	3 403	34.0
72	50.3	81	28.93	240	0.0007	12.37	4.396	11.276	93	134	169	76	78	62	155	1.001	36.616	3 397	34.5
73	50.3	81	28.93	240	0.0008	11.90	4.388	11.275	93	134	169	76	78	62	155	1.001	36.545	3 396	35.0
74	50.4	81	28.93	240	0.0008	11.97	4.391	11.278	93	134	169	76	78	62	155	1.001	36.577	3 397	35.4
75	50.7	81	28.93	240	0.0007	12.25	4.389	11.280	93	134	169	75	78	62	155	1.001	36.555	3 393	35.9
76	50.7	81	28.93	240	0.0007	12.16	4.400	11.271	93	134	169	75	78	62	155	1.001	36.650	3 405	36.4
77	51.0	81	28.93	240	0.0006	12.58	4.404	11.293	93	134	169	75	78	62	155	1.001	36.680	3 413	36.9
78	51.0	81	28.93	240	0.0007	12.54	4.410	11.281	93	134	170	75	78	62	155	1.001	36.733	3 425	37.3
79	51.0	81	28.93	240	0.0008	11.78	4.401	11.282	93	134	170	75	78	62	155	1.001	36.660	3 419	37.8
80	51.0	81	28.94	240	0.0008	12.16	4.390	11.274	93	134	169	75	78	62	155	1.001	36.565	3 395	38.3
81	51.0	80	28.93	240	0.0008	12.16	4.394	11.280	93	134	169	75	78	62	155	1.001	36.601	3 400	38.8
82	51.3	80	28.93	240	0.0008	12.00	4.397	11.276	93	134	169	75	77	62	155	1.001	36.626	3 404	39.3
83	51.5	80	28.93	240	0.0009	12.16	4.392	11.281	93	134	169	75	78	62	155	1.001	36.579	3 394	39.7
84	51.8	80	28.93	240	0.0008	12.32	4.380	11.269	93	134	169	75	78	62	155	1.001	36.479	3 392	40.2
85	51.7	80	28.93	240	0.0008	11.97	4.400	11.269	93	134	169	75	78	62	155	1.001	36.650	3 407	40.7
86	51.6	80	28.93	240	0.0008	12.11	4.394	11.272	93	134	169	75	78	62	155	1.001	36.602	3 399	41.2
87	51.7	80	28.93	240	0.0007	12.06	4.393	11.270	93	134	169	75	78	62	155	1.001	36.589	3 401	41.7
88	51.7	80	28.93	240	0.0008	12.12	4.389	11.275	93	134	169	75	78	62	155	1.001	36.560	3 394	42.1
89	51.7	80	28.93	241	0.0008	12.67	4.396	11.291	93	134	169	75	78	62	155	1.001	36.614	3 406	42.6
90	51.9	80	28.93	241	0.0007	12.75	4.376	11.262	93	134	170	75	78	62	155	1.001	36.448	3 404	43.1
91	52.2	80	28.93	240	0.0010	11.95	4.391	11.268	93	134	169	75	78	62	155	1.001	36.572	3 414	43.6

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
92	52.2	80	28.93	241	0.0007	12.86	4.391	11.273	93	134	170	75	77	62	155	1.001	36.572	3 408	44.0
93	52.0	80	28.93	240	0.0009	11.97	4.388	11.273	93	134	169	75	77	62	155	1.001	36.553	3 411	44.5
94	51.9	80	28.93	240	0.0010	12.09	4.391	11.279	93	134	169	75	77	62	155	1.001	36.575	3 397	45.0
95	51.8	80	28.93	241	0.0007	13.17	4.394	11.271	93	134	169	75	78	62	155	1.001	36.597	3 405	45.5
96	51.8	80	28.93	240	0.0008	11.96	4.396	11.259	93	134	170	75	78	62	155	1.001	36.614	3 416	46.0
97	51.9	80	28.93	241	0.0008	12.40	4.401	11.269	93	134	169	75	78	62	155	1.001	36.656	3 412	46.4
98	51.5	80	28.93	241	0.0007	12.34	4.386	11.257	93	134	169	75	78	62	155	1.001	36.528	3 401	46.9
99	51.5	80	28.93	240	0.0008	12.47	4.388	11.262	93	134	169	75	78	62	155	1.001	36.553	3 405	47.4
100	51.4	80	28.93	240	0.0007	12.20	4.393	11.255	93	134	169	75	78	62	155	1.001	36.587	3 412	47.9
101	51.3	80	28.93	241	0.0008	12.19	4.391	11.263	93	134	169	75	78	62	155	1.001	36.575	3 408	48.4
102	51.5	80	28.93	241	0.0009	12.14	4.394	11.255	93	134	169	75	77	62	155	1.001	36.599	3 407	48.8
103	51.5	80	28.93	241	0.0007	12.24	4.400	11.250	93	134	169	75	77	62	155	1.001	36.648	3 408	49.3
104	51.6	80	28.93	241	0.0008	12.73	4.399	11.268	93	134	169	75	78	62	155	1.001	36.641	3 408	49.8
105	51.9	80	28.93	241	0.0007	12.12	4.402	11.260	93	134	170	75	77	62	155	1.001	36.665	3 420	50.3
106	52.2	80	28.93	241	0.0007	12.30	4.401	11.254	93	134	169	75	78	62	155	1.001	36.653	3 414	50.7
107	52.0	80	28.93	241	0.0008	12.24	4.387	11.257	93	134	169	75	77	62	155	1.001	36.541	3 402	51.2
108	51.8	80	28.93	241	0.0007	12.49	4.394	11.273	93	134	169	75	77	62	155	1.001	36.602	3 411	51.7
109	51.9	80	28.93	241	0.0007	12.09	4.393	11.264	93	134	169	75	77	62	155	1.001	36.592	3 415	52.2
110	51.8	80	28.93	241	0.0009	11.72	4.383	11.250	93	134	169	75	78	62	155	1.001	36.504	3 395	52.7
111	51.7	80	28.93	241	0.0008	12.53	4.382	11.238	93	134	169	75	78	62	155	1.001	36.497	3 392	53.1
112	51.5	81	28.93	241	0.0008	12.30	4.390	11.252	93	134	169	75	78	62	155	1.001	36.563	3 406	53.6
113	51.7	81	28.93	241	0.0008	12.40	4.390	11.248	93	134	169	75	78	62	155	1.001	36.568	3 407	54.1
114	51.8	80	28.93	241	0.0008	12.35	4.381	11.240	93	134	169	75	78	62	155	1.001	36.494	3 405	54.6
115	51.6	81	28.93	241	0.0007	12.27	4.384	11.253	93	134	169	75	78	62	155	1.001	36.516	3 410	55.1
116	51.4	81	28.93	241	0.0007	12.08	4.391	11.252	93	134	169	75	78	62	155	1.001	36.570	3 411	55.5
117	51.5	81	28.93	240	0.0007	11.77	4.391	11.246	93	134	169	75	77	62	155	1.001	36.577	3 405	56.0
118	51.3	81	28.93	241	0.0008	12.34	4.384	11.242	93	134	169	75	77	62	155	1.001	36.514	3 391	56.5

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
119	51.6	81	28.93	241	0.0007	12.52	4.389	11.239	93	134	169	75	77	62	155	1.001	36.555	3 399	57.0
120	51.8	81	28.93	241	0.0008	12.20	4.375	11.246	93	134	170	74	77	62	155	1.001	36.438	3 401	57.5
121	51.7	81	28.93	241	0.0009	12.17	4.371	11.243	93	134	169	75	77	62	156	1.001	36.406	3 400	57.9
122	52.0	80	28.93	241	0.0008	12.13	4.396	11.243	93	134	169	75	77	62	155	1.001	36.611	3 415	58.4
123	51.8	81	28.92	241	0.0008	12.54	4.391	11.255	93	134	170	75	77	62	155	1.001	36.577	3 413	58.9
124	51.7	81	28.92	241	0.0007	11.61	4.397	11.257	93	134	169	75	77	62	155	1.001	36.626	3 415	59.4
125	51.7	81	28.92	241	0.0009	12.02	4.397	11.252	93	134	169	75	77	62	155	1.001	36.624	3 403	59.8
126	51.9	80	28.92	241	0.0008	12.38	4.384	11.257	93	134	169	75	77	62	155	1.001	36.519	3 394	60.3
127	52.0	80	28.92	241	0.0007	12.44	4.393	11.241	93	134	169	75	77	62	155	1.001	36.590	3 408	60.8
128	52.2	80	28.92	241	0.0008	12.30	4.381	11.224	93	134	170	74	77	62	155	1.001	36.492	3 406	61.3
129	52.3	80	28.92	241	0.0009	11.98	4.388	11.254	93	134	169	74	77	62	155	1.001	36.546	3 407	61.8
130	52.4	80	28.92	241	0.0007	12.60	4.385	11.238	93	134	169	74	77	62	155	1.001	36.524	3 407	62.2
131	52.3	80	28.92	241	0.0008	11.83	4.386	11.234	93	134	169	74	77	62	155	1.001	36.533	3 410	62.7
132	52.1	80	28.92	242	0.0007	12.34	4.401	11.251	93	134	169	74	77	62	155	1.001	36.653	3 413	63.2
133	52.2	80	28.92	241	0.0007	12.16	4.395	11.237	93	134	169	75	77	62	155	1.001	36.607	3 414	63.7
134	52.1	80	28.92	241	0.0008	12.11	4.374	11.234	93	134	170	75	77	62	155	1.001	36.436	3 398	64.2
135	51.9	80	28.92	241	0.0008	11.65	4.385	11.245	93	134	169	75	77	62	155	1.001	36.524	3 398	64.6
136	51.8	80	28.92	242	0.0007	12.49	4.386	11.241	93	134	169	75	77	62	155	1.001	36.536	3 394	65.1
137	51.9	80	28.92	242	0.0007	12.67	4.388	11.242	93	134	170	75	77	62	155	1.001	36.553	3 410	65.6
138	52.0	80	28.92	242	0.0008	12.29	4.397	11.245	93	134	170	75	77	62	156	1.001	36.621	3 426	66.1
139	52.1	80	28.92	242	0.0009	11.89	4.389	11.229	93	134	169	75	77	62	155	1.001	36.560	3 415	66.5
140	52.2	80	28.92	241	0.0009	12.10	4.387	11.242	93	134	169	75	77	62	155	1.001	36.541	3 406	67.0
141	52.3	80	28.92	242	0.0008	12.29	4.379	11.234	93	134	169	74	77	62	155	1.001	36.477	3 399	67.5
142	52.5	80	28.92	242	0.0007	12.56	4.390	11.242	93	134	170	74	77	62	155	1.001	36.563	3 412	68.0
143	52.7	80	28.92	241	0.0008	11.65	4.393	11.224	93	134	169	74	77	62	155	1.001	36.595	3 419	68.5
144	52.6	80	28.92	242	0.0008	12.15	4.397	11.244	93	134	169	74	77	62	155	1.001	36.621	3 406	68.9
145	52.7	80	28.92	242	0.0006	12.58	4.393	11.232	93	134	170	74	77	62	155	1.001	36.590	3 410	69.4

Testing Laboratory
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El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
146	52.6	80	28.92	241	0.0007	11.70	4.388	11.240	93	134	169	74	77	62	155	1.001	36.546	3 409	69.9
147	52.6	80	28.92	242	0.0007	12.35	4.390	11.232	93	134	169	74	77	62	155	1.001	36.565	3 403	70.4
148	52.4	80	28.92	242	0.0007	12.14	4.395	11.230	93	134	170	74	77	62	155	1.001	36.604	3 413	70.9
149	52.4	80	28.92	242	0.0008	12.16	4.404	11.233	93	134	169	74	77	62	155	1.001	36.685	3 415	71.3
150	52.4	80	28.92	241	0.0007	11.97	4.391	11.238	93	134	169	74	77	62	155	1.001	36.578	3 409	71.8
151	52.4	80	28.92	241	0.0008	11.86	4.391	11.220	93	134	169	74	77	62	155	1.001	36.570	3 397	72.3
152	52.3	80	28.92	242	0.0007	12.25	4.392	11.233	93	134	169	74	77	62	155	1.001	36.585	3 395	72.8
153	52.4	80	28.92	242	0.0007	12.58	4.384	11.231	93	134	169	74	77	62	155	1.001	36.519	3 399	73.3
154	52.4	80	28.92	242	0.0007	12.22	4.381	11.225	93	134	170	74	77	62	155	1.001	36.495	3 410	73.7
155	52.5	80	28.92	241	0.0008	11.92	4.374	11.227	93	134	169	74	77	62	155	1.001	36.436	3 399	74.2
156	52.6	80	28.92	242	0.0007	12.06	4.383	11.239	93	134	169	74	77	62	155	1.001	36.507	3 400	74.7
157	52.8	80	28.92	242	0.0008	12.38	4.378	11.222	93	134	169	74	77	62	155	1.001	36.468	3 396	75.2
158	52.7	80	28.92	242	0.0007	12.14	4.373	11.226	93	134	169	75	77	62	155	1.001	36.426	3 402	75.6
159	52.8	80	28.92	241	0.0009	11.35	4.377	11.224	93	134	169	75	77	62	155	1.001	36.460	3 395	76.1
160	52.7	80	28.92	242	0.0008	12.09	4.376	11.228	93	134	169	75	77	62	155	1.001	36.448	3 379	76.6
161	52.4	80	28.92	242	0.0007	12.50	4.381	11.233	93	134	169	75	77	62	155	1.001	36.492	3 389	77.1
162	52.0	80	28.92	242	0.0007	12.37	4.383	11.243	93	134	169	75	78	62	155	1.001	36.504	3 404	77.6
163	52.1	80	28.92	242	0.0008	12.37	4.383	11.251	93	134	170	75	78	62	155	1.001	36.512	3 409	78.0
164	52.2	80	28.92	242	0.0007	11.81	4.384	11.231	93	134	169	75	77	62	155	1.001	36.517	3 405	78.5
165	52.1	80	28.92	242	0.0008	12.29	4.379	11.228	93	134	169	75	77	62	155	1.001	36.478	3 397	79.0
166	51.7	80	28.92	242	0.0009	12.31	4.387	11.227	93	134	169	75	78	62	155	1.001	36.541	3 408	79.5
167	51.7	80	28.92	242	0.0008	12.52	4.378	11.234	93	134	170	75	78	62	155	1.001	36.468	3 408	80.0
168	51.5	80	28.92	242	0.0008	12.28	4.390	11.235	93	134	169	75	78	62	156	1.001	36.563	3 422	80.4
169	51.3	80	28.92	242	0.0008	11.90	4.381	11.231	93	134	169	75	78	62	156	1.001	36.490	3 413	80.9
170	51.3	81	28.92	242	0.0009	11.49	4.392	11.236	93	134	169	75	78	62	155	1.001	36.585	3 406	81.4
171	51.6	80	28.91	242	0.0007	12.53	4.388	11.229	93	134	169	75	78	62	155	1.001	36.549	3 395	81.9
172	51.4	80	28.92	242	0.0007	12.23	4.401	11.225	93	134	169	75	78	62	155	1.001	36.654	3 414	82.3

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
173	51.2	81	28.92	242	0.0007	12.10	4.393	11.214	93	134	169	75	78	62	155	1.001	36.595	3 409	82.8
174	51.0	81	28.91	242	0.0008	12.07	4.389	11.233	93	134	169	75	78	62	155	1.001	36.561	3 399	83.3
175	51.1	81	28.92	242	0.0007	12.36	4.396	11.204	93	134	169	75	78	62	155	1.001	36.617	3 406	83.8
176	51.0	81	28.91	242	0.0009	11.90	4.391	11.225	93	134	169	76	78	62	155	1.001	36.573	3 402	84.3
177	50.8	81	28.91	242	0.0007	12.28	4.400	11.220	93	134	169	76	78	62	155	1.001	36.649	3 407	84.7
178	50.5	81	28.91	242	0.0007	12.30	4.391	11.228	93	134	169	76	78	62	155	1.001	36.575	3 407	85.2
179	50.5	81	28.91	242	0.0008	11.85	4.393	11.228	93	134	169	76	78	62	155	1.001	36.588	3 408	85.7
180	50.5	81	28.91	242	0.0007	12.16	4.388	11.230	93	134	169	76	78	62	155	1.001	36.551	3 396	86.2
181	50.5	81	28.91	242	0.0008	11.98	4.390	11.234	93	134	169	76	78	62	155	1.001	36.565	3 397	86.7
182	50.7	81	28.91	242	0.0008	12.14	4.386	11.217	93	134	169	76	78	62	155	1.001	36.536	3 392	87.1
183	50.4	81	28.91	242	0.0007	11.79	4.393	11.222	93	134	169	76	78	62	155	1.001	36.592	3 395	87.6
184	50.5	81	28.91	242	0.0007	12.45	4.386	11.235	93	134	169	76	78	62	155	1.001	36.531	3 389	88.1
185	50.6	81	28.91	242	0.0007	11.99	4.405	11.237	93	134	169	76	78	62	155	1.001	36.688	3 403	88.6
186	50.6	81	28.91	242	0.0007	12.35	4.398	11.232	93	134	169	76	78	62	155	1.001	36.629	3 398	89.1
187	50.7	81	28.91	242	0.0007	12.39	4.392	11.233	93	134	169	76	78	62	155	1.001	36.583	3 399	89.5
188	50.5	81	28.91	242	0.0007	12.47	4.391	11.221	93	134	169	76	78	62	155	1.001	36.573	3 407	90.0
189	50.3	81	28.91	242	0.0009	11.72	4.383	11.226	93	134	169	76	78	62	155	1.001	36.512	3 397	90.5
190	50.2	81	28.91	242	0.0008	12.00	4.370	11.224	93	134	169	76	78	62	155	1.001	36.397	3 385	91.0
191	50.1	81	28.91	242	0.0008	12.17	4.382	11.217	93	134	169	76	78	62	155	1.001	36.497	3 392	91.4
192	50.1	81	28.91	242	0.0008	11.92	4.393	11.221	93	134	169	76	78	62	155	1.001	36.588	3 399	91.9
193	50.1	81	28.91	243	0.0007	12.59	4.390	11.231	93	134	169	76	78	62	155	1.001	36.566	3 394	92.4
194	50.2	81	28.91	242	0.0006	12.26	4.395	11.226	93	134	169	76	78	62	155	1.001	36.610	3 409	92.9
195	50.2	81	28.91	242	0.0007	11.94	4.395	11.221	93	134	169	76	78	62	155	1.001	36.610	3 405	93.4
196	50.1	81	28.91	242	0.0007	12.07	4.401	11.214	93	134	169	76	78	62	155	1.001	36.661	3 403	93.8
197	50.0	81	28.91	242	0.0007	11.97	4.392	11.214	93	134	169	76	78	62	155	1.001	36.585	3 395	94.3
198	50.0	81	28.91	242	0.0007	12.29	4.389	11.211	93	134	169	76	78	62	155	1.001	36.556	3 390	94.8
199	50.0	81	28.91	242	0.0008	11.82	4.383	11.220	93	134	169	76	78	62	155	1.001	36.504	3 387	95.3

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
200	50.0	81	28.91	242	0.0008	12.33	4.387	11.232	93	134	169	76	78	62	155	1.001	36.544	3 387	95.8
201	49.9	81	28.91	242	0.0007	12.43	4.390	11.212	93	134	169	76	78	62	155	1.001	36.565	3 394	96.2
202	49.8	81	28.91	242	0.0007	12.09	4.388	11.214	93	134	169	76	78	62	155	1.001	36.551	3 398	96.7
203	49.7	82	28.91	243	0.0006	12.35	4.392	11.208	93	134	169	76	78	62	155	1.001	36.580	3 403	97.2
204	49.7	82	28.91	243	0.0007	11.84	4.389	11.216	93	134	169	76	78	62	155	1.001	36.561	3 400	97.7
205	49.7	82	28.91	242	0.0008	11.89	4.396	11.224	93	134	169	76	78	62	155	1.001	36.619	3 396	98.1
206	49.9	81	28.91	243	0.0008	11.99	4.388	11.189	93	134	169	76	78	62	155	1.001	36.551	3 387	98.6
207	50.1	81	28.91	243	0.0007	12.58	4.383	11.219	93	134	169	76	78	62	155	1.001	36.512	3 390	99.1
208	50.0	81	28.91	243	0.0007	12.40	4.381	11.222	93	134	169	76	78	62	155	1.001	36.487	3 394	99.6
209	50.0	81	28.91	243	0.0007	12.61	4.381	11.227	93	134	169	76	78	62	155	1.001	36.495	3 401	100.1
210	50.0	81	28.91	243	0.0007	12.02	4.394	11.219	93	134	170	76	78	62	155	1.001	36.600	3 415	100.5
211	49.9	82	28.91	242	0.0007	11.67	4.382	11.203	93	134	169	76	78	62	155	1.001	36.497	3 396	101.0
212	49.8	82	28.91	243	0.0007	12.13	4.391	11.208	93	134	169	76	78	62	155	1.001	36.573	3 392	101.5
213	49.8	82	28.91	243	0.0007	12.19	4.383	11.222	93	134	169	76	78	62	155	1.001	36.507	3 387	102.0
214	49.8	82	28.91	243	0.0006	12.61	4.398	11.211	93	134	169	76	78	62	155	1.001	36.629	3 408	102.5
215	49.7	82	28.91	243	0.0008	11.93	4.394	11.221	93	134	169	76	78	62	155	1.001	36.597	3 406	102.9
216	49.9	82	28.91	243	0.0007	11.94	4.385	11.205	93	134	169	76	78	62	155	1.001	36.524	3 392	103.4
217	50.1	81	28.91	243	0.0006	12.01	4.387	11.210	93	134	169	76	78	62	155	1.001	36.541	3 393	103.9
218	50.1	81	28.91	243	0.0007	12.18	4.376	11.221	93	134	169	76	78	62	155	1.001	36.453	3 382	104.4
219	49.9	82	28.91	243	0.0007	12.14	4.375	11.211	93	134	169	76	78	62	155	1.001	36.441	3 385	104.9
220	50.0	81	28.91	243	0.0007	12.15	4.380	11.195	93	134	169	76	78	62	155	1.001	36.485	3 390	105.3
221	50.0	82	28.91	243	0.0008	12.03	4.393	11.204	93	134	169	76	78	62	155	1.001	36.590	3 397	105.8
222	50.1	81	28.91	243	0.0008	12.04	4.379	11.210	93	134	169	76	78	62	155	1.001	36.478	3 384	106.3
223	50.2	81	28.91	243	0.0007	12.53	4.391	11.206	93	134	169	76	78	62	155	1.001	36.571	3 395	106.8
224	50.2	81	28.90	243	0.0007	12.36	4.388	11.204	93	134	169	76	78	62	155	1.001	36.546	3 405	107.2
225	50.1	81	28.90	243	0.0007	12.12	4.382	11.200	93	134	169	76	78	62	155	1.001	36.500	3 403	107.7
226	50.0	81	28.90	243	0.0008	11.85	4.385	11.209	93	134	169	76	78	62	155	1.001	36.522	3 400	108.2

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
227	50.0	81	28.90	243	0.0008	12.23	4.379	11.208	93	134	169	76	78	62	155	1.001	36.478	3 393	108.7
228	50.0	82	28.90	243	0.0008	11.63	4.378	11.201	93	134	169	76	78	62	155	1.001	36.463	3 389	109.2
229	50.0	81	28.90	243	0.0009	12.40	4.385	11.190	93	134	169	76	78	62	155	1.001	36.522	3 386	109.6
230	50.2	81	28.90	243	0.0006	12.53	4.381	11.195	93	134	169	77	78	62	155	1.001	36.487	3 396	110.1
231	50.2	81	28.90	243	0.0007	11.76	4.382	11.202	93	134	169	77	79	62	155	1.001	36.500	3 396	110.6
232	50.2	81	28.90	243	0.0009	11.65	4.373	11.201	93	134	169	77	79	62	155	1.001	36.424	3 380	111.1
233	50.4	81	28.90	244	0.0007	12.89	4.376	11.186	93	134	169	76	79	62	155	1.001	36.451	3 381	111.6
234	50.5	81	28.90	243	0.0007	12.20	4.383	11.199	93	134	169	76	79	62	155	1.001	36.509	3 403	112.0
235	50.7	81	28.90	243	0.0008	11.84	4.374	11.207	93	134	169	76	79	62	155	1.001	36.431	3 390	112.5
236	50.8	81	28.90	243	0.0007	12.28	4.380	11.202	93	134	169	76	79	62	155	1.001	36.485	3 389	113.0
237	51.0	81	28.90	243	0.0007	11.93	4.380	11.199	93	134	169	76	78	62	155	1.001	36.483	3 394	113.5
238	51.1	81	28.90	243	0.0007	12.15	4.379	11.200	93	134	169	76	79	62	155	1.001	36.473	3 386	113.9
239	50.9	81	28.90	243	0.0006	12.41	4.375	11.205	93	134	169	76	79	62	155	1.001	36.441	3 386	114.4
240	51.1	81	28.90	242	0.0007	11.94	4.385	11.191	93	134	169	77	79	62	155	1.001	36.522	3 397	114.9
																		3 397	
	50.7	**81**	**28.92**	**240**	**0.0008**	**12.19**	**4.392**	**11.258**	**93**	**134**	**169**	**75**	**78**	**62**	**155**	**1.001**	**36.578**	**814667**	

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

Hydronic heating appliances – test method ASTM E2618-13 Annex A2 Water test data

Manufacturer:		Fröling Heizkessel- und Behälterbau Ges.m.b.H.
Model:		P4 Pellet 60
Project No.:		31-31313
Run No.:		2
Test date:		04.08.2020
Technician:		Foit
Beginning clock time:		8:32:00
Recording interval:	[min]	1
Total sampling time:	[min]	240

Boiler dry weight:	[lbs]	1676
Boiler water weight:	[lbs]	375

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
0	45.0	80	28.84	147	0.0338	3.73	0.612	2.109	92	133	161	75	77	66	158	1.001	5.095		0.0
1	45.0	80	28.84	147	0.0289	4.18	0.612	2.104	92	133	161	75	77	66	158	1.001	5.097	468	0.1
2	45.1	80	28.84	147	0.0282	4.52	0.608	2.104	92	133	161	75	77	66	158	1.001	5.063	464	0.1
3	45.1	80	28.84	147	0.0272	4.10	0.611	2.105	92	133	161	75	77	66	158	1.001	5.090	466	0.2
4	45.1	80	28.84	147	0.0254	4.63	0.612	2.106	91	133	161	75	77	66	158	1.001	5.095	466	0.3
5	45.1	80	28.84	147	0.0198	5.42	0.610	2.104	91	133	161	75	77	66	158	1.001	5.080	464	0.4
6	45.1	80	28.84	147	0.0242	4.78	0.613	2.103	91	133	161	74	77	66	158	1.001	5.100	466	0.4
7	45.2	80	28.84	147	0.0276	4.50	0.612	2.106	91	133	161	74	77	66	157	1.001	5.092	465	0.5
8	45.3	80	28.84	147	0.0223	4.77	0.610	2.105	91	133	161	75	77	66	157	1.001	5.080	463	0.6

Testing Laboratory
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El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
9	45.1	80	28.84	147	0.0223	4.60	0.613	2.106	91	133	161	75	77	66	157	1.001	5.102	466	0.7
10	44.9	80	28.84	147	0.0262	4.50	0.610	2.104	91	133	161	75	77	66	158	1.001	5.078	464	0.7
11	45.1	80	28.85	147	0.0266	4.39	0.603	2.105	91	133	161	75	77	66	158	1.001	5.024	459	0.8
12	44.8	80	28.85	147	0.0262	4.32	0.604	2.104	91	133	161	75	77	66	158	1.001	5.031	460	0.9
13	44.6	80	28.85	147	0.0279	4.34	0.609	2.103	91	133	161	75	77	66	158	1.001	5.073	464	0.9
14	44.7	80	28.85	147	0.0269	4.44	0.605	2.106	91	133	161	75	77	66	158	1.001	5.034	460	1.0
15	44.4	80	28.85	147	0.0243	4.91	0.609	2.103	91	133	161	75	77	66	158	1.001	5.068	463	1.1
16	44.4	80	28.85	147	0.0223	4.48	0.610	2.105	91	133	161	75	77	66	158	1.001	5.078	464	1.2
17	44.5	80	28.85	148	0.0303	3.66	0.604	2.103	91	133	161	75	77	66	158	1.001	5.029	460	1.2
18	44.2	81	28.85	147	0.0271	4.55	0.609	2.104	91	133	161	75	77	66	158	1.001	5.070	464	1.3
19	44.0	81	28.85	148	0.0303	4.01	0.610	2.102	91	133	161	75	77	66	158	1.001	5.080	465	1.4
20	44.0	81	28.85	147	0.0258	4.27	0.609	2.102	91	133	161	75	77	66	158	1.001	5.070	464	1.5
21	43.9	81	28.85	148	0.0283	4.35	0.605	2.100	91	133	161	75	77	66	158	1.001	5.036	461	1.5
22	43.8	81	28.85	148	0.0244	4.77	0.611	2.101	91	133	161	75	77	66	158	1.001	5.083	465	1.6
23	43.9	81	28.85	147	0.0251	4.57	0.607	2.103	91	133	161	75	77	66	157	1.001	5.056	462	1.7
24	44.0	81	28.85	148	0.0248	4.69	0.606	2.103	91	133	160	75	77	66	157	1.001	5.046	461	1.7
25	43.9	81	28.85	147	0.0233	5.19	0.607	2.103	91	133	160	75	77	66	157	1.001	5.053	461	1.8
26	44.4	80	28.85	148	0.0205	5.77	0.605	2.101	91	133	160	75	77	66	157	1.001	5.039	460	1.9
27	44.1	81	28.85	148	0.0233	4.93	0.602	2.103	91	132	161	75	77	66	157	1.001	5.012	457	2.0
28	43.4	81	28.85	148	0.0231	4.89	0.606	2.100	91	133	161	75	77	66	157	1.001	5.044	461	2.0
29	43.5	81	28.85	148	0.0276	4.13	0.608	2.104	91	132	161	75	77	66	157	1.001	5.058	462	2.1

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
30	43.8	81	28.85	148	0.0314	3.71	0.608	2.103	91	133	161	75	77	66	157	1.001	5.063	463	2.2
31	44.0	81	28.85	148	0.0283	3.77	0.606	2.100	92	133	161	75	77	66	157	1.001	5.041	462	2.3
32	44.2	81	28.85	148	0.0301	3.68	0.608	2.103	92	132	161	75	77	66	157	1.001	5.058	463	2.3
33	44.3	80	28.86	148	0.0340	3.60	0.609	2.101	92	132	161	75	77	66	157	1.001	5.071	465	2.4
34	43.9	81	28.85	148	0.0326	3.97	0.607	2.102	92	133	161	75	77	66	157	1.001	5.056	463	2.5
35	43.8	81	28.85	148	0.0330	4.28	0.612	2.100	92	132	161	75	77	66	157	1.001	5.095	467	2.5
36	43.5	81	28.86	148	0.0269	5.14	0.611	2.100	92	132	161	75	77	66	157	1.001	5.090	467	2.6
37	43.6	81	28.86	148	0.0230	5.40	0.611	2.100	92	132	161	75	77	66	158	1.001	5.083	466	2.7
38	43.7	81	28.86	148	0.0231	5.18	0.610	2.098	92	133	161	75	77	66	158	1.001	5.078	467	2.8
39	43.7	81	28.86	148	0.0216	5.35	0.610	2.098	92	133	161	75	77	66	158	1.001	5.080	467	2.8
40	43.1	81	28.86	148	0.0289	4.40	0.614	2.101	92	133	161	75	77	66	158	1.001	5.115	471	2.9
41	43.2	81	28.86	148	0.0278	4.45	0.611	2.099	92	133	161	75	77	66	158	1.001	5.090	468	3.0
42	43.5	81	28.86	148	0.0284	4.59	0.611	2.099	92	133	162	75	77	66	158	1.001	5.085	469	3.1
43	43.9	81	28.86	148	0.0289	4.36	0.610	2.100	92	133	162	75	77	66	158	1.001	5.075	468	3.1
44	44.1	81	28.86	148	0.0354	4.02	0.612	2.100	92	133	162	75	77	66	158	1.001	5.093	470	3.2
45	43.6	81	28.86	148	0.0251	4.82	0.608	2.100	92	133	161	75	77	66	158	1.001	5.066	468	3.3
46	43.4	81	28.86	148	0.0290	4.89	0.609	2.101	92	133	161	75	77	66	158	1.001	5.073	468	3.3
47	42.9	81	28.86	148	0.0279	4.68	0.607	2.100	92	133	161	75	77	66	158	1.001	5.056	466	3.4
48	43.1	81	28.86	148	0.0231	5.15	0.612	2.101	92	133	161	75	77	66	158	1.001	5.092	468	3.5
49	43.5	81	28.86	148	0.0295	4.38	0.610	2.099	92	133	161	75	77	66	158	1.001	5.078	465	3.6
50	43.3	81	28.86	148	0.0297	4.20	0.611	2.098	91	133	161	75	77	66	157	1.001	5.083	465	3.6

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
51	43.4	81	28.86	148	0.0295	4.18	0.611	2.098	91	132	161	75	77	66	157	1.001	5.090	465	3.7
52	43.7	81	28.86	149	0.0378	3.47	0.613	2.098	91	132	161	75	77	66	157	1.001	5.102	466	3.8
53	43.8	81	28.86	148	0.0343	4.18	0.607	2.098	91	132	161	75	77	66	157	1.001	5.051	461	3.9
54	44.1	81	28.86	148	0.0368	3.82	0.610	2.097	91	132	161	75	77	66	157	1.001	5.078	464	3.9
55	44.0	81	28.86	148	0.0316	4.50	0.607	2.097	91	133	160	75	77	66	157	1.001	5.053	462	4.0
56	43.4	81	28.86	148	0.0255	5.10	0.608	2.096	91	133	160	75	77	66	157	1.001	5.063	463	4.1
57	43.1	81	28.86	148	0.0307	4.32	0.607	2.098	91	133	161	75	77	66	157	1.001	5.053	462	4.1
58	42.9	81	28.86	148	0.0309	4.99	0.603	2.099	91	133	161	75	77	66	157	1.001	5.017	458	4.2
59	43.4	81	28.86	148	0.0275	4.96	0.606	2.097	91	133	161	75	77	66	157	1.001	5.048	461	4.3
60	43.0	81	28.86	149	0.0248	5.12	0.612	2.097	91	133	161	75	77	66	157	1.001	5.095	466	4.4
61	42.7	82	28.86	149	0.0258	4.76	0.609	2.095	92	133	162	75	77	66	158	1.001	5.068	465	4.4
62	42.5	82	28.86	149	0.0292	4.13	0.608	2.097	92	133	162	75	77	66	158	1.001	5.061	466	4.5
63	42.5	82	28.86	149	0.0331	4.38	0.610	2.096	92	133	162	75	77	66	158	1.001	5.080	469	4.6
64	42.7	82	28.86	149	0.0277	4.89	0.606	2.094	92	133	162	75	77	66	158	1.001	5.046	467	4.7
65	42.5	82	28.86	149	0.0358	3.85	0.611	2.096	93	133	162	75	77	66	159	1.001	5.090	472	4.7
66	42.3	82	28.86	149	0.0345	4.51	0.608	2.095	93	133	162	75	77	66	159	1.001	5.058	470	4.8
67	42.5	82	28.86	149	0.0319	4.85	0.611	2.098	93	133	162	75	77	66	159	1.001	5.085	473	4.9
68	42.6	82	28.86	149	0.0278	5.26	0.607	2.095	93	133	162	75	77	66	159	1.001	5.053	470	4.9
69	42.1	82	28.86	149	0.0281	4.68	0.612	2.096	93	134	162	75	77	66	159	1.001	5.097	474	5.0
70	42.5	82	28.86	149	0.0357	3.85	0.612	2.095	93	133	162	75	77	66	159	1.001	5.095	474	5.1
71	42.8	82	28.86	149	0.0360	4.01	0.608	2.095	93	133	162	75	77	66	159	1.001	5.063	470	5.2

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
72	43.3	81	28.86	149	0.0279	4.87	0.611	2.093	93	133	162	75	77	66	159	1.001	5.088	472	5.2
73	43.6	81	28.86	149	0.0306	4.73	0.608	2.094	92	133	162	75	77	66	158	1.001	5.063	469	5.3
74	43.2	81	28.86	149	0.0292	5.06	0.612	2.095	92	133	162	75	77	66	158	1.001	5.097	472	5.4
75	43.3	81	28.86	149	0.0240	5.42	0.612	2.094	92	133	162	75	77	66	158	1.001	5.093	471	5.4
76	43.2	81	28.86	149	0.0268	4.37	0.615	2.095	92	133	161	75	77	66	158	1.001	5.117	473	5.5
77	43.7	81	28.86	149	0.0354	3.42	0.613	2.094	92	133	161	75	77	66	158	1.001	5.107	472	5.6
78	43.4	81	28.86	149	0.0437	3.21	0.611	2.095	92	133	161	75	77	66	158	1.001	5.088	470	5.7
79	43.4	81	28.86	149	0.0390	4.21	0.609	2.093	92	133	161	75	77	66	158	1.001	5.068	467	5.7
80	43.6	81	28.86	149	0.0325	4.50	0.614	2.094	92	133	161	75	77	66	158	1.001	5.110	471	5.8
81	43.9	81	28.86	149	0.0356	4.25	0.611	2.093	92	133	162	75	77	66	158	1.001	5.088	469	5.9
82	44.1	81	28.86	149	0.0279	5.55	0.609	2.094	92	133	162	75	77	66	158	1.001	5.068	467	6.0
83	44.2	81	28.87	149	0.0209	5.92	0.608	2.090	92	133	162	75	77	66	158	1.001	5.063	468	6.0
84	44.3	81	28.86	149	0.0324	4.43	0.612	2.093	92	133	162	75	77	66	159	1.001	5.092	471	6.1
85	44.2	81	28.87	149	0.0395	3.84	0.612	2.093	92	133	162	75	77	66	159	1.001	5.095	472	6.2
86	43.8	81	28.87	149	0.0379	3.95	0.613	2.091	92	133	162	75	77	66	158	1.001	5.102	472	6.2
87	43.7	81	28.87	149	0.0329	4.60	0.611	2.090	92	133	162	75	77	66	158	1.001	5.090	471	6.3
88	43.6	81	28.87	149	0.0321	4.55	0.610	2.092	92	133	161	75	77	66	158	1.001	5.078	469	6.4
89	43.3	81	28.87	149	0.0332	4.86	0.609	2.094	92	133	161	75	77	66	158	1.001	5.073	468	6.5
90	43.1	81	28.87	149	0.0240	5.56	0.609	2.092	92	133	161	75	77	66	158	1.001	5.073	467	6.5
91	43.1	81	28.87	149	0.0276	5.21	0.612	2.092	92	133	161	75	77	66	158	1.001	5.092	468	6.6
92	43.4	81	28.87	149	0.0340	4.34	0.607	2.093	92	133	161	75	77	66	158	1.001	5.051	463	6.7

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
93	43.6	81	28.87	148	0.0413	4.14	0.609	2.093	92	133	160	75	77	66	158	1.001	5.070	464	6.8
94	43.4	81	28.87	148	0.0338	4.88	0.610	2.092	91	133	160	75	77	66	158	1.001	5.075	464	6.8
95	43.3	81	28.87	148	0.0343	4.76	0.613	2.095	91	133	160	75	77	66	157	1.001	5.107	466	6.9
96	43.3	81	28.87	148	0.0375	4.34	0.607	2.091	91	132	160	75	77	66	157	1.001	5.051	459	7.0
97	42.7	82	28.87	148	0.0351	4.45	0.611	2.089	91	132	160	75	77	66	157	1.001	5.085	461	7.0
98	43.1	82	28.87	148	0.0404	3.82	0.610	2.093	91	132	160	75	77	66	157	1.001	5.078	460	7.1
99	43.5	81	28.87	148	0.0461	3.29	0.611	2.092	90	132	160	75	77	66	157	1.001	5.087	460	7.2
100	43.8	81	28.87	148	0.0433	3.86	0.613	2.094	90	132	160	75	77	66	157	1.001	5.100	461	7.3
101	43.4	81	28.87	148	0.0394	4.28	0.613	2.096	90	132	160	75	77	66	157	1.001	5.100	461	7.3
102	43.5	81	28.87	148	0.0387	4.48	0.610	2.092	90	132	160	75	77	66	157	1.001	5.080	459	7.4
103	43.2	82	28.87	148	0.0280	5.59	0.610	2.092	90	132	160	75	77	66	157	1.001	5.075	458	7.5
104	42.9	82	28.87	149	0.0327	4.73	0.611	2.092	90	132	160	75	77	66	157	1.001	5.090	459	7.6
105	42.5	82	28.87	149	0.0397	4.18	0.611	2.093	90	132	160	75	77	66	157	1.001	5.085	459	7.6
106	42.5	82	28.87	148	0.0362	4.58	0.611	2.094	90	132	160	75	77	66	157	1.001	5.090	460	7.7
107	42.9	82	28.87	148	0.0339	4.83	0.610	2.091	91	132	161	75	77	66	157	1.001	5.078	460	7.8
108	43.4	81	28.88	148	0.0328	4.76	0.610	2.092	91	132	161	75	77	66	157	1.001	5.078	461	7.8
109	43.7	81	28.88	148	0.0418	3.63	0.615	2.093	91	132	160	75	77	66	157	1.001	5.117	465	7.9
110	43.8	81	28.87	148	0.0396	4.25	0.612	2.093	91	133	160	75	77	66	157	1.001	5.095	463	8.0
111	43.7	81	28.88	148	0.0327	4.96	0.609	2.091	91	132	160	75	77	66	157	1.001	5.070	460	8.1
112	43.1	82	28.88	148	0.0359	4.12	0.608	2.090	91	132	160	75	77	66	157	1.001	5.065	459	8.1
113	42.6	82	28.88	148	0.0374	4.24	0.613	2.091	90	132	159	75	78	66	157	1.001	5.102	461	8.2

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
114	43.1	82	28.88	148	0.0414	3.71	0.611	2.090	90	132	159	75	78	66	157	1.001	5.090	459	8.3
115	43.3	81	28.88	148	0.0443	3.89	0.610	2.091	90	132	159	75	78	66	156	1.001	5.078	457	8.4
116	43.2	81	28.88	148	0.0356	4.80	0.614	2.091	90	132	159	75	78	66	156	1.001	5.109	460	8.4
117	43.5	81	28.88	148	0.0392	4.40	0.611	2.090	90	132	159	75	77	66	156	1.001	5.082	456	8.5
118	43.7	81	28.88	148	0.0322	5.38	0.611	2.090	90	132	159	75	77	66	156	1.001	5.090	456	8.6
119	43.6	81	28.88	148	0.0237	5.57	0.607	2.090	89	131	159	75	77	66	156	1.001	5.056	452	8.6
120	43.2	82	28.87	148	0.0305	4.97	0.611	2.092	89	131	159	75	77	66	156	1.001	5.085	455	8.7
121	43.3	81	28.88	148	0.0378	4.25	0.610	2.093	89	131	159	75	78	66	156	1.001	5.078	454	8.8
122	43.4	81	28.88	148	0.0415	3.51	0.611	2.089	90	131	159	75	77	66	156	1.001	5.087	456	8.9
123	43.4	81	28.88	148	0.0401	3.45	0.611	2.091	90	131	160	75	77	66	156	1.001	5.090	457	8.9
124	43.3	82	28.87	148	0.0376	3.95	0.609	2.088	90	132	160	75	77	66	156	1.001	5.068	455	9.0
125	42.7	82	28.87	148	0.0396	3.82	0.605	2.088	90	132	160	75	78	66	156	1.001	5.036	453	9.1
126	43.1	82	28.88	148	0.0424	3.32	0.606	2.089	90	132	160	75	77	66	156	1.001	5.048	455	9.2
127	43.7	81	28.88	148	0.0427	3.73	0.610	2.089	90	132	160	75	78	66	156	1.001	5.080	458	9.2
128	44.0	81	28.88	148	0.0436	4.15	0.606	2.090	90	132	160	75	78	66	156	1.001	5.041	454	9.3
129	43.6	81	28.88	148	0.0380	4.60	0.603	2.093	90	132	160	75	78	66	156	1.001	5.024	453	9.4
130	43.3	82	28.88	148	0.0359	4.78	0.605	2.089	90	132	160	75	78	66	156	1.001	5.038	454	9.4
131	43.2	82	28.88	148	0.0363	4.50	0.604	2.089	90	132	160	75	78	66	156	1.001	5.026	453	9.5
132	43.0	82	28.88	148	0.0328	5.13	0.606	2.087	90	132	160	76	78	66	156	1.001	5.043	454	9.6
133	43.2	81	28.88	148	0.0261	5.45	0.606	2.089	90	132	160	75	78	66	157	1.001	5.043	455	9.7
134	43.6	81	28.88	148	0.0321	4.66	0.607	2.088	90	132	160	75	77	66	157	1.001	5.051	456	9.7

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
135	43.8	81	28.88	148	0.0364	3.79	0.605	2.086	90	132	160	75	77	66	157	1.001	5.034	455	9.8
136	44.2	81	28.88	148	0.0400	3.94	0.604	2.089	90	132	161	75	77	66	157	1.001	5.029	455	9.9
137	44.5	81	28.88	148	0.0429	3.73	0.610	2.089	91	132	161	76	77	66	157	1.001	5.080	461	10.0
138	44.6	81	28.88	149	0.0408	3.97	0.604	2.089	91	133	161	76	77	66	157	1.001	5.031	457	10.0
139	44.5	81	28.88	149	0.0333	4.55	0.609	2.089	91	133	161	76	77	66	157	1.001	5.068	461	10.1
140	44.6	81	28.88	149	0.0358	4.71	0.606	2.088	91	133	161	75	77	66	157	1.001	5.048	459	10.2
141	44.5	81	28.88	149	0.0282	4.98	0.606	2.087	91	133	161	76	77	66	157	1.001	5.048	460	10.2
142	44.4	81	28.88	149	0.0431	3.82	0.611	2.088	91	133	161	76	77	66	157	1.001	5.082	463	10.3
143	44.4	81	28.88	149	0.0350	4.25	0.604	2.087	91	133	161	76	77	66	157	1.001	5.031	457	10.4
144	44.4	81	28.88	149	0.0396	4.10	0.607	2.088	91	133	161	76	78	66	157	1.001	5.056	459	10.5
145	44.6	81	28.88	149	0.0425	4.21	0.604	2.084	91	133	161	76	78	66	157	1.001	5.031	458	10.5
146	44.6	80	28.88	149	0.0308	4.94	0.607	2.086	91	133	160	76	78	66	157	1.001	5.051	459	10.6
147	44.5	81	28.88	149	0.0313	4.50	0.605	2.087	91	133	160	76	78	66	157	1.001	5.036	457	10.7
148	44.5	81	28.88	149	0.0375	4.19	0.605	2.087	91	133	160	76	78	66	157	1.001	5.034	456	10.8
149	44.4	81	28.89	149	0.0262	5.29	0.606	2.086	91	133	161	76	78	66	157	1.001	5.048	458	10.8
150	44.3	81	28.88	149	0.0424	3.53	0.607	2.087	91	133	161	76	78	66	157	1.001	5.053	458	10.9
151	44.4	81	28.88	149	0.0377	3.99	0.606	2.086	91	133	161	76	78	66	157	1.001	5.043	458	11.0
152	44.5	81	28.89	149	0.0392	3.73	0.604	2.087	91	133	161	76	78	66	157	1.001	5.031	457	11.0
153	44.4	81	28.88	149	0.0386	4.00	0.606	2.085	91	133	161	76	78	66	157	1.001	5.048	459	11.1
154	44.4	81	28.89	149	0.0341	4.31	0.602	2.085	91	133	161	76	78	66	157	1.001	5.014	456	11.2
155	44.4	81	28.89	149	0.0357	3.85	0.604	2.085	91	133	161	76	78	66	157	1.001	5.026	458	11.3

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
156	44.4	81	28.88	149	0.0368	4.12	0.602	2.086	91	133	161	76	78	66	157	1.001	5.014	457	11.3
157	44.5	81	28.88	149	0.0306	5.02	0.603	2.084	91	133	161	76	78	66	157	1.001	5.019	458	11.4
158	44.4	81	28.89	150	0.0333	4.36	0.605	2.084	91	133	161	76	78	66	157	1.001	5.039	460	11.5
159	44.5	81	28.89	149	0.0374	4.47	0.605	2.083	91	133	161	76	78	66	157	1.001	5.039	460	11.6
160	44.5	81	28.89	149	0.0275	5.42	0.606	2.085	91	133	161	76	78	66	157	1.001	5.041	461	11.6
161	44.4	81	28.89	149	0.0230	5.54	0.604	2.085	91	133	160	76	78	66	157	1.001	5.029	460	11.7
162	44.4	81	28.89	149	0.0320	4.37	0.603	2.086	91	133	161	76	78	66	157	1.001	5.022	459	11.8
163	44.4	81	28.89	149	0.0383	3.75	0.603	2.084	91	133	161	76	78	66	157	1.001	5.017	457	11.8
164	44.3	81	28.89	150	0.0354	4.07	0.602	2.084	91	133	161	76	78	66	157	1.001	5.014	457	11.9
165	44.4	81	28.89	150	0.0335	4.21	0.601	2.083	91	133	161	76	78	66	157	1.001	5.002	456	12.0
166	44.4	81	28.89	150	0.0366	3.98	0.605	2.082	91	133	161	76	78	66	157	1.001	5.036	459	12.1
167	44.5	81	28.89	149	0.0374	3.76	0.604	2.083	91	133	161	76	78	66	157	1.001	5.026	459	12.1
168	44.5	81	28.89	149	0.0357	4.24	0.604	2.085	91	133	161	76	78	66	158	1.001	5.026	460	12.2
169	44.4	81	28.89	149	0.0315	4.55	0.605	2.084	91	133	161	76	78	66	158	1.001	5.034	460	12.3
170	44.4	81	28.89	149	0.0352	4.56	0.604	2.086	91	133	161	76	78	66	158	1.001	5.031	460	12.4
171	44.3	81	28.89	149	0.0273	5.26	0.603	2.083	91	133	161	76	78	66	157	1.001	5.019	458	12.4
172	44.5	81	28.89	149	0.0228	5.55	0.601	2.084	91	133	161	76	78	66	157	1.001	5.007	456	12.5
173	44.4	81	28.89	149	0.0268	4.84	0.603	2.083	91	133	161	76	78	66	157	1.001	5.019	457	12.6
174	44.6	81	28.89	149	0.0310	4.45	0.603	2.085	91	133	161	76	78	66	157	1.001	5.016	456	12.6
175	44.4	81	28.89	149	0.0319	4.29	0.604	2.084	91	133	160	76	78	66	157	1.001	5.026	457	12.7
176	44.5	81	28.89	149	0.0390	3.65	0.606	2.083	91	133	160	76	78	66	157	1.001	5.048	459	12.8

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
177	44.5	81	28.89	150	0.0339	3.96	0.605	2.082	91	133	161	76	78	66	157	1.001	5.034	457	12.9
178	44.5	81	28.89	149	0.0357	3.93	0.603	2.081	91	133	161	76	78	66	157	1.001	5.016	455	12.9
179	44.4	81	28.89	149	0.0307	4.30	0.604	2.082	91	133	161	76	78	66	157	1.001	5.026	456	13.0
180	44.4	81	28.89	149	0.0334	3.70	0.603	2.080	91	133	161	76	78	66	157	1.001	5.024	457	13.1
181	44.5	81	28.89	149	0.0340	3.85	0.602	2.083	91	133	161	76	78	66	157	1.001	5.009	456	13.2
182	44.5	81	28.89	149	0.0297	4.15	0.603	2.084	91	133	161	76	78	66	157	1.001	5.019	457	13.2
183	44.5	81	28.89	150	0.0318	4.16	0.602	2.080	91	133	161	76	78	66	157	1.001	5.014	457	13.3
184	44.4	81	28.89	150	0.0347	4.18	0.604	2.081	91	133	161	76	78	66	157	1.001	5.031	458	13.4
185	44.3	81	28.89	149	0.0317	4.54	0.602	2.083	91	133	161	76	78	66	157	1.001	5.014	457	13.4
186	44.4	81	28.89	150	0.0259	4.84	0.601	2.082	91	133	161	76	78	66	157	1.001	5.002	456	13.5
187	44.6	81	28.89	150	0.0304	4.20	0.601	2.081	91	133	161	76	78	66	157	1.001	5.007	456	13.6
188	44.5	81	28.89	150	0.0321	4.33	0.598	2.081	91	133	161	76	78	66	157	1.001	4.980	454	13.7
189	44.5	81	28.89	150	0.0298	4.74	0.594	2.082	91	133	161	76	78	66	157	1.001	4.943	451	13.7
190	44.5	81	28.89	149	0.0272	4.98	0.600	2.081	91	133	161	76	78	66	158	1.001	4.992	456	13.8
191	44.4	81	28.89	150	0.0245	5.17	0.598	2.079	91	133	161	76	78	66	158	1.001	4.980	455	13.9
192	44.4	81	28.89	150	0.0286	4.74	0.604	2.080	91	133	161	76	78	66	158	1.001	5.026	459	14.0
193	44.3	81	28.89	149	0.0268	4.50	0.604	2.083	91	133	161	76	78	66	158	1.001	5.031	459	14.0
194	44.3	81	28.90	149	0.0323	4.07	0.598	2.083	91	133	161	76	78	66	157	1.001	4.982	454	14.1
195	44.3	81	28.90	150	0.0311	4.09	0.599	2.084	91	133	161	76	78	66	157	1.001	4.990	455	14.2
196	44.2	81	28.90	150	0.0318	3.63	0.597	2.082	91	133	161	76	78	66	157	1.001	4.972	452	14.2
197	44.1	81	28.90	150	0.0364	3.49	0.604	2.080	91	133	161	76	78	66	157	1.001	5.031	457	14.3

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
198	44.0	81	28.90	150	0.0321	4.40	0.604	2.079	91	133	161	76	78	66	157	1.001	5.026	458	14.4
199	44.2	81	28.90	150	0.0271	4.84	0.601	2.080	91	133	162	76	78	66	158	1.001	5.004	458	14.5
200	44.2	81	28.90	150	0.0299	4.64	0.595	2.080	92	133	161	76	78	66	158	1.001	4.953	454	14.5
201	44.4	81	28.90	150	0.0294	4.61	0.602	2.081	92	133	161	76	78	66	158	1.001	5.009	459	14.6
202	44.4	81	28.90	150	0.0306	4.32	0.598	2.083	92	133	161	76	78	66	158	1.001	4.977	456	14.7
203	44.3	81	28.90	150	0.0318	4.13	0.603	2.078	91	133	161	76	78	66	158	1.001	5.016	459	14.8
204	44.2	81	28.90	150	0.0310	4.04	0.594	2.079	91	133	161	76	78	66	158	1.001	4.946	452	14.8
205	44.2	81	28.91	150	0.0376	3.45	0.603	2.082	91	133	161	76	78	66	158	1.001	5.019	458	14.9
206	44.2	81	28.90	150	0.0365	3.57	0.601	2.081	91	133	161	76	78	66	157	1.001	4.999	456	15.0
207	44.4	81	28.91	150	0.0331	4.06	0.604	2.078	91	133	161	76	78	66	157	1.001	5.026	458	15.0
208	44.3	81	28.90	150	0.0300	4.65	0.598	2.079	91	133	161	76	78	66	157	1.001	4.975	453	15.1
209	44.3	81	28.90	150	0.0286	4.85	0.601	2.078	91	133	161	76	78	66	157	1.001	4.999	455	15.2
210	44.3	81	28.90	150	0.0225	5.35	0.603	2.079	91	133	161	76	78	66	157	1.001	5.021	457	15.3
211	44.4	81	28.90	150	0.0267	4.45	0.596	2.079	91	133	161	76	78	66	157	1.001	4.958	452	15.3
212	44.4	81	28.90	150	0.0283	4.21	0.607	2.081	91	133	161	76	78	66	157	1.001	5.051	461	15.4
213	44.3	81	28.90	150	0.0308	3.90	0.599	2.080	91	133	161	76	78	66	157	1.001	4.990	455	15.5
214	44.3	81	28.91	150	0.0306	4.03	0.597	2.079	91	133	161	76	78	66	158	1.001	4.970	454	15.5
215	44.4	81	28.91	150	0.0312	4.19	0.600	2.082	92	133	161	76	78	66	158	1.001	4.997	458	15.6
216	44.4	81	28.91	150	0.0261	4.81	0.600	2.081	92	133	161	76	78	66	158	1.001	4.995	458	15.7
217	44.4	81	28.91	150	0.0289	4.47	0.604	2.080	92	133	161	76	78	66	158	1.001	5.029	461	15.8
218	44.4	81	28.91	150	0.0292	4.43	0.590	2.080	92	133	161	76	78	66	158	1.001	4.914	450	15.8

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
219	44.4	81	28.91	150	0.0332	4.16	0.604	2.081	92	133	161	76	78	66	158	1.001	5.029	461	15.9
220	44.3	81	28.91	150	0.0275	4.72	0.600	2.081	92	133	161	76	78	66	158	1.001	4.995	458	16.0
221	44.2	81	28.91	150	0.0212	5.17	0.601	2.078	92	133	161	76	78	66	158	1.001	4.999	458	16.1
222	44.2	81	28.91	150	0.0249	4.81	0.600	2.077	92	133	161	76	78	66	158	1.001	4.992	457	16.1
223	44.1	81	28.91	150	0.0259	4.91	0.599	2.078	92	133	161	76	78	66	158	1.001	4.985	457	16.2
224	44.2	81	28.91	150	0.0252	4.51	0.600	2.079	92	133	162	76	78	66	158	1.001	4.992	458	16.3
225	44.1	81	28.91	150	0.0297	3.91	0.605	2.077	92	133	161	76	78	66	158	1.001	5.034	462	16.3
226	44.3	81	28.91	150	0.0319	3.81	0.608	2.078	92	133	161	76	78	66	158	1.001	5.063	465	16.4
227	44.4	81	28.91	150	0.0321	3.50	0.601	2.077	92	133	161	76	78	66	158	1.001	5.004	460	16.5
228	44.5	81	28.91	149	0.0325	3.64	0.600	2.078	92	133	161	76	78	66	158	1.001	4.997	459	16.6
229	44.5	81	28.91	150	0.0287	4.43	0.601	2.079	92	133	161	76	78	66	158	1.001	5.007	459	16.6
230	44.5	81	28.91	150	0.0246	4.99	0.603	2.078	92	133	161	76	78	66	158	1.001	5.017	460	16.7
231	44.5	81	28.91	150	0.0249	4.75	0.598	2.077	91	133	161	76	78	66	158	1.001	4.975	455	16.8
232	44.4	81	28.91	150	0.0242	4.93	0.597	2.079	91	133	160	76	78	66	157	1.001	4.970	453	16.9
233	44.3	81	28.91	150	0.0229	4.76	0.598	2.078	91	133	161	76	78	66	157	1.001	4.982	454	16.9
234	44.4	81	28.91	149	0.0262	4.38	0.602	2.079	91	133	161	76	78	66	157	1.001	5.014	456	17.0
235	44.3	81	28.91	150	0.0274	4.44	0.595	2.078	91	133	161	76	78	66	157	1.001	4.951	451	17.1
236	44.2	81	28.91	150	0.0263	4.00	0.594	2.077	91	133	161	76	78	66	157	1.001	4.943	450	17.1
237	44.2	81	28.91	150	0.0297	3.76	0.600	2.078	91	133	161	76	78	66	157	1.001	4.997	456	17.2
238	44.1	81	28.91	149	0.0319	3.78	0.598	2.074	91	133	161	76	78	66	157	1.001	4.977	455	17.3
239	44.1	81	28.92	150	0.0294	2.97	0.597	2.077	91	133	161	76	78	66	158	1.001	4.968	454	17.4

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side therm. ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
240	44.1	81	28.92	154	0.0240	2.61	0.598	2.078	91	133	161	76	78	66	158	1.001	4.975	455	17.4
																		456	
	43.9	**81**	**28.88**	**149**	**0.0315**	**4.41**	**0.606**	**2.090**	**91**	**133**	**161**	**75**	**78**	**66**	**157**	**1.001**	**5.047**	**110579**	

Hydronic heating appliances – test method ASTM E2618-13 Annex A2 Water test data

Manufacturer:		Fröling Heizkessel- und Behälterbau Ges.m.b.H.
Model:		P4 Pellet 60
Project No.:		31-31313
Run No.:		3
Test date:		04.08.2020
Technician:		Foit
Beginning clock time:		14:08:00
Recording interval:	[min]	1
Total sampling time:	[min]	240

Boiler dry weight:	[lbs]	1676
Boiler water weight:	[lbs]	375

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
0	49.2	78	28.96	158	0.0278	5.73	0.933	2.571	92	126	159	73	76	64	156	1.001	7.773	713	0.0
1	48.9	78	28.96	158	0.0229	6.18	0.928	2.577	92	126	159	72	76	64	156	1.001	7.729	709	0.1
2	49.2	78	28.96	158	0.0222	6.52	0.929	2.582	91	126	159	72	75	64	156	1.001	7.734	708	0.2
3	49.6	77	28.96	158	0.0212	6.10	0.923	2.580	91	126	158	71	75	64	155	1.001	7.682	701	0.3
4	49.9	77	28.96	158	0.0194	6.63	0.929	2.575	91	126	159	72	75	64	155	1.001	7.738	704	0.4
5	50.1	77	28.96	158	0.0138	7.42	0.927	2.578	91	126	158	72	75	64	155	1.001	7.721	702	0.6
6	49.5	78	28.96	158	0.0182	6.78	0.931	2.577	91	126	159	73	76	64	155	1.001	7.751	705	0.7
7	48.4	78	28.96	158	0.0216	6.50	0.925	2.577	91	126	159	73	76	64	155	1.001	7.699	701	0.8
8	47.2	79	28.96	158	0.0163	6.77	0.922	2.577	91	126	160	74	76	64	155	1.001	7.675	700	0.9
9	46.2	80	28.96	158	0.0163	6.60	0.930	2.574	91	126	160	74	76	64	156	1.001	7.743	709	1.0

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
10	45.4	80	28.96	158	0.0202	6.50	0.923	2.578	92	126	160	75	76	64	156	1.001	7.687	706	1.1
11	45.2	81	28.96	158	0.0206	6.39	0.924	2.577	92	126	160	75	76	64	156	1.001	7.692	708	1.2
12	44.6	81	28.96	158	0.0202	6.32	0.925	2.577	92	127	161	75	77	64	156	1.001	7.707	711	1.3
13	44.2	81	28.96	158	0.0219	6.34	0.923	2.578	92	127	161	75	77	64	157	1.001	7.682	710	1.4
14	43.6	82	28.96	158	0.0209	6.44	0.923	2.575	92	127	161	75	77	64	157	1.001	7.687	712	1.6
15	43.4	82	28.96	158	0.0183	6.91	0.923	2.578	93	127	160	75	77	64	157	1.001	7.682	711	1.7
16	43.3	82	28.96	158	0.0163	6.48	0.923	2.578	92	127	160	75	77	64	157	1.001	7.682	711	1.8
17	43.1	82	28.96	158	0.0243	5.66	0.920	2.575	92	127	161	75	77	64	157	1.001	7.660	709	1.9
18	43.2	82	28.96	158	0.0211	6.55	0.922	2.577	93	127	161	76	77	64	157	1.001	7.680	711	2.0
19	43.2	82	28.96	158	0.0243	6.01	0.927	2.576	93	127	161	76	77	64	157	1.001	7.719	716	2.1
20	43.4	82	28.96	158	0.0198	6.27	0.923	2.578	93	127	161	76	77	64	157	1.001	7.687	713	2.2
21	43.3	82	28.96	158	0.0223	6.35	0.923	2.578	93	127	160	76	77	64	157	1.001	7.689	713	2.3
22	43.2	82	28.96	158	0.0184	6.77	0.923	2.578	93	127	160	76	77	64	157	1.001	7.684	712	2.4
23	43.1	82	28.96	158	0.0191	6.57	0.922	2.573	92	127	160	76	78	64	157	1.001	7.675	710	2.6
24	43.1	82	28.96	158	0.0188	6.69	0.922	2.576	92	127	160	76	78	64	157	1.001	7.675	710	2.7
25	42.9	82	28.96	158	0.0173	7.19	0.920	2.574	92	127	161	76	78	64	157	1.001	7.658	708	2.8
26	42.6	82	28.96	158	0.0145	7.77	0.923	2.576	92	127	161	76	78	64	157	1.001	7.684	711	2.9
27	42.6	82	28.96	158	0.0173	6.93	0.922	2.575	93	127	161	76	78	64	157	1.001	7.677	712	3.0
28	42.5	82	28.96	159	0.0171	6.89	0.918	2.574	93	127	162	76	78	64	157	1.001	7.645	710	3.1
29	42.4	83	28.96	159	0.0216	6.13	0.924	2.575	93	127	162	76	78	64	158	1.001	7.697	717	3.2
30	42.1	83	28.96	159	0.0254	5.71	0.923	2.576	94	128	163	76	78	64	158	1.001	7.689	720	3.3

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
31	42.1	83	28.96	159	0.0223	5.77	0.924	2.576	94	128	162	76	78	64	158	1.001	7.692	723	3.5
32	42.0	83	28.96	159	0.0241	5.68	0.923	2.577	94	128	162	76	78	64	159	1.001	7.689	724	3.6
33	42.0	83	28.96	158	0.0280	5.60	0.919	2.574	94	128	162	76	78	64	159	1.001	7.655	721	3.7
34	41.9	83	28.97	158	0.0266	5.97	0.916	2.573	94	128	161	76	78	64	158	1.001	7.630	717	3.8
35	42.0	83	28.97	158	0.0270	6.28	0.916	2.575	94	128	161	76	78	64	158	1.001	7.626	714	3.9
36	42.9	83	28.97	158	0.0209	7.14	0.918	2.577	93	128	160	76	78	65	158	1.001	7.643	713	4.0
37	42.8	83	28.97	158	0.0170	7.40	0.916	2.573	93	128	160	76	78	65	157	1.001	7.626	709	4.1
38	42.9	82	28.97	159	0.0171	7.18	0.917	2.577	93	128	161	76	78	65	157	1.001	7.638	708	4.2
39	43.2	82	28.97	159	0.0156	7.35	0.921	2.572	93	127	161	76	78	65	157	1.001	7.669	710	4.3
40	43.5	82	28.97	159	0.0229	6.40	0.918	2.573	93	127	162	76	78	65	157	1.001	7.645	709	4.5
41	43.7	82	28.97	159	0.0218	6.45	0.918	2.571	93	128	162	76	78	65	158	1.001	7.640	711	4.6
42	43.4	82	28.97	159	0.0224	6.59	0.915	2.577	93	128	162	76	78	65	158	1.001	7.618	712	4.7
43	42.7	82	28.97	159	0.0229	6.36	0.916	2.572	94	128	162	76	78	65	158	1.001	7.625	716	4.8
44	43.0	82	28.97	159	0.0294	6.02	0.915	2.574	94	128	163	76	78	65	159	1.001	7.618	717	4.9
45	43.3	82	28.97	159	0.0191	6.82	0.914	2.573	94	129	163	76	78	65	159	1.001	7.608	718	5.0
46	43.6	82	28.97	159	0.0230	6.89	0.921	2.575	94	129	162	76	78	65	159	1.001	7.669	724	5.1
47	43.5	83	28.97	159	0.0219	6.68	0.917	2.579	94	129	162	77	78	65	159	1.001	7.635	720	5.2
48	42.7	83	28.97	159	0.0171	7.15	0.913	2.577	94	129	163	76	78	65	159	1.001	7.603	717	5.3
49	42.2	83	28.97	160	0.0235	6.38	0.913	2.573	94	129	162	76	78	65	159	1.001	7.604	717	5.5
50	41.5	84	28.97	160	0.0237	6.20	0.912	2.575	94	129	163	76	78	65	159	1.001	7.591	716	5.6
51	41.1	84	28.97	160	0.0235	6.18	0.913	2.574	94	129	163	76	78	65	159	1.001	7.606	718	5.7

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
52	41.7	84	28.97	160	0.0318	5.47	0.913	2.573	94	129	163	76	78	65	159	1.001	7.599	718	5.8
53	41.5	84	28.97	159	0.0283	6.18	0.914	2.574	95	129	163	76	78	65	159	1.001	7.613	721	5.9
54	40.8	84	28.97	159	0.0308	5.82	0.912	2.570	95	129	162	77	78	65	159	1.001	7.594	719	6.0
55	40.6	84	28.97	159	0.0256	6.50	0.910	2.575	94	129	162	77	78	65	159	1.001	7.579	717	6.1
56	40.3	85	28.97	159	0.0195	7.10	0.911	2.573	94	129	162	77	78	65	159	1.001	7.586	716	6.2
57	40.3	85	28.97	159	0.0247	6.32	0.910	2.574	94	129	162	77	78	64	159	1.001	7.577	715	6.3
58	41.0	84	28.97	160	0.0249	6.99	0.910	2.571	94	129	162	77	78	64	158	1.001	7.577	714	6.5
59	41.3	84	28.97	160	0.0215	6.96	0.913	2.575	94	128	162	77	78	64	158	1.001	7.599	716	6.6
60	41.5	83	28.97	160	0.0188	7.12	0.913	2.575	94	128	162	77	78	64	158	1.001	7.599	716	6.7
61	41.9	83	28.97	160	0.0198	6.76	0.909	2.575	94	128	163	77	78	64	159	1.001	7.567	713	6.8
62	41.9	84	28.97	160	0.0232	6.13	0.914	2.572	94	129	163	77	78	65	159	1.001	7.608	717	6.9
63	41.7	84	28.97	160	0.0271	6.38	0.907	2.572	94	129	163	77	79	65	159	1.001	7.552	714	7.0
64	41.6	84	28.97	160	0.0217	6.89	0.913	2.569	95	129	163	77	79	65	159	1.001	7.601	720	7.1
65	41.0	84	28.97	160	0.0298	5.85	0.912	2.572	95	129	163	77	79	65	160	1.001	7.594	721	7.2
66	40.3	85	28.97	160	0.0285	6.51	0.912	2.574	95	129	163	77	79	65	160	1.001	7.591	721	7.3
67	40.4	85	28.97	160	0.0259	6.85	0.909	2.575	95	129	163	77	79	65	160	1.001	7.567	718	7.5
68	40.7	84	28.97	160	0.0218	7.26	0.911	2.576	95	129	163	77	78	65	160	1.001	7.581	720	7.6
69	40.6	85	28.98	160	0.0221	6.68	0.910	2.574	95	129	163	77	78	65	159	1.001	7.574	718	7.7
70	40.6	85	28.98	160	0.0297	5.85	0.909	2.573	95	129	163	77	78	65	159	1.001	7.569	717	7.8
71	40.4	84	28.98	160	0.0300	6.01	0.908	2.574	95	129	163	77	78	65	159	1.001	7.559	717	7.9
72	40.7	84	28.98	160	0.0219	6.87	0.909	2.572	95	129	163	77	79	65	160	1.001	7.569	719	8.0

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
73	41.5	84	28.98	160	0.0246	6.73	0.911	2.571	95	129	163	77	79	65	160	1.001	7.584	721	8.1
74	42.3	83	28.98	160	0.0232	7.06	0.913	2.573	95	129	163	77	79	65	160	1.001	7.598	721	8.2
75	42.0	83	28.98	160	0.0180	7.42	0.908	2.573	95	129	163	77	79	65	159	1.001	7.557	716	8.4
76	41.7	84	28.98	160	0.0208	6.37	0.906	2.575	95	129	163	77	79	65	159	1.001	7.547	715	8.5
77	41.3	84	28.98	160	0.0294	5.42	0.911	2.575	95	129	164	77	79	65	160	1.001	7.586	720	8.6
78	40.7	84	28.98	160	0.0377	5.21	0.910	2.573	95	129	164	77	79	65	160	1.001	7.574	720	8.7
79	41.4	84	28.98	160	0.0330	6.21	0.908	2.572	95	130	164	77	79	65	160	1.001	7.559	721	8.8
80	40.8	84	28.98	160	0.0265	6.50	0.906	2.574	95	130	163	77	79	65	160	1.001	7.545	720	8.9
81	40.5	84	28.98	160	0.0296	6.25	0.909	2.572	95	130	163	77	79	65	160	1.001	7.572	721	9.0
82	40.4	85	28.98	160	0.0219	7.55	0.906	2.572	95	130	163	77	79	65	160	1.001	7.547	716	9.1
83	40.5	84	28.98	160	0.0149	7.92	0.905	2.576	95	129	162	77	79	65	159	1.001	7.537	714	9.2
84	41.1	84	28.98	160	0.0264	6.43	0.911	2.571	94	129	163	77	79	65	159	1.001	7.584	717	9.4
85	41.6	83	28.98	160	0.0335	5.84	0.905	2.572	94	129	163	77	79	65	159	1.001	7.535	711	9.5
86	41.5	83	28.98	160	0.0319	5.95	0.915	2.571	95	129	164	77	79	65	159	1.001	7.620	721	9.6
87	41.4	84	28.98	160	0.0269	6.60	0.908	2.573	95	129	164	77	79	65	160	1.001	7.557	718	9.7
88	41.4	83	28.98	160	0.0261	6.55	0.910	2.572	95	130	163	77	79	65	160	1.001	7.579	721	9.8
89	41.7	84	28.98	160	0.0272	6.86	0.911	2.573	95	130	163	77	79	65	160	1.001	7.584	722	9.9
90	41.7	84	28.98	160	0.0180	7.56	0.908	2.571	95	130	163	76	79	65	160	1.001	7.559	719	10.0
91	41.5	84	28.98	160	0.0216	7.21	0.908	2.574	95	130	163	77	79	65	160	1.001	7.562	719	10.1
92	41.0	84	28.98	160	0.0280	6.34	0.908	2.572	95	130	164	77	79	65	160	1.001	7.564	719	10.2
93	40.6	84	28.98	160	0.0353	6.14	0.908	2.570	95	130	164	77	79	65	160	1.001	7.557	720	10.4

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
94	40.4	84	28.98	160	0.0278	6.88	0.910	2.574	95	130	164	77	79	65	160	1.001	7.574	723	10.5
95	41.0	84	28.98	160	0.0283	6.76	0.908	2.570	96	130	164	77	79	65	160	1.001	7.559	723	10.6
96	41.4	84	28.99	160	0.0315	6.34	0.911	2.570	96	130	164	77	79	65	160	1.001	7.584	726	10.7
97	40.5	84	28.99	160	0.0291	6.45	0.913	2.571	96	130	164	77	79	65	160	1.001	7.598	727	10.8
98	40.9	84	28.99	160	0.0344	5.82	0.914	2.571	96	130	164	77	79	65	160	1.001	7.611	728	10.9
99	41.7	83	28.99	160	0.0401	5.29	0.910	2.571	96	130	164	77	79	65	160	1.001	7.574	724	11.0
100	42.1	83	28.99	160	0.0373	5.86	0.912	2.571	96	130	164	77	79	65	160	1.001	7.596	726	11.1
101	42.2	83	28.99	160	0.0334	6.28	0.907	2.570	95	130	163	77	79	65	160	1.001	7.554	722	11.2
102	42.1	84	28.99	160	0.0327	6.48	0.911	2.573	95	130	163	77	79	65	160	1.001	7.589	723	11.4
103	41.2	84	28.99	160	0.0220	7.59	0.911	2.572	95	130	162	77	79	65	160	1.001	7.589	720	11.5
104	40.5	84	28.99	160	0.0267	6.73	0.910	2.573	95	129	162	77	79	65	159	1.001	7.574	717	11.6
105	40.9	84	28.99	160	0.0337	6.18	0.909	2.573	94	129	163	77	79	65	159	1.001	7.572	715	11.7
106	40.5	84	29.00	160	0.0302	6.58	0.911	2.570	94	129	163	77	79	65	159	1.001	7.584	716	11.8
107	40.3	85	29.00	160	0.0279	6.83	0.912	2.571	95	129	163	77	79	65	159	1.001	7.596	719	11.9
108	41.2	84	29.00	160	0.0268	6.76	0.912	2.574	95	129	163	77	79	65	160	1.001	7.591	720	12.0
109	41.5	84	29.00	160	0.0358	5.63	0.909	2.572	95	129	164	77	79	65	160	1.001	7.569	718	12.1
110	41.1	84	29.00	160	0.0336	6.25	0.911	2.574	95	129	164	77	79	65	160	1.001	7.589	721	12.2
111	41.6	83	29.00	160	0.0267	6.96	0.902	2.570	95	130	163	77	79	65	160	1.001	7.513	715	12.4
112	41.8	83	29.00	160	0.0299	6.12	0.911	2.572	95	130	163	77	79	65	160	1.001	7.581	721	12.5
113	41.3	84	29.00	160	0.0314	6.24	0.908	2.571	95	130	163	77	79	65	160	1.001	7.564	719	12.6
114	41.9	83	29.00	160	0.0354	5.71	0.905	2.568	95	130	163	77	79	65	160	1.001	7.532	714	12.7

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
115	42.4	83	29.00	160	0.0383	5.89	0.911	2.570	95	130	163	77	79	65	160	1.001	7.583	719	12.8
116	41.8	84	29.00	160	0.0296	6.80	0.904	2.573	95	130	163	77	79	65	160	1.001	7.525	712	12.9
117	41.4	84	29.00	160	0.0332	6.40	0.904	2.568	94	130	162	77	79	65	160	1.001	7.527	711	13.0
118	41.1	84	29.00	160	0.0262	7.38	0.903	2.569	94	129	163	77	79	65	159	1.001	7.517	708	13.1
119	41.7	84	29.00	160	0.0177	7.57	0.910	2.571	94	129	163	77	79	65	159	1.001	7.574	712	13.2
120	42.7	84	29.00	160	0.0245	6.97	0.905	2.570	94	129	163	77	79	65	159	1.001	7.534	708	13.4
121	42.1	84	29.00	160	0.0318	6.25	0.915	2.572	94	129	163	77	79	65	159	1.001	7.615	716	13.5
122	41.6	84	29.00	160	0.0355	5.51	0.906	2.571	94	129	164	77	79	65	159	1.001	7.539	710	13.6
123	41.4	84	29.00	160	0.0341	5.45	0.906	2.569	95	130	164	77	79	65	160	1.001	7.542	713	13.7
124	41.7	83	29.00	159	0.0316	5.95	0.902	2.570	95	130	164	77	79	65	160	1.001	7.510	712	13.8
125	42.2	83	29.00	160	0.0336	5.82	0.909	2.573	95	130	163	77	79	65	160	1.001	7.568	718	13.9
126	42.1	83	29.00	159	0.0364	5.32	0.904	2.570	95	130	163	77	79	65	160	1.001	7.527	713	14.0
127	42.7	83	29.00	159	0.0367	5.73	0.907	2.570	94	130	162	77	79	65	160	1.001	7.554	712	14.1
128	42.5	83	29.00	159	0.0376	6.15	0.906	2.571	94	130	162	77	79	65	159	1.001	7.542	709	14.3
129	42.4	83	29.00	159	0.0320	6.60	0.905	2.569	94	129	161	77	79	65	159	1.001	7.537	706	14.4
130	43.1	83	29.00	159	0.0299	6.78	0.910	2.572	93	129	161	77	79	65	159	1.001	7.576	706	14.5
131	43.1	83	29.00	159	0.0303	6.50	0.911	2.573	93	129	161	77	79	65	158	1.001	7.588	705	14.6
132	43.1	83	29.00	159	0.0268	7.13	0.902	2.570	93	129	162	77	79	65	158	1.001	7.510	697	14.7
133	43.0	83	29.00	159	0.0201	7.45	0.905	2.571	93	129	162	77	79	65	158	1.001	7.532	699	14.8
134	42.9	83	29.00	159	0.0261	6.66	0.907	2.571	93	129	162	77	79	65	158	1.001	7.554	702	14.9
135	43.0	82	29.00	159	0.0304	5.79	0.907	2.567	93	129	163	77	79	65	159	1.001	7.551	703	15.0

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
136	42.9	82	29.00	159	0.0340	5.94	0.912	2.569	93	129	163	77	79	65	159	1.001	7.595	710	15.1
137	43.3	82	29.00	159	0.0369	5.73	0.906	2.566	94	129	163	77	79	65	159	1.001	7.539	708	15.3
138	43.8	82	29.00	159	0.0348	5.97	0.910	2.569	94	129	163	77	79	66	160	1.001	7.573	713	15.4
139	43.2	82	29.00	159	0.0273	6.55	0.907	2.568	94	130	163	77	79	66	160	1.001	7.551	710	15.5
140	43.3	82	29.00	159	0.0298	6.71	0.907	2.569	94	130	162	77	79	66	159	1.001	7.549	709	15.6
141	43.1	82	29.00	159	0.0222	6.98	0.908	2.570	94	129	162	77	79	66	159	1.001	7.563	708	15.7
142	43.1	82	29.00	159	0.0371	5.82	0.909	2.571	93	129	162	77	79	66	159	1.001	7.568	707	15.8
143	42.8	82	29.00	159	0.0290	6.25	0.911	2.568	93	129	163	77	79	66	159	1.001	7.583	707	15.9
144	42.9	82	29.00	159	0.0336	6.10	0.908	2.568	93	129	162	77	79	66	159	1.001	7.561	706	16.0
145	42.7	82	29.00	159	0.0365	6.21	0.906	2.570	93	129	162	77	79	66	159	1.001	7.544	705	16.1
146	42.2	83	29.00	159	0.0248	6.94	0.911	2.570	93	129	162	76	78	66	159	1.001	7.583	707	16.3
147	42.8	83	29.00	159	0.0253	6.50	0.907	2.571	93	129	162	77	79	66	159	1.001	7.549	704	16.4
148	43.0	83	29.00	159	0.0315	6.19	0.906	2.570	93	129	162	77	79	66	159	1.001	7.539	702	16.5
149	42.8	82	29.00	159	0.0202	7.29	0.909	2.570	93	129	162	77	79	66	159	1.001	7.568	705	16.6
150	42.9	82	29.00	159	0.0364	5.53	0.905	2.570	93	129	162	77	79	66	159	1.001	7.534	702	16.7
151	43.4	82	29.00	159	0.0317	5.99	0.904	2.568	93	129	163	77	79	66	159	1.001	7.529	702	16.8
152	43.5	82	29.00	159	0.0332	5.73	0.909	2.570	93	129	162	77	79	66	159	1.001	7.566	706	16.9
153	43.0	82	29.00	159	0.0326	6.00	0.907	2.569	93	129	162	77	79	66	159	1.001	7.551	705	17.0
154	43.0	82	29.00	159	0.0281	6.31	0.908	2.571	93	129	162	77	79	66	159	1.001	7.561	705	17.1
155	42.6	82	29.00	159	0.0297	5.85	0.905	2.572	93	129	162	77	79	66	159	1.001	7.536	702	17.3
156	42.6	82	29.00	159	0.0308	6.12	0.906	2.567	93	129	162	77	79	66	159	1.001	7.539	700	17.4

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
157	42.5	82	29.00	158	0.0246	7.02	0.906	2.569	93	129	161	77	79	66	158	1.001	7.541	699	17.5
158	42.5	82	29.00	159	0.0273	6.36	0.909	2.570	92	129	161	77	79	66	158	1.001	7.568	700	17.6
159	42.4	82	29.00	159	0.0314	6.47	0.904	2.568	92	129	162	77	79	66	158	1.001	7.524	695	17.7
160	42.6	82	29.00	158	0.0215	7.42	0.906	2.568	92	129	162	77	79	66	158	1.001	7.541	697	17.8
161	42.8	82	29.01	159	0.0170	7.54	0.908	2.569	92	129	162	76	79	66	158	1.001	7.563	700	17.9
162	42.3	83	29.01	159	0.0260	6.37	0.905	2.565	93	129	162	76	79	66	158	1.001	7.536	698	18.0
163	42.5	82	29.01	159	0.0323	5.75	0.906	2.567	93	129	163	76	78	66	159	1.001	7.539	700	18.1
164	43.1	82	29.01	159	0.0294	6.07	0.914	2.567	93	129	163	77	79	66	159	1.001	7.612	709	18.3
165	42.9	82	29.01	159	0.0275	6.21	0.909	2.568	93	129	163	76	79	66	159	1.001	7.568	708	18.4
166	42.8	82	29.01	159	0.0306	5.98	0.906	2.566	94	130	163	76	78	66	160	1.001	7.539	707	18.5
167	43.0	82	29.01	159	0.0314	5.76	0.903	2.567	94	130	163	77	78	66	160	1.001	7.514	704	18.6
168	43.2	82	29.01	159	0.0297	6.24	0.907	2.566	93	130	162	77	78	66	159	1.001	7.553	707	18.7
169	43.3	82	29.01	159	0.0255	6.55	0.907	2.567	93	130	162	77	78	66	159	1.001	7.551	705	18.8
170	43.4	82	29.01	159	0.0292	6.56	0.907	2.563	93	129	162	77	78	66	159	1.001	7.551	703	18.9
171	43.4	82	29.01	159	0.0213	7.26	0.901	2.566	93	129	162	77	78	66	159	1.001	7.497	696	19.0
172	43.4	82	29.01	159	0.0168	7.55	0.902	2.567	93	129	162	77	78	66	159	1.001	7.512	696	19.1
173	43.1	82	29.01	159	0.0208	6.84	0.909	2.567	93	129	162	77	78	66	159	1.001	7.565	700	19.3
174	43.1	82	29.01	160	0.0250	6.45	0.909	2.568	93	129	163	77	78	66	159	1.001	7.568	701	19.4
175	43.1	82	29.01	159	0.0259	6.29	0.907	2.567	93	129	163	77	78	66	159	1.001	7.553	702	19.5
176	43.1	82	29.01	159	0.0330	5.65	0.910	2.567	93	130	163	76	78	66	159	1.001	7.573	706	19.6
177	43.2	82	29.01	159	0.0279	5.96	0.911	2.563	93	130	163	77	78	66	160	1.001	7.582	709	19.7

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
178	43.1	82	29.01	159	0.0297	5.93	0.906	2.565	94	130	163	77	78	66	160	1.001	7.541	706	19.8
179	43.0	82	29.01	159	0.0247	6.30	0.906	2.566	94	130	163	77	78	66	160	1.001	7.543	706	19.9
180	43.1	82	29.01	159	0.0274	5.70	0.905	2.564	93	130	162	77	78	66	160	1.001	7.536	704	20.0
181	43.2	82	29.01	159	0.0280	5.85	0.910	2.564	93	130	162	77	78	66	159	1.001	7.575	705	20.2
182	43.0	82	29.01	159	0.0237	6.15	0.902	2.565	93	130	162	77	79	66	159	1.001	7.509	697	20.3
183	43.0	82	29.01	159	0.0258	6.16	0.903	2.563	93	130	162	77	79	66	159	1.001	7.519	697	20.4
184	43.1	82	29.01	159	0.0287	6.18	0.903	2.564	92	130	162	76	78	66	159	1.001	7.521	695	20.5
185	43.1	82	29.01	159	0.0257	6.54	0.902	2.564	92	129	162	76	78	66	159	1.001	7.506	692	20.6
186	42.9	82	29.01	159	0.0199	6.84	0.903	2.563	92	129	162	76	78	66	158	1.001	7.521	692	20.7
187	42.8	82	29.01	159	0.0244	6.20	0.901	2.567	92	129	162	76	78	67	158	1.001	7.499	689	20.8
188	42.7	82	29.01	159	0.0261	6.33	0.903	2.563	92	129	162	76	78	67	158	1.001	7.518	691	20.9
189	42.8	82	29.01	159	0.0238	6.74	0.902	2.564	92	129	162	76	78	67	159	1.001	7.511	691	21.0
190	42.9	82	29.01	159	0.0212	6.98	0.904	2.565	92	129	162	76	78	67	159	1.001	7.526	694	21.2
191	42.9	82	29.01	159	0.0185	7.17	0.904	2.565	92	129	163	76	78	67	159	1.001	7.523	694	21.3
192	43.0	82	29.01	159	0.0226	6.74	0.904	2.560	92	130	163	77	78	67	159	1.001	7.523	695	21.4
193	42.9	82	29.02	159	0.0208	6.50	0.905	2.563	92	130	163	76	78	67	159	1.001	7.530	697	21.5
194	43.1	82	29.02	159	0.0263	6.07	0.906	2.563	93	130	163	77	78	67	159	1.001	7.543	700	21.6
195	43.0	82	29.02	159	0.0251	6.09	0.906	2.561	93	130	164	77	78	67	160	1.001	7.543	702	21.7
196	43.0	82	29.02	159	0.0258	5.63	0.903	2.564	93	130	163	77	78	67	160	1.001	7.521	701	21.8
197	42.9	82	29.02	159	0.0304	5.49	0.904	2.565	93	130	163	76	78	67	160	1.001	7.523	702	21.9
198	42.8	82	29.02	159	0.0261	6.40	0.902	2.562	93	130	163	77	78	67	160	1.001	7.506	699	22.0

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
199	42.9	82	29.02	159	0.0211	6.84	0.906	2.561	93	130	162	77	78	67	160	1.001	7.540	701	22.2
200	43.0	82	29.02	159	0.0239	6.64	0.904	2.565	93	130	162	77	78	67	159	1.001	7.525	697	22.3
201	42.5	82	29.02	159	0.0234	6.61	0.901	2.562	92	130	162	77	78	67	159	1.001	7.503	693	22.4
202	42.6	82	29.02	159	0.0246	6.32	0.901	2.562	92	130	162	77	78	67	159	1.001	7.496	691	22.5
203	42.7	82	29.02	159	0.0258	6.13	0.901	2.563	92	130	163	76	78	67	159	1.001	7.498	691	22.6
204	42.8	82	29.02	159	0.0250	6.04	0.906	2.559	92	130	163	76	78	67	159	1.001	7.540	695	22.7
205	42.9	82	29.02	159	0.0316	5.45	0.906	2.563	92	130	163	76	78	67	159	1.001	7.540	696	22.8
206	42.9	82	29.02	159	0.0305	5.57	0.909	2.561	92	130	163	76	78	67	159	1.001	7.564	699	22.9
207	42.9	81	29.02	159	0.0271	6.06	0.911	2.561	92	130	162	76	78	67	159	1.001	7.579	700	23.0
208	43.1	81	29.02	159	0.0240	6.65	0.904	2.562	92	130	162	76	78	67	159	1.001	7.528	694	23.2
209	43.1	81	29.02	159	0.0226	6.85	0.903	2.562	92	130	162	77	78	67	159	1.001	7.515	691	23.3
210	43.0	81	29.02	159	0.0165	7.35	0.906	2.559	92	130	162	77	78	67	159	1.001	7.537	691	23.4
211	43.0	81	29.02	159	0.0207	6.45	0.904	2.560	91	129	162	76	78	67	159	1.001	7.523	689	23.5
212	42.8	82	29.02	159	0.0223	6.21	0.905	2.560	92	129	163	76	78	67	159	1.001	7.532	690	23.6
213	42.6	82	29.02	159	0.0248	5.90	0.906	2.563	92	129	163	76	78	67	159	1.001	7.537	692	23.7
214	42.8	82	29.02	159	0.0246	6.03	0.908	2.562	92	130	163	76	78	67	159	1.001	7.554	696	23.8
215	42.8	82	29.02	159	0.0252	6.19	0.904	2.560	92	130	163	76	78	67	159	1.001	7.523	695	23.9
216	42.7	82	29.02	159	0.0201	6.81	0.908	2.558	92	130	163	76	78	67	159	1.001	7.554	699	24.0
217	42.7	82	29.02	159	0.0229	6.47	0.902	2.561	92	130	163	76	78	67	159	1.001	7.510	694	24.2
218	42.8	82	29.02	159	0.0232	6.43	0.898	2.564	92	130	163	76	78	67	159	1.001	7.474	690	24.3
219	42.8	82	29.02	159	0.0272	6.16	0.905	2.559	92	130	163	76	78	67	159	1.001	7.532	695	24.4

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
220	42.8	82	29.03	159	0.0215	6.72	0.908	2.560	92	130	163	76	78	67	159	1.001	7.562	698	24.5
221	42.8	82	29.03	159	0.0152	7.17	0.902	2.559	92	130	163	76	78	67	159	1.001	7.510	693	24.6
222	42.8	82	29.03	159	0.0189	6.81	0.902	2.561	92	130	163	77	78	67	159	1.001	7.510	694	24.7
223	42.8	82	29.03	160	0.0199	6.91	0.897	2.561	92	130	163	77	78	67	159	1.001	7.464	689	24.8
224	42.7	82	29.03	160	0.0192	6.51	0.901	2.558	92	130	163	77	78	67	160	1.001	7.496	693	24.9
225	42.7	82	29.03	160	0.0237	5.91	0.910	2.560	93	130	164	77	78	67	160	1.001	7.576	703	25.1
226	42.8	82	29.03	160	0.0259	5.81	0.903	2.559	93	130	164	77	78	67	160	1.001	7.518	699	25.2
227	43.2	82	29.03	160	0.0261	5.50	0.903	2.558	93	131	164	77	78	67	160	1.001	7.520	701	25.3
228	42.8	82	29.03	160	0.0265	5.64	0.898	2.561	93	131	163	77	78	67	160	1.001	7.471	697	25.4
229	42.8	82	29.03	159	0.0227	6.43	0.904	2.557	93	131	163	77	78	67	160	1.001	7.523	701	25.5
230	42.7	82	29.03	159	0.0186	6.99	0.900	2.557	93	131	162	77	78	67	160	1.001	7.488	696	25.6
231	42.5	82	29.03	160	0.0189	6.75	0.900	2.560	92	130	162	77	78	67	160	1.001	7.491	693	25.7
232	42.4	82	29.03	160	0.0182	6.93	0.906	2.558	92	130	163	76	78	67	159	1.001	7.537	696	25.8
233	42.6	82	29.03	160	0.0169	6.76	0.904	2.560	92	130	163	77	78	67	159	1.001	7.527	694	25.9
234	42.7	82	29.04	160	0.0202	6.38	0.899	2.561	92	130	163	77	78	67	159	1.001	7.483	691	26.1
235	42.7	82	29.04	160	0.0214	6.44	0.903	2.556	92	130	164	77	78	67	160	1.001	7.513	694	26.2
236	42.5	82	29.04	160	0.0203	6.00	0.902	2.560	93	130	164	77	78	67	160	1.001	7.510	696	26.3
237	42.4	82	29.04	160	0.0237	5.76	0.896	2.556	93	131	164	77	78	67	160	1.001	7.457	693	26.4
238	42.5	82	29.04	160	0.0259	5.78	0.904	2.555	93	131	164	77	78	67	160	1.001	7.522	700	26.5
239	42.6	82	29.04	160	0.0234	4.97	0.901	2.559	93	131	163	76	78	67	160	1.001	7.496	698	26.6
240	42.6	82	29.04	164	0.0180	4.61	0.903	2.557	93	131	163	76	78	67	160	1.001	7.520	700	26.7

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
																		700	
	42.7	82	28.99	159	0.0255	6.41	0.910	2.569	93	129	162	76	78	65	159	1.001	7.576	170624	

Testing Laboratory
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Hydronic heating appliances – test method ASTM E2618-13 Annex A2 Water test data

Manufacturer:		Fröling Heizkessel- und Behälterbau Ges.m.b.H.
Model:		P4 Pellet 60
Project No.:		31-31313
Run No.:		4
Test date:		04.08.2020
Technician:		Foit
Beginning clock time:		7:56:00
Recording interval:	[min]	1
Total sampling time:	[min]	240

Boiler dry weight:	[lbs]	1676
Boiler water weight:	[lbs]	375

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
0	41.2	78	29.18	173	0.0032	9.77	1.959	5.165	84	123	156	73	75	65	149	1.001	16.313		0.0
1	41.0	78	29.18	173	0.0024	9.92	1.958	5.151	84	123	156	73	75	65	149	1.001	16.303	1 366	0.2
2	40.6	79	29.18	173	0.0032	9.23	1.974	5.150	84	124	157	73	75	65	149	1.001	16.438	1 387	0.4
3	40.5	79	29.18	173	0.0036	9.18	1.949	5.149	85	124	157	73	75	65	150	1.001	16.227	1 376	0.6
4	40.4	79	29.18	173	0.0034	9.09	1.967	5.144	85	124	157	73	75	65	150	1.001	16.379	1 391	0.8
5	40.2	79	29.18	173	0.0027	9.45	1.952	5.152	85	124	157	74	75	65	150	1.001	16.249	1 381	1.0
6	40.0	79	29.18	173	0.0040	9.03	1.955	5.150	85	124	157	74	75	65	150	1.001	16.276	1 385	1.3
7	40.2	79	29.18	173	0.0032	9.51	1.964	5.147	85	124	157	74	76	65	150	1.001	16.352	1 392	1.5

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
8	39.8	79	29.18	174	0.0036	9.18	1.960	5.147	85	124	157	74	76	65	150	1.001	16.318	1 391	1.7
9	39.1	80	29.18	174	0.0024	9.66	1.948	5.153	85	124	157	74	76	65	150	1.001	16.223	1 384	1.9
10	38.8	80	29.18	174	0.0033	9.13	1.960	5.151	86	125	158	74	76	65	151	1.001	16.318	1 398	2.1
11	38.6	80	29.18	174	0.0027	9.50	1.954	5.150	86	125	158	74	76	65	151	1.001	16.269	1 397	2.3
12	38.5	81	29.18	174	0.0039	9.05	1.947	5.147	86	125	158	74	76	65	151	1.001	16.210	1 394	2.5
13	37.9	81	29.18	174	0.0044	9.04	1.954	5.149	86	125	158	74	76	65	151	1.001	16.271	1 401	2.7
14	37.9	81	29.18	173	0.0044	8.77	1.969	5.143	86	125	157	74	76	65	151	1.001	16.391	1 408	2.9
15	38.1	81	29.18	174	0.0054	9.15	1.964	5.141	86	125	157	74	76	65	151	1.001	16.350	1 403	3.1
16	38.6	80	29.18	174	0.0031	9.68	1.958	5.141	86	125	157	73	76	65	151	1.001	16.298	1 396	3.3
17	38.9	80	29.18	174	0.0027	9.45	1.964	5.141	86	125	158	73	76	65	151	1.001	16.355	1 406	3.5
18	38.6	80	29.18	174	0.0035	9.30	1.958	5.142	86	125	158	73	76	65	151	1.001	16.298	1 403	3.8
19	38.3	80	29.18	175	0.0024	10.14	1.960	5.141	86	125	158	74	76	65	151	1.001	16.315	1 408	4.0
20	38.0	81	29.18	174	0.0038	9.27	1.944	5.143	87	125	159	74	76	65	152	1.001	16.183	1 402	4.2
21	37.8	81	29.18	174	0.0041	8.79	1.971	5.140	87	126	158	74	76	65	152	1.001	16.411	1 428	4.4
22	37.8	81	29.18	174	0.0041	8.94	1.948	5.140	87	126	158	74	76	65	152	1.001	16.218	1 407	4.6
23	38.3	80	29.18	174	0.0037	9.48	1.953	5.136	86	125	158	74	76	65	152	1.001	16.257	1 406	4.8
24	38.2	81	29.18	175	0.0040	9.36	1.954	5.134	86	125	158	74	76	65	152	1.001	16.269	1 407	5.0
25	37.7	81	29.18	175	0.0026	10.07	1.954	5.140	86	125	159	74	76	65	152	1.001	16.266	1 407	5.2
26	38.0	81	29.18	175	0.0020	10.11	1.955	5.131	87	126	159	74	76	65	152	1.001	16.281	1 414	5.4
27	38.3	81	29.18	175	0.0027	9.42	1.953	5.133	87	126	159	74	76	65	152	1.001	16.257	1 418	5.6
28	38.1	81	29.18	175	0.0039	9.07	1.956	5.131	87	126	159	73	76	65	153	1.001	16.283	1 425	5.8

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
29	38.0	81	29.18	175	0.0061	8.51	1.948	5.128	87	126	159	74	76	65	153	1.001	16.220	1 419	6.1
30	37.9	81	29.18	175	0.0053	8.80	1.963	5.123	87	126	158	74	76	65	152	1.001	16.340	1 422	6.3
31	37.8	81	29.18	175	0.0040	9.05	1.954	5.125	87	126	158	74	76	65	152	1.001	16.266	1 410	6.5
32	37.3	81	29.18	175	0.0035	9.51	1.962	5.122	87	125	158	73	76	65	152	1.001	16.332	1 414	6.7
33	37.8	81	29.18	175	0.0033	9.69	1.953	5.121	87	126	159	73	76	65	152	1.001	16.264	1 410	6.9
34	37.9	81	29.18	175	0.0024	9.61	1.963	5.113	87	126	159	73	76	65	152	1.001	16.347	1 423	7.1
35	37.8	81	29.18	175	0.0049	8.79	1.948	5.116	87	126	159	73	76	65	152	1.001	16.220	1 415	7.3
36	37.7	81	29.18	175	0.0043	9.11	1.953	5.117	87	126	159	73	76	65	152	1.001	16.259	1 419	7.5
37	37.8	81	29.19	175	0.0050	9.09	1.960	5.110	87	126	159	73	76	65	152	1.001	16.320	1 422	7.7
38	38.0	81	29.18	175	0.0047	9.13	1.952	5.109	87	126	159	73	76	65	152	1.001	16.252	1 415	7.9
39	38.1	81	29.19	175	0.0036	9.39	1.959	5.105	87	126	159	73	76	65	152	1.001	16.313	1 419	8.1
40	38.4	80	29.19	175	0.0037	9.43	1.946	5.101	87	126	159	73	76	65	152	1.001	16.205	1 410	8.3
41	38.5	80	29.19	175	0.0039	9.04	1.946	5.095	87	126	159	73	76	65	152	1.001	16.203	1 411	8.6
42	38.7	80	29.19	175	0.0028	9.48	1.963	5.096	87	126	159	73	76	65	152	1.001	16.347	1 424	8.8
43	39.0	80	29.19	175	0.0036	9.15	1.969	5.095	87	126	159	73	75	65	152	1.001	16.391	1 430	9.0
44	39.3	80	29.19	175	0.0031	9.19	1.944	5.088	87	126	159	73	75	65	152	1.001	16.186	1 412	9.2
45	39.3	80	29.19	175	0.0038	9.25	1.962	5.086	87	126	159	73	75	65	152	1.001	16.335	1 425	9.4
46	38.9	80	29.19	175	0.0042	9.18	1.947	5.085	87	126	159	73	75	65	152	1.001	16.212	1 415	9.6
47	39.0	80	29.19	175	0.0048	9.12	1.938	5.084	87	126	159	73	76	65	152	1.001	16.132	1 406	9.8
48	39.3	80	29.19	176	0.0035	9.59	1.961	5.080	87	126	159	73	75	65	152	1.001	16.330	1 424	10.0
49	39.6	79	29.19	176	0.0038	9.46	1.949	5.079	87	126	159	73	75	65	152	1.001	16.229	1 416	10.2

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
50	39.7	79	29.18	176	0.0029	9.72	1.968	5.073	87	126	160	73	75	65	153	1.001	16.383	1 433	10.4
51	39.9	79	29.19	176	0.0035	9.53	1.947	5.070	88	126	160	73	76	65	153	1.001	16.207	1 420	10.6
52	40.0	79	29.19	176	0.0021	10.15	1.963	5.068	88	126	160	74	76	65	153	1.001	16.344	1 435	10.9
53	40.0	79	29.18	176	0.0024	9.75	1.947	5.061	88	126	160	74	75	65	153	1.001	16.212	1 427	11.1
54	40.0	79	29.18	176	0.0017	10.26	1.963	5.064	88	127	161	73	75	65	154	1.001	16.347	1 444	11.3
55	40.1	79	29.18	176	0.0035	9.10	1.949	5.059	89	127	161	73	76	65	154	1.001	16.227	1 439	11.5
56	39.9	79	29.19	176	0.0041	8.65	1.960	5.054	89	127	160	74	76	65	154	1.001	16.315	1 448	11.7
57	39.8	79	29.18	176	0.0054	8.29	1.931	5.056	88	127	160	74	76	65	154	1.001	16.078	1 422	11.9
58	39.7	79	29.19	176	0.0060	8.78	1.960	5.053	88	127	159	74	76	65	153	1.001	16.315	1 436	12.1
59	39.8	79	29.19	176	0.0045	8.98	1.936	5.052	87	126	159	74	76	65	153	1.001	16.122	1 409	12.3
60	40.0	79	29.19	176	0.0041	9.09	1.959	5.047	87	126	159	74	76	65	153	1.001	16.308	1 425	12.5
61	40.1	79	29.19	176	0.0038	8.92	1.957	5.042	87	126	159	73	76	65	152	1.001	16.296	1 422	12.7
62	40.1	79	29.19	175	0.0037	8.95	1.940	5.040	87	126	159	73	76	65	152	1.001	16.151	1 408	12.9
63	40.1	79	29.19	176	0.0032	9.27	1.937	5.038	87	126	159	73	76	65	152	1.001	16.124	1 406	13.1
64	39.4	80	29.19	176	0.0018	10.23	1.953	5.040	87	126	159	73	76	65	152	1.001	16.256	1 419	13.4
65	38.8	80	29.19	176	0.0023	9.63	1.966	5.033	88	126	160	74	76	65	153	1.001	16.366	1 434	13.6
66	39.1	80	29.19	176	0.0016	10.29	1.926	5.031	88	126	160	74	76	65	153	1.001	16.039	1 412	13.8
67	39.3	80	29.19	176	0.0016	9.90	1.961	5.031	88	127	161	74	76	65	154	1.001	16.325	1 445	14.0
68	39.5	80	29.19	176	0.0029	9.02	1.957	5.029	89	127	161	73	76	65	154	1.001	16.293	1 446	14.2
69	39.5	80	29.19	176	0.0064	7.96	1.934	5.027	89	127	160	73	76	65	154	1.001	16.100	1 429	14.4
70	39.5	80	29.19	176	0.0051	8.59	1.965	5.025	88	127	159	73	76	65	153	1.001	16.361	1 442	14.6

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
71	39.4	80	29.19	176	0.0045	8.69	1.937	5.024	87	126	159	73	76	65	153	1.001	16.124	1 411	14.8
72	39.5	80	29.19	176	0.0031	9.14	1.956	5.023	87	126	159	73	76	65	152	1.001	16.283	1 419	15.0
73	39.2	80	29.19	176	0.0016	9.94	1.966	5.022	87	126	159	73	76	65	152	1.001	16.366	1 425	15.2
74	38.9	80	29.19	176	0.0016	9.92	1.929	5.023	87	126	160	73	76	65	153	1.001	16.063	1 404	15.4
75	39.3	80	29.18	176	0.0027	9.13	1.955	5.020	88	126	160	73	76	65	153	1.001	16.276	1 431	15.7
76	39.4	80	29.19	176	0.0036	9.02	1.970	5.016	88	126	160	74	76	65	153	1.001	16.403	1 444	15.9
77	39.5	80	29.19	176	0.0024	9.53	1.941	5.017	88	126	160	74	76	65	153	1.001	16.159	1 420	16.1
78	39.3	80	29.19	176	0.0031	9.24	1.949	5.015	88	126	160	74	76	65	153	1.001	16.227	1 428	16.3
79	39.3	80	29.19	176	0.0042	8.99	1.945	5.013	88	126	159	73	76	65	153	1.001	16.195	1 424	16.5
80	39.3	80	29.19	176	0.0029	9.20	1.937	5.013	88	126	159	73	76	65	153	1.001	16.129	1 417	16.7
81	39.7	79	29.19	176	0.0020	9.60	1.936	5.009	88	126	160	73	76	65	153	1.001	16.120	1 414	16.9
82	39.6	79	29.19	176	0.0019	9.75	1.946	5.011	88	126	160	73	76	65	153	1.001	16.200	1 424	17.1
83	39.6	79	29.19	176	0.0015	9.84	1.948	5.010	88	126	160	73	76	65	153	1.001	16.217	1 427	17.3
84	39.7	79	29.19	176	0.0028	9.12	1.960	5.007	88	127	160	74	76	65	153	1.001	16.320	1 442	17.5
85	39.8	79	29.19	176	0.0042	8.67	1.947	4.986	88	127	160	74	76	65	153	1.001	16.208	1 432	17.7
86	39.9	79	29.19	176	0.0038	8.71	1.956	4.767	88	126	160	73	76	65	153	1.001	16.286	1 432	17.9
87	40.1	79	29.19	176	0.0026	9.16	1.963	4.783	87	125	160	74	76	65	153	1.001	16.345	1 431	18.2
88	40.1	79	29.19	176	0.0026	9.15	1.923	4.773	88	125	160	74	76	65	153	1.001	16.007	1 403	18.4
89	40.1	79	29.19	176	0.0044	8.53	1.958	4.772	88	125	160	73	75	65	153	1.001	16.303	1 434	18.6
90	40.2	79	29.19	175	0.0054	8.39	1.939	4.776	88	125	160	73	76	65	153	1.001	16.144	1 417	18.8
91	40.1	79	29.19	176	0.0036	9.05	1.969	4.755	87	125	159	73	76	65	153	1.001	16.396	1 436	19.0

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
92	40.3	79	29.19	176	0.0012	10.09	1.937	4.774	87	125	160	73	76	65	153	1.001	16.125	1 410	19.2
93	40.4	79	29.19	176	0.0008	10.44	1.959	4.770	88	125	161	74	76	65	153	1.001	16.308	1 431	19.4
94	40.2	79	29.19	177	0.0009	10.68	1.949	4.761	88	125	161	74	76	65	153	1.001	16.225	1 433	19.6
95	40.3	79	29.19	177	0.0014	9.85	1.966	4.763	89	126	162	73	76	65	154	1.001	16.371	1 460	19.8
96	40.4	79	29.19	176	0.0040	8.60	1.963	4.749	89	126	162	74	76	65	155	1.001	16.344	1 463	20.0
97	40.4	79	29.19	176	0.0055	8.04	1.932	4.772	89	126	161	73	76	65	154	1.001	16.083	1 436	20.2
98	40.5	79	29.19	176	0.0069	8.26	1.960	4.761	89	126	160	74	76	65	154	1.001	16.320	1 447	20.5
99	40.1	79	29.19	176	0.0030	9.22	1.948	4.750	88	125	160	74	76	65	153	1.001	16.215	1 424	20.7
100	40.3	79	29.19	176	0.0017	9.48	1.949	4.754	88	125	160	74	76	65	153	1.001	16.230	1 423	20.9
101	40.3	79	29.19	176	0.0026	9.12	1.970	4.743	88	125	160	74	76	65	153	1.001	16.398	1 438	21.1
102	40.4	79	29.19	176	0.0032	8.60	1.943	4.754	88	125	160	74	76	65	153	1.001	16.181	1 420	21.3
103	40.5	79	29.19	176	0.0034	8.58	1.961	4.753	88	125	160	74	76	65	153	1.001	16.330	1 432	21.5
104	40.4	79	29.19	176	0.0041	8.43	1.943	4.750	87	125	159	74	76	65	153	1.001	16.173	1 414	21.7
105	40.5	79	29.19	176	0.0017	9.58	1.957	4.757	87	125	159	74	76	65	152	1.001	16.291	1 419	21.9
106	40.4	79	29.19	176	0.0007	10.57	1.941	4.752	87	125	160	74	76	65	152	1.001	16.164	1 408	22.1
107	40.2	79	29.19	176	0.0007	10.61	1.949	4.746	88	125	161	74	76	65	153	1.001	16.225	1 423	22.3
108	40.2	79	29.19	176	0.0013	9.42	1.950	4.752	89	125	161	74	76	65	154	1.001	16.237	1 439	22.5
109	40.2	79	29.19	176	0.0029	8.68	1.943	4.734	89	126	161	74	76	65	154	1.001	16.178	1 439	22.7
110	40.2	79	29.19	176	0.0034	8.64	1.949	4.745	89	126	160	73	76	65	154	1.001	16.225	1 440	23.0
111	40.0	79	29.19	176	0.0023	8.72	1.951	4.740	88	126	160	73	76	65	153	1.001	16.247	1 433	23.2
112	39.8	79	29.19	176	0.0019	9.20	1.961	4.763	88	125	160	73	76	65	153	1.001	16.327	1 434	23.4

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
113	39.6	79	29.19	175	0.0033	8.39	1.939	4.750	87	125	159	73	76	65	153	1.001	16.142	1 413	23.6
114	39.6	79	29.19	176	0.0020	9.42	1.960	4.741	87	125	159	73	76	65	152	1.001	16.322	1 425	23.8
115	39.6	80	29.19	176	0.0008	10.10	1.937	4.758	87	125	160	73	76	65	152	1.001	16.127	1 406	24.0
116	39.6	80	29.19	176	0.0009	9.87	1.940	4.736	87	125	160	73	76	65	153	1.001	16.149	1 413	24.2
117	39.6	80	29.19	176	0.0019	9.01	1.951	4.734	88	125	160	74	76	65	153	1.001	16.242	1 431	24.4
118	39.5	80	29.19	176	0.0016	9.23	1.953	4.739	88	125	160	74	76	65	153	1.001	16.264	1 433	24.6
119	39.6	80	29.19	175	0.0018	8.88	1.933	4.753	88	125	160	73	76	65	153	1.001	16.098	1 418	24.8
120	39.5	80	29.19	175	0.0034	8.25	1.951	4.728	88	125	159	73	76	65	153	1.001	16.242	1 427	25.0
121	39.4	80	29.19	175	0.0036	8.54	1.939	4.725	87	125	159	73	76	65	153	1.001	16.142	1 410	25.3
122	39.3	80	29.19	176	0.0020	9.16	1.944	4.760	87	125	159	73	76	65	152	1.001	16.186	1 409	25.5
123	39.5	80	29.19	176	0.0008	10.57	1.948	4.737	87	125	159	74	76	65	152	1.001	16.220	1 409	25.7
124	39.5	80	29.19	176	0.0007	10.35	1.949	4.734	87	125	160	74	76	65	153	1.001	16.230	1 418	25.9
125	39.4	80	29.20	176	0.0012	9.34	1.950	4.741	88	125	161	74	76	65	153	1.001	16.232	1 430	26.1
126	39.3	80	29.20	176	0.0017	9.00	1.957	4.741	88	125	160	74	76	65	154	1.001	16.293	1 442	26.3
127	39.2	80	29.20	176	0.0013	9.39	1.931	4.750	88	126	160	74	76	65	154	1.001	16.076	1 421	26.5
128	39.1	80	29.20	176	0.0014	9.19	1.960	4.727	88	126	160	74	76	65	153	1.001	16.315	1 441	26.7
129	39.0	80	29.20	176	0.0024	8.43	1.948	4.737	88	125	160	74	76	65	153	1.001	16.215	1 428	26.9
130	38.8	80	29.20	175	0.0036	8.19	1.942	4.733	88	125	159	74	76	65	153	1.001	16.166	1 420	27.1
131	39.0	80	29.20	175	0.0027	8.66	1.949	4.728	87	125	159	74	76	65	152	1.001	16.230	1 417	27.3
132	39.2	80	29.20	176	0.0016	9.15	1.957	4.742	87	125	159	74	76	65	152	1.001	16.296	1 417	27.5
133	39.0	80	29.20	176	0.0010	9.63	1.931	4.720	87	125	159	74	76	65	152	1.001	16.076	1 396	27.8

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
134	38.9	80	29.20	176	0.0007	9.98	1.958	4.730	87	125	160	74	76	65	152	1.001	16.303	1 420	28.0
135	38.9	80	29.20	176	0.0008	9.56	1.943	4.737	87	125	160	74	76	65	153	1.001	16.176	1 416	28.2
136	38.7	80	29.20	176	0.0011	9.43	1.943	4.720	88	125	160	74	76	65	153	1.001	16.176	1 424	28.4
137	38.4	81	29.20	176	0.0012	9.30	1.952	4.722	88	125	160	74	76	65	153	1.001	16.254	1 431	28.6
138	38.7	80	29.20	176	0.0029	8.33	1.956	4.735	88	125	160	74	76	65	153	1.001	16.283	1 435	28.8
139	38.6	80	29.20	176	0.0024	8.71	1.924	4.722	88	125	159	74	76	65	153	1.001	16.017	1 406	29.0
140	38.6	80	29.20	176	0.0010	9.65	1.968	4.723	87	125	159	74	76	65	153	1.001	16.383	1 433	29.2
141	38.5	80	29.20	176	0.0010	9.40	1.954	4.728	87	125	160	74	76	65	153	1.001	16.269	1 421	29.4
142	38.4	81	29.20	175	0.0014	9.04	1.946	4.707	87	125	160	74	76	65	153	1.001	16.205	1 419	29.6
143	38.4	81	29.20	176	0.0010	9.55	1.943	4.726	87	125	160	74	76	65	153	1.001	16.181	1 417	29.8
144	38.4	80	29.20	176	0.0008	9.72	1.955	4.715	88	125	160	74	76	65	153	1.001	16.278	1 429	30.1
145	38.5	80	29.20	176	0.0009	9.46	1.953	4.737	88	125	160	74	76	65	153	1.001	16.256	1 428	30.3
146	38.5	80	29.20	176	0.0010	9.48	1.943	4.732	88	125	160	74	76	65	153	1.001	16.173	1 424	30.5
147	38.2	81	29.20	176	0.0011	9.19	1.952	4.728	88	125	160	74	76	65	153	1.001	16.251	1 431	30.7
148	38.3	81	29.20	176	0.0016	8.72	1.943	4.709	88	125	160	74	76	65	153	1.001	16.173	1 426	30.9
149	37.6	81	29.20	175	0.0029	8.27	1.955	4.716	88	125	159	74	76	65	153	1.001	16.281	1 432	31.1
150	37.6	81	29.20	175	0.0039	8.03	1.935	4.708	87	125	159	74	76	65	153	1.001	16.110	1 410	31.3
151	37.6	81	29.20	175	0.0021	8.98	1.958	4.705	87	125	159	74	77	65	152	1.001	16.298	1 418	31.5
152	37.3	81	29.20	175	0.0008	9.90	1.933	4.717	87	124	159	74	77	65	152	1.001	16.098	1 395	31.7
153	37.2	82	29.20	176	0.0006	10.45	1.963	4.733	87	125	160	74	77	65	152	1.001	16.342	1 421	31.9
154	37.5	81	29.20	176	0.0006	10.18	1.928	4.715	87	125	160	74	77	65	153	1.001	16.056	1 404	32.1

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
155	37.2	82	29.20	176	0.0012	9.11	1.959	4.717	88	125	161	75	77	65	153	1.001	16.308	1 438	32.3
156	37.1	82	29.20	176	0.0014	9.00	1.937	4.708	88	125	160	75	77	65	154	1.001	16.124	1 424	32.6
157	37.0	82	29.20	176	0.0014	9.09	1.954	4.707	88	125	160	75	77	65	153	1.001	16.271	1 436	32.8
158	37.0	82	29.20	176	0.0012	9.15	1.927	4.711	88	125	160	74	77	65	153	1.001	16.046	1 413	33.0
159	37.0	82	29.20	175	0.0022	8.69	1.951	4.719	88	125	160	74	77	65	153	1.001	16.242	1 427	33.2
160	37.0	82	29.20	176	0.0011	9.32	1.943	4.712	88	125	159	74	77	65	153	1.001	16.173	1 417	33.4
161	36.8	82	29.20	175	0.0016	8.75	1.957	4.698	87	125	159	75	77	65	153	1.001	16.291	1 425	33.6
162	37.2	82	29.20	175	0.0015	8.80	1.940	4.723	87	125	159	75	77	65	153	1.001	16.149	1 413	33.8
163	37.5	81	29.20	175	0.0021	8.50	1.949	4.707	87	125	159	75	77	65	153	1.001	16.230	1 418	34.0
164	37.5	81	29.20	175	0.0014	9.21	1.949	4.708	87	125	159	75	77	65	152	1.001	16.227	1 412	34.2
165	37.3	82	29.20	175	0.0011	9.38	1.938	4.706	87	125	159	75	77	65	152	1.001	16.137	1 402	34.4
166	37.3	82	29.20	176	0.0008	9.70	1.931	4.709	87	125	159	75	77	65	152	1.001	16.076	1 400	34.6
167	37.7	81	29.20	176	0.0007	9.87	1.936	4.711	87	125	160	75	77	65	153	1.001	16.117	1 407	34.9
168	37.8	81	29.20	176	0.0006	10.15	1.962	4.712	88	125	160	75	77	65	153	1.001	16.332	1 433	35.1
169	37.8	81	29.20	176	0.0007	9.70	1.928	4.698	88	125	161	75	77	65	153	1.001	16.049	1 414	35.3
170	37.7	81	29.20	176	0.0008	9.35	1.931	4.703	88	125	161	75	77	65	154	1.001	16.073	1 421	35.5
171	37.9	81	29.20	176	0.0012	8.87	1.936	4.701	89	126	160	74	77	65	154	1.001	16.122	1 429	35.7
172	38.1	81	29.20	175	0.0025	8.08	1.942	4.707	88	126	160	75	77	65	154	1.001	16.166	1 430	35.9
173	38.1	81	29.20	175	0.0028	8.14	1.946	4.709	88	125	159	75	77	65	153	1.001	16.200	1 425	36.1
174	38.2	81	29.20	175	0.0015	8.96	1.939	4.703	87	125	159	75	77	65	152	1.001	16.144	1 409	36.3
175	38.2	81	29.20	175	0.0013	9.22	1.951	4.718	87	125	159	74	77	65	152	1.001	16.242	1 414	36.5

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
176	37.8	81	29.20	175	0.0009	9.50	1.956	4.710	87	125	159	75	77	65	152	1.001	16.284	1 417	36.7
177	38.0	81	29.20	176	0.0008	9.56	1.939	4.691	87	124	159	74	77	65	152	1.001	16.142	1 408	36.9
178	37.8	81	29.20	176	0.0008	9.69	1.958	4.708	87	125	160	75	77	65	152	1.001	16.301	1 427	37.1
179	37.7	81	29.20	176	0.0006	9.98	1.940	4.703	88	125	160	75	77	65	153	1.001	16.154	1 419	37.4
180	37.9	81	29.20	176	0.0006	9.88	1.947	4.717	88	125	161	75	77	65	153	1.001	16.208	1 432	37.6
181	37.8	81	29.20	176	0.0012	8.80	1.932	4.708	89	125	160	75	77	65	154	1.001	16.084	1 425	37.8
182	37.2	82	29.20	175	0.0030	8.09	1.972	4.688	88	125	160	75	77	65	153	1.001	16.423	1 453	38.0
183	37.0	82	29.20	175	0.0017	8.58	1.941	4.704	88	125	159	75	77	65	153	1.001	16.162	1 421	38.2
184	37.5	82	29.20	175	0.0034	7.85	1.959	4.702	87	125	159	75	77	65	152	1.001	16.311	1 426	38.4
185	37.9	81	29.20	175	0.0025	8.83	1.939	4.695	87	124	158	75	77	65	152	1.001	16.147	1 401	38.6
186	38.0	81	29.20	175	0.0007	9.89	1.940	4.690	86	124	159	75	77	65	152	1.001	16.152	1 397	38.8
187	38.0	81	29.20	176	0.0007	9.90	1.962	4.691	87	124	159	75	77	65	152	1.001	16.335	1 417	39.0
188	38.2	81	29.20	175	0.0010	9.19	1.930	4.710	87	124	159	75	77	65	152	1.001	16.069	1 401	39.2
189	38.6	81	29.20	175	0.0013	8.92	1.958	4.696	87	125	159	75	77	65	153	1.001	16.298	1 427	39.4
190	38.9	80	29.20	175	0.0013	9.03	1.930	4.695	88	125	159	75	77	65	153	1.001	16.066	1 408	39.7
191	39.0	80	29.20	175	0.0014	8.99	1.948	4.705	87	125	159	75	77	65	152	1.001	16.218	1 419	39.9
192	38.9	80	29.20	175	0.0013	9.09	1.939	4.690	87	125	159	75	77	65	152	1.001	16.147	1 412	40.1
193	39.4	80	29.20	175	0.0014	9.02	1.928	4.689	87	124	159	75	77	65	152	1.001	16.052	1 402	40.3
194	39.3	80	29.20	175	0.0009	9.53	1.942	4.695	87	124	159	75	77	65	152	1.001	16.172	1 413	40.5
195	39.5	80	29.20	175	0.0012	9.02	1.953	4.684	87	125	159	75	77	65	152	1.001	16.265	1 423	40.7
196	39.2	80	29.20	175	0.0014	8.85	1.928	4.707	87	124	159	75	77	65	152	1.001	16.055	1 405	40.9

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
197	39.2	80	29.20	175	0.0018	8.52	1.931	4.681	88	125	159	75	77	65	152	1.001	16.077	1 408	41.1
198	39.1	80	29.20	175	0.0019	8.48	1.946	4.702	87	124	158	75	77	65	152	1.001	16.206	1 414	41.3
199	38.9	80	29.20	175	0.0021	8.44	1.953	4.690	87	124	158	75	77	65	152	1.001	16.257	1 414	41.5
200	38.9	80	29.20	175	0.0024	8.44	1.917	4.701	87	124	158	75	77	65	151	1.001	15.964	1 383	41.7
201	38.8	81	29.20	175	0.0017	8.69	1.974	4.695	86	124	158	75	77	65	151	1.001	16.436	1 421	41.9
202	38.7	81	29.20	175	0.0021	8.65	1.929	4.685	86	124	158	75	77	65	151	1.001	16.060	1 385	42.2
203	38.5	81	29.20	175	0.0012	9.02	1.948	4.696	86	124	158	75	77	65	151	1.001	16.216	1 398	42.4
204	38.0	81	29.20	175	0.0012	9.17	1.927	4.697	86	124	158	75	77	64	151	1.001	16.043	1 386	42.6
205	38.2	81	29.20	174	0.0012	9.01	1.967	4.707	87	124	158	75	77	64	151	1.001	16.376	1 418	42.8
206	38.4	81	29.20	175	0.0010	9.25	1.917	4.688	87	124	158	75	77	64	151	1.001	15.960	1 384	43.0
207	38.6	81	29.20	175	0.0013	8.98	1.955	4.688	87	124	158	75	77	64	151	1.001	16.281	1 415	43.2
208	38.1	81	29.20	175	0.0008	9.45	1.934	4.696	87	124	158	75	77	64	151	1.001	16.105	1 401	43.4
209	38.0	81	29.20	174	0.0011	8.93	1.950	4.674	87	124	158	75	77	64	151	1.001	16.234	1 415	43.6
210	38.2	81	29.20	174	0.0022	8.45	1.923	4.678	87	124	158	75	77	64	151	1.001	16.009	1 397	43.8
211	38.0	81	29.20	174	0.0017	8.66	1.960	4.670	87	124	158	75	77	64	151	1.001	16.322	1 422	44.0
212	38.3	81	29.20	174	0.0019	8.86	1.950	4.691	87	123	158	75	77	64	151	1.001	16.237	1 410	44.2
213	38.1	81	29.20	174	0.0010	9.15	1.931	4.688	87	123	158	75	77	64	151	1.001	16.076	1 394	44.5
214	38.2	81	29.20	174	0.0022	8.25	1.928	4.717	87	123	157	75	77	64	151	1.001	16.059	1 393	44.7
215	37.9	81	29.20	174	0.0024	8.50	1.947	4.667	87	123	157	75	77	64	151	1.001	16.215	1 404	44.9
216	38.2	81	29.20	174	0.0012	9.13	1.929	4.701	86	123	157	75	77	64	150	1.001	16.061	1 385	45.1
217	38.4	81	29.20	174	0.0011	9.06	1.976	4.701	86	123	157	75	77	64	150	1.001	16.452	1 420	45.3

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
218	38.1	81	29.20	174	0.0012	9.20	1.925	4.671	86	123	157	75	77	64	150	1.001	16.027	1 385	45.5
219	38.1	81	29.20	174	0.0007	9.53	1.947	4.670	87	123	158	75	77	64	150	1.001	16.215	1 405	45.7
220	38.2	81	29.20	174	0.0015	8.75	1.924	4.682	87	123	158	75	77	64	151	1.001	16.022	1 393	45.9
221	38.5	81	29.20	174	0.0017	8.51	1.955	4.678	87	123	157	75	77	64	151	1.001	16.284	1 415	46.1
222	38.3	81	29.20	174	0.0023	8.27	1.938	4.681	87	123	157	75	78	64	150	1.001	16.140	1 398	46.3
223	38.3	81	29.20	174	0.0016	8.79	1.946	4.676	86	123	157	75	77	64	150	1.001	16.208	1 401	46.5
224	38.1	81	29.20	174	0.0013	8.74	1.958	4.676	86	123	157	75	77	64	150	1.001	16.301	1 404	46.7
225	38.0	81	29.20	173	0.0025	8.21	1.942	4.678	86	123	156	75	77	64	150	1.001	16.172	1 392	47.0
226	38.1	81	29.20	173	0.0022	8.32	1.952	4.687	86	123	156	75	77	64	150	1.001	16.255	1 396	47.2
227	38.0	81	29.20	173	0.0020	8.52	1.934	4.683	86	122	156	75	78	64	149	1.001	16.108	1 379	47.4
228	37.9	81	29.20	173	0.0016	8.86	1.944	4.672	85	122	156	75	78	64	149	1.001	16.189	1 382	47.6
229	37.7	81	29.20	174	0.0008	9.62	1.946	4.681	85	122	156	75	78	64	149	1.001	16.203	1 383	47.8
230	37.7	81	29.20	174	0.0006	9.64	1.961	4.690	86	122	157	75	78	64	149	1.001	16.330	1 398	48.0
231	37.7	81	29.21	174	0.0006	9.86	1.932	4.675	86	122	157	75	78	64	150	1.001	16.088	1 384	48.2
232	37.9	81	29.20	174	0.0006	9.70	1.933	4.682	86	123	158	75	78	64	150	1.001	16.098	1 392	48.4
233	38.2	81	29.20	174	0.0010	8.90	1.940	4.690	87	123	158	75	78	64	151	1.001	16.157	1 407	48.6
234	37.8	81	29.21	173	0.0016	8.31	1.962	4.684	87	123	157	75	78	64	151	1.001	16.335	1 423	48.8
235	37.1	82	29.21	173	0.0028	7.93	1.952	4.681	87	123	157	75	78	64	150	1.001	16.252	1 409	49.0
236	37.0	82	29.21	173	0.0032	7.91	1.945	4.688	86	123	156	75	78	64	150	1.001	16.196	1 394	49.3
237	37.1	82	29.20	173	0.0018	8.51	1.942	4.691	85	122	155	75	78	64	149	1.001	16.169	1 380	49.5
238	37.7	81	29.21	173	0.0014	8.66	1.954	4.696	85	122	155	75	78	64	149	1.001	16.269	1 384	49.7

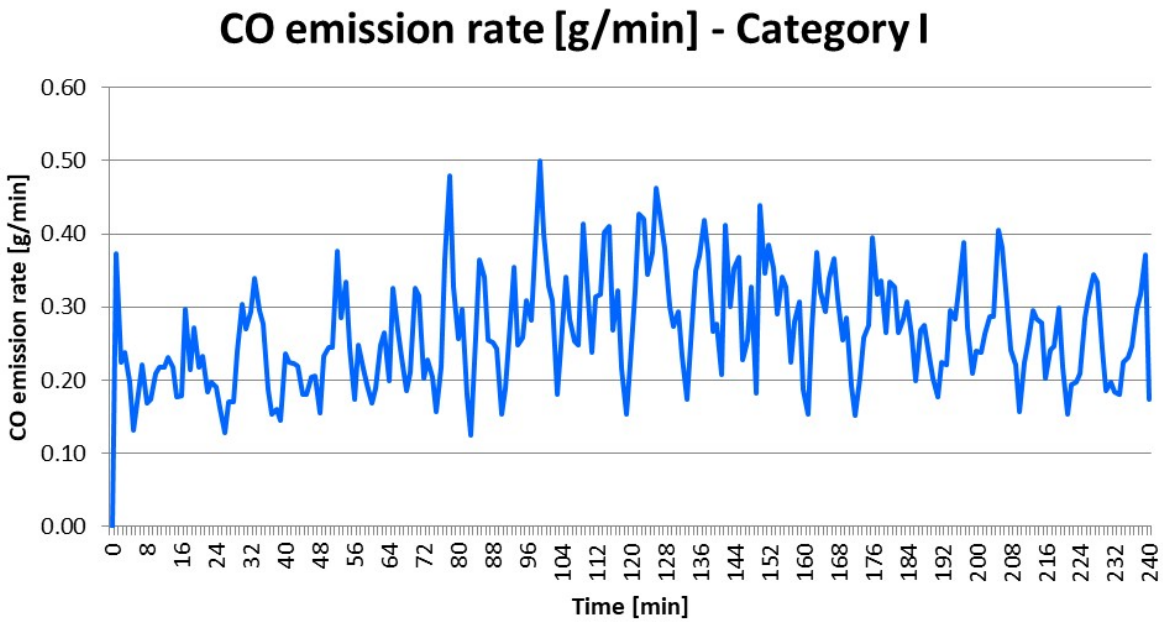
Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

El. time	Ambient conditions			Gas conditions			Flow		Water temperature data										
	Humidity	Ambient temp.	Barom. pressure	Gas temp.	CO	CO_2	Load side flow rate	Boiler side flow rate	Load side thermopile ΔT	Boiler IN	Boiler OUT	Tank side IN	Tank side OUT	Load side IN	Load side OUT	Specific heat of inlet water	Mass flow rate of inlet water	Heat output	Scale
	%	°F	inch Hg	°F	%	%	gpm	gpm	°F	°F	°F	°F	°F	°F	°F	Btu/lb.°F	lb/min	Btu	lb
239	37.6	81	29.21	173	0.0012	8.83	1.941	4.681	85	122	156	75	78	64	149	1.001	16.162	1 374	49.9
240	37.6	82	29.21	173	0.0012	8.83	1.941	4.681	85	122	156	75	78	64	149	1.001	16.162	1 374	50.1
																		1 374	
	38.8	**80**	**29.19**	**175**	**0.0024**	**9.16**	**1.949**	**4.848**	**87**	**125**	**159**	**74**	**76**	**65**	**152**	**1.001**	**16.224**	**339289**	

X. Heat output and CO emissions (B415.1)

Test results in accordance with CSA B415.1-09

Manufacturer		Fröling Heizkessel- und Behälterbau Ges.m.b.H.			
Model		P4 Pellet 60			
Run		1	2	3	4
Test date		03.08.2020	04.08.2020	04.08.2020	05.08.2020
Output category		IV	I	II	III
Overall Efficiency	HHV	86.7%	86.2%	87.4%	87.8%
	LHV	93.0%	92.5%	93.7%	94.2%
Combustion Efficiency	HHV	99.5%	99.5%	99.5%	99.5%
	LHV	99.5%	99.5%	99.5%	99.5%
Heat transfer efficiency	HHV	87.1%	86.7%	87.8%	88.3%
	LHV	93.4%	92.9%	94.2%	94.7%
Output rate	kJ/h	212 443	31 808	49 471	93 307
	Btu/h	201 525	30 174	46 928	88 512
Burn rate	kg/h	12.24	1.85	2.84	5.33
	lb/h	26.98	4.08	6.26	11.75
Input	kJ/h	245 007	36 893	56 612	106 227
	Btu/h	232 416	34 997	53 703	100 768
Test load weight (dry)	kg	48.98	7.42	11.38	21.36
	lb	107.98	16.35	25.09	47.08
MC wet	%	6.02	6.02	6.02	6.02
MC dry	%	6.41	6.41	6.41	6.41
Particulate emissions	g	8.31	4.83	6.48	5
CO	g	4	63	54	6
Test duration	h	4.00	4.00	4.00	4.00
Emissions		**CO**			
g/MJ output		0.00	0.50	0.27	0.02
g/kg dry fuel		0.07	8.54	4.71	0.30
g/hr		0.89	15.84	13.42	1.62
g/min		0.01	0.26	0.22	0.03
lb/MM Btu output		0.01	1.16	0.63	0.04
Air/Fuel ratio		9.40	23.31	16.88	12.26


CO emission rate [g/min] - Category I
CO emission rate [g/min]
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0.50
0.40
0.30
0.20
0.10
0.00
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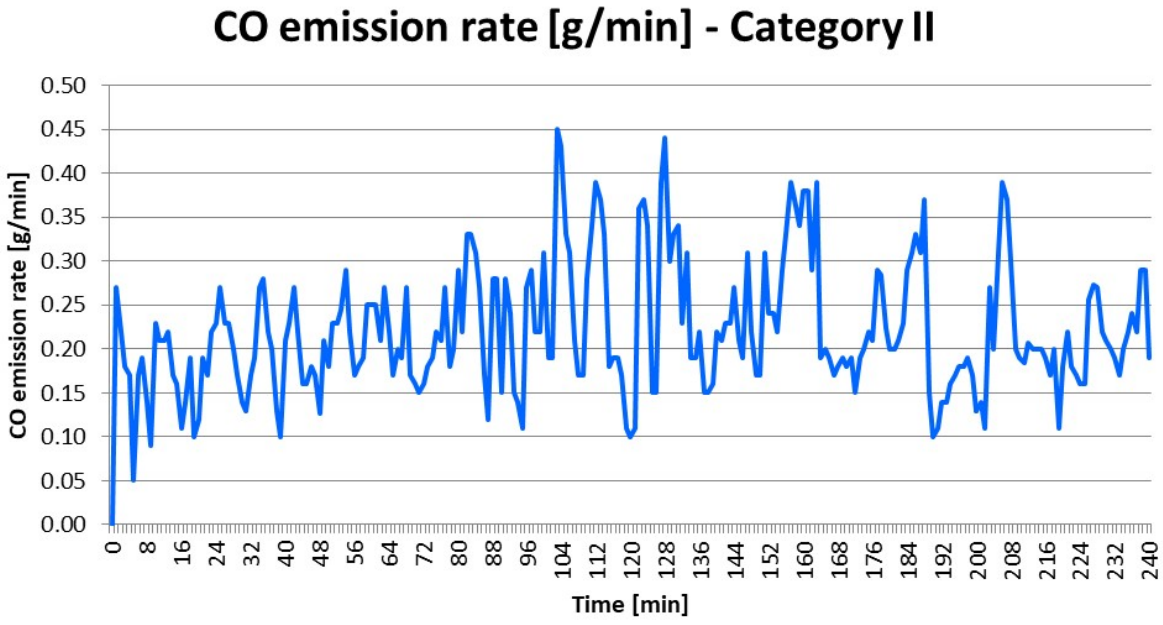
Time [min]


CO emission rate [g/min] - Category II
CO emission rate [g/min]
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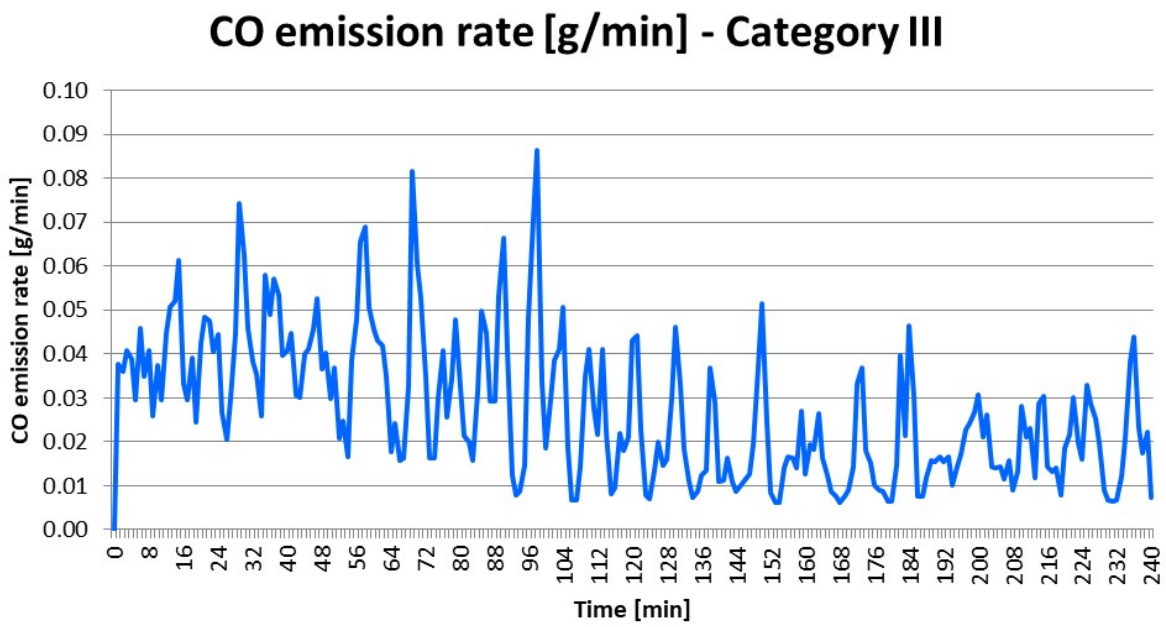
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120 128 136 144 152 160 168 176 184 192 200 208 216 224 232 240
Time [min]


CO emission rate [g/min] - Category III
CO emission rate [g/min]
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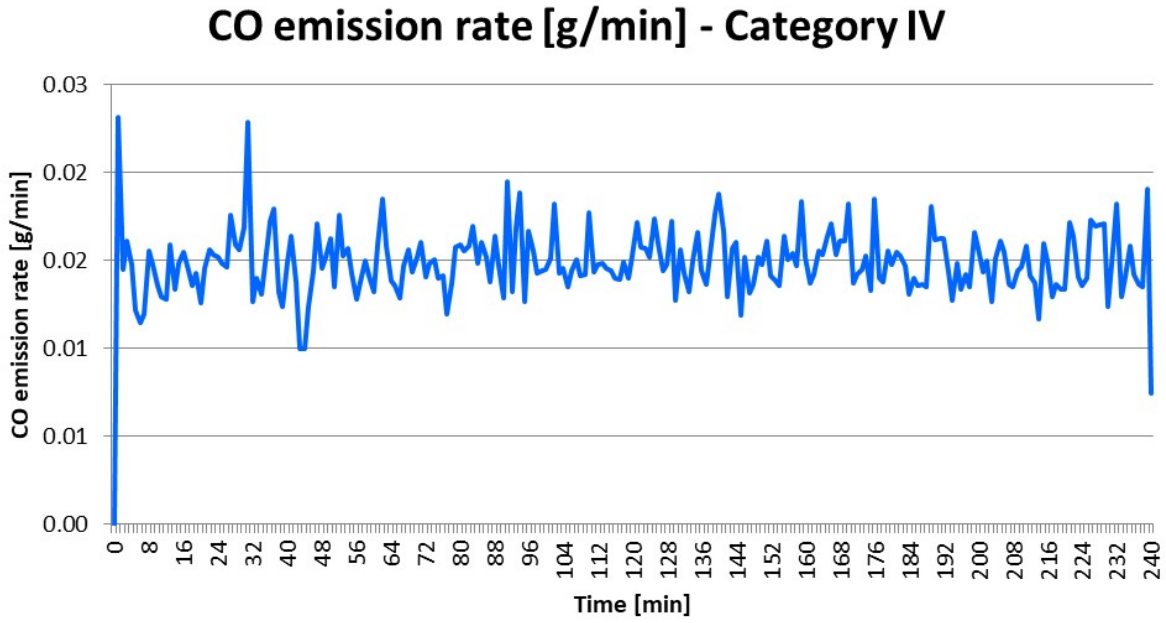
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120 128 136 144 152 160 168 176 184 192 200 208 216 224 232 240
Time [min]


CO emission rate [g/min] - Category IV
CO emission rate [g/min]
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0.02
0.02
0.01
0.01
0.00
0 8 16 24 32 40 48 56 64 72 80 88 96 104 112 120 128 136 144 152 160 168 176 184 192 200 208 216 224 232 240
Time [min]

XI. Data summary

Table A

						Θ	$W_{fuel\ wet}$	MC_{ave}	Q_{in}	Q_{out}
Cat.	Run	Load % capacity	Target load Btu/hr	Actual load Btu/hr	Actual load %	Test duration min	Wood weight lb (wet)	Wood moist. % DB	Heat input Btu	Heat output Btu
I	2	< 15% of max	< 29925	27 753	14	240	17.4	6.4	140 941	110 487
II	3	16 to 24 % of max	31920 - 47880	42 822	22	240	26.7	6.4	215 955	173 038
III	4	25 to 50 % of max	49875 - 99750	84 916	43	240	50.1	6.4	404 826	339 686
IV	1	Max capacity	199500	203 667	102	240	114.9	6.4	928 677	814 337

Table B

			T_{2min}	E_T	E	E	$E_{g/h}$	$E_{g/kg}$	η_{del}	η_{SLM}
Cat	Run	Load % capacity	Min return water temp. °F	Total PM emissions g	PM Output based lb/MMBtu output lb/MMBtu out	PM Output based g/MJ g/MJ	PM Rate g/h	PM Factor g/kg	Deliver. eff. %	Stack loss eff. %
I	2	< 15% of max	131	4.83	0.096	0.041	1.207	0.647	78.4	86.2
II	3	16 to 24 % of max	126	6.48	0.082	0.035	1.621	0.567	80.1	87.4
III	4	25 to 50 % of max	122	5.00	0.032	0.014	1.245	0.233	83.9	87.8
IV	1	Max capacity	133	8.31	0.022	0.010	2.070	0.169	87.7	86.7

Heating season weighting

Cat.	Weighting factor (F_i)	$\eta_{del,i} \times F_i$	Eg/MJ, i × Fi	Eg/kg, i × Fi	E lb/MMBTU Out, i × Fi	Eg/h, i × Fi
I	0.175	13.7	0.007	0.113	0.017	0.211
II	0.275	22.0	0.010	0.156	0.023	0.446
III	0.450	37.8	0.006	0.105	0.015	0.560
IV	0.100	8.8	0.001	0.017	0.002	0.207
Total	**1.000**	**82.3**	**0.024**	**0.391**	**0.056**	**1.424**

Year-round use weighting

Cat.	Weighting factor (F_i)	$\eta_{del,i} \times F_i$	Eg/MJ, i × Fi	Eg/kg, i × Fi	E lb/MMBTU Out, i × Fi	Eg/h, i × Fi
I	0.437	34.3	0.018	0.283	0.042	0.528
II	0.238	19.1	0.008	0.135	0.020	0.386
III	0.275	23.1	0.004	0.064	0.009	0.342
IV	0.050	4.4	0.000	0.008	0.001	0.104
Total	**1.000**	**80.8**	**0.031**	**0.490**	**0.072**	**1.359**

Tested by: Ing. Vladimír Foit Date: 2020-08-03 - 2020-08-05 Signed:

Reviewed by: Mr. Milan Holomek Date: 2022-07-08 Signed:

XII. Example calculations

All calculation was performed based on equations from ASTM E2618-13 and ASTM E2515-11. The equations are described in this chapter, including a sample calculation for Run 1.

TI_{avg}	Average temperature of appliance water at start of the test, °F
TF_{avg}	Average temperature of appliance water at the end of the test, °F
MC_{avg}	Average fuel moisture content in percent based on dry fuel weight
$Q_{in\ gross}$	Gross heat input from all fuel sources, Btu
$Q_{in\ net}$	Net heat input, Btu
Q_{unit}	Net energy content change of appliance and on-board water, Btu
M_i	Mass flow rate of water at interval i, lb/min
Q_{load}	Total heat delivered to simulated load, Btu
$Q_{storage}$	Net energy content change in storage, Btu
$Q_{out\text{-}total}$	Total heat output, Btu
Total Heat Output Rate	Total heat output rate, Btu/hr
Load Heat Output Rate	Simulated load heat output rate, Btu/hr
m_n	Total Particulate Matter Collected, mg
$V_{m(std)}$	Volume of gas sampled corrected to standard conditions, dscf
v_s	Average dilution tunnel gas velocity, ft/sec
C_s	Particulate concentration, g/dscf
Q_{std}	Dilution tunnel gas flow rate, dscf/min
E_T	Total particulate emissions, grams
PR	Proportional rate variation, %
$E_{g/MJ}$	Emission rate, g/MJ
$E_{lb/MMBtu\ output}$	Emission rate, lb/MMBtu output
$E_{g/kg}$	Emission factor, g/kg
$E_{g/hr}$	Emission rate, g/hr
η_{del}	Delivered efficiency, %

TI_{avg} – Average temperature of appliance water at start of the test, °F ASTM E2618 Equation (1):
TF_{avg} – Average temperature of appliance water at the end of the test, °F ASTM E2618 Equation (2):

$TI_{avg} = (T1 + T2) / 2$
$TF_{avg} = (T1 + T2) / 2$

Sample Calculation:

Using data at beginning of test (t=0) TI_{avg} = (134 °F + 169 °F) / 2 = **151 °F**
Using data at end of test (t=179) TF_{avg} = (134 °F + 169 °F) / 2 = **151 °F**

Where,
T1 = Temperature of water at the inlet on the supply side, °F
T2 = Temperature of water at the outlet on the supply side, °F

Q_{in} – Heat input HHV, Btu ASTM E2618 Equation (4):

$$Q_{in} = (W_{fuel} / (1 + (MC_{ave} / 100))) \times HHV$$

Sample Calculation:

Q_{in} = {114.9/ [1+(6.41/100)]} × 8600 = **928 677 Btu**

Where,
W_{fuel} = weight of fuel
MC_{fuel} = Average fuel moisture content, percent dry basis
HHV = The assumed higher heating value of the fuel, 8600 Btu/lb
Q_{in} = Heat input from automatic ignition source, if used, Btu

Q_{unit} – Net energy content change of appliance and on-board water, Btu ASTM E2618 Equation (A2.4):

$Q_{unit} = (W_{app} \times C_{steel} + C_{pa} \times W_{water}) \times (TF_{avg} - TI_{avg})$
$C_{pa} = 1.0014 + [-0.000003485 \times (TI_{avg} + TF_{avg})/2]$

Sample calculation:

C_{pa} = 1.0014 + [-0.000003485*(151+151)/2] ≈ 1.0009Btu/lb.°F
Q_{unit} = (1675 × 0.1+1.0009 × 375) × (151-151) = **-329 Btu**

Where,
W_{app} = Weight of empty appliance in pounds
C_{steel} = Specific heat of steel (0.1 Btu/lb·ºF)
C_{pa} = Average specific heat of water in appliance Btu per pound ºF
W_{water} = Weight of water in supply side of the system in pounds

M_i – Mass flow rate of water at interval i, lb/min ASTM E2618 Equation (9,10):

$M_i = V_{fi} \times \sigma_i$
$\sigma = (62.56 + (-0.0003413 \times T_{3i}) + (-0.00006225 \times T_{3i}^2) \times 0.1337$

Sample Calculation:

Using data from sampling interval at t=1
σ = (62.56 +(-0.0003413 · 62) + (-0.00006225 · 62^2)) x 0.1337= 8.329 lb/gall
M_i = 4.402x 8.329 = 36.66 lb/min

Where,

V_{fi} = Volumetric flow rate of load water at interval *i* , gal/min
σ = Density of water at time interval *i* , lb/gal
T_{3i} = Temperature of water at the inlet to the load side

Q_{load} – Total heat delivered to simulated load, Btu ASTM E2618 Equation (A2.5):

$$Q_{load} = \left| \sum (C_{pi} \times \Delta T_i \times M_i \times t_i) \right|$$

Sample Calculation:

Using data from sampling interval at t=1
Qload @ t=1 = 1.001 x 36,66 x 93 x 1 = **3398 Btu**

SUM for RUN 1 = 814 667 Btu

Where,
C_{pi} = Specific heat of water during time interval *i* , BTU/lb·°F
ΔT_i = Temperature difference between simulated load water entering and exiting HEX 2
M_i = Mass flow rate of water at interval *i* , lb/min
t_i = Data sampling interval, minutes

Q_{out_total} – Total heat output, Btu

$Q_{out\ total} = Q_{load} + Q_{unit}$

Sample Calculation:

$Q_{out\ total}$ = -329 + 814667 = **814 337 Btu**

Total Heat Output Rate – Total heat output rate, Btu/hr ASTM E2618 Equation (15):
Heat Output Rate = $Q_{out\text{-}Total}/\theta$

Sample Calculation:
Total heat output rate = 814337/240/60 = **203584 Btu/hr**
(Load heat output rate = 814667 / 240/60 = 203667 Btu/hr)

Where,
θ = Total length of test run in hours

η_{del} – Delivered Efficiency, % ASTM E2618 Equation (20)

$\eta_{del} = (Q_{out\ total} / Q_{in\ net}) \times 100$

Sample calculation:

ηdel = (814337 / 928677) x 100 = **87.7 %**

m_n – Total Particulate Matter Collected, mg ASTM E2515 Equation (12)

$m_n = m_f + m_b$

Sample calculation (startup, steady, final):

m_n = 1,9 + 0 mg 1st hr phase
m_n = 6,8 + 0 mg post 1st hrl phase

m_n = 8,7 + 0,6 = 9.3 mg I. train
m_n = 8.3 + 0.6 = 8.9 mg II. train

Where,
m_f = front filter
m_b = rear filter

$V_{m(std)}$ – Volume of Gas Sampled Corrected to Dry Standard Conditions, dscf ASTM E2515 equation (6)

$$V_{m(std)} = V_m \times Y \times K_1 \times \frac{(P_b + \frac{\Delta H}{13.6})}{T_m}$$

Where:
K_1 = 0.3855 K/mm Hg
V_m = Volume of gas sample measured at the dry gas meter, m3
Y = Dry gas meter calibration factor, dimensionless
P_b = Barometric pressure at the testing site, mmHg
ΔH = Average pressure differential across the orifice meter, mmH2O
T_m = Absolute average dry gas meter temperature, K

Sample calculation:

$V_{m(std)}$ = 0.321 × 0.9916 × 0.3855 × [734.7+(1.79/13.6)] / 297.5 = 0.303 m^3 1st hr
$V_{m(std)}$ = 1.135 × 0.9916 × 0.3855 × [734.6+(1.65/13.6)] / 297.0 = 1.073 m^3 post 1st hr

$V_{m(std)}$ = 1.367 × 0.9916 × 0.3855 × [734.7+(1.69/13.6)] / 297.1 = **1.292 m^3** I. train
$V_{m(std)}$ = 1.404 × 1.0057 × 0.3855 × [734.6+(1.84/13.6)] / 297.5 = **1.344 m^3** II. train

v_s – Dilution Tunnel Gas Velocity, ft/sec ASTM E2515 equation (7)

$$v_s = F_p \times k_p \times C_p \times (\sqrt{\Delta P})_{avg} \times \sqrt{\frac{T_{s(avg)}}{P_s \times M_s}}$$

Sample calculation:

V_s = 0.9317 × 34.97 × 0.99 × 1.9^0.5 × [326.6/(734.3 × 29.00)]^0.5 = **5.54 ms^{-1}**

C_s – Particulate Concentration, g/dscf ASTM E2515 equation (13)

$$C_s = K_2 \times \frac{m_n}{V_{m(std)}}$$

Sample calculation:

C_s = = 0.001 × 1.9 / 0.303 = 0.00627 g/dscm 1st hr
C_s = = 0.001 × 6.8 / 1.073 = 0.00634 g/dscm post 1st hr

C_s = = 0.001 × 9.3 / 1.292= **0.00720 g/dscm** I. train
C_s = = 0.001 × 8.9 / 1.344 = **0.00662 g/dscm** II. train

Where:
K_2 = Constant, 0.001 g/mg
C_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, g/dscf
m_n = Total mass of particulate matter collected in the sampling train, mg
$V_{m(std)}$ = Volume of gas sampled corrected to dry standard conditions, dscf

Q_{sd} – Average Dilution Tunnel Gas Flow Rate, dscf/hr ASTM E2515 equation (3)

$$Q_{sd} = 3600 \times (1 - B_{ws}) \times v_s \times A \times \frac{T_{std}}{T_{s(avg)}} \times \frac{P_s}{P_{std}}$$

Sample calculation:
Q_{sd} = 60 × (1-0.02) × 5.54 × 0.017671 × (293/326.6) × (734.4/760) = 4.9938 **dscm/min**

Where:
Q_{sd} = Gas flow rate corrected to dry, standard conditions, dscf/hr
3600 = Conversion from seconds to hours (ASTM method uses 60 to convert in minutes)
B_{ws} = Moisture content of dilution tunnel gas, ratio; assume 2%
v_s = Average dilution tunnel gas velocity, ft/sec
A = Cross sectional area of dilution tunnel, ft^2
T_{std} = Standard absolute temperature, 528 °R
$T_{s(avg)}$ = Average absolute dilution tunnel temperature, °R, (°R = °F + 460)
P_b = Barometric pressure at test site, in. Hg
P_g = Dilution tunnel static pressure, in. Hg
P_s = Absolute dilution tunnel gas pressure, in Hg, (Hg = P_b + P_g)
P_{std} = Standard absolute pressure, 29.92 in Hg

E_T – Particulate Emissions, grams ASTM E2515 equation (15)

$$E_T = (c_s - c_r) \times Q_{std} \times \Theta$$

Sample calculation:

E_T = (0.00627 – 0.00) × 5.0018 × 60 = 1.88 g 1st hr
E_T = (0.00634 – 0.00) × 4.9908 × 60 = 5.69 g post 1st hr

E_T = (0.00720 – 0.00) × 4.9938 × 240 = 8.62 g I. train
E_T = (0.00662 – 0.00) × 4.9935 × 240 = 7.93 g II. train

PR - Proportional Rate Variation ASTM E2515 equation (16)

$$PR = \left[\frac{\theta \times V_{mi} \times V_s \times T_m \times T_{si}}{\theta_i \times V_m \times V_{si} \times T_{mi} \times T_s} \right] \times 100$$

Sample calculation (t=1, train I.):

PR = (240×0.201×5.54×(460+75)×(460+125)) / (1×48.275×5.54×(460+75)×(460+128)) × 100
PR= **99.63 %**

Where:
θ = Time of test, min
θ_i = Time of interval, 1 min
V_{mi} = Volume of gas sample measured by the dry gas meter during the “ith” time interval, dscf
V_m = Volume of gas sample as measured by dry gas meter, dscf
V_{si} = Average gas velocity in the dilution tunnel during the "ith" time interval, m/sec

Testing Laboratory
Workplace Brno, Hudcova 424/56b, 621 00 Brno

V_s = Average gas velocity in the dilution tunnel, m/sec
T_{mi} = Average dry gas meter temperature during the "ith" time interval, ^oR
T_m = Average dry gas meter temperature, ^oR
T_{si} = Average gas temperature in the dilution tunnel during the "ith" time interval, ^oR
T_s = Average gas temperature in the dilution tunnel, ^oR

Emission Rates, g/MJ, lb/MMBTU, g/kg, g/hr ASTM E2618 Equations (16)(17)(18)(19)

$$E_{g/MJ} = E_T / (Q_{out-total} \times 0.001055)$$

$$E_{lb/MMBtu\ output} = (E_T / 453.59) / (Q_{out-total} \times 10^{-6})$$

$$E_{g/kg} = E_T / (W_{fuel} / (1 + MC/100))$$

$$E_{g/hr} = E_T / \Theta$$

$E_{g/MJ}$ = 8.28 / (814337×0.001055) = 0.0096 g/MJ
$E_{lb/MMBtu\ output}$ = (8.28 / 453.59) / (814337 × 10^-6) = 0.022 lb/MMBtu output
$E_{g/kg}$ = 8.28 / (52.12 / (1+ 6.41/100)) = 0.169 g/kg
$E_{g/hr}$ = 8.28 / 240/60 = 2.1 g/hr

XIII. SUMMARY PAGE

Version	Test report	Date	EPA Statement	
Initial	**32-10198/1/T**	**2019-10-31**	**see Annex C 1.**	**Mr. Sanchez 2020-05-08**

First revision	**32-10198/4/T**	**2020-08-31**	**see Annex C 2.**	**Mr. Emhofer 2020-11-02**

- To new version of test report 32-10198/4/T were added:
  - based on new testing – first hour data (all runs)
  - correction of data and filled to the table 1C (page 11)
  - new side and front view photographs (pages 7, 8)

Second revision	**32-10198/4-1/T**	**2021-11-20**	**see Annex C 3.**	**Mr. Emhofer 2021-01-15**

- To new version of test report 32-10198/4-1/T were added:
  - Conditioning data (Annex B)
  - Correction of molecular weight (all runs)
  - Correction of time and weight (pages 112, 113)
  - Correction of burn rate (pages 13, 109)
  - Correction of Burn rate (page 13)
  - Volume of firebox (page 4)

Third revision	**32-10198/4-2/T**	**2021-01-21**	**see Annex C 4.**	**Mr. Sanchez 2021-03-12**

- To new version of test report 32-10198/4-2/T were added:
  - Discussion on run appropriateness, run validity, run anomalies (page 10)
  - Sample calculation (pages 114 - 119)

Fourth revision	**32-10198/4-3/T**	**2021-03-19**	**see Annex C 5.**	**Mr. Sanchez 2022-06-30**

- To new version of test report 32-10198/4-3/T were added:
  - Annex C - Email comunaction (Annex C)
  - Summary page (page 120)

Fiveth revision	**32-10198/4-4/T**	**2022-07-08**

- To new version of test report 32-10198/4-4/T were added:
  - Index „wet“ and description „wet“ into the table A at page 112 (column Wood weight)

XIV. List of source materials

- Order B-66546 dated 2019-05-10 (received on 2019-05-10)
- Contract B-66546/32 dated 2019-03-1
- Amendment D1 of Contract B-66546/32
- CEN/TS 15883 – Residential solid fuel burning appliances- Emission test methods
- Boiler documentation P4 Pellet 60

Test Report compiled by: Ing. Vladimír Foit

Person responsible for correctness of the Report:

Accredited Testing Laboratory No. 1045.1 STROJÍRENSKÝ VÝZKUMNÝ ÚSTAV, s.p. 1

Milan Holomek
Head of Heat and Environment-Friendly Equipment
Test Station

-End of text-

Annex A

Boiler documentation P4 Pellet 60

No.	Version	Pages
1.	01_EPA NSPS Affected Source Application_Froeling_P4 Pellet 60	1 - 5
4.	03_Listing-Label_P4_48-60_2014-09-02	6
5.	04_QM-certification_ISO9001_2018en	7
6.	05_Froeling P4 Pellet Warranty Oct 2016 Version	8 - 10
7.	06a_M1500014_assembly-instructions_P4 Pellet_en_US_LQ	11 - 82
8.	06b_ B0990220_Bedienungsanleitung P4 Pellet - Touch_en-US_LQ	83 - 186
9.	06c_B1440619_service-manual_Lambdatronic P 3200_en_LQ	187 - 306
10.	07_Conditioning P4-60	307

Note: Annex A is an integral part of test report 32-10198/4-4/T

United States
Environmental Protection
Agency

OMB Control No. 2060-0161
Approval expires 3/31/2019

OMB Control No. 2060-0693
Approval expires 3/31/2019

EPA Form 6400-03

RESIDENTIAL WOOD HEATER CERTIFICATE OF COMPLIANCE APPLICATION

INSTRUCTIONS

Any manufacturer of an affected residential wood heater must obtain a certificate of compliance from EPA in order to manufacture, advertise for sale, offer for sale, or sell the residential wood heater in the United States.

By completing and submitting this application to EPA, you will satisfy the requirement to apply for a certificate of compliance. To submit a complete application, this application must include the following:

(1) Certification test report prepared by an EPA-approved test laboratory
(2) Certification of conformity by an EPA-approved third party certifier
(3) Quality assurance plan
(4) All required supporting documentation and manufacturer statements pursuant to the 2015 Wood Heater Rule (40 CFR Part 60, §60.533 or §60.5475; <u>see</u> pp. 4-5 of this application)

This application must be signed by a responsible representative of the manufacturer or an authorized representative. Once completed with all required information/documentation included, this application must be submitted to WoodHeaterReports@epa.gov.

Affected residential wood-burning room heaters currently include, but are not limited to, adjustable burn rate stoves, catalytic adjustable burn rate stoves; hybrid adjustable burn rate stoves; single burn rate stoves; and pellet stoves. (40 CFR Part 60, Subpart AAA)

Affected residential wood-burning central heaters currently include, but are not limited to, indoor hydronic heaters ("wood boilers"); outdoor hydronic heaters ("outdoor wood boilers"); and forced-air furnaces ("warm air furnaces"). (40 CFR Part 60, Subpart QQQQ)

The public reporting and recordkeeping burden for this collection of information is estimated to average 8 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Regulatory Support Division, U.S. Environmental Protection Agency (EPA) (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed application to this address.

Disclaimer: The statutory provisions and the EPA regulations described in this document contain legally binding requirements. This document is not a substitute for those provisions or regulations, nor is it a regulation itself. In the event of a discrepancy, please refer to Part 60 Subparts AAA AND QQQQ, Sections 60.537 and 60.5479. If you have additional questions, please contact Rafael Sanchez at 202-564-7028, Residential Wood Heater Compliance Program Lead, or via email at sanchez.rafael@epa.gov.

MANUFACTURER INFORMATION

Manufacturer's Name:
Fröling Heizkessel- und Behälterbau Ges.m.b.H.

Manufacturer's Physical Address:
Industriestraße 12, A-4710, Grieskirchen, Austria

Manufacturer's Mailing Address (if different from physical address):

Name and Title of Manufacturer's Responsible/Authorized Representative Submitting this Application:
Mr. Werner Emhofer, Fa. Fröling GmbH, Export Sales Manager

Manufacturer's Contact E-mail:
w.emhofer@froeling.com

Manufacturer's Phone Number:
+43 (7248) 606 - 0

Manufacturer's Website Address:
www.froeling.com

Manufacturer's Website Address where the test report and owner's manual will be posted, if known:
www.froeling.com

AFFECTED WOOD HEATER MODEL INFORMATION

Model Name(s) (as appearing on the certification test report). Please note: the model name and design number must clearly distinguish one model from another. The name and design number cannot include the EPA symbol or logo or name or derivatives such as "EPA":

Product: Solid Fuel-Fired Hydronic Heating Appliances
Type: P4 Pellet 60

Model Number(s) (as appearing on the certification test report):

P4 Pellet 60

Heater Type Check one):	☐Adjustable Burn Rate Wood Stover	☐Pellet Stove	☐Single Burn Rate Wood Stove	☒Hydronic Heater	☐Forced-Air Furnace (FAF)
Hydronic Heater Type (Check one):	☐Full Storage	☐Partial Storage	☒Indoor	☐Outdoor	
Forced-Air Furnace Type (Check one):	☐Small (less than 65,000 BTU/hr heat output)		☐Large (greater than 65,000 BTU/hr heat output)		
Fuel Tested (Check one):	☐Crib	☒Pellet	☐Cordwood	☐Wood Chips	☐Other:
Certification Step:	☐2015 / ☐2016 (FAFs only)	☐2017 (FAFs only)	☒2020 (ALL HEATERS)		

Was this heater tested using an EPA-approved Alternative Test Method (ATM)? ☐Yes ☒No

If yes, provide date of EPA approval and attach copy of EPA approved ATM letter):
Click or tap to enter a date.

If not, what Test Method(s) did the test laboratory use for the certification test? (List all applicable test methods):
EPA Method 28 WHH

Heater equipped with a catalytic combustor? ☐Yes ☒No

Date of submission of 30-Day Notice to the EPA:9/11/2019 **What was the proposed date(s) of testing? 10/2019** **What was the actual date(s) of testing? 10/2019** **Was the compliance test postponed or suspended? ☐Y ☒N If yes, date of EPA notification of postponement or suspension:** Click or tap to enter a date. **Explain reason for postponing or suspending the certification test:**

EPA-APPROVED TEST LABORATORY

Name of EPA-Approved Test Laboratory: **Engineering Test Institute,** **Public Enterprise (SZU)** **Hudcova 424/56b, 621 00 Brno,** **Czech Republic**		
Name(s) of Person(s) Authorized and/or Responsible for Conducting Certification Test: **Mr. Havlů**		
Position/Title: **test engineer**		
Address: Hudcova 424/56b, 621 00 Brno, **Czech Republic**		
City: Brno	**State: Czech Republic**	**ZIP Code: 62100**
Phone: +420606023661	**Email: havlu@szutest.cz**	

EPA-APPROVED THIRD PARTY CERTIFIER

Name of EPA-Approved Third-Party Certifier: **Engineering Test Institute,** **Public Enterprise (SZU)** **Hudcova 424/56b, 621 00 Brno,** **Czech Republic**		
Name(s) of Person(s) Authorized and/or Responsible for Reviewing Test Report and/or Issuing Certification of Conformity: **Mr. Holomek**		
Position/Title: **test engineer**		
Address: Hudcova 424/56b, 621 00 Brno, **Czech Republic**		
City: Brno	**State: Czech Republic**	**ZIP Code: 62100**
Phone: +420606023661	**Email: havlu@szutest.cz**	

REQUIRED SUPPORTING DOCUMENTATION/MANUFACTURER STATEMENTS

NOTE: TO COMPLETE THIS APPLICATION, ALL REQUIRED DOCUMENTATION AND MANUFACTURER STATEMENTS MUST ACCOMPANY THIS APPLICATION.

1. Engineering Drawings

Engineering drawings and specifications of components that may affect emissions (including specifications for each component listed in paragraphs (k)(2), (3) and (4) of 60.533(b) and 60.5475(b). Manufacturers may use assembly or design drawings that have been prepared for other purposes, but must designate on the drawings the dimensions of each component listed in paragraph (k) of this section. Manufacturers must identify tolerances of components listed in paragraph (k)(2) of 60.533(b) and 60.5475(b) that are different from those specified in that paragraph, and show that such tolerances cannot reasonably be anticipated to cause wood heaters in the model line to exceed the applicable emission limits. The drawings must identify how the emission-critical parts, such as air tubes and catalyst, can be readily inspected and replaced.

2. Firebox Statement Requirement

A statement whether the firebox or any firebox component (including the materials listed in paragraph (k)(3) of 60.533(b) and 60.5475(b) will be composed of material different from the material used for the firebox or firebox component in the wood heater on which certification testing was performed, a description of any such differences and demonstration that any such differences may not reasonably be anticipated to adversely affect emissions or efficiency.

3. Confidential Business Information

Clear identification of any claimed confidential business information (CBI). Submit such information under separate cover to the EPA CBI Office; Attn: Residential Wood Heater Compliance Program Lead, 1200 Pennsylvania Ave., NW, Room 7149-D, MS:2227A, Washington, DC 20460. **Note that all emissions data, including all information necessary to determine emission rates in the format of the standard, cannot be claimed as CBI.**

4. All Documentation Pertaining to a Valid Certification Test

All documentation pertaining to a valid certification test including the complete test report and, for all test runs: Raw data sheets, laboratory technician notes, calculations and test results. Documentation must include the items specified in the applicable test methods. Documentation must include discussion of each test run and its appropriateness and validity, and must include detailed discussion of all anomalies, whether all burn rate categories were achieved, any data not used in the calculations and, for any test runs not completed, the data collected during the test run and the reason(s) that the test run was not completed and why. The burn rate for the low burn rate category must be no greater than the rate that an operator can achieve in home use and no greater than is advertised by the manufacturer or retailer. The test report must include a summary table that clearly presents the individual and overall emission rates, efficiencies and heat outputs. Submit the test report and all associated required information, according to the procedures for electronic reporting specified in § 60.537(f) and 60.5475(f).

5. Warranties

A copy of the warranties for the model line, which must include a statement that the warranties are void if the unit is used to burn materials for which the unit is not certified by the EPA and void if not operated according to the owner's manual.

6. Quality Assurance Program Statement

A statement that the manufacturer will conduct a quality assurance program for the model line that satisfies the requirements of § 60.533(m).

7. Laboratory Sealing of Unit

A statement describing how the tested unit was sealed by the laboratory after the completion of certification testing and asserting that such unit will be stored by the manufacturer in the sealed state until 5 years after the certification test.

8. Statements that the Wood Heaters Manufactured under this Certificate will be:

(i) Similar in all material respects that would affect emissions as defined in § 60.531 to the wood heater submitted for certification testing, and

(ii) Labeled as prescribed in § 60.536 and 60.5478, and

(iii) Accompanied by an owner's manual that meets the requirements in § 60.536 and 60.5478. In addition, a copy of the owner's manual must be submitted to the EPA and be available to the public on the manufacturer's web site.

9. Third Party Certification Statement

A statement that the manufacturer has entered into contracts with an approved laboratory and an approved third-party certifier that satisfy the requirements of § 60.533(f).

10. Approved Laboratory/Third Party Statement

A statement that the approved laboratory and approved third-party certifier are allowed to submit information on behalf of the manufacturer, including any claimed to be CBI.

11. Manufacturer's Website Certification Test Reports Availability Statement

A statement that the manufacturer will place a copy of the certification test report and summary on the manufacturer's web site available to the public within 30 days after the EPA issues a certificate of compliance.

12. Transferability Acknowledgement Statement

A statement of acknowledgment that the certificate of compliance cannot be transferred to another manufacturer or model line without written approval by the EPA.

13. Statement about Selling Wood Heaters without an EPA Certificate

A statement acknowledging that it is unlawful to sell, distribute or offer to sell or distribute an affected wood heater without a valid certificate of compliance.

PLEASE ACKNOWLEDGE THAT ALL REQUIRED SUPPORTING DOCUMENTATION AND MANUFACTURER STATEMENTS ACCOMPANY THIS APPLICATION.

Initials: **WE**

SIGNATURE OF RESPONSIBLE OFFICER OR AUTHORIZED REPRESENTATIVE OF THE MANUFACTURER CERTIFYING THE ACCURACY AND COMPLETENESS OF THIS APPLICATION:

Signature:

Print Name: **WERNER EMHOFER**

Title: **EXPORT SALES MANAGER**

Date: **13-Sep-2019**

The responsible officer or authorized representative of the manufacturer whose signature is above is certifying that the manufacturer has complied with all requirements of the 2015 Wood Heater Rule for compliance certification and will continue to do so. The manufacturer remains responsible for compliance regardless of any error by the EPA-approved test laboratory or third-party certifier.

P4 PELLET

WOOD PELLETS FIRED HYDRONIC FURNACE - BURN WOOD PELLETS ONLY!
FOURNAISE À GRANULÉS DE BOIS – CHAUFFEZ AU GRANULÉS DE BOIS UNIQUEMENT

Manufactured By: Froling GmbH, Grieskirchen, Austria
Test Standards: UL 2523 - 2013, CAN/CSA B366.1-2011
TestDates: 12/2012

Tested & Listed By O-T-L Portland Oregon USA
C US
OMNI-Test Laboratories, Inc.
Report #456-S-02-2

2006/42/EG
2006/95/EG
EN 303-5

Serial # : _____

Do Not Remove or Cover This Label
Ne pas enlever ou recouvir cette étiquette

	Model Modèle	Fuel Combustible	BTU/h (kW) Output Puissance Calorifique	Electrical Rating Classification Électrique	Date of Manufacture / Date de Fabrication:
❒	P4 Pellet 48	Wood Pellets	163,700 (48.0 kW)	230V, 60Hz, 110W	
❒	P4 Pellet 60	Wood Pellets	199,500 (58.5 kW)	230V, 60Hz, 110W	

Fuel / Combustible: Wood Pellets PFI “Super Premium“ or “Premium“ only! / Uniquement granulés de bois PFI “Super Premium“ ou “Premium“
Chimney Connector Size / Diamètre du tube des fumées: 6“ (150 mm)
Maximum Overcurrent Protection - Regular Type / Protection Maximum du Courant - type régulaire: 15 AMP / 250 V

Clearances to Combustibles / Espaces Libres aux Combustibles	
Side Wall to Appliance / Mur Latéral à l‘Appareil	12” (300 mm)
Back Wall to Appliance / Mur Arrière à l‘Appareil	12” (300 mm)
Front of Appliance to Combustibles / Front de l‘Appareil aux Combustibles	19” (490 mm)
Combustibles to Flue Pipe / Matériaux Combustibles au Tuyau de Fumée	18” (460 mm)
Ceiling to Appliance / Haute de la chaudiére au Plafond	18” (460 mm)

FLOORING MUST BE A MINIMUM 3/8“ (10MM) NON-COMBUSTIBLE MATERIAL COVERING THE INSTALLATION CLEARANCE AREA!
LE REVÊTEMENT DE SOL COUVRANT L’INSTALLATION DE LA FOURNAISE DOIT AVOIR UNE ÉPAISSEUR MINIMUM DE 3/8” (10MM) DE MATÉRIEL ININFLAMMABLE.
DO NOT OPERATE WITH FLUE DRAFT EXCEEDING 0.10 INCHES IN WATER COLUMN (25PA), IF NO DRAFT LIMITER IS INSTALLED!
NE PAS METTRE EN SERVICE AVEC UN TIRAGE SUPÉRIEUR À 0.10 POUCES COLONNE D’EAU (25PA), SI AUCUN LIMITEUR DE TIRAGE N’EST INSTALLÉ.
ONLY USE SUPPLIED HOT WATER BOILER SAFETY RELIEF VALVE FOR FIELD ASSEMBLY!
INSTALLER UNIQUEMENT LA SOUPAPE DE SURPRESSION FOURNIE AVEC LA FOURNAISE.
DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE!
NE JAMAIS RELIER CETTE FOURNAISE À UNE CHEMINÉE COMMUNE.

Pressure Relief Valve - Requirements / Soupape de sécurité - exigences	
Maximum Working Pressure / Pression maximale	30 Psi (2 bar)
Minimum Pressure Relief Valve Capacity / Capacité minimum soupape de surpression	535,000 Btu/h (155 kW)
Maximum Pressure Relief Valve Pressure / Pression maximale soupape de surpression	30 Psi (2 bar)
Test Pressure / Pression d'épreuve	67 Psi (4,5 bar)
Maximum Operating Temperature / Température maximale de service	190°F (88°C)

CERTIFICATE

ZERTIFIKAT | CERTIFICATE | CERTIFICAT | CERTIFICADO | СЕРТИФИКАТ | شهادة | 证书 | 인증서

TÜV AUSTRIA

Management system as per EN ISO 9001:2015

In accordance with TÜV AUSTRIA CERT procedures, it is hereby certified that

FRÖLING Heizkessel- und Behälterbau Ges.m.b.H.
Industriestraße 12
A-4710 Grieskirchen

applies a management system in line with the above standard for the following scope

development, production, sale and service of biomass boilers (log wood, wood chip and pellet boilers, wood gas CHP, control systems, feed systems, tanks and heat exchangers)

Certificate Registration No. 201006394

Valid until 2021-09-11
Initial certification: 1997-01-14

Certification Body
at TÜV AUSTRIA CERT GMBH

Vienna, 2018-09-12

This certification was conducted in accordance with TÜV AUSTRIA CERT auditing and certification procedures and is subject to regular surveillance audits.
TÜV AUSTRIA CERT GMBH Deutschstraße 10 A-1230 Wien www.tuv.at

Akkreditierung Austria 0943 ISO/IEC 17021-1

Online Verification
www.tuv.at/certcheck

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011117-18-4

P4 Pellet Boiler Warranty

LIMITED WARRANTY - FOR USE ONLY IN UNITED STATES

Tarm Biomass ("Importer") warrants the steel boiler identified below and its steel doors, high temperature insulation boards, burn chamber, day hopper, auger mechanism, ash bins, and turbulators against defects in material and workmanship under normal use and service ***TO THE ORIGINAL PURCHASER AT THE ORIGINAL INSTALLATION SITE*** in the United States under the following terms.

WARRANTY IS VOID if the boiler is operated with fuel other than premium wood pellet fuel as defined by the Pellet Fuels Institute.

BOILER BODY -- LIMITED 20 YEAR WARRANTY: Subject to the below limitations, Tarm Biomass warrants the steel boiler body (not including doors, burn chamber, or other components) against defects in materials or workmanship causing breaks or leaks that significantly impair the boiler's performance. During the first five years of the warranty period Tarm Biomass will pay for all required labor at the usual and customary rate paid by Tarm Biomass for similar labor performed in Orford, NH, and provide or pay the cost of all materials for the repair of the warranted unit. In years six through twenty Tarm Biomass will pay the below stated percentage multiplied times the retail price of the warranted unit on the date of purchase to the original purchaser toward of the cost of repair of the warranted item or, if Tarm Biomass and the original purchaser agree, use the resultant sum as a partial allowance toward Tarm Biomass's replacement of the warranted item. The original purchaser shall be responsible for all shipping and installation charges in connection with any replacement or repair.

A year for the purposes of this warranty is defined as either 365 calendar days or 3000 service hours, whichever is less.

Warranty Year (beginning from date of purchase)	Percentage Tarm Biomass will pay
1-5	100%
6	60%
7	50%
8	40%
9	30%
10-20	20%

Example 1: Repair costing $250.00 in year 7, Tarm Biomass will pay $125.00 (50% of this repair).

Example 2: Boiler (original retail $4,000.00) needs major repair in year 9. Tarm Biomass will pay $1,200 (30% of $4,000) toward replacement with similar warranted unit or up to 30% of the repair cost ($1,200 maximum).

OTHER COMPONENTS -- LIMITED THREE YEAR WARRANTY

Subject to the application of the following percentages to parts and/or labor, Tarm Biomass provides the following limited warranty of each of its steel doors, high temperature insulation boards, burn chamber, day hopper, auger mechanism, ash bins, and turbulators against defects in material and workmanship causing breaks or leaks that significantly impair the boiler's performance.

Warranty Year (beginning from date of purchase)	Percentage Tarm Biomass will pay
1	100% of parts and labor
2	100% of parts ONLY
3	50% of parts ONLY

OTHER COMPONENTS – ONE YEAR WARRANTY

Motors, electronics controls, and other electronic components have one year warranty.

TARM BIOMASS' LIMITED EXPRESS WARRANTY IS ONLY EXTENDED TO AND COVERS THE TARM BIOMASS PRODUCT'S END USER WHO OWNS THE BUILDING IN WHICH THE TARM BIOMASS PRODUCT IS INSTALLED, AND COVERS ONLY REPAIRS OR REPLACEMENTS RESULTING FROM DEFECTS IN MATERIALS AND WORKMANSHIP.THERE ARE NO WARRANTIES THAT EXTEND BEYOND THE DESCRIPTION IN THIS LIMITED WARRANTY, AND TARM BIOMASS' LIMITED WARRANTY IS IN LIEU OF AND TO THE EXCEPTION OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, WARRANTIES OF MERCHANTABILITY OR WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE. EXCEPT AS OTHERWISE PROVIDED BY THIS LIMITED WARRANTY, TARM BIOMASS TAKES NO RESPONSIBILITY FOR THE QUALITY OF TARM BIOMASS PRODUCTS OR THAT THE GOODS WILL BE FIT FOR ANY PARTICULAR PURPOSE FOR WHICH YOU MAY BE BUYING THESE GOODS. UNDER NO CIRCUMSTANCES SHALL TARM BIOMASS BE SUBJECT TO INCIDENTAL, CONSEQUENTIAL, INDIRECT, SPECIAL, PUNITIVE, ENHANCED COMPENSATORY, OR CONTINGENT DAMAGES, WHETHER A CLAIM IS BASED ON CONTRACT, TORT, STRICT LIABILITY, OR ANY OTHER THEORY OF LAW, ALL SUCH DAMAGES AND CLAIMS BEING SPECIFICALLY DISCLAIMED.

Tarm Biomass' limited warranty is void if a Tarm Biomass product is installed by someone other than a qualified contractor whose principal occupation is the sale or installation of plumbing and heating equipment, or if the original purchaser fails to have the boiler serviced or inspected at least once every year by an experienced and qualified service person. Repairs or replacements under this limited warranty must be performed by your dealer or someone authorized by him. You may be required to present this limited warranty to the dealer before any work is performed. You must pay for any work performed that is not covered by this limited warranty or that is not authorized by the dealer. Tarm Biomass' limited warranty shall be construed under the laws of New Hampshire. Any dispute arising out of this warranty shall be tried only in a court in the State of New Hampshire, including the United States District Court for the State of New Hampshire. If any legal action is brought in connection with this limited warranty, the prevailing party shall be entitled to recover all reasonable expenses it incurs in the action, including its reasonable attorneys' fees, from the nonprevailing party.

TARM BIOMASS' LIMITED WARRANTY EXPRESSLY EXCLUDES COVERAGE FOR THE FOLLOWING:

1. Ordinary wear and tear and repairs or replacements necessitated by normal use.
2. Repairs or replacements arising from corrosion including, but not limited to, the effects of a corrosive water supply or corrosive by-products of combustion formed when a boiler is run during warm weather temperatures or under other conditions that do not permit the boiler to reach necessary operating temperatures on a frequent basis as described in the Owner's Manual provided by Tarm Biomass.
3. Repairs or replacements of fittings, motors, fuel units, oil and gas burners, any and all controls, relief or regulating valves, transformers, and accessories.
4. Repairs or replacements to repair damage caused by (i) operation with inadequate draft, (ii) having installed a boiler model that is incorrectly sized for the application (too few or too many BTU's under normal operating conditions) or that is otherwise inappropriate for the application, (iii) burning other than super premium or premium wood pellets Certified by the Pellet Fuels Institute, or excessive boiler internal temperature from burning improper materials as fuel or operating the boiler without appropriate draft control (for example, burning the boiler too hot when the boiler is coming up to temperature from a cold start), or (iv) any similar use that violates or is not recommended in the Owner's Manual provided by Tarm Biomass.
5. The repair or replacement of any component furnished by any other manufacturer or damage caused by the functioning or malfunctioning of any such component.

This warranty gives you specific legal rights. You may also have other rights that vary from state to state. This warranty shall not be construed as inconsistent with any federal, state, or municipal law, regulation, or code that was applicable to the original installation site on the date the Tarm Biomass product was installed.

Questions regarding this warranty may be referred to:
Tarm Biomass, 322 Archertown Rd., P.O. Box 322, Orford, NH 03777 U.S.A. (603) 795-9100

KEEP THIS INFORMATION FOR YOUR RECORDS:

Model: _____ Place of Purchase: _____

Serial No.: _____ Installation Date:_____

Installer:_____

Assembly Instructions

P4 Pellet 8 - 100

Tested & Listed By O-T-L Portland Oregon USA
C US
OMNI-Test Laboratories, Inc.
Report #456-S-02-2
Do Not Remove or Cover This Label
Ne pas enlever ou recouvrir cette étiquette

TÜV AUSTRIA

English version of the assembly instructions for technicians.
Read and follow the instructions and safety instructions!
Subject to technical change.

Froling Heizkessel- und Behälterbau Ges.m.b.H, Industriestraße 12, A-4710 Grieskirchen
Tel +43 (0) 7248 606-0 Fax +43 (0) 7248 606-600 info@froeling.com www.froeling.com

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1 Supplementary instructions

These instructions ensure safe and efficient use of the P4 Pellet (hereinafter referred to as the “system"). These instructions are a component part of the system and must be kept next to the system and within the immediate reach of staff at all times.

Staff must carefully read and understand these instructions before commencing all work. All the safety instructions and operating guidelines specified in this manual must be observed to ensure safety at work. In addition, the local accident prevention regulations and general safety regulations apply to the area of application of the system.

Images in these instructions are intended solely to aid understanding and may differ from the actual design.

NOTICE

SAVE THESE INSTRUCTIONS!

Copyright

This instruction manual is protected by copyright.

This instruction manual must not be transferred to third parties, reproduced in any form – even excerpts thereof – or the contents used and/or disclosed without the written consent of Fröling Ges.m.b.H. (hereinafter “manufacturer”), unless for internal purposes. Failures to comply with this shall incur damages. The manufacturer reserves the right to assert further claims.

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2 Safety

2.1 Explanation of symbols

Safety information

Safety information in these instructions is indicated by symbols. The safety information is preceded by signal words which reflect the extent of the risk.

⚠ DANGER **This symbol and signal word combination indicates a hazardous situation which will lead to death or serious injury if it is not avoided.**

⚠ WARNING **This symbol and signal word combination indicates a hazardous situation which could lead to death or serious injury if it is not avoided.**

⚠ CAUTION **This symbol and signal word combination indicates a hazardous situation which could lead to slight or minor injuries if it is not avoided.**

NOTICE **This signal word indicates important, but not safety-related information e.g. damage to property or pollution**

Safety information in operating instructions

Safety information can refer to certain, individual operating instructions. To avoid disrupting the flow of the text when you are performing the action, this safety information is not incorporated in the operating instruction. The signal words set out above are used.

Example:

❒ Undo screw
❒ **CAUTION! Pinching hazard at cover**
Take care when closing the cover.
❒ Tighten the screw

Special safety information

The following symbols are used to draw your attention to particular hazards

Tips and recommendations

Italics indicate useful tips and recommendations as well as information for efficient and smooth running.

Other markers

The following markers are used in these instructions to highlight operating guidelines, results, lists, references, and other elements:

Marker	Explanation
r	Step-by-step operating instructions
↪	Results of actions
ð	Links to sections of these instructions and other relevant documents
▪	Lists without a specified order
[Button]	Operating elements (e.g. button, switch), display elements (e.g. signal lights)
“Display“	Screen elements (e.g. buttons, assignment of function keys)

Units used

All units of measure are specified in these operating instructions in both SAE units and SI units. The SAE unit appears first, followed by the SI unit in brackets.

Example using information about heat output: 17 (5) BTU/h (kW) equals 17 BTU/h (SAE system) or 5 kW (SI system).

2.2 Permitted uses

The Froling P4 Pellet boiler is intended exclusively for heating up heating water. Only use those fuels specified in the “Permitted fuels” section.

Permitted use includes compliance with all the specifications in this instruction manual.

Any use other than or above and beyond the permitted use is considered misuse.

2.3 Requirements at the place of installation

2.3.1 Approval for the heating system

The appropriate supervisory authority (inspection agency) must always be informed when installing or modifying a heating system, and authorization must be obtained from the building authorities. Also observe ANSI/NFPA 211 and CAN/CSA B365 for the installation.

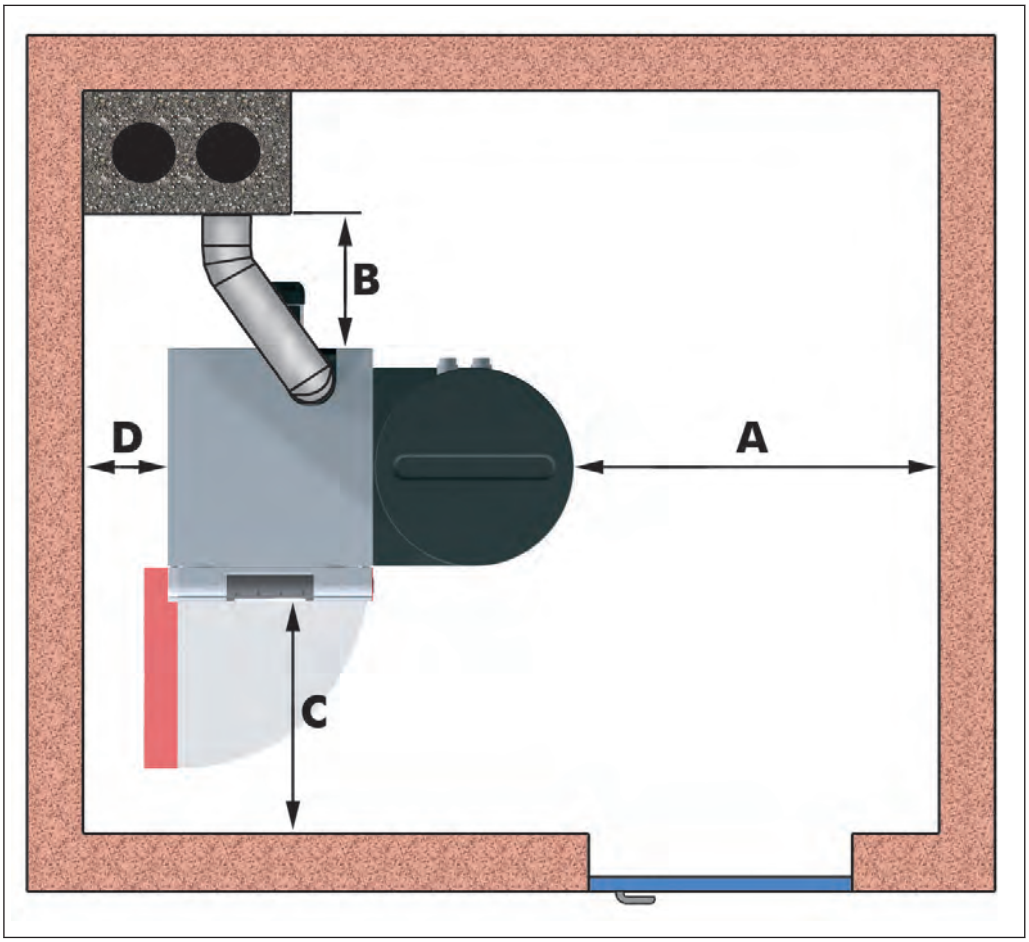
2.3.2 Minimum distances and clearances to combustibles in the boiler room

- The system should generally be set up so that it is accessible from all sides allowing quick and easy maintenance.
- Regional regulations regarding necessary maintenance areas for inspecting the chimney should be observed in addition to the specified minimum distances!
- Observe the applicable standards and regulations when setting up the system.
- Observe additional standards for noise protection
  (ÖNORM H 5190 - Noise protection measures)

FOR SAFE INSTALLATION AND OPERATION CLEANRANCES TO COMBUSTIBLES MUST BE MAINTAINED.

The diagram below shows the required space for the system in the boiler room.

The boiler may only be installed on non-combustible floors with these clearances!



			P4 Pellet				
	Description	**Unit**	**8 – 15**	**20 – 25**	**32 – 38**	**48 – 60**	**80 – 100**
A	Minimum distance to stoker assembly	inch (mm)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)
B	Induced draft fan maintenance area		12 (300)	12 (300)	12 (300)	12 (300)	12 (300)
C	Space for insulated door		22 (550)	29 (720)	33 (830)	20 (490)	24 (590)
D	Minimum distance to side of boiler		8 (200)	8 (200)	8 (200)	8 (200)	8 (200)
Distance between ceiling and boiler			18 (460)	18 (460)	18 (460)	18 (460)	18 (460)
Additional area to be covered is underneath the chimney connector and extending at least 2 inches (50 mm) on either side of the chimney connector.							

2.3.3 Requirements for central heating water

Water quality

Water of the following quality is required for the first fill:

- The water must be clean, pure or purified as well as odorless and must not contain suspended matter.
- The water hardness must not exceed 190 grain/fl.oz. or 100 ppm $CaCO_3$ (100 mg/l), i.e. soft water is required.
- The chlorine concentration in the water must not exceed 58 grain/fl.oz. (30 mg/l).
- The pH value in the heating system must be between 8.0 and 8.6.
- If the water quality is too poor, use additives to prepare the water. If you are topping up with small amounts, always use clean water.

NOTICE

The hot water must not be used directly in swimming pools or thermae. Use a heat consumer of the right size to consume the heat. Do not use the heating water as drinking water.

To ensure good water quality during operation, avoid leaks and use a closed heating system. If necessary, use a return temperature control.

First fill

To prevent air from getting into the heating system during the first fill, fill the filling hose with water.

Frost protection

You can add anti-freeze to the heating water, however, this can reduce the heating efficiency. Always follow the manufacturer's dosing instructions when using anti-freeze, as using the incorrect amount can cause corrosion. Check the concentration of the anti-freeze at regular intervals.

2.3.4 Ventilation requirements for boiler room

Introduction

The external combustion air must meet certain requirements to ensure that adequate combustion air is supplied to the boiler and no by-products from the combustion get into the boiler room.

Ventilation air for the boiler room must be taken from and expelled directly outside, and the openings and air ducts must be designed to prevent weather conditions (e.g. from foliage or snowdrifts), plants or animals from obstructing the air flow. Permanent ventilation is required to ensure that the boiler runs smoothly.

In North America there are several regulations which govern the minimum requirements of combustion air for chimneys.

The boiler must be installed in such a way that it receives adequate ventilation and combustion air and that the fuel in the boiler burns. The exhaust air must be expelled safely outside via the chimney and maintained within a safe temperature range.

Boiler rooms are usually so small that normal ventilation does not provide enough air and air must be brought in from outside. External air openings and air channels must be of an appropriate size to supply adequate combustion air. The design must comply with NFPA 211.

Consult your local chimney inspector for the installation and install the boiler in accordance with the applicable local regulations.

Recommended size of air openings according to NFPA 54 and NFPA 211:

The boiler requires a fresh air supply of between 1 sq.in. per 2,500 BTU/h and 1 sq.in. per 4,000 BTU/h (550 mm²/kW and 880 mm²/kW), depending on local conditions and the climate zone. Local conditions may necessitate an additional air supply.

2.3.5 Requirements for the heating system

- The whole heating system must be designed in accordance with relevant national and local regulations.
- The boiler's nominal load must be adjusted to the calculated heating requirements of all the consumer loads connected in the heating circuit in summer and winter.
- The heating system must be big enough to transport the heat generated by the boiler and an additional heat source (if present). The pressure throughout the whole system including all heating zones must be even.
- Special equipment must be available for filling and ventilating the heating circuit. Flow valves and zone valves must be fitted to set the correct water flow volume.
- All fitted pipes must be water-tight and air-tight and safely insulated.
- If there is a risk of parts of the heating system freezing, add anti-freeze to the water in these heat zones.

2.3.6 Requirements for the installation room (boiler room)

- There must not be a potentially explosive atmosphere in the boiler room as the boiler is not suitable for use in potentially explosive environments!
- The boiler room must be frost-free.
- The boiler does not provide any light, so the customer must ensure sufficient lighting in the boiler room in accordance with national workplace design regulations.
- When using the boiler above 2000 meters above sea level you should consult the manufacturer!
- Danger of fire due to flammable materials!
  No flammable materials should be stored near the boiler. Flammable objects (e.g. clothing) must not be put on the boiler to dry.
- Damage due to impurities in combustion air!
  Do not use any solvents or cleaning agents containing chlorine in the boiler room.
- Keep the air suction opening of the boiler free of dust!

⚠ WARNING **Do not store fuel within installation clearances!**

2.3.7 Requirements for the fuel store

- The fuel store must be protected against the direct effects of weather.
- Before refilling the fuel store, check for pellet dust and clean if necessary.
- When fans are used in the fuel storage area, they should be installed so as not to create negative pressure in the room where the solid-fuel-burning appliance is located.

2.3.8 Combination with a storage tank

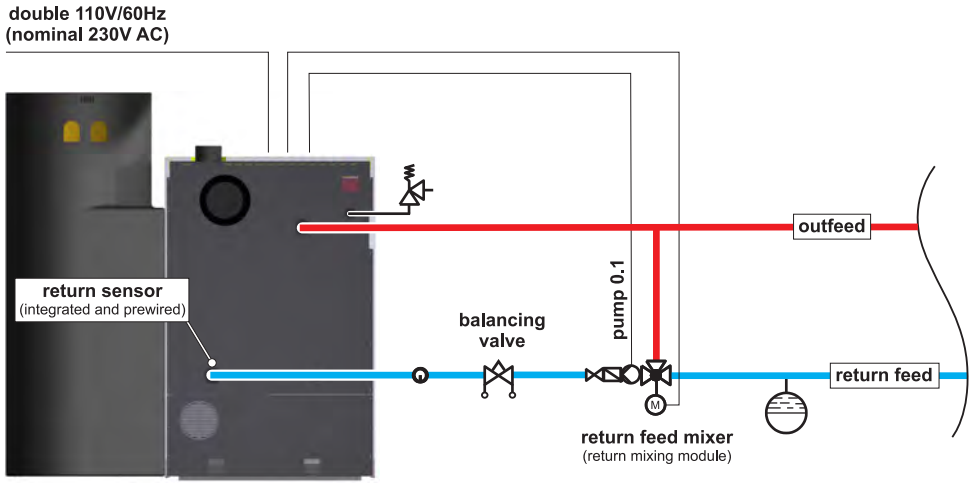
A storage tank does not need to be used for the heating system to run smoothly. However, we recommend that you use the system with a storage tank to ensure a continuous supply of fuel in the boiler's ideal output range.

For the correct dimensions of the storage tank and the line insulation (in accordance with ÖNORM M 7510 or guideline UZ37) please consult your installer or Froling.

2.3.9 Return temperature control for P4 Pellet 80/100

When installing a P4 Pellet 80/100, a return temperature control must be installed. If the hot water return is below the minimum return temperature, some of the hot water outflow will be mixed in via the return temperature control.

Pellet boiler P4 Pellet 80/100 - Return feed lift with mixing valve



Check parameter setting:

Navigate to menu „*System*" ⇨ „*System selection*" ⇨ „*Boiler type*" ⇨ „*P4 Pellet 32 - 100*" and set parameter „*Return flow mixer through external modul*" to „*YES*".

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2.3.10 Requirements for the chimney connection

The chimney connection must be big enough to channel flue gases from the building. The whole flue gas system must be designed to prevent possible seepage, insufficient feed pressure and condensation.

The manufacturer recommends fitting a draft regulator to limit the pressure to 0.10 mm WC (25 Pa). The draft regulator should be fitted directly below the chimney connection where the pressure is very low.

The boiler must be connected to a brick chimney or a shop-made chimney in accordance with UL 103 HT (ULC S629 in Canada). The chimney must be clean and in good condition at the time of installation.

The pipe unions within the chimney must be made of stainless special steel (with 304, 316 or 321 alloys). The individual pipe sections must be joined together with at least three self-tapping screws and the joins sealed using high-temperature silicone. The flue gas pipe must not contain more than two 90° bends.

All connections must conform to NFPA 211. Consult your local chimney sweep for the installation and install the boiler in accordance with the applicable local regulations.

The chimney connection, ventilation ducts and fresh air openings must not be closed over or blocked.

The flue gas pipe must not be displaced by an attic, loft, fuel store or similar areas.

Basic data for designing the chimney connection

Description		P4 Pellet			
		8	15	20	25
Flue gas temperature at nominal load	°C	140	150	150	150
Flue gas mass flow at nominal load	kg/s	0.007	0.010	0.014	0.018
Flue gas mass flow at partial load		0.003	0.004	0.006	0.007
Required feed pressure at nominal load	mbar	0.08	0.08	0.08	0.08
Required feed pressure at partial load		0.06	0.06	0.06	0.06
Maximum permissible feed pressure		0.25			
Flue spigot diameter	mm	130	130	130	130

Description		P4 Pellet			
		32	38	48	60
Flue gas temperature at nominal load	°C	160	160	160	170
Flue gas mass flow at nominal load	kg/s	0.022	0.039	0.039	0.043
Flue gas mass flow at partial load		0.009	0.017	0.017	0.019
Required feed pressure at nominal load	mbar	0.08	0.08	0.08	0.08
Required feed pressure at partial load		0.06	0.06	0.06	0.06
Maximum permissible feed pressure		0.25			
Flue spigot diameter	mm	150	150	150	150

Description		P4 Pellet	
		80	100
Flue gas temperature at nominal load	°C	160	170
Flue gas mass flow at nominal load	kg/s	0.060	0.076
Flue gas mass flow at partial load		0.021	0.026
Required feed pressure at nominal load	mbar	0.08	0.08
Required feed pressure at partial load		0.06	0.06
Maximum permissible feed pressure		0.25	
Flue spigot diameter	mm	200	200

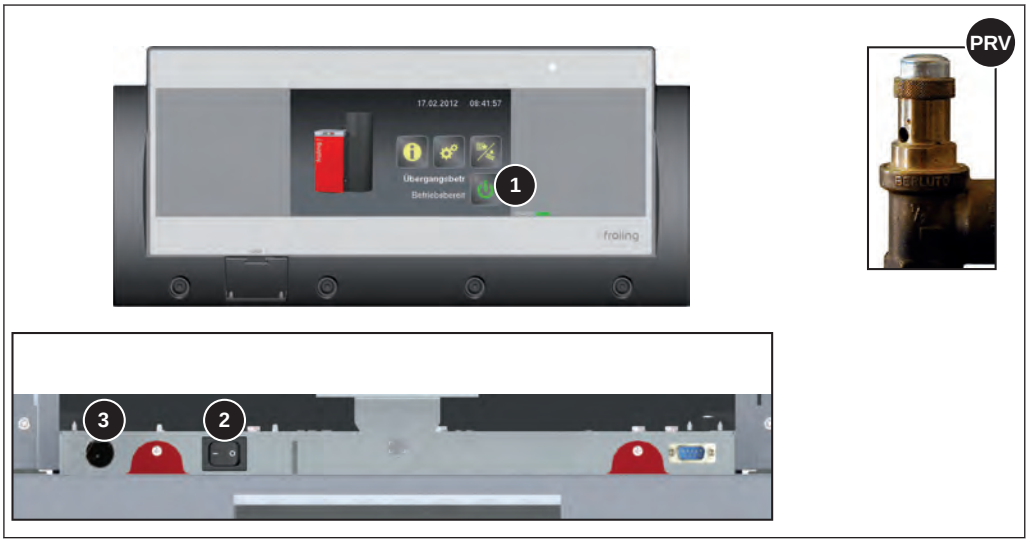
⚠ CAUTION

ADJUSTMENT OF THE FLUE DRAFT HIGHER THAN 0.10 INCHES WATER COLUMN (25 Pa) COULD CAUSE FIRE TO BURN OUT OF CONTROL AND AN UNSAFE CONDITION!

❒ Maximum permitted setting: 0.10 inches WC (25 Pa)
Ideal setting: 0.04 inches WC (10 Pa)

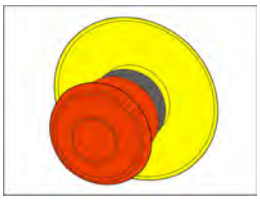
2.4 Safety devices

2.4.1 Position of safety devices



1	Lambdatronic P 3200
2	Main switch
3	High-limit thermostat STL

2.4.2 Description of safety devices



Emergency stop button (optional)

Pressing the emergency stop button stops the entire boiler (fuel infeed, combustion process in the boiler and the blower fan). Only the pump in the heating circuit continues to run to be able to dissipate the residual heat. The emergency stop button is on the same safety chain as the high-limit thermostat.

After an emergency stop button has been pressed, it must be released again by turning it and the fault acknowledged at the SPS so that you can turn the heating system back on again.

The system is controlled via the Lambdatronic P 3200. The "*Boiler OFF*" command allows you to switch off the boiler in the event of overheating. After the boiler has been switched off via the control system, automatic mode is switched off and the control shuts the boiler down according to the shutdown procedure. The pumps continue to run.

Main switch

The system is powered via the main switch. Turning the main switch to the "0" position disconnects the system from the power supply. The main switch is located under the upper insulating cover.

⚠ WARNING

When turning off the main switch in automatic mode:

Serious combustion faults leading to serious accidents are possible.

Before turning off the main switch:

❒ Switch boiler off by tapping “Boiler OFF”.

➥ The boiler follows the shutdown procedure and switches to "Boiler off" status after the cleaning cycle.

Safety valve (provided by the customer)

Depending on the boiler type which is use, different kinds of pressure values of the safety valves are necessary! When the boiler reaches a pressure of 30 psi (2 bar), 43.5 psi (3 bar) or 45 psi (3 bar) the safety valve opens and the heated water is blown off in the form of steam.

⇨ See "Technical specifications" [page 41]

2.5 Safety markers

2.5.1 Mandatory signs

Refer to the operating instructions

Only use the indicated system once you have read the operating instructions.

Wear hearing protection

This sign indicates that hearing protection must be worn in the area concerned.

Wear protective gloves

This sign indicates that protective gloves must be worn in the area concerned.

Wear safety shoes

This sign indicates that safety shoes must be worn in the area concerned.

Wear a dust mask

This sign indicates that a dust mask must be worn in the area concerned.

Keep the doors closed

Keep the doors closed during operation.

Turning off the main switch

Switch off the main switch and take precautions to prevent accidental switching on before carrying out work to the system

Switch off the main switch for the fuel infeed and take precautions to prevent accidental switching on before entering the storeroom.

Securing the main switch

Switch off the main switch and secure with a padlock when carrying out maintenance work to the boiler.

2.5.2 Prohibitions

Unauthorized access prohibited

Only persons authorized by the operator may enter the danger zone and storeroom. Keep children away! Keep the storeroom locked and keep the access key in a safe place. Protect the fuel from moisture.

No fire, open flames or smoking

Areas marked with this are at risk of fire or explosion. Keep ignition sources away from these areas.

2.5.3 Warning signs

Risk of falling

There is a risk of falling when working at heights in the storeroom or on components of the fuel infeed. Use a suitable ladder or hoist for all work.

Automatic start-up

This sign indicates that there is a risk of the system starting up automatically. Work may only be carried out in areas with this marking if the system has been secured.

Electric current

Only licensed electricians may work in workspace with this marking.

Unauthorized persons are not permitted to enter work areas with this marking or open the cabinet with this marking.

Risk of collapse

There is a risk of collapse and being buried alive as a result of cavity formation in the fuel storeroom. Never step on piles of fuel.

Harmful or irritant materials

These materials can be irreparably harmful to health, trigger allergic reactions or irritate the mucous membranes.

Observe the information on the packaging and containers.

Danger from carbon monoxide

There is a risk of poisoning from a possible concentration of carbon monoxide in the fuel storeroom and boiler room. Ventilate the fuel storeroom for at least 15 minutes before entering. Two people must always be present when working in the fuel storeroom. The access door must be kept open at all times. Also wear a dust mask because of the high dust levels.

Hand injuries

Keep hands away from areas bearing this warning.

There is a risk that your hands could get trapped, pulled in or otherwise injured.

Hot surfaces

Hot surfaces, such as hot system parts, may not always be obvious. Do not touch these parts without protective gloves.

Crushing hazard

Keep hands away from areas bearing this warning.

There is a risk that your hands could get trapped, pulled into or otherwise injured in automatic screws.

Risk of falling

There is a risk of falling in the fuel store because of slippery surfaces or fuel lying about. Take extreme care and wear personal protective equipment.

Risk of injury at fans

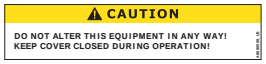
Keep hands away from areas bearing this warning.

There is a risk that your hands could get trapped, pulled into or otherwise injured in automatic fans.

Risk of being buried alive

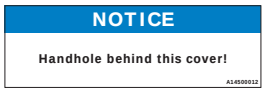
There is a risk of being buried alive in the fuel storeroom. Keep out of the fuel storeroom, especially during filling.

2.5.4 Additional safety signage



Warning sign for covers

Do not modify the system peripherals. The covers must be kept shut during operation.



Notice for maintenance opening

The opening for the visual inspection of the heat exchanger tubes is behind this cover.

2.5.5 Signage on the boiler

The following signs are located on the boiler. They highlight dangers during operation as well as the correct procedure in hazardous situations.

Notice of risks during installation

P4 PELLET - WOOD PELLET FIRED BOILER

INSTALLATION HAZARDS

Install, modify and use only in accordance with manufacturer's manuals. Refer to authorities having jurisdiction for proper installation. Contact local building and fire officials about restrictions and installation inspection in your area. If there are no applicable local codes, follow ANSI/NFPA 211 and CAN/CSA B365. Special precautions are required for passing the chimney through a combustible wall or ceiling.
Inspect and clean exhaust system, heat exchanger, burner, pellet hopper and ash boxes frequently in accordance with owner's manual.

Basic boiler data for layout of chimney system		P4 PELLET				
Quantity	**Unit**	**8 / 15**	**20 / 25**	**32 / 38**	**48 / 60**	**80 / 100**
Flue gas temperature Rated / partial load	°F °C	300 / 210 150 / 100	300 / 210 150 / 100	320 / 210 160 / 100	340 / 210 170 / 100	340 / 210 170 / 100
Minimum draft at boilers flue gas connection		0.03 inches water column (5 Pa)				
Maximum draft at boilers flue gas connection		0.10 inches water column (25 Pa)				
Flue gas connector Diameter		5 inches (130 mm)		6 inches (150 mm)		8 inches (200 mm)
Maximum water temperature	°F °C	176 80			190 88	
Maximum allowable working pressure according to heat exchanger design:	EN 303-5	30 psi (2 bar)				45 psi (3 bar)
	ASME	not available				43.5 psi (3 bar)

For detailed design information please refer to Installation Manual! For unit specifications, see Listing Label! For supply connections use No. 14 AWG (2.1mm²) or larger wires acceptable for at least 194°F (90°C). Use copper. Use regular overcurrent protection device 15 AMP, two phases (L1 & L2).

DANGER!

- Working on electrical components may cause severe injuries from electric shocks!

WARNING!

- The electrical system of the boiler shall be supplied from a double 115 V 60 Hz (nominal 230 V AC) 15 amp branch circuit including neutral and earth connection. For wiring instructions please refer to Installation Manual!
- Chimney must be 5" (130mm - P4 Pellet 8 - 25), 6'' (150 mm - P4 Pellet 32 - 60) or 8" (200 mm – P4 Pellet 80/100) diameter listed UL-103 HT or ULC-S629 residential all-fuel type or tile-lined masonry. Flue connector pipe must be 5" (130mm - P4 Pellet 8 - 25), 6'' (150 mm - P4 Pellet 32 - 60) or 8" (200 mm – P4 Pellet 80/100) diameter made of a minimum 24 MSG black steel.
- Inadequate design, installation and maintenance of the flue gas system will lead to insufficient chimney draft and could result in Danger of Life or Severe Injury caused by serious faults in combustion, e.g. explosively combustion of carbonization gases and flash fires!
- This boiler requires fresh air for safe operation and must be installed so there are provision for adequate combustion and ventilation air!

CAUTION!

- DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE!
- LOAD FUEL CAREFULLY OR DAMAGE MAY RESULT.
- REFER TO OWNER´S MANUAL. DO NOT ALTER THIS EQUIPMENT IN ANY WAY.
- UNSAFE TO ADJUST FLUE DRAFT HIGHER THAN 0.10 INCHES WATER COLUMN (25 Pa)
- MAY BE CONNECTED TO AN EXISTING BOILER SYSTEM.
- Flooring must be a minimum 3/8'' (10 mm) non-combustible material covering the installation clearance area! The floor must be level and reinforced if required. For construction of the floor beneath the boiler mind the weight of boiler, water content and wood fuel according to the Installation Manual!
- This boiler is for use with an automatic stoker only!
- Use original spare parts only. Installation of non-licensed replacement parts will void the warranty!

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Notice of risks during operation

P4 PELLET - WOOD PELLET FIRED BOILER

OPERATION HAZARDS

NOTICE! Burn Wood Pellets only as specified in Owner's Manual!

Pellet Fuel Institute (PFI) Standard "Premium" recommended.

DANGER! Risk of Fire or Explosion!

- Do not burn garbage, gasoline, drain oil, or other flammable liquids.
- DO NOT BURN GARBAGE, GASOLINE, NAPHTA, ENGINE OIL, OR OTHER INAPPROPRIATE MATERIALS!
- DO NOT USE CHEMICALS OR FLUIDS TO START UP THE FIRE.
- Use of inappropriate fuels can result in Danger of Life or Severe Injury caused by explosive combustion and flash fires!
- Burning fuels other those designated in the manual will void the warranty!

DANGER! Explosive Gases!

- Never open Boiler doors, Covers or Heat Exchanger Cask Cover during operation!
- Faulty operation of boiler system will cause Danger of Life or Severe Injury and Material Damage!
- TO AVOID INJURY FROM MOVING PARTS; SHUT OFF BOILER CONTROL SYSTEM BEFORE OPENING BOILER DOORS; COVERS OR HOPPER CASING!

WARNING! Risk of Fire!

- Do not burn garbage, gasoline, drain oil, or other flammable liquids or materials.
- KEEP ALL BOILER DOORS, FUEL STORAGE DOOR AND ALL COVERS TIGHTLY CLOSED DURING OPERATION!
- AFTER OPENING BOILER DOORS, COVERS OR HOPPER CASING CLOSE ALL DOORS, COVERS AND CASING TIGHTLY!
- DO NOT OPERATE WITH FLUE DRAFT EXCEEDING 0.10 INCHES WATER COLUMN (25 Pa)!
- Do not operate with flue draft exceeding 0.10 inches in water column (25 Pa).
- UNSAFE TO ADJUST FLUE DRAFT HIGHER THAN 0.10 INCHES WATER COLUMN (25 Pa)!
- THE HEAT EXCHANGER, DRAFT INDUCER, FLUE PIPE, AND CHIMNEY MUST BE CLEANED REGULARLY TO REMOVE ACCUMULATED CREOSOTE AND ASH. ENSURE THAT THE HEAT EXCHANGER, FLUE PIPE, AND CHIMNEY ARE CLEANED AT THE END OF HEATING SEASON TO MINIMIZE CORROSION DURING THE SUMMER MONTHS. THE APPLIANCE, FLUE PIPE, AND CHIMNEY MUST BE IN GOOD CONDITION. THESE INSTRUCTIONS ALSO APPLY TO A DRAFT INDUCER IF USED.
- Do not store fuel or other combustible material within marked installation clearances!
- Faulty operating conditions not complying with Owner's Manual, such as insufficient combustion air, incorrect or insufficient cleaning and maintenance or non-permitted fuel could result in Danger of Life or Severe Injury caused by serious faults in combustion (e.g. spontaneous combustion of carbonization gases or flash fires)!
- Inspect and clean flues and chimney regularly!
- First firing during start-up of boiler system shall be carried out in attendance of an authorized installer or manufacturer's representative only! Disregarding of warning may cause damage or explosion of combustion chamber and severe injuries unfavorably!

CAUTION! Hot surfaces!

- Hot parts and the flue pipe can cause serious burns!
- Do not touch during operation.
- Maximum draft marked on nameplate.
- Unauthorized access to the boiler room and pellets store could result in personal injury and damage to property!
- FOR SAFETY KEEP FIRING AND ASHPIT DOORS TIGHTLY CLOSED.
- Keep children away.
- Always use protective gloves during maintenance.
- Always use control handles when open boiler doors.
- Insulate flue pipe and do not touch during operation.
- Do not carry out maintenance when the boiler is hot.
- Do not touch hot surfaces behind Boiler doors, Covers and Hopper casing.

A 963 02 13

Notice regarding procedures in an emergency

P4 Pellet – WOOD PELLET FIRED BOILER

EMERGENCY PROCEDURES

⚠ DANGER! In case of strong smell of flue gas!

Flue gases can cause fatal poisoning!
- Do not open any boiler doors or covers, or fuel transportation system door or covers!
- Turn off the boiler by pressing “Boiler OFF” (⏻)
- Air the room where boiler is installed!
- Close the door of the boiler room and doors to living areas!

⚠ DANGER! In the event of loss of electrical power!

- Do not open any boiler doors or covers, or fuel transportation system doors or covers!
- Boiler Control automatically restarts after power fail restart.
- Half an hour after power has returned, check system for normal operation and compare the pressure gauge reading to initial settings. If system pressure is low, replenish water to the heating system according plumber’s instructions.

⚠ DANGER! In the event of runaway fire!

- Call the fire department!
- Turn off Emergency Switch, if installed.
- Do not open any boiler doors or covers, or fuel transportation system doors or covers!
- Do not switch off Main switch at Boiler!
- Evacuate your house.
- If possible, wet your entire roof with a garden hose.
- When there is no more risk of runaway fire, turn on Emergency Switch and resume to normal operation of the system.

To cool overheated boiler (over 220°F / 105°C)!

- Turn off Emergency Switch, if installed.
- Do not open any boiler doors or covers, or fuel transportation system doors or covers!
- Turn off boiler by pressing “Boiler OFF” (⏻)
- Open all mixer taps, switch on all pumps.
- Leave the boiler room and close the door.
- Open all hot water faucets.
- Turn all thermostats in your house to their highest temperature settings and open all windows if room heat is too hot
- When boiler temperature has dropped below 180°F (82°C), reverse the above steps.
- In case Safety Temperature Limit Switch automatically has been activated please refer to Owner’s Manual.

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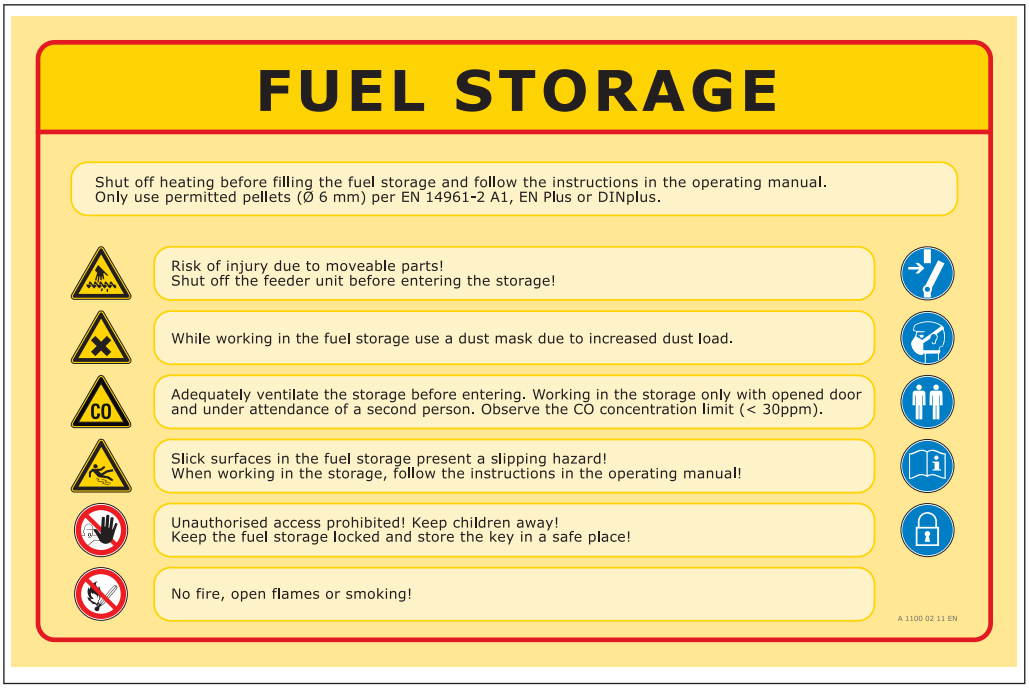
2.5.6 Sign on fuel store

The following signage is to be posted in the access area of the fuel store. It explains the correct fuel store procedures.



2.6 Residual risks

The system has been designed to the state of the art and in accordance with current safety requirements. There are, however, still some residual risks which require care and attention. The residual risks and consequential procedures and measures are listed below.

2.6.1 Basic risks

Incorrect operation

⚠ WARNING

Risk of injury from operating the system incorrectly!

❒ Modifications to the control system must only be undertaken in consultation with the manufacturer.

➥ Modifying parameters on the control system can cause malfunctions.

Noise

⚠ WARNING

Hearing loss from noise!

❒ Always wear hearing protection when working around the discharge system

➥ Depending on the discharge system and fuel, the noise level inside the discharge system can reach over 80 dB(A) during transportation of the fuel.

Risk of falling

⚠ WARNING

Risk of falling when working close to the boiler!

- ❒ When working on ladders, always ensure that the ladder is securely positioned on a firm and even surface.
- ❒ Always observe the relevant safety regulations when working with a hoist.
- ❒ Never step on the boiler.
  - ➥ Careless work on ladders or hoists during installation, maintenance and repair work can cause injury.

Working in the fuel store

⚠ WARNING

Risk of injury when carrying out work in the fuel store

- ❒ Switch the boiler off at the control system before entering the fuel store.
- ❒ Turn off the boiler's main switch.
- ❒ Never climb onto piles of fuel.
- ❒ For safety reasons never work in the fuel store alone. Take another person with you.
- ❒ Always wear personal protective equipment for work (protective clothing, safety shoes, protective gloves, dust mask, protective goggles).
- ❒ Also observe the information on the notice on the access door to the fuel store.
  - ➥ Piles of fuel are at risk of caving in if you stand on them when working in the fuel store. There is also a risk of poisoning due to an increased concentration of carbon monoxide in the air.

Dirt and objects lying around

⚠ CAUTION

Risk of injury from stumbling on dirt or objects lying around!

- ❒ Always keep the boiler room clean and tidy.
- ❒ Take any items no longer required out of the boiler room and, in particular, remove from ground level.
  - ➥ Dirt and objects lying around the boiler room constitute a risk of slipping and tripping. Falling can result in injury.

2.6.2 Risks from electricity

Electric current

⚠ DANGER

Risk of death from electrocution!

- ❒ Only allow licensed electricians to carry out electrical work to the electrical system.
- ❒ If the isolation gets damaged, switch off the power supply immediately and have it repaired.
- ❒ Prior to commencing work to active parts, shut off electrical systems and equipment so that they are no longer live and secure so that they remain off for the duration of the work. Follow the five safety rules:
  - Disconnect.
  - Secure against switching back on.
  - Check the system is no longer live.
  - Earth and short circuit.
  - Cover or shield any adjacent live parts.
- ❒ Never bypass or disable fuses. When replacing fuses, use the correct amperage.
- ❒ Always lay lines and cables far away from hot surfaces.
- ❒ Use shielded cables when using frequency converters.
- ❒ Ensure that the system is properly earthed with a protective earth system. Have all component assemblies checked at regular intervals to ensure the correct earthing.
- ❒ Keep moisture away from live parts. This can cause short circuits.
  - ➥ Touching live parts can cause immediate death by electrocution. Damage to the isolation or individual components can be perilous.

Static electricity from charge

⚠ CAUTION

Risk of injury from residual electrostatic potential!

- ❒ Always proceed with caution when working in the storeroom and wear personal protective equipment (protective clothing, safety shoes, protective gloves).
  - ➥ Electrostatic potential can build up when pellets are being blown in. Touching pellets in the storeroom can, therefore, result in injury.

2.6.3 Danger from movement of the system

Automatic start-up

⚠ WARNING

Risk of injury from automatic start-up!

- ❒ Before doing any work, switch the boiler off at the control system.
- ❒ Switch off the main switch and take precautions to prevent accidental switching on.
  - ➥ There is a risk of serious injury from the system starting up automatically if it is switched on during inspection and cleaning.

Screw movement

⚠ WARNING

Risk of injury from getting crushed, trapped and caught in moving screws!

- ❒ Never step onto the screws (if present) in the fuel store.
- ❒ Never reach into the transport screw of the fuel infeed or the ash discharge screws (if present) when they are running.
- ❒ Never bypass limit switches and fuses.
- ❒ Switch off the boiler at the control system and allow it to cool before carrying out work on the screws.
- ❒ Always wear personal protective equipment for work (protective clothing, safety shoes, protective gloves).
  - ➥ Moving screws can catch on parts of clothing or long hair and clamp or sever body parts, resulting in serious injury or death.

2.6.4 Danger from fire and explosion

Risk of fire and explosion

⚠ WARNING

Risk of fire and explosion around the boiler!

- ❒ DO NOT BURN GARBAGE, GASOLINE, NAPHTA, ENGINE OIL OR OTHER INAPPROPRIATE MATERIALS.
- ❒ DO NOT USE CHEMICALS OR FLUIDS TO START THE FIRE.
- ❒ DO NOT OPERATE WITH FLUE DRAFT EXCEEDING 0.10 INCHES WATER COLUMN (25 Pa).
- ❒ UNSAFE TO ADJUST FLUE DRAFT HIGHER THAN 0.10 INCHES WATER COLUMN (25 Pa).
- ❒ THE HEAT EXCHANGER, DRAFT INDUCER, FLUE PIPE, AND CHIMNEY MUST BE CLEANED REGULARLY TO REMOVE ACCUMULATED CREOSOTE AND ASH. ENSURE THAT THE HEAT EXCHANGER, FLUE PIPE, AND CHIMNEY ARE CLEANED AT THE END OF HEATING SEASON TO MINIMIZE CORROSION DURING THE SUMMER MONTHS. THE APPLIANCE, FLUE PIPE, AND CHIMNEY MUST BE IN GOOD CONDITION. THESE INSTRUCTIONS ALSO APPLY TO A DRAFT INDUCER IF USED.
- ❒ DO NOT INSTALL IN A MOBILE HOME.
- ❒ Keep covers on the boiler and the access doors to the fuel store closed during operation.
- ❒ Smoking, fire and open flames are not permitted in the fuel store and boiler room.
- ❒ Do not store flammable materials in the boiler room.
- ❒ Do not set flammable objects on the boiler to dry (e.g. clothing).
- ❒ Always ensure that the boiler room is adequately ventilated.
- ❒ Maintain and inspect the heating system at the prescribed intervals. Ensure that the chimney vent is cleaned regularly.
- ❒ Do not use any hydrogen halides or cleaning agents containing chlorine in the boiler room.
- ❒ Observe the safety signs around the system.
  - ➥ Using the boiler incorrectly can cause fire or explosions.

Fire protection

⚠ WARNING

Risk of injury from limited or incorrect firefighting!

- ❒ Ensure that all fire extinguishers provided are suitable for the fire class.
- ❒ Test that the fire extinguishers are fit for use every two years or in accordance with the regulations set out by the fire authorities.
- ❒ Refill the fire extinguisher after each use.
- ❒ Only use approved extinguishing agents and spare parts that match the prototype on the fire extinguisher.
- ❒ When using the fire extinguisher, follow the safety and operating instructions on it.
- ❒ Note the operating temperature range when using the extinguisher.
  - ➥ If, in the event of a fire, the fire extinguisher is not fit for use or unsuitable for the specific fire class, this can result in serious injuries or even death and significant damage to property.

Flue gas system

⚠ WARNING

Risk of injury and damage to property from obstructing the flue gas system!

- ❒ The chimney is only to be used as an outlet for one heating system.
- ❒ Optimum performance can only be guaranteed if the flue gas system is functioning correctly. It is, therefore, important to have the flue gas system cleaned regularly to ensure that the flue gas can escape properly.
- ❒ Arrange for the chimney sweep to check the chimney connection and chimney for tar oil deposits twice a month during the heating period.
  - ➥ Problems with the flue system, such as poor cleaning of the flue pipe or insufficient chimney escape can cause serious faults in combustion (such as spontaneous combustion of carbonization gases/explosion).

2.6.5 Danger from high temperatures

Hot surfaces

⚠ WARNING

Risk of injury from hot surfaces!

- ❒ FOR SAFETY REASONS, KEEP COVERS AND ASH PIT DOORS TIGHTLY CLOSED.
- ❒ Before carrying out any work on the boiler, switch it off at the control system (“Boiler OFF” status) and allow it to cool down.
- ❒ Protective gloves must usually be worn for work on the boiler. Only touch the boiler using the handles provided.
- ❒ Insulate the flue gas pipes and do not touch them during operation.
- ❒ Do not touch system parts and heating pipes during operation.
- ❒ Keep children and unauthorized persons away from the boiler and fuel store.
- ❒ Allow the boiler to cool before carrying out any maintenance work.
  - ➥ Touching hot surfaces on the boiler, on the flue gas pipe and on heating pipes can cause serious burns.

Hot media

⚠ WARNING

Risk of scalding from hot media!

- ❒ Temperature modifications in the control system must only be undertaken in consultation with the manufacturer.
- ❒ Do not touch heating pipes and consumer loads in the heating circuit (radiator etc.) during operation.
- ❒ Allow the system to cool before carrying out any maintenance work. Always wear protective gloves when working on the system.
- ❒ Keep children and unauthorized persons away from the heating system.
  - ➥ Heating pipes and consumer loads in the heating circuit can heat up considerably from the hot water. An incorrect setting in the control system means that the water obtained can be extremely hot. Contact with hot water or hot surfaces can cause scalding to skin.

Hot ashes

⚠ WARNING

Risk of injury from hot ashes!

- ❒ Always wear protective clothing and protective gloves when working on the system.
- ❒ Before handling ash, check whether or not it is still hot. Allow to cool if necessary.
  - ➥ Ash is extremely hot after the combustion process. Contact can cause serious burns.

2.6.6 Risks from flue gases, incorrect fuel and other equipment

Lubricants

⚠ WARNING

Risk of damage to health from lubricants!

- ❒ Always wear protective gloves when handling lubricants.
- ❒ Do not swallow, do not inhale fumes.
- ❒ If you accidentally get lubricant in your eyes, rinse thoroughly with plenty of water and seek medical advice if necessary.
- ❒ Following skin contact wash off thoroughly with plenty of soap and water.
- ❒ Observe the lubricant manufacturer’s safety data sheets.
  - ➥ Contact with lubricants can cause allergies and skin irritations.

Proposition 65

⚠ WARNING

CALIFORNIA Proposition 65

This product may contain chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Leaking flue gas

⚠ WARNING

Risk of poisoning from flue gases in the boiler room!

- ❒ If you smell flue gas keep all the doors on the boiler closed.
- ❒ Switch off the boiler under controlled conditions using the controller.
- ❒ Ventilate the boiler room.
- ❒ Close the fire door and doors to living areas.
  - ➥ Contact with flue gases can cause perilous situations.

Carbon monoxide

⚠ WARNING

Risk of poisoning from carbon monoxide in the storeroom!

- ❒ Ensure that there is adequate ventilation before entering the storeroom.
- ❒ For safety reasons never work in the storeroom alone. Take another person with you.
  - ➥ Carbon monoxide is an odorless gas and, therefore, goes unnoticed. Carbon monoxide can develop from storing pellets in the storeroom, and an increased carbon monoxide concentration in the air can pose a risk of poisoning.

Explosive dusts

⚠ WARNING

Risk of death from fire and explosion due to dispersed dust deposits!

- ❒ Do not smoke within or close to the danger zone. Do not work with any kind of naked flame, fire or ignition sources.
- ❒ Keep the danger zone free from dust. Dust deposits over 5 mm thick are not permitted and must be removed.
- ❒ Do not enter the storeroom whilst pellets are being blown in.
- ❒ Always wear protective clothing, protective goggles and breathing protection when working in the storeroom. Follow the manufacturer's instructions with regard to the requirements of the breathing protection.
- ❒ Stop work immediately in the event of a fire. Leave the danger zone until you get the all-clear and notify the fire brigade.
  - ➥ Dust deposits could catch fire or form an explosive compound if dispersed with the ambient air when blown into the storeroom. This can result in serious and even fatal injuries.

Incorrect fuel

⚠ WARNING

Risk of injury and damage to the boiler if the incorrect fuel is added.

- ❒ Only use fuel permitted by the boiler manufacturer.
- ❒ Only store permitted fuel in the fuel store.
- ❒ Never burn corn, cereal, coal, coke, garbage, painted or treated wood, bark, petrol, oil or other flammable liquids in the boiler.
- ❒ Never store fuel or other flammable materials in the boiler room.
- ❒ Never use chemicals, kerosene, charcoal, spirits or other flammable liquids to start or reignite the combustion process in the boiler.
  - ➥ Using the incorrect fuel can cause dangerous malfunctions or damage to the system or the discharge system.

2.7 What to do in the case of danger

What to do if the system overheats (at temperatures above 220°F (105°C))

⚠ WARNING

Risk of injury from switching the system off prematurely at the main switch!

- ❒ To switch the boiler off, switch off automatic mode using “Boiler OFF" at the control system. The boiler follows the controlled shutdown procedure via the control. The system must only be switched off at the main switch once the boiler has cooled down sufficiently.
  - ➥ Switching off the main switch in automatic mode can cause major combustion faults leading to serious accidents.

If the boiler overheats, proceed as follows:

- ❒ Switch the boiler off at the control system.
- ❒ Keep all doors on the boiler and all covers closed.
- ❒ Open all mixing valves; switch on all pumps. The Froling heating circuit control takes on this function in automatic operation.
- ❒ Leave the boiler room and close the access door.
- ❒ Ensure that heat is being consumed. To do this, activate all consumer loads.
- ❒ Open any available radiator thermostat valves.
- ❒ Once the boiler temperature has fallen to 185°F (85°C), return the heating circuit to normal status.

If the temperature does not drop:

- ❒ Inform the installer or Froling customer service.

What to do in the event of a power failure

In the event of a power failure proceed as follows:

- ❒ Keep all the doors on the boiler and covers on the fuel infeed closed
- ❒ The boiler controller will start again automatically after the restart.
  - ➥ Half an hour after the boiler restart, compare the values in the controller and the values on the pressure gauges with the original values. If the pressure level is too low, add water to the heating system in accordance with the instructions of the heating installer.

In the event of excessive temperature the high-limit thermostat may have triggered. You may have to release this to allow the boiler to restart.

What to do if there is a smell of flue gas

If you smell flue gas, proceed as follows:

- ❒ Keep all doors on the boiler and all covers closed.
- ❒ Switch the boiler off at the control system.
- ❒ Ventilate the boiler room where the boiler is located.
- ❒ Close the fire door and doors to living areas.

What to do in the event of fire

In the event of a fire proceed as follows:

- ❒ Press the emergency stop button (if present).
- ❒ Keep all the doors on the boiler and covers on the fuel infeed closed
- ❒ Leave the main switch on the control cabinet switched on.
- ❒ Close the fire door.
- ❒ Leave the boiler room and the building.
- ❒ Notify the fire brigade.

2.8 Staff requirements

Risk of injury from inadequate qualification of staff!

⚠ WARNING

Risk of injury from inadequate qualification of staff!

If unqualified staff work on the system, or are within the danger zone of the system, this creates hazards which could cause serious injuries and considerable damage to property.

- ❒ All such activities should be carried out only by suitably qualified staff.
- ❒ Keep unqualified staff away from danger zones.

Definition of staff qualifications

The staff qualifications listed here for the United States are based on the descriptions of professional qualifications in the Occupational Outlook Handbook 2011-12 edition of the United States Department of Labor, Bureau of Labor Statistics.

In this manual, staff qualifications for the various activity areas are named as follows:

Operator

The operator is the person who operates the heating system for commercial or economic purposes by himself or cedes use/application to a third party and bears the legal responsibility concerning the product for the protection of the user or third parties during the operation.

He has been trained by the manufacturers and the suppliers in dealing with the system and its components and can independently detect potential hazards and avoid the associated risks.

Froling customer service or an authorized partner

The Froling customer service or its authorized partner is able to perform the tasks assigned to it and recognize and avoid possible dangers thanks to its professional, product-related training, knowledge and experience as well as its knowledge of the relevant local regulations.

Heating system installer

The heating system installer has demonstrably received specific instructions by the manufacturer regarding the tasks entrusted to him and potential dangers associated with improper conduct. The heating system installer must have read and understood these instructions. The heating system installer must have undertaken training and have professional experience of at least one year in his field of application.

The skills of the heating system installer include:

- ❒ Understanding technical contexts
- ❒ Reading and understanding technical drawings and diagrams
- ❒ Installing system components
- ❒ Installing and connecting of heating lines
- ❒ Performing maintenance work
- ❒ Dismantling and repairing or replacing system components, if a problem occurs

Licensed electrician

Thanks to his training, knowledge, experiences and knowledge of relevant standards and provisions the licensed electrician is capable of performing the following tasks on electrical systems professionally and according to safety requirements:

- ❒ Planning and connecting electrical systems based on circuit and current flow diagrams
- ❒ Assembling pipes and connecting electric components
- ❒ Analyzing, measuring and testing electrical systems and functions
- ❒ Performing safety checks on electrical systems, components and devices
- ❒ Troubleshooting electrical systems

The licensed electrician is able to independently recognize and avoid hazards associated with these works.

Chimney sweep

The chimney sweep is able to perform the tasks assigned to him and recognize and avoid possible dangers thanks to his professional training, knowledge and experience as well as his knowledge of the relevant standards and regulations.

The skills of the chimney sweep include:

- ❒ Understanding technical contexts
- ❒ Reading and understanding technical drawings and diagrams
- ❒ Checking heating, flue gas and ventilation systems as well as fuel stores for proper operation and fire safety
- ❒ Cleaning heating plants, smoke ducts and ventilation systems
- ❒ Knowledge of provisions under building law and environmental protection law, as well as knowledge in the field of energy efficiency, fire protection and climate protection
- ❒ Performing seal checks

Basic requirements

Only persons expected to carry out their work reliably are admitted as staff. Persons, whose responsiveness is influenced e.g. by drugs, alcohol or medicine are not admitted.

When choosing staff, observe the applicable age and profession-specific regulations on site.

Unauthorized

⚠ WARNING

Risk of death for unauthorized persons due to hazards in the danger zone and work area!

- ❒ Keep unauthorized persons away from the danger zone and work area.
- ❒ In case of doubt, address the persons and direct them to leave the danger zone and work area.
- ❒ Suspend the work as long as there are unauthorized persons in the danger zone and work area.
  - ➥ Unauthorized persons that do not meet the requirements described here, do not know the dangers in the work area. Therefore, unauthorized persons are exposed to risk of serious injury and even death.

Instruction

The operator must regularly instruct the staff. For the purposes of traceability, you must create a training log containing the following at minimum:

- ❒ Date of training
- ❒ Name of the trainees
- ❒ Contents of the training
- ❒ Name of the instructor
- ❒ Signatures of the trainees and the instructor

2.9 Personal protective equipment

Personal protective equipment is used to protect persons from compromised health and safety at work.

During the various types of work to and with the system the staff must wear personal protective equipment which is set out separately in the individual sections of this manual.

Description of the personal protective equipment

The personal protective equipment is as follows:

Protective workwear:

Protective workwear is tight-fitting work clothing with low tear resistance, narrow sleeves and without any protruding parts.

Protective goggles

Protective goggles are used to protect the eyes from flying parts when cleaning the system.

Protective gloves

Protective gloves are used to protect the hands against friction, abrasion, puncture, or deeper injuries and contact with hot surfaces.

Safety shoes

Safety shoes protect feet from crushing and falling parts as well as from sliding on slippery surfaces.

Dust mask

The dust mask is used for protection against dust when cleaning the system and when working in the fuel store.

2.10 Replacement parts

Incorrect replacement parts

⚠ WARNING

Danger of injury when using incorrect replacement parts!

- ❒ Use only original Froling replacement parts or spare parts approved by Froling.
- ❒ In case of doubt, always contact our customer service.
  - ➥ Hazards for the staff can arise through the use of incorrect or faulty spare parts and cause damage, malfunction or total failure.

Spare parts can be obtained from the manufacturer or importer.

2.11 Environmental protection

NOTICE

Danger to the environment resulting from incorrect handling of environmentally hazardous substances!

- ❒ Always follow the instructions below when handling hazardous substances and their disposal.
- ❒ If hazardous substances are accidentally released into the environment, take appropriate measures immediately. In case of doubt, inform the competent authority about the damage and request that proper measures be taken.
  - ➥ Incorrect handling of environmentally hazardous substances, in particular incorrect disposal, can cause significant damage to the environment.

The following hazardous substances are used:

Ash

Ashes should be placed in a metal container with a tight-fitting lid. The closed container of ashes should be placed on a non-combustible floor on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have thoroughly cooled. For the disposal of ash from the heat exchanger, consult the local chimney sweep or waste disposal service of the municipality or province.

Lubricants

Lubricants such as greases and oils contain poisonous substances. They must not be released into the environment. Disposal must be carried out by a specialist disposal company. Observe the manufacturer’s safety data sheet.

2.12 The operator's responsibilities

Operator

The operator is the person who operates the system for commercial or economic purposes by himself or cedes use to a third party and bears the legal responsibility concerning the product for the protection of the user, staff or third parties during the operation.

Operator duties

The system is used in the commercial sector. The system operator is therefore subject to the legal obligations for safety at work.

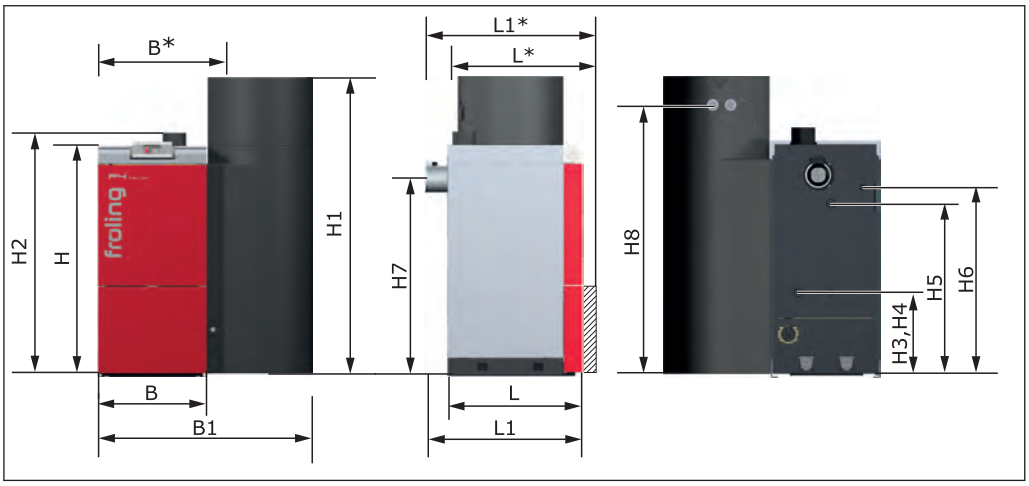
In addition to the safety instructions in this manual, the applicable regulations on safety, safety at work and environmental protection must be observed.

Therefore, in particular, the following applies:

- The "Occupational Safety and Health Act" of 1970 lays down that a safe workplace must be provided at all times during the execution of work.
- The operator must be aware of the applicable occupational safety regulations. Additionally, he must perform a risk assessment to determine hazards arising from special working conditions at the site where the system is used. He must implement these in the form of operating instructions for system operation.
- The operator must check throughout the entire period of use of the system whether the operating instructions created by him correspond to the current version of the regulations, and, if necessary, adjust them.
- The operator must clearly manage and determine the responsibilities for operation, troubleshooting, maintenance and cleaning.
- The operator must ensure that all persons who deal with the system have read and understood this manual. In addition, he must train the staff at regular intervals and inform them about possible dangers. Moreover, the operator must ensure that unauthorized persons do not get close to the system.
- The operator must provide the required protective equipment to staff and instruct them that it is obligatory to wear the necessary protective equipment.
- The operator must ensure that only fuels approved by the manufacturer are used.
- The operator must ensure that the prescribed safety tests are performed.
- The operator must ensure that the regulatory approval requirements are respected.
- The operator must ensure compliance with the requirements of the installation site and the safety measures when working in the storeroom.
- Furthermore, the operator is responsible for ensuring that the system is always in full working order. Therefore the following applies:
- The operator must ensure that the maintenance intervals described in these instructions are respected.
- The operator must ensure that the safety devices are regularly checked for proper functioning and completeness.

3 Technology

3.1 Dimensions P4 Pellet 8-38



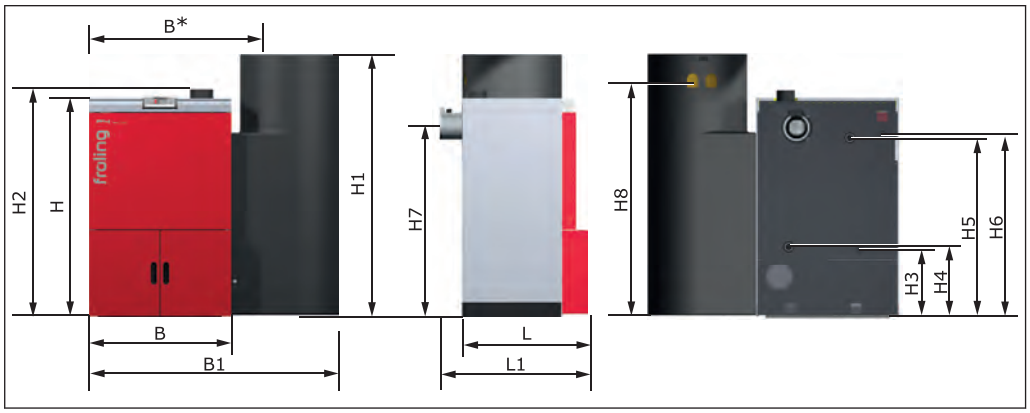
Item	Description	Unit	8 - 15	20 - 25	32 - 38
L	Length, boiler	mm	740	740	-
L*	Length, boiler	mm	-	-	820
L1	Total length incl. induced draught fan	mm	940	940	-
L1*	Total length incl. induced draught fan	mm	-	-	1020
B	Width, boiler	mm	600	770	860
B*	Width, boiler, incl. support for positioning unit [1)]	mm	705	875	965
B1	Total width including suction cyclone	mm	1185	1355	1445
H	Height, boiler [2)]	mm	1280	1280	1430
H1	Total height incl. suction cyclone	mm	1660	1660	1900
H2	Height, flue gas pipe connection	mm	1350	1350	1530
H3	Height, drainage connection	mm	460	460	460
H4	Height, flow connection	mm	460	460	460
H5	Height, return connection	mm	940	955	1085
H6	Height, ventilation connection	mm	1030	1030	1155
H7	Height, induced draught fan connection	mm	1090	1090	1215
H8	Height, suction system connection	mm	1480	1480	1720

1. Corresponds to the minimum positioning width after removing the stoker assembly, suction cyclone and positioning unit
2. Corresponds to the minimum positioning height after removing the stoker assembly, suction cyclone and positioning unit

3.2 Dimensions P4 Pellet 48-100

NOTICE

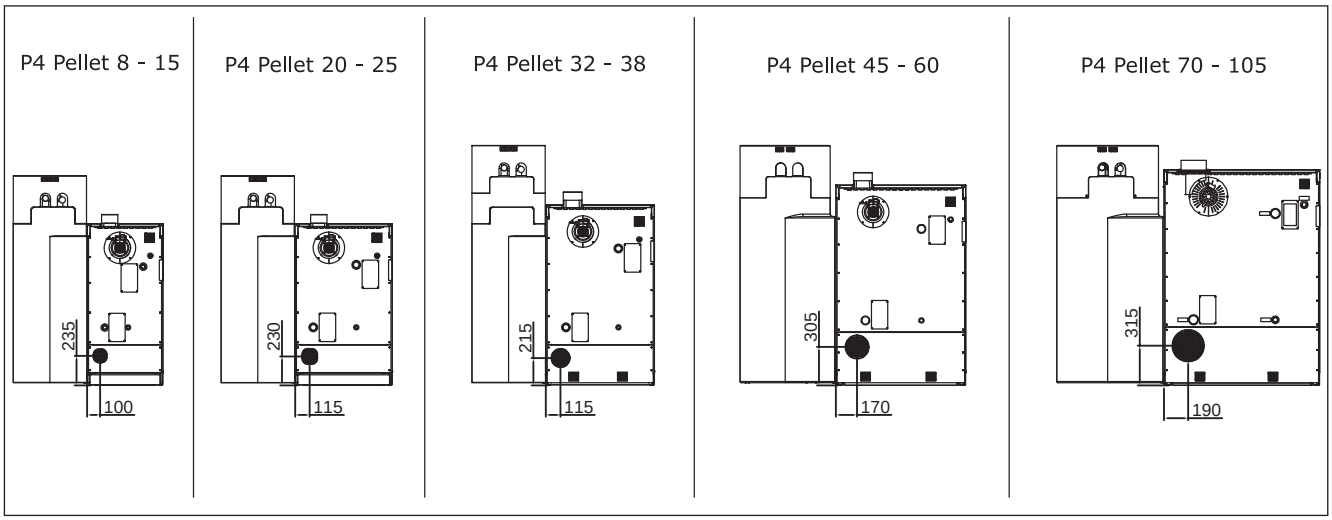
CAUTION: Note the modified flow connection / return connection starting with P4 Pellet 48!



Item	Description	Unit	48 - 60	80 - 100
L	Length, boiler	mm	900	1000
L1	Total length incl. induced draft fan	mm	1100	1070
B	Width, boiler	mm	1030	1235
B*	Width, boiler incl. support for positioning unit [1)]	mm	1275	1480
W1	Total width incl. suction cyclone	mm	1790	2085
H	Height, boiler [2)]	mm	1585	1710
H1	Total height incl. suction cyclone	mm	1900	1900
H2	Height, flue gas pipe connection	mm	1685	1785
H3	Height of drainage connection	mm	490	500
H4	Height, return connection	mm	515	520
H5	Height of flow connection	mm	1290	1410
H6	Height, ventilation connection	mm	1310	1430
H7	Height, ID fan connection	mm	1375	1495
H8	Height, suction system connection	mm	1720	1720

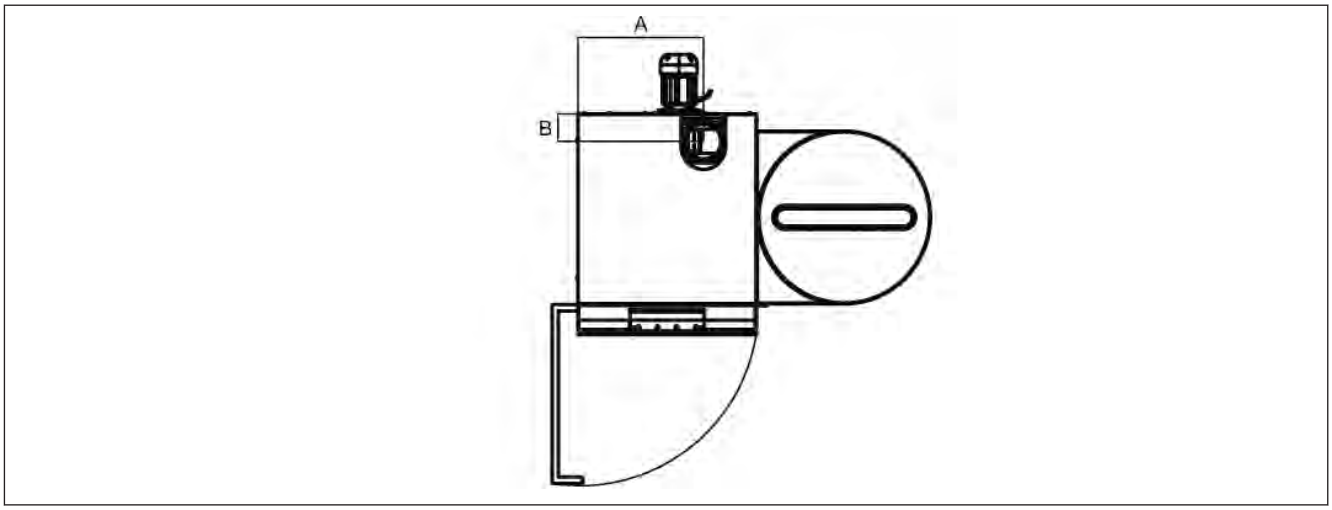
1. Corresponds to the minimum positioning width after removing the stoker assembly, suction cyclone and positioning unit
2. Corresponds to the minimum positioning height after removing the stoker assembly, suction cyclone and positioning unit

3.3 Supply air connections for room air-independent operation



Description	Unit	8/15	20/25	32/38	48/60	80/100
Supply air connection pipe (external diameter)	mm	80	100	125	160	200

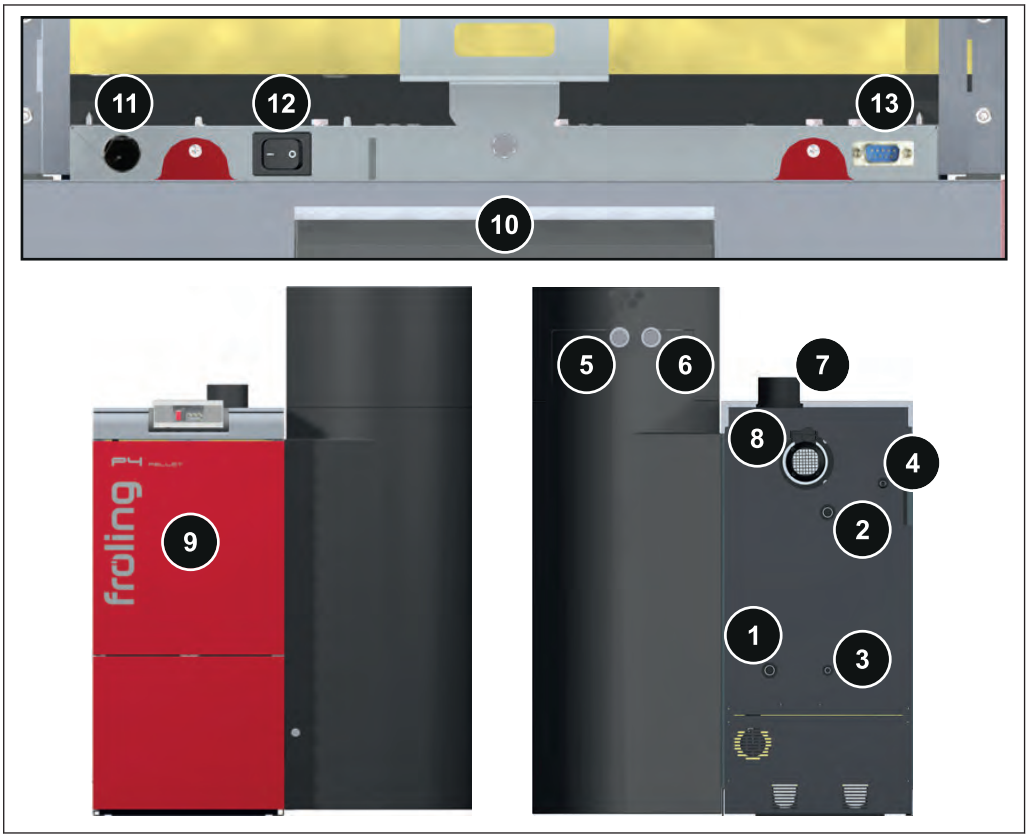
3.4 Flue gas pipe position



Description	Unit	8/15	20/25	32/30	48/60	80/100
A – Lateral distance	mm	420	585	650	815	1000
B – Depth distance	mm	90	90	85	90	80

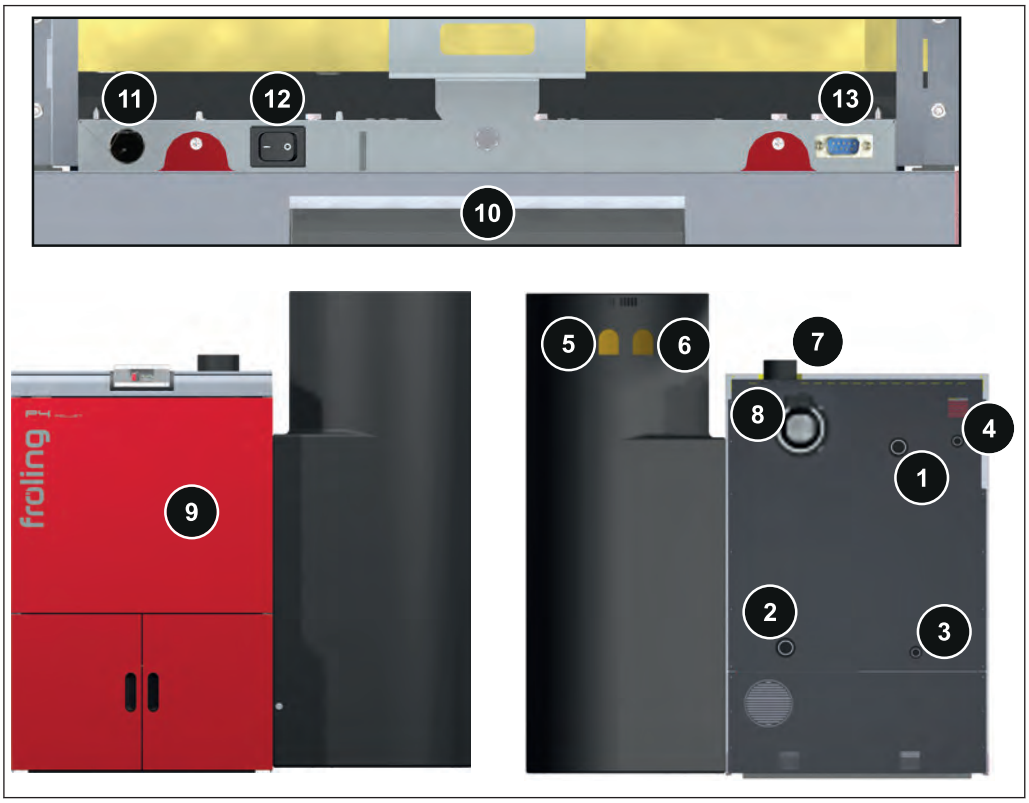
3.5 Components and connections

3.5.1 P4 Pellet 8-38



Item	Description	Unit	8 - 15	20 - 25	32 - 38
1	Boiler flow connection	inches	1	6/4	6/4
2	Boiler return connection	inches	1	6/4	6/4
3	Drainage connection	inches	1/2	1/2	1/2
4	Air vent connection	inches	1/2	1/2	1/2
5	Pellet suction line	mm	DA 60	DA 60	DA 60
6	Pellet return air line	mm	DA 60	DA 60	DA 60
7	Flue gas pipe connection (DM)	mm	130	130	150
8	Induced draught fan				
9	Controller box				
10	Lambdatronic P 3200 control				
11	High-limit thermostat (STL)				
12	Main switch				
13	Service interface				

3.5.2 P4 Pellet 48-100



Item	Description	Unit	48 - 60	80 - 100
1	Boiler flow connection	inches	6/4	2
2	Boiler return connection	inches	6/4	2
3	Drainage connection	inches	1/2	1
4	Air vent connection	inches	1	1
5	Pellet suction line	mm	DA 60	DA 60
6	Pellet return air line	mm	DA 60	DA 60
7	Flue gas pipe connection (DM)	mm	150	200
8	Induced draught fan			
9	Controller box			
10	Lambdatronic P 3200 control			
11	High-limit thermostat (STL)			
12	Main switch			
13	Service interface			

3.6 Technical specifications

3.6.1 P4 Pellet 8 - 25

Description		P4 Pellet			
		8	15	20	25
Heat exchanger design standard		EN 303-5			
Nominal heat output	kW	8	15	20	25
Heat output range		3,2-10,5	4,5-14,9	6,0-20,0	7,5-25,0
Electrical connection		230V / 50Hz / C16A			
Power consumption NL / PL	W	48 / 34	55 / 34	71 / 49	87 / 63
Boiler weight	kg	350	350	430	430
Boiler capacity (water)	l	70	70	80	80
Content ashcans heat exchanger / combustion chamber	l	13 / 13	13 / 13	25 / 15	25 / 15
Water pressure drop (ΔT = 20 K / 10K)	mbar	4,3 / 17,2	6,1 / 24,4	4,5 / 17,9	2,8 / 11,5
Min. boiler return temperature	°C	Not applicable due to internal return temperature control			
Max. permitted operating temperature	°C	80			
Min. operating temperature setting	°C	40			
Permitted operating pressure	psi bar	30 2			
Boiler class as per EN 303-5:2012		5			
Airborne sound level	dB(A)	< 70			
Permitted fuel as per EN 14961 [1)]		Part 2: Wood pellets class A1 / D06			

3.6.2 P4 Pellet 32 - 60

Description		P4 Pellet			
		32	38	48	60
Heat exchanger design standard		EN 303-5			
Nominal heat output	kW	32,0	38,0	48,0	58,5
Heat output range		9,6-32,0	11,4-38,0	14,4-48,0	17,6-58,5
Electrical connection		230V / 50Hz / C16A			
Power consumption NL / PL	W	104 / 78	110 / 78	114 / 45	119 / 80
Boiler weight	kg	530	530	760	760
Boiler capacity (water)	l	125	125	170	170
Content ash containers heat exchanger / combustion chamber	l	33 / 19	33 / 19	33 / 33	33 / 33
Water pressure drop (ΔT = 20 K / 10K)	mbar	1,5 / 6,2	2,1 / 8,7	3,7 / 10,5	5,3 / 12,3
Min. boiler return temperature	°C	Not applicable due to internal return temperature control			
Max. permitted operating temperature		80		88	
Min. operating temperature setting		40			
Permitted operating pressure	psi bar	30 2			
Boiler class as per EN 303-5:2012		5			
Airborne sound level	dB(A)	< 70			
Permitted fuel as per EN 14961 [1)]		Part 2: Wood pellets class A1 / D06			

3.6.3 P4 Pellet 80 - 100

Description		P4 Pellet			
		80	100	80	100
Heat exchanger design standard		EN 303-5		ASME	
Nominal heat output	kW	80,0	100,0	80,0	100,0
Heat output range		24-80	30-100	24-80	30-100
Electrical connection		230V / 50Hz / C16A			
Power consumption NL / PL	W	115 / 49	112 / 49	115 / 49	112 / 49
Boiler weight	kg	1090	1100	1090	1100
Boiler capacity (water)	l	280	280	280	280
Content ash containers heat exchanger / combustion chamber	l	33 / 33	33 / 33	33 / 33	33 / 33
Water pressure drop (ΔT = 20 K / 10K)	mbar	4,8 / 14,3	4,3 / 14,3	4,8 / 14,3	4,3 / 14,3
Min. boiler return temperature	°C	60			
Max. permitted operating temperature		88			
Min. operating temperature setting		40			
Permitted operating pressure	psi bar	45 3		43.5 3	
Boiler class as per EN 303-5:2012		5			
Airborne sound level	dB(A)	< 70			
Permitted fuel as per EN 14961 [1)]		Part 2: Wood pellets class A1 / D06			

3.6.4 Airborne sound level

The sound levels specified in the following table are based on a sound measurement on a P4 Pellet 15. (measuring device: Omega HHSL 1)

The sound level of the individual units was plotted at a distance of 1 m from the sound source.

Ambient level for measurement: 32 dBA

Unit	Measurement
Units in continuous operation:	
Induced draught fan (activation: 50%)	41 dBA
Induced draught fan (activation: 65%)	44 dBA
Induced draught fan (activation: 90%)	50 dBA
Units in non-continuous operation:	
Suction turbine	68 dBA
Grate motor	42 dBA
Stoker motor / Stoker screw	33 dBA
Ignition fan	53 dBA
WOS motor / WOS system	60 dBA
Burn back slide valve actuator (open)	34 dBA
Burn back slide valve actuator (close)	50 dBA

Please note that all the measurements were taken in-house and do not come from a certified test centre. This data should, therefore, be viewed as individual guideline measurements.

Please also note the sound levels required in the standards listed below, which must be fulfilled by planning and construction measures:

ÖNORM B 8115-2	Sound insulation and room acoustics in building construction - Requirements for sound insulation
ÖNORM H 5190	Heating systems - Acoustic insulation

4 Assembly

4.1 Materials supplied

The boiler comes pre-assembled on a pallet in cardboard packaging.

1	Pre-assembled boiler	Not pictured:
2	Insulated doors and ash container	In the suction cyclone container: ▪ ID fan ▪ Accessories package: adjusting spanner, heating circuit controller, DHW tank sensor boiler underlay, 2x hose clamps
3	Cleaning devices	Installation and operating instructions, guarantee certificate, identification plate

❒ Move the boiler without jarring or jolting.
❒ Follow the instructions on the packaging when moving the boiler.

4.1.1 Tools required

The following tools are required for assembling the P4 Pellet:
❒ Socket set

4.2 Positioning

NOTICE

Damage to components if handled incorrectly
❒ Follow the transport instructions on the packaging
❒ Transport components with care to avoid damage
❒ Protect the packaging against damp conditions
❒ Pay attention to the pallet's centre of gravity when lifting

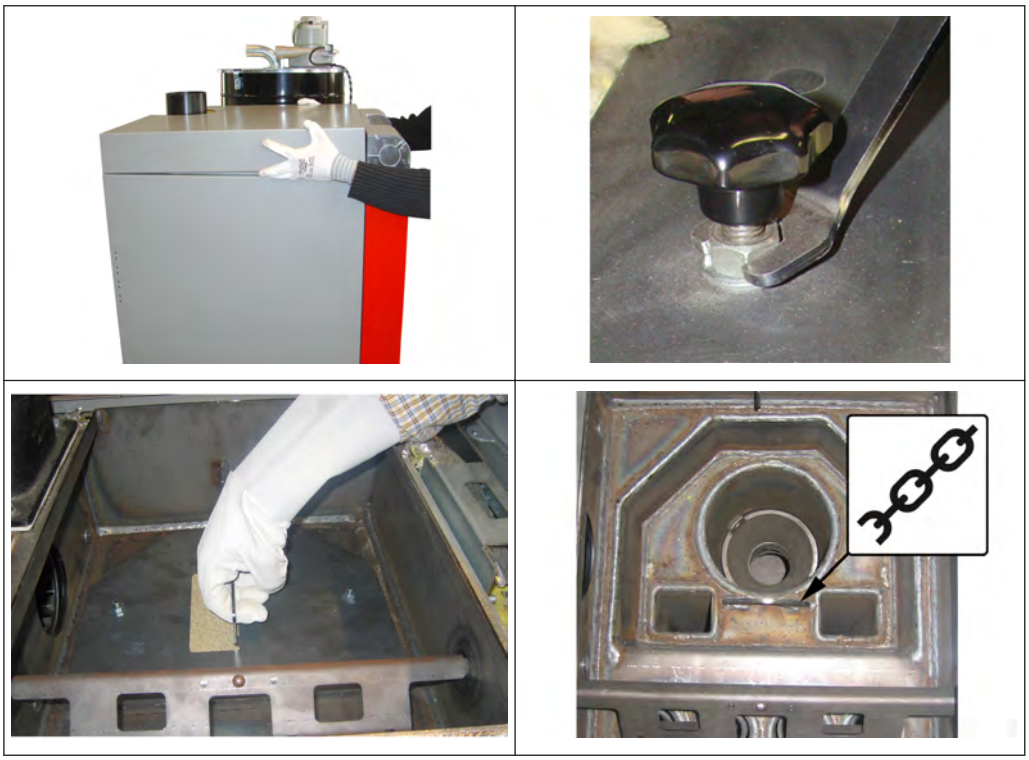
❒ Position a fork-lift or similar lifting device at the pallet and bring in the components

If the boiler cannot be brought in on the pallet:
❒ Remove the cardboard and remove the boiler from the pallet
⇨ See "Remove boiler from pallet" [page 47]

If you need to dismantle the boiler to bring it in:

❒ Dismantle the components of the boiler until it can be brought in
⇨ See "Dismantling for location where positioning is difficult" [page 50]

Positioning using a crane:



❒ Remove the insulating cover, heat exchanger cover and combustion chamber cover

❒ Correctly attach the crane hook to the attachment point for lifting eye bolt (underneath the cover) and position the boiler

4.3 Temporary storage

If the system is to be assembled at a later stage:

❒ Store components at a protected location, which is dry and free from dust

➥ Damp conditions and frost can damage components, particularly electric ones!

4.4 Setting up in the boiler room

4.4.1 Remove boiler from pallet

- ❒ Remove packing bands with suitable tools
- ❒ Lift off the cardboard

- ❒ Remove the transport covers (1) from the ashcan (P4 Pellet 8 – 25) / insulated door(s) and ash container (P4 Pellet 32 – 100) as well as the cleaning devices (2)
- ❒ Remove the protective casing

On the front of the boiler (P4 Pellet 8 – 25):

- ❒ Open the insulated door
- ❒ Remove securing devices used during transportation on the left and right side of the base
- ❒ Tilt the lock bolt for the door hinges forward
- ❒ Lift the insulated door out of the hinges and remove
- ❒ Pull out floor insulation

On the front of the boiler (P4 Pellet 32 – 100):

- ❒ Remove securing devices used during transportation on the left and right side of the base
- ❒ Remove two screws each on the left and right of the ash collecting plate and remove the collecting plate
- ❒ Pull out the floor insulation behind

At the back of the boiler:

❒ Remove securing devices used during transportation on the left and right side of the base

❒ Lift boiler off pallet

TIP: Use Froling's KHV 1400 boiler lifting system to help remove the pallet!

4.4.2 Moving the boiler in the boiler room

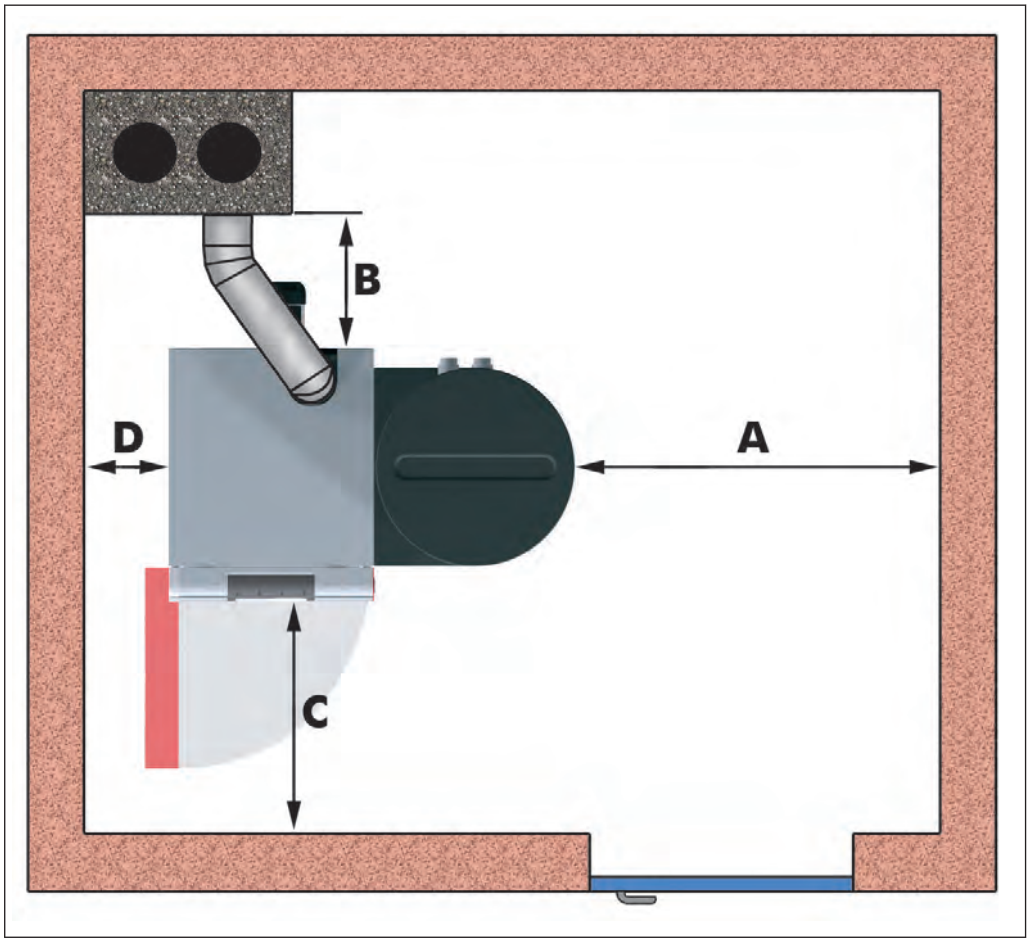
❒ Position a fork-lift or similar lifting device with a suitable load-bearing capacity at the base frame

❒ Lift and transport to the intended position in the installation room

➥ Observe the minimum distances in the boiler room.

4.4.3 Minimum distances in the boiler room

- The system should generally be set up so that it is accessible from all sides allowing quick and easy maintenance.
- Regional regulations regarding necessary maintenance areas for inspecting the chimney should be observed in addition to the specified minimum distances!
- Observe the applicable standards and regulations when setting up the system.
- Observe additional standards for noise protection
  (ÖNORM H 5190 - Noise protection measures)



			P4 Pellet				
	Description	**Unit**	**8 – 15**	**20 – 25**	**32 – 38**	**48 – 60**	**80 – 100**
A	Minimum distance to stoker assembly	inch (mm)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)
B	Induced draft fan maintenance area		12 (300)	12 (300)	12 (300)	12 (300)	12 (300)
C	Space for insulated door		22 (550)	29 (720)	33 (830)	20 (490)	24 (590)
D	Minimum distance to side of boiler		8 (200)	8 (200)	8 (200)	8 (200)	8 (200)
Distance between ceiling and boiler			18 (460)	18 (460)	18 (460)	18 (460)	18 (460)
Additional area to be covered is underneath the chimney connector and extending at least 2 inches (50 mm) on either side of the chimney connector.							

4.5 Dismantling for location where positioning is difficult

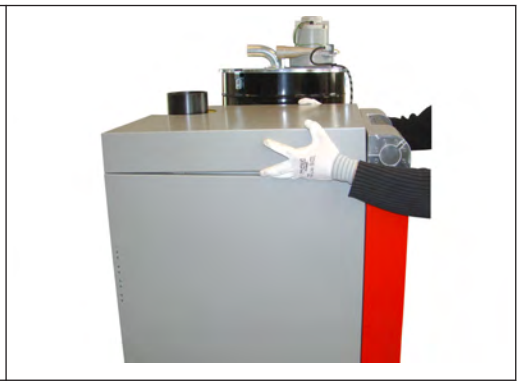
If there is not enough room to bring in the pre-assembled boiler, certain components can be dismantled.

This section shows the maximum possible disassembly. Only dismantle the parts absolutely necessary to bring in the boiler.

4.5.1 Removing the stoker assembly and insulation

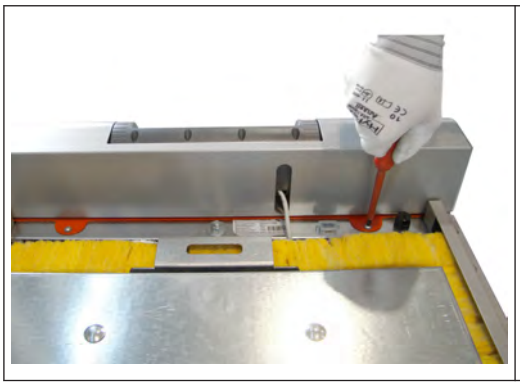
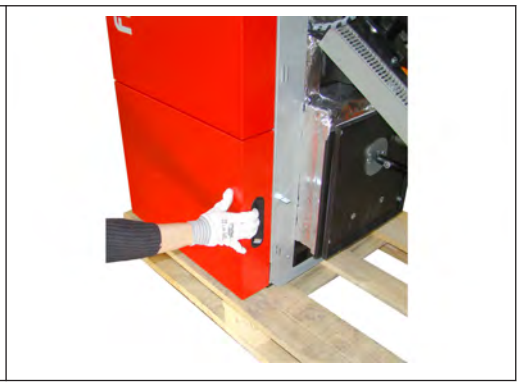
❒ Remove the locking screws on the sound insulation hood of the stoker assembly and remove the sound insulation hood

❒ Lift the front part of the stoker assembly up and remove



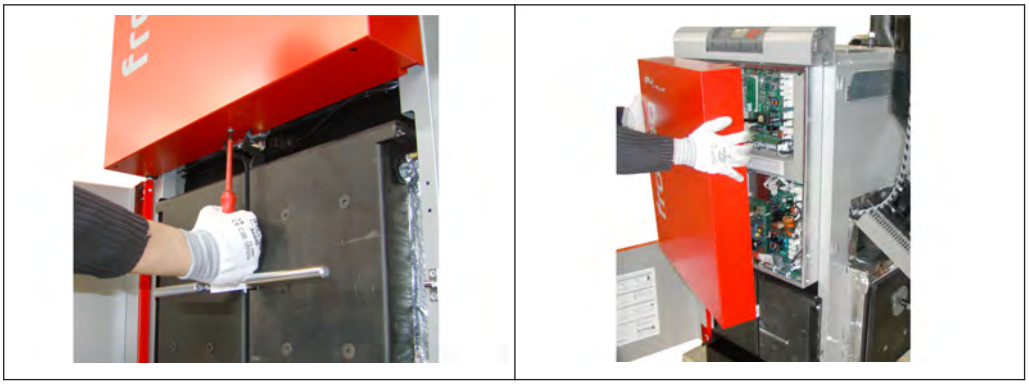
❒ Lift the back part of the stoker assembly up and remove

❒ Remove the insulating cover

❒ Remove the two screws and contact washers from the flaps of the controller cover

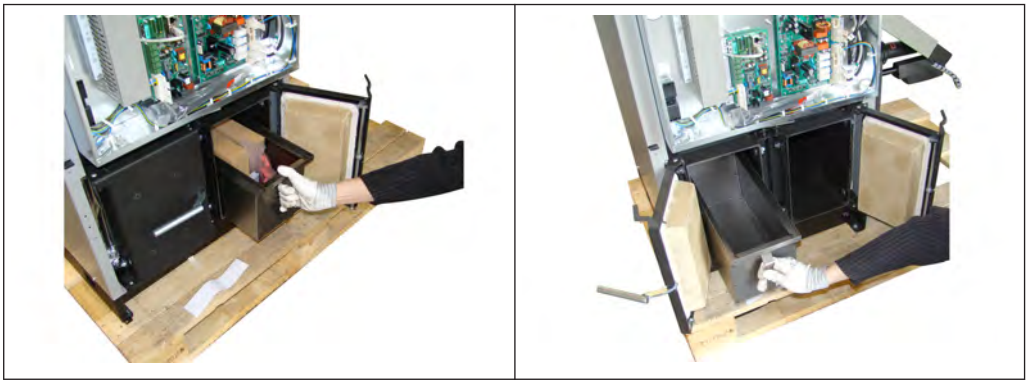
➥ Caution: Do not lose the contact washers!



❒ Remove the screw and contact washer on the bottom of the controller cover
❒ Remove the controller cover

4.5.2 Removing the door and ash drawer (P4 Pellet 8 - 25)

❒ Tilt the lock bolt for the door hinges forwards
❒ Lift the insulated door out of the hinges and remove



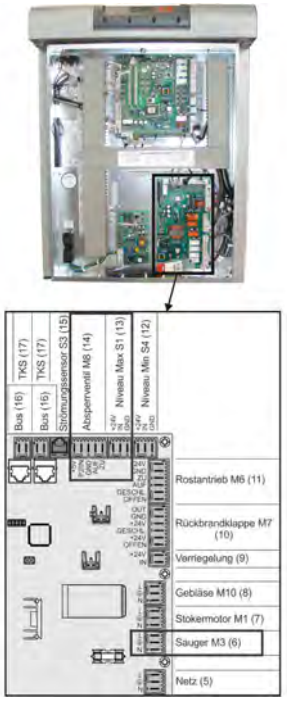
❒ Open both ash doors and remove the ash drawer

Optional:

❒ Remove the heat exchanger cover and combustion chamber cover to further reduce the weight

4.5.3 Dismantling the suction cyclone cover

❒ Remove the covering of the middle cable duct



At the pellet module:

❒ Unplug the units:

- "Suction unit M3"
- "Max level S1"
- "Gate valve M8"

❒ Undo the cable ties at the cable leadthrough

❒ Pull out the cables of the unplugged units

❒ Wind up the unplugged cables on the units

❒ Open the clamps and take off the cover

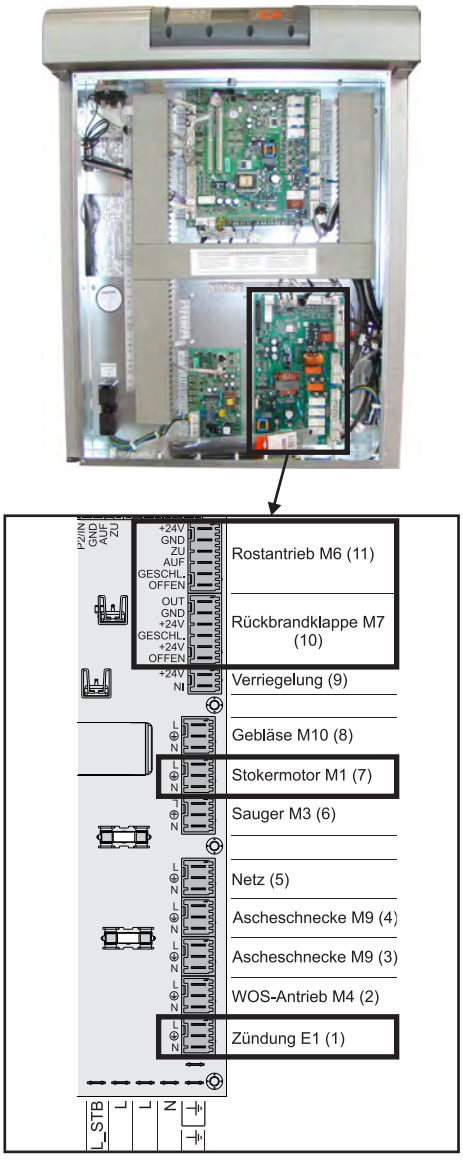
4.5.4 Dismantling the stoker unit

❒ Remove the covering of the cable duct

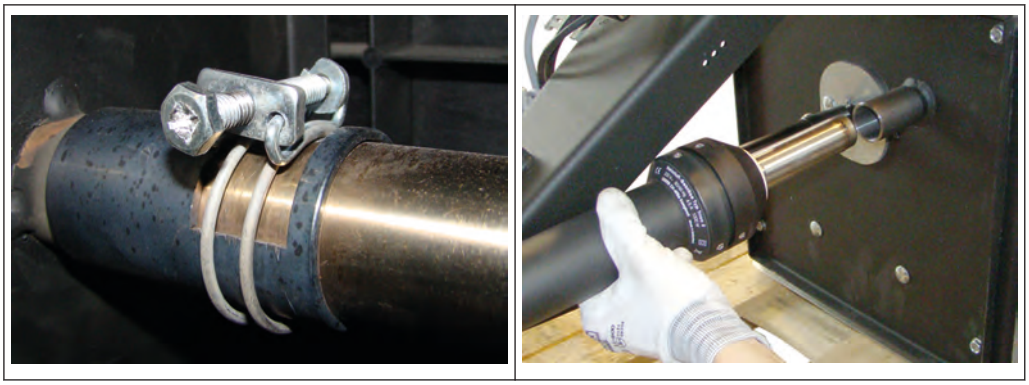
At the pellet module:

❒ Unplug the units:

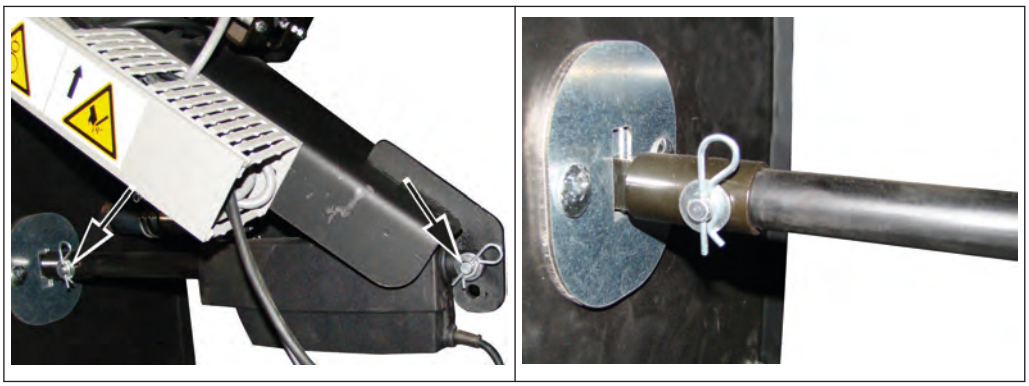
- "Min level S4"
- "Grate drive M6"
- "Burn back flap M7"
- "Stoker motor M1"
- "Ignition E1"



❒ Pull out the cables of the unplugged units

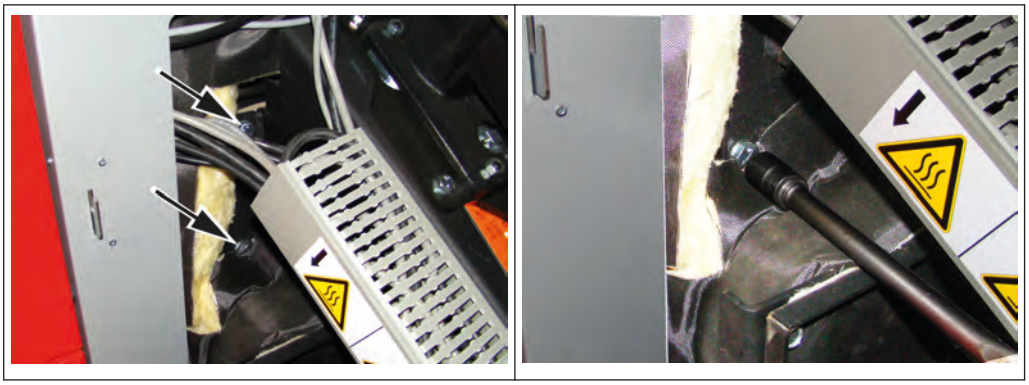


❒ Undo the screw and remove the clamp on the ignition blower fan
❒ Remove the ignition fan



❒ Remove the spring cotter at the front and back of the grate drive and remove the bolts
➥ CAUTION: Secure the grate motor so that it does not fall!

❒ Push the sleeve on the grate rod back
❒ Remove the grate motor

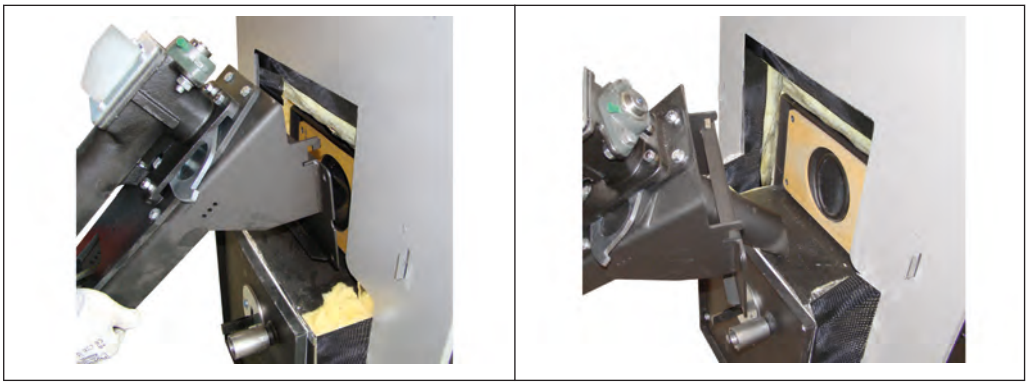


❒ Push the heat insulation mat aside slightly and remove two screws each from the right and left of the flange of the stoker unit

➥ You can remove the screws completely as the stoker unit is secured to the boiler with two hooks

NOTICE! The following steps require two people:

- Weight of stoker unit P4 Pellet 8 - 25: approx. 32 kg
- Weight of stoker unit P4 Pellet 32 - 38: approx. 36 kg
- Weight of stoker unit P4 Pellet 48 - 60: approx. 46 kg
- Weight of stoker unit P4 Pellet 80 - 100: approx. 68 kg

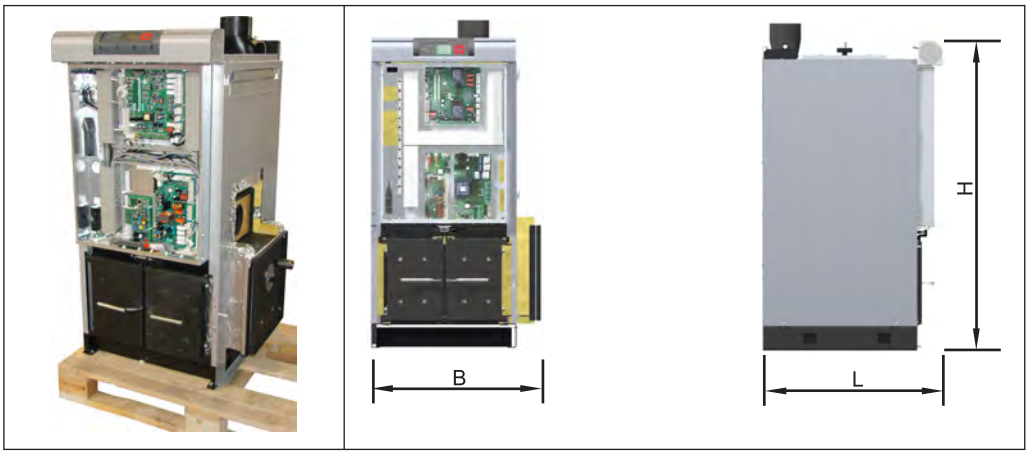


❒ Pull the stoker unit up slightly until the hooks come out of the stoker flange

❒ Tip the unit back slightly and lift away

The P4 is now fully dismantled and can be brought in.

4.5.5 Positioning dimensions after dismantling

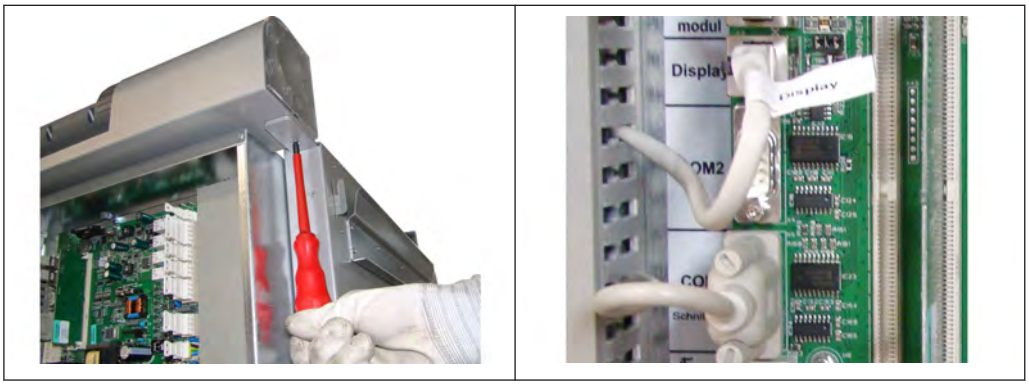


			P4 Pellet				
Dimen-sion	Description		8 - 15	20 - 25	32 - 38	48 - 60	80 - 100
L	Length, boiler	mm	740	740	740	820[1)]	910[2)]
B	Width, boiler		705	875	965	1275	1480
H	Height, boiler		1280	1280	1430	1585	1710

1. You can reduce the size to 780 mm by removing the control (e.g. to fit through a door with a clearance of 800 mm)
2. You can reduce the size to 880 mm by removing the control (e.g. to fit through a door with a clearance of 900 mm)

Removing the control

❒ Remove the left and right end caps



❒ Secure the bottom nuts to the bracket of the control
❒ Remove the screws on the right and left of the control
❒ Unplug the cable marked “Display” and pull up out of the controller
❒ Remove the control

4.5.6 Notes for reassembly

❒ After positioning, reassemble the boiler in the reverse order

It is particularly important to carry out the following steps during assembly:

Assembling the grate motor

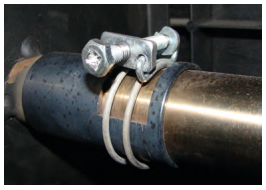
P4 Pellet 8-38:

❒ Correct position at back support:

- P4 Pellet 8-15: top position
- P4 Pellet 20-38: bottom position

❒ Check that the housing is in the right position at the grate rod (see figure)

Ignition fan



❒ Fit the clamp to the igniter tube using screws

➥ Fix the cable with the cable ties supplied.

➥ There must not be any loose cables in the area of the igniter.

➥ Only connect the power supply after completing assembly.

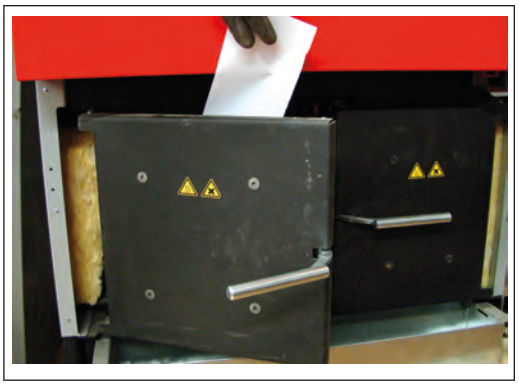
NOTICE! The individual units should be checked by a qualified technician and adjusted if necessary during initial start-up.

4.6 Assembling the pellet boiler

4.6.1 Before Installation

Checking the seal of the ash doors

❒ Open the door



❒ Insert a sheet of paper at the top between the door and boiler

❒ Close the door

❒ Try to pull the sheet of paper out

➥ If the paper cannot be removed:
The door seal is OK and the settings are correct

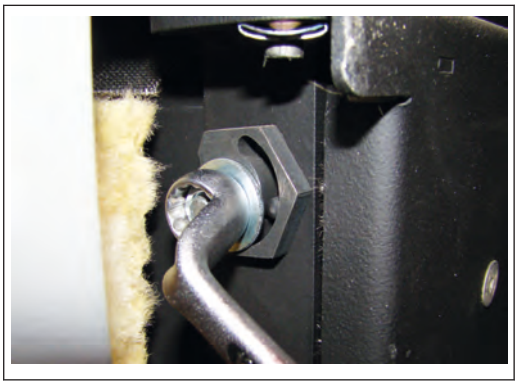
➥ If the paper can be removed:
The door is not sealed properly and must be adjusted!

❒ Check the seal again after positioning the doors

❒ Repeat the procedure at the bottom of the ash door and on the side of the door handle above and below the door handle as well as at the same positions on the other ash door

Adjusting the doors

P4 Pellet 8-25



❒ Using an Allen key (13 mm), loosen the lock nuts on the locking cams at the top and bottom

❒ Close the door

➥ With a gap of approx. 2 to 3 cm there should be a noticeable resistance

❒ If the resistance is too low or too high, move the locking cams backwards or forwards using an Allen key (32 mm)

➥ The movement of the locking cams causes the hinged plate to move, allowing the contact pressure to be adjusted

➥ Caution: The two locking cams (top and bottom) must be aligned

❒ Close the door

❒ If the door will not close, move the locking cams forward slightly

➥ Caution: The two locking cams (top and bottom) must be aligned

❒ Secure the lock nuts again

The locking plate can be moved in the same way using the locking cam at the side of the door handle, allowing the contact pressure to be adjusted on this side.

P4 Pellet 32-100: On the side with the door handle:

❒ Loosen the lock nuts at the top and bottom of the locking plate using an Allen key (13 mm)

❒ Close the door

➥ With a gap of approx. 2 to 3 cm there should be a noticeable resistance

❒ If the resistance is too low or too high, move the locking plate backwards or forwards using appropriate tools (e.g. screwdriver and hammer)

➥ Caution: The locking plate must be aligned at the top and bottom.

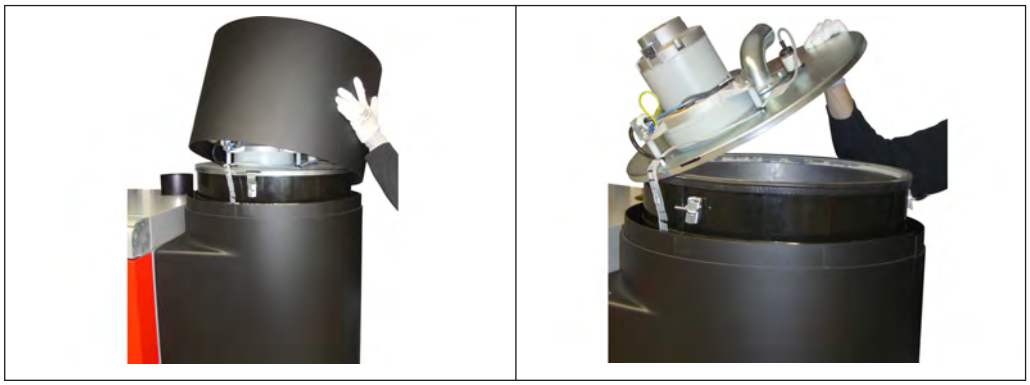
❒ Close the door

❒ If the door will not close, move the locking plate forward slightly

➥ Caution: The locking plate must be aligned at the top and bottom.

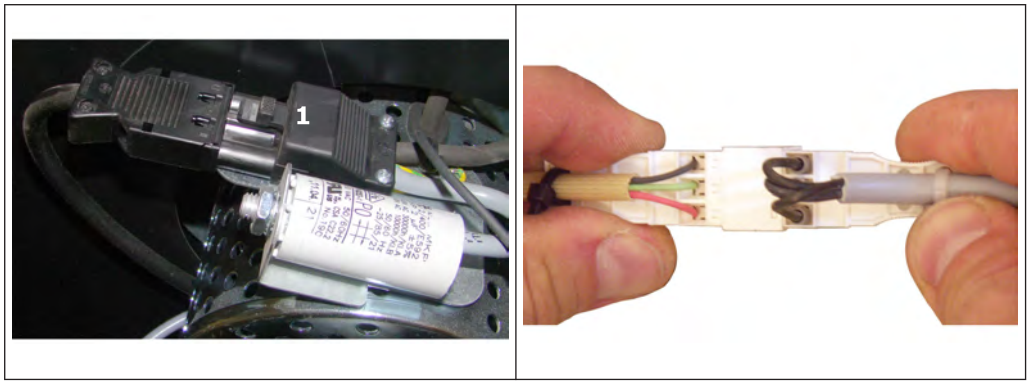
❒ Secure the lock nuts again

4.6.2 Fitting the induced draught fan



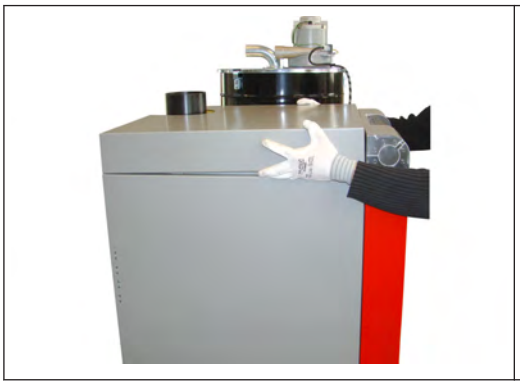
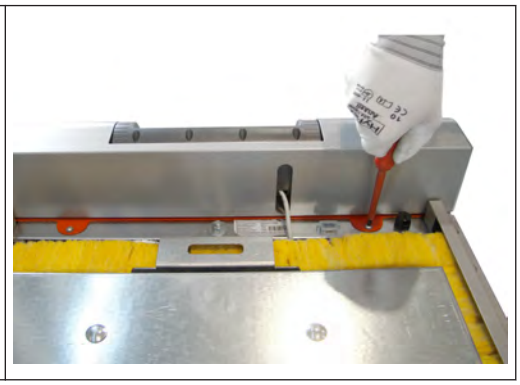
❒ Remove the locking screws on the sound insulation hood of the stoker assembly and remove the sound insulation hood
❒ Open the clamps on the suction cyclone container and remove the cover
❒ Remove the cardboard containing the induced draught fan and accessories package from the suction cyclone container

❒ Remove the pre-assembled induced draught cover plates
❒ Remove the pre-assembled nuts and spacer washers for induced draught
❒ Attach and fit the ID fan as illustrated



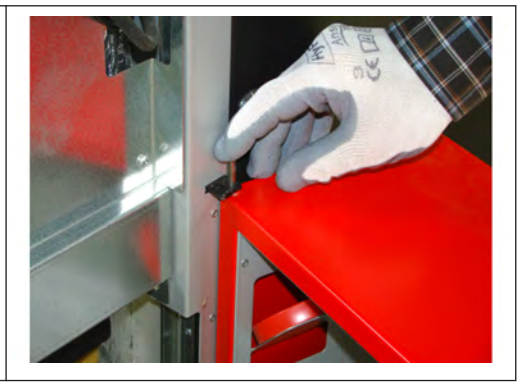
❒ Join the two cables of the ID fan with the pre-installed cables
➥ The locking device (1) must click into place.
❒ Push the cable behind the cladding and replace the induced draught cover plates.

4.6.3 Fitting the ash container and doors

❒ Remove the insulating cover
❒ Remove the two screws and contact washers from the flaps of the controller cover
➥ Caution: Do not lose the contact washers!

❒ Remove the screw and contact washer on the bottom of the controller cover
❒ Remove the controller cover



❒ Hang the insulated door to the boiler base and secure with lock bolt

❒ Take the two covers for the ash containers out of the ash containers, position and secure with clamps

❒ Put the left and right ash containers onto the ash screws and secure with lever

❒ Replace the controller cover after connecting to the power supply

4.7 Connecting the discharge system

❒ Fit the discharge system according to the installation instructions enclosed

❒ Connect the suction hose and return air line at the back of the boiler:

➥ Left port (1) = suction hose (Pellets sticker)

➥ Right port (2) = return air line

NOTICE! Ensure the potential equalisation matches the discharge system assembly instructions when connecting the lines!

4.8 Power connection

DANGER

When working on electrical components:

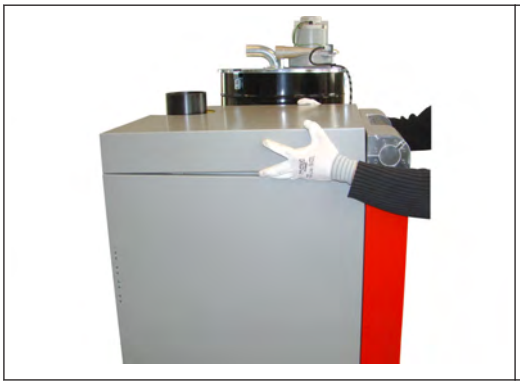
Risk of electrocution!

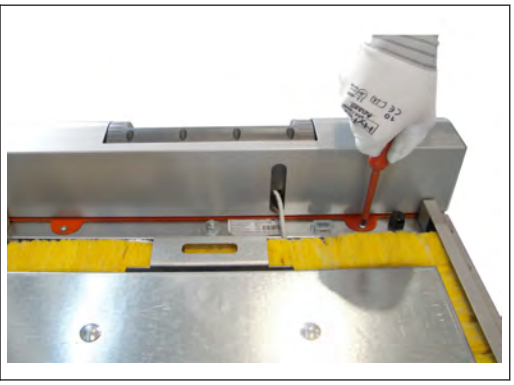
When work is carried out on electrical components:

- ❒ Only have work carried out by a qualified electrician
- ❒ Observe the applicable standards and regulations

  ➥ Work must not be carried out on electrical components by unauthorised persons

- ❒ Flexible sheathed cable must be used for the wiring; this must be of the correct size to comply with applicable regional standards and regulations.
- ❒ The power supply line (mains connection) must be fitted with a C16A fuse by the customer.





- ❒ Remove the insulating cover
- ❒ Remove the two screws and contact washers from the flaps of the controller cover

  ➥ Caution: Do not lose the contact washers!

- ❒ Open the insulated door (P4 Pellet 8 -25)

- ❒ Remove the screw and contact washer on the bottom of the controller cover
- ❒ Remove the controller cover

- ❒ Wire the connections in accordance with the circuit diagram

  ➥ For circuit diagrams see operating instructions for "Lambdatronic P 3200"

- ❒ To reassemble the controller cover and insulating cover, perform the disassembly steps in the reverse order

4.8.1 Information on circulating pumps

NOTICE

According to 2012/622/EU external, wet running circulating pumps must comply with the following limit values of the Energy Efficiency Index (EEI):

- Effective from 01/01/2013: Wet running circulating pumps with EEI ≤ 0.27
- Effective from 08/01/2015: Wet running circulating pumps with EEI ≤ 0.23

Only high efficiency pumps with a connection option for a control signal (PDM / 0-10V) should be connected to speed-controlled pump outputs (pump 1 on the core module and pump outputs on the hydraulic module). In this case, the control line is connected to the corresponding PDM outputs of the boards. Observe the connection instructions in the boiler controller documentation!

⚠ CAUTION

When using high efficiency pumps without an additional control line at speed-controlled pump outputs:

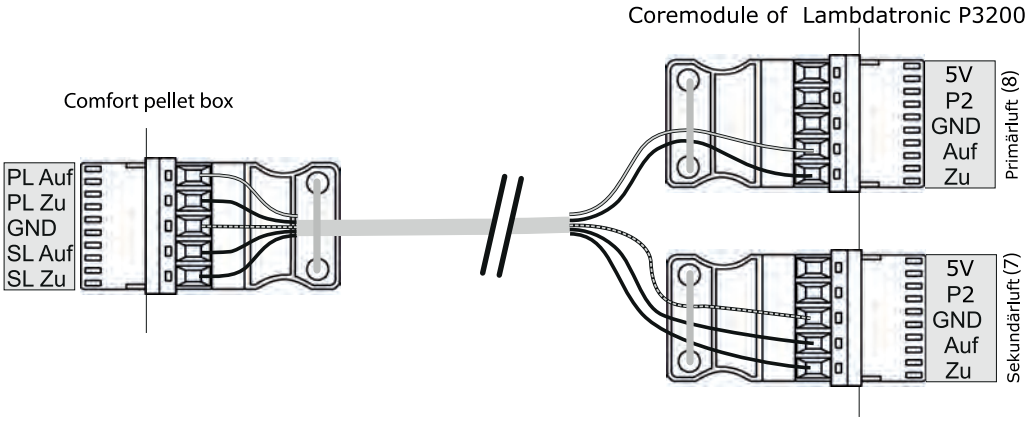
Malfunctions of the boiler, the pump and the hydraulic system may occur!

Therefore:

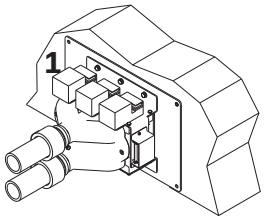
❒ Do not connect EC motor pumps without a control line to the speed-controlled pump outputs of the boards.
  ➥ Only use special high efficiency pumps with a connection option for a control line (PWM/0-10V)!
  ➥ Observe the additional instructions and information on board outputs in the operation instructions for the boiler controller.

4.8.2 Comfort pellet box port

With the automatic universal suction system, the Comfort pellet box is connected to the core module using flexible cable (5x0.75mm², YMM as per ÖVE-K41-5 or H05VV-F as per DIN VDE 0881-5). This is a 24V control line.



The previous figure shows the plugged-in 5-pin connecting plug of the Comfort pellet box and the accompanying connection layout at the Lambdatronic P 3200 controller.



To check the plug configuration:

❒ Perform check using the board's labels

➥ The actuators (1) of the pellet box must be switched to the "R" position.

The actuators are ready to plug in and are connected to the board.
The pellet box comes with all the necessary plug clips.

5 Start-up

5.1 Before commissioning / configuring the boiler

The boiler must be adjusted to the heating system during commissioning.

NOTICE

Optimum efficiency and efficient, low-emission operation can only be guaranteed if the system is set up by trained professionals and the standard factory settings are observed.

Take the following precautions:

❒ Initial startup should be carried out with an authorized installer or with Froling customer services.

❒ Adjust the boiler controller to the system type.

❒ Apply boiler standard values.

NOTICE! Detailed instructions for keypad assignment and the steps required for modifying the parameters can be found in the operating instructions for the boiler control unit.

❒ Check the heating system pressure.

❒ Ensure that the heating system is fully ventilated (free of air).

❒ Ensure that the safety devices are present and working correctly.

❒ Ensure that there is sufficient ventilation in the boiler room.

❒ Check the boiler seals

➥ All doors and inspection openings must be tightly sealed!

❒ Ensure that drives and actuators are working and turning in the right direction.

NOTICE! For information about checking the analog and digital outputs, see the operating instructions for the boiler controller.

❒ Ensure that the door contact switch is working correctly.

NOTICE! For information about checking the digital inputs, see the operating instructions for the boiler controller.

5.2 Initial startup

5.2.1 Permitted fuels

Wood pellets

Wood pellets made from natural wood with a diameter of 6 mm

Note on standards

EU:	Fuel acc. to EN 14961 - Part 2: Wood pellets class A1 / D06
and/or:	Certification program EN*plus* or DIN*plus*

General note:

Before refilling the store, check for pellet dust and clean if necessary.

5.2.2 Non-permitted fuels

The use of fuels not defined in the "Permitted fuels" section, and particularly the burning of refuse, is not permitted.

⚠ CAUTION

In case of use of non-permitted fuels:

Burning non-permitted fuels increases the cleaning requirements and leads to a build-up of aggressive sedimentation and condensation, which can damage the boiler and also invalidates the guarantee. Using non-standard fuels can also lead to serious problems with combustion.

For this reason, when operating the boiler:

❒ Only use permitted fuels

5.2.3 Heating up for the first time

NOTICE

Escaping condensation during the initial heat-up phase does not indicate a fault.

❒ Tip: If this occurs, clean it up with a cleaning rag.

6 Decommissioning

6.1 Mothballing

The following measures should be taken if the boiler is to remain out of service for several weeks (e.g. during the summer):

❒ Clean the boiler thoroughly and close the doors completely.

If the boiler is to remain out of service during the winter:

❒ Have the system completely drained by a qualified technician.
  ➥ Protection against frost

6.2 Disassembly

To disassemble the system, follow the steps for assembly in reverse order.

6.3 Disposal

❒ Ensure that they are disposed of in an environmentally friendly way in accordance with waste management regulations.
❒ You can separate and clean recyclable materials and send them to a recycling centre.

7 Appendix

7.1 Adresses

7.1.1 Address of manufacturer

FROLING
Heizkessel- und Behälterbau GesmbH

Industriestraße 12
A-4710 Grieskirchen
AUSTRIA

TEL 0043 (0)7248 606 0
FAX 0043 (0) 7248 606 600
INTERNET www.froeling com

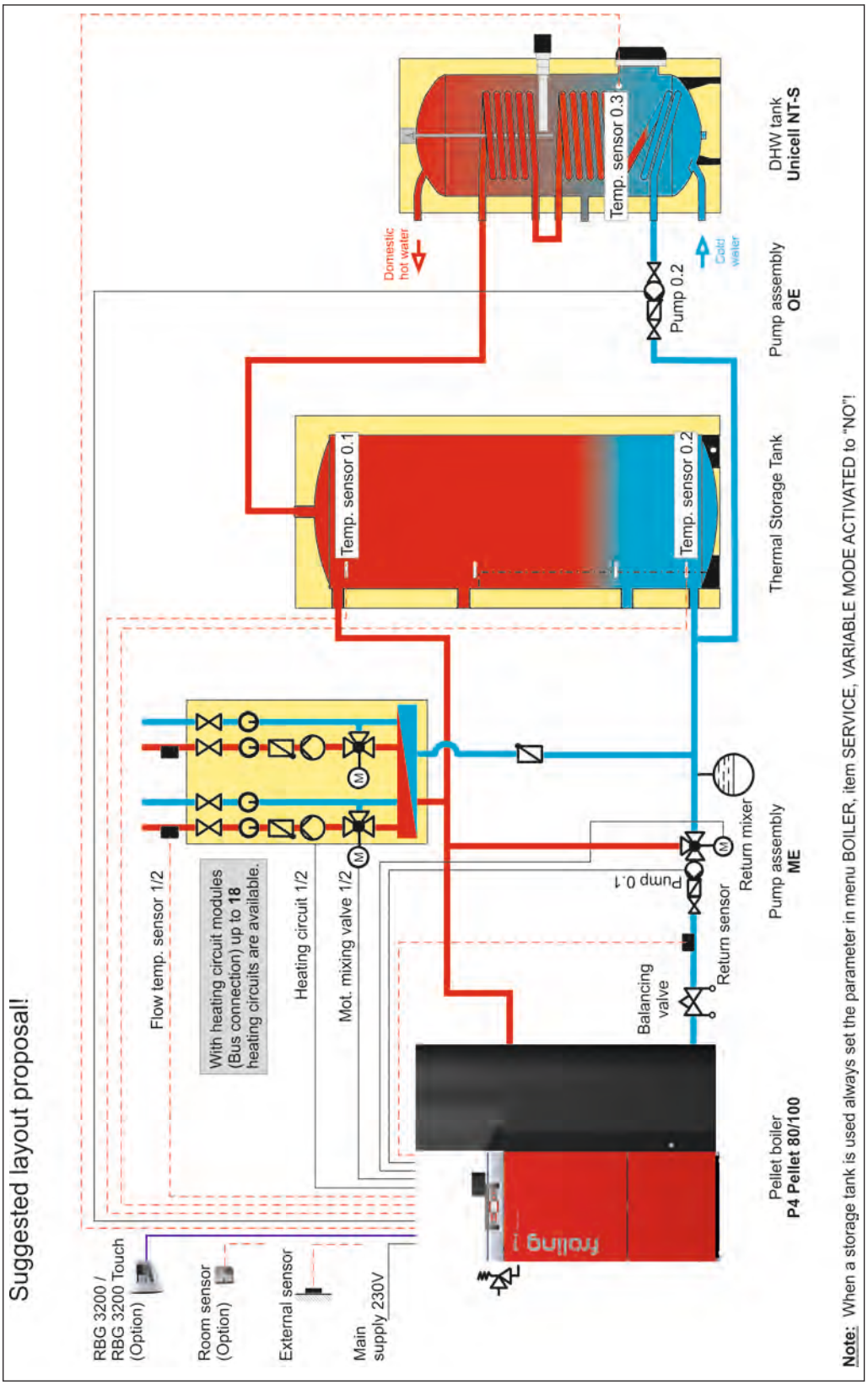
7.1.2 Address of importer

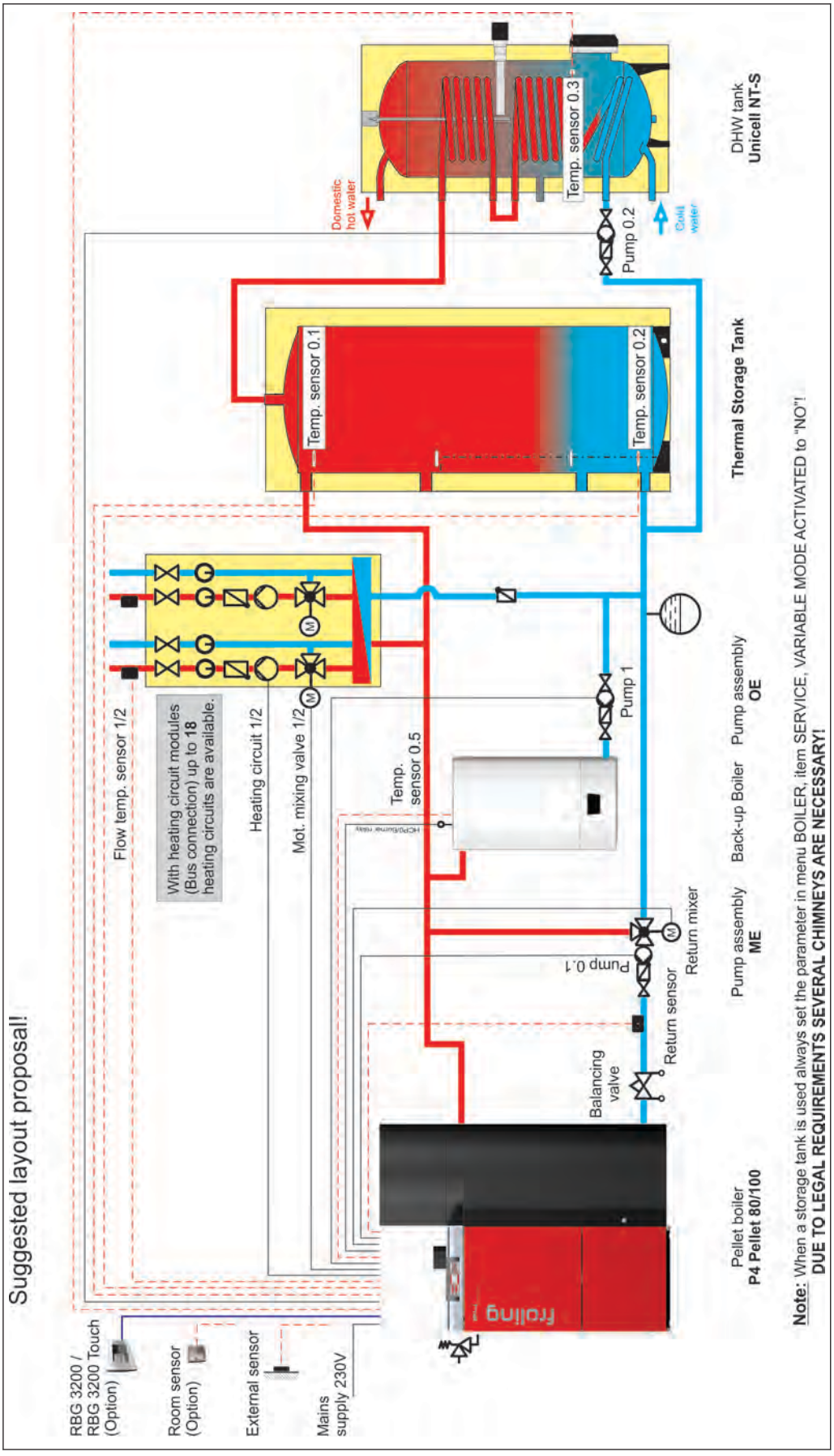
STAMP

7.1.3 Address of Local Dealer

STAMP

7.2 Hydraulic schematics




Suggested layout proposal!
DHW tank
Unicell NT-S
Temp. sensor 0.3
Domestic hot water
Cold water
Pump 0.2
Thermal Storage Tank
Temp. sensor 0.1
Temp. sensor 0.2
Pump assembly
OE
Pump 1
Back-up Boiler
Temp. sensor 0.5
Flow temp. sensor 1/2
With heating circuit modules (Bus connection) up to 18 heating circuits are available.
Heating circuit 1/2
Mot. mixing valve 1/2
Pump assembly
ME
Pump 0.1
Return mixer
Return sensor
Balancing valve
Pellet boiler
P4 Pellet 80/100
RBG 3200 / RBG 3200 Touch (Option)
Room sensor (Option)
External sensor
Mains supply 230V
Note: When a storage tank is used always set the parameter in menu BOILER, item SERVICE, VARIABLE MODE ACTIVATED to "NO"!
DUE TO LEGAL REQUIREMENTS SEVERAL CHIMNEYS ARE NECESSARY!

Owner´s Manual

Pellet boiler P4 Pellet -Touch

Read and follow the instructions and safety informations!
Technical changes, typographical errors and omissions reserved!
B0990220_en-US | Edition 1/21/2021

Froling GesmbH | A-4710 Grieskirchen, Industriestraße 12 | www.froeling.com

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1 Supplementary instructions

These instructions ensure safe and efficient use of the P4 Pellet (hereinafter referred to as the “system"). These instructions are a component part of the system and must be kept next to the system and within the immediate reach of staff at all times.

Staff must carefully read and understand these instructions before commencing all work. All the safety instructions and operating guidelines specified in this manual must be observed to ensure safety at work. In addition, the local accident prevention regulations and general safety regulations apply to the area of application of the system.

Images in these instructions are intended solely to aid understanding and may differ from the actual design.

NOTICE

SAVE THESE INSTRUCTIONS!

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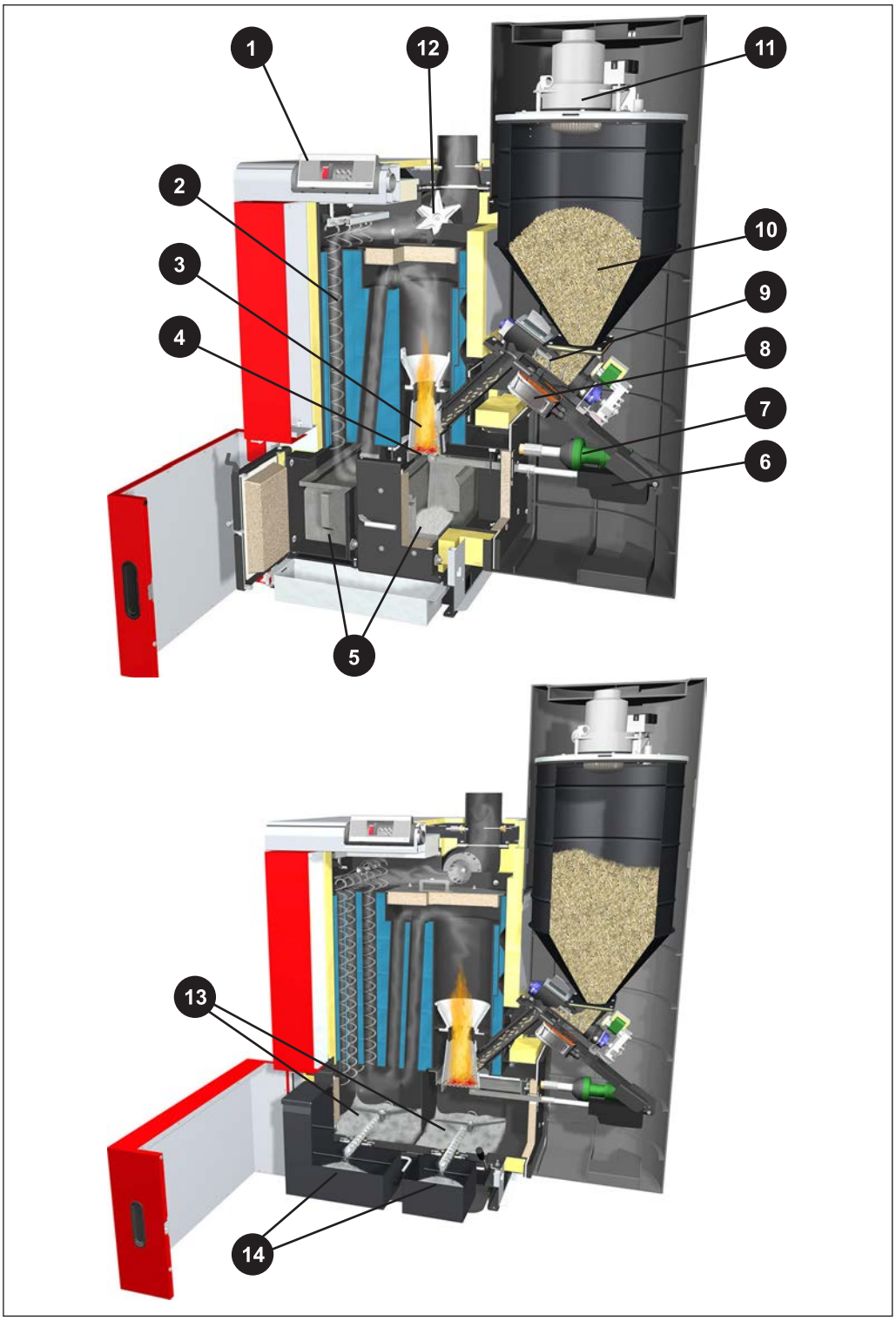
2 Overview

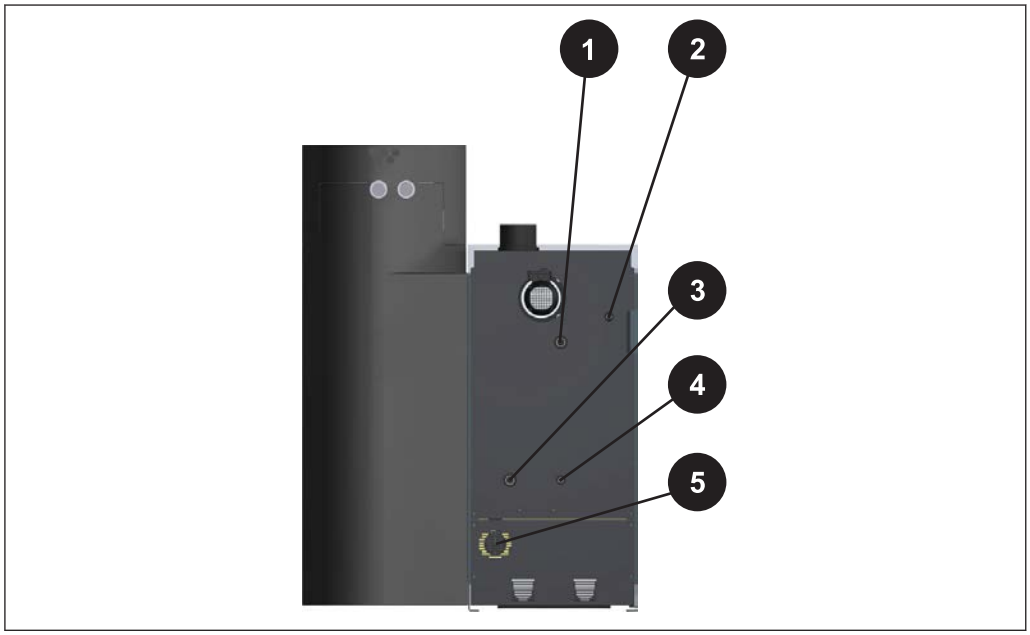
2.1 Width



1	Control panel of the Lambdatronic P 3200 Touch control
2	Heat exchanger with integrated spiral springs
3	Steel combustion chamber
4	Combustion grate
5	Comfort ash box (P4 Pellet 8 – 25)
6	Grate output
7	Hot air ignition
8	Burn back flap
9	Stoker screw
10	Hopper
11	Suction turbine
12	Speed-controlled induced draft fan
13	Ash chamber
14	Ash container (P4 Pellet 32-100)

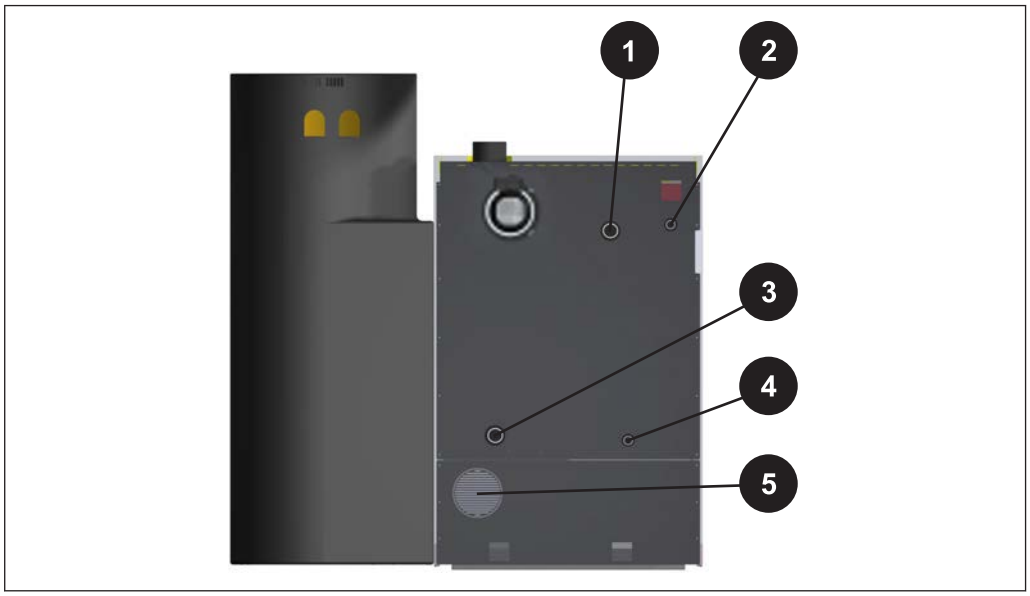
2.2 Back view

2.2.1 P4 Pellet 8-38



1	Boiler return connection
2	Air vent connection
3	Boiler flow connection
4	Drainage connection
5	Combustion air connection

2.2.2 P4 Pellet 48-100



1	Boiler flow connection
2	Air vent connection
3	Boiler return connection
4	Drainage connection
5	Combustion air connection

2.3 Boiler Fabrication and Testing

Your boiler was manufactured by Froling, a world leader in hot water (hydronic) heating for over 50 years. The P4 Pellet boiler confirms to traditional high standards for quality and reliability. It offers modern wood pellets boiler technology with operating efficiencies at over 90% based on net calorific value of fuel. If treated properly and operated according to the guidelines in this manual it will provide years of safe, dependable and economic heating.

P4 Pellet boilers are designed and built in accordance with European Standard EN 303-5. Beyond that the P4 Pellet 80/100 boiler is also available with an ASME stamp. The units were safety and performance tested and listed to UL 2523-2013 and CAN/CSA B366.1-2011 by OMNI Test Laboratories, Inc; Portland, Oregon. The installer should follow local or state installation requirements.

The P4 Pellet boiler is a wood pellets boiler designed and constructed for highly efficient combustion of wood pellets.

Do not burn other fuels in the P4 Pellet boiler. The P4 Pellet boiler is not a self contained weather-tight boiler. It should be installed within the heating building. P4 Pellet boilers should be installed with a thermal storage system to prevent short-cycling of the boiler during periods when the building is not calling for heat.

2.4 Models and Application

Ten P4 Pellet boiler models are available (8/15, 20/25, 30/38, 48/60 and 80/100) covering an output range between 35,800 Btu/hr and 341,200 Btu/hr. Models 8/15, and 20/25 are available with pneumatic hopper or 63,4 gal (240 liter) day bin. Specification data for each P4 Pellet boiler is approved in the Owner´s Manual and Assembly Instrustions. The boiler can be used either as a single heat source or in parallel with another boiler.

2.5 Short description

The P4 Pellet boiler is a boiler that produces useful heat for heating space and preparing hot water. The boiler uses wood pellets for fuel.

The pellets are transported by the suction turbine via the suction hoses into the large hopper. The pellets are transported to the downpipe with the stoker screw and fall in a metered quantity onto the combustion grate of the sturdy steel combustion chamber. Hot air is added by the automatic ignition to ignite the pellets.

The heat generated during combustion is used in the heat exchanger to heat the water. The flue gases produced during the combustion process are channeled outside through the chimney.

The movement of the integrated spiral springs automatically cleans the heat exchanger, maintaining the high operating efficiency. The ash from the steel combustion chamber falls through an automatic sliding grate into large, comfort ash drawers (P4 Pellet 8 – 25). Starting with the P4 Pellet 32 model, the ash falls into the ash chamber, where it is transported via the ash screw into large ash containers.

3 Safety

3.1 Explanation of symbols

Safety information

Safety information in these instructions is indicated by symbols. The safety information is preceded by signal words which reflect the extent of the risk.

⚠ DANGER **This symbol and signal word combination indicates a hazardous situation which will lead to death or serious injury if it is not avoided.**

⚠ WARNING **This symbol and signal word combination indicates a hazardous situation which could lead to death or serious injury if it is not avoided.**

⚠ CAUTION **This symbol and signal word combination indicates a hazardous situation which could lead to slight or minor injuries if it is not avoided.**

NOTICE **This signal word indicates important, but not safety-related information e.g. damage to property or pollution**

Safety information in operating instructions

Safety information can refer to certain, individual operating instructions. To avoid disrupting the flow of the text when you are performing the action, this safety information is not incorporated in the operating instruction. The signal words set out above are used.

Example:

❒ Undo screw
❒ **CAUTION! Pinching hazard at cover**
Take care when closing the cover.
❒ Tighten the screw

Special safety information

The following symbols are used to draw your attention to particular hazards

Tips and recommendations

Italics indicate useful tips and recommendations as well as information for efficient and smooth running.

Other markers

The following markers are used in these instructions to highlight operating guidelines, results, lists, references, and other elements:

Marker	Explanation
❒	Step-by-step operating instructions
⇀	Results of actions
⇨	Links to sections of these instructions and other relevant documents
▪	Lists without a specified order
[Button]	Operating elements (e.g. button, switch), display elements (e.g. signal lights)
“Display“	Screen elements (e.g. buttons, assignment of function keys)

Units used

All units of measure are specified in these operating instructions in both SAE units and SI units. The SAE unit appears first, followed by the SI unit in brackets.

Example using information about heat output: 17 (5) BTU/h (kW) equals
17 BTU/h (SAE system) or 5 kW (SI system).

3.2 Permitted uses

The Froling P4 Pellet boiler is intended exclusively for heating up heating water. Only use those fuels specified in the “Permitted fuels” section.

Permitted use includes compliance with all the specifications in this instruction manual.

Any use other than or above and beyond the permitted use is considered misuse.

3.3 Requirements at the place of installation

3.3.1 Approval for the heating system

The appropriate supervisory authority (inspection agency) must always be informed when installing or modifying a heating system, and authorization must be obtained from the building authorities. Also observe ANSI/NFPA 211 and CAN/CSA B365 for the installation.

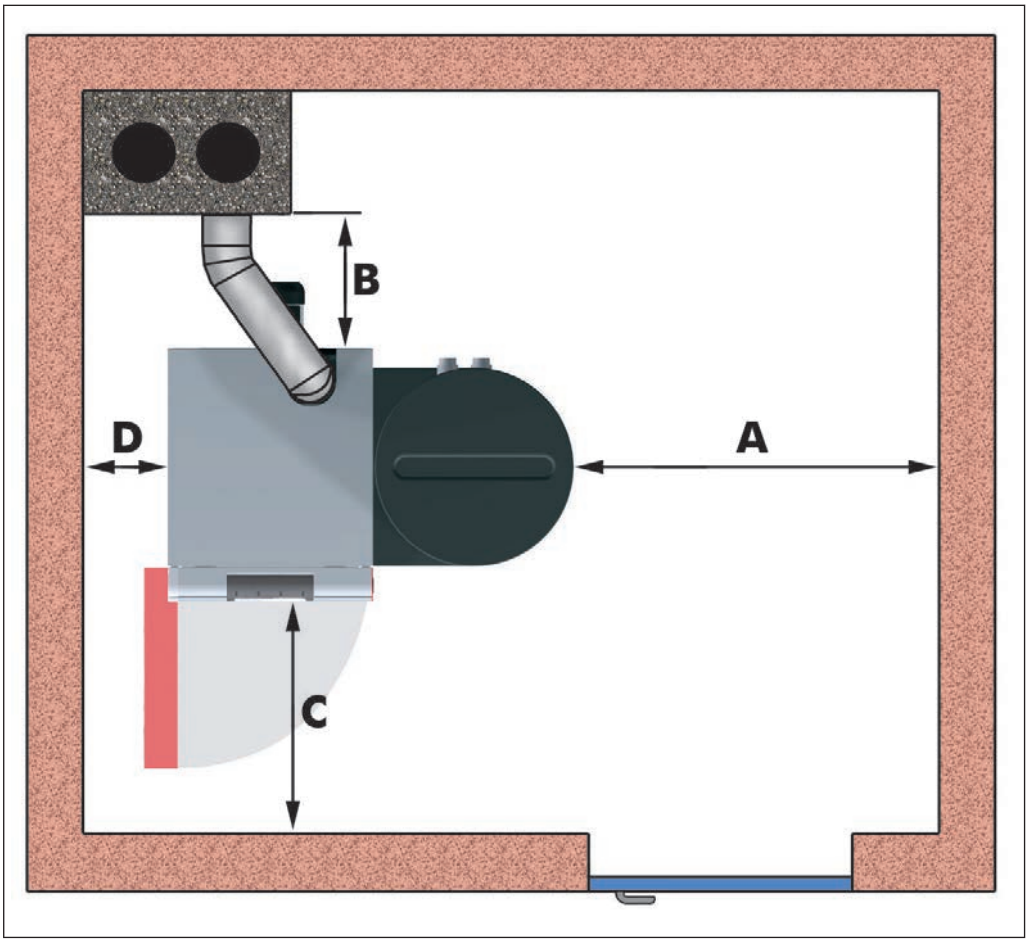
3.3.2 Minimum distances and clearances to combustibles in the boiler room

- The system should generally be set up so that it is accessible from all sides allowing quick and easy maintenance.
- Regional regulations regarding necessary maintenance areas for inspecting the chimney should be observed in addition to the specified minimum distances!
- Observe the applicable standards and regulations when setting up the system.
- Observe additional standards for noise protection
  (ÖNORM H 5190 - Noise protection measures)

FOR SAFE INSTALLATION AND OPERATION CLEANRANCES TO COMBUSTIBLES MUST BE MAINTAINED.

The diagram below shows the required space for the system in the boiler room.

The boiler may only be installed on non-combustible floors with these clearances!



			P4 Pellet				
	Description	**Unit**	**8 – 15**	**20 – 25**	**32 – 38**	**48 – 60**	**80 – 100**
A	Minimum distance to stoker assembly	inch (mm)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)
B	Induced draft fan maintenance area		12 (300)	12 (300)	12 (300)	12 (300)	12 (300)
C	Space for insulated door		22 (550)	29 (720)	33 (830)	20 (490)	24 (590)
D	Minimum distance to side of boiler		8 (200)	8 (200)	8 (200)	8 (200)	8 (200)
Distance between ceiling and boiler			18 (460)	18 (460)	18 (460)	18 (460)	18 (460)
Additional area to be covered is underneath the chimney connector and extending at least 2 inches (50 mm) on either side of the chimney connector.							

3.3.3 Requirements for central heating water

Water quality

Water of the following quality is required for the first fill:

- The water must be clean, pure or purified as well as odorless and must not contain suspended matter.
- The water hardness must not exceed 190 grain/fl.oz. or 100 ppm $CaCO_3$ (100 mg/L), i.e. soft water is required.
- The chlorine concentration in the water must not exceed 58 grain/fl.oz. (30 mg/L).
- The pH value in the heating system must be between 8.0 and 8.6.
- If the water quality is too poor, use additives to prepare the water. If you are topping up with small amounts, always use clean water.

NOTICE

The hot water must not be used directly in swimming pools or thermae. Use a heat consumer of the right size to consume the heat. Do not use the heating water as drinking water.

To ensure good water quality during operation, avoid leaks and use a closed heating system. If necessary, use a return temperature control.

First fill

To prevent air from getting into the heating system during the first fill, fill the filling hose with water.

Frost protection

You can add anti-freeze to the heating water, however, this can reduce the heating efficiency. Always follow the manufacturer's dosing instructions when using anti-freeze, as using the incorrect amount can cause corrosion. Check the concentration of the anti-freeze at regular intervals.

3.3.4 Ventilation requirements for boiler room

Introduction

The external combustion air must meet certain requirements to ensure that adequate combustion air is supplied to the boiler and no by-products from the combustion get into the boiler room.

Ventilation air for the boiler room must be taken from and expelled directly outside, and the openings and air ducts must be designed to prevent weather conditions (e.g. from foliage or snowdrifts), plants or animals from obstructing the air flow. Permanent ventilation is required to ensure that the boiler runs smoothly.

In North America there are several regulations which govern the minimum requirements of combustion air for chimneys.

The boiler must be installed in such a way that it receives adequate ventilation and combustion air and that the fuel in the boiler burns. The exhaust air must be expelled safely outside via the chimney and maintained within a safe temperature range.

Boiler rooms are usually so small that normal ventilation does not provide enough air and air must be brought in from outside. External air openings and air channels must be of an appropriate size to supply adequate combustion air. The design must comply with NFPA 211.

Consult your local chimney inspector for the installation and install the boiler in accordance with the applicable local regulations.

Recommended size of air openings according to NFPA 54 and NFPA 211:

The boiler requires a fresh air supply of between 1 sq.in. per 2,500 BTU/h and 1 sq.in. per 4,000 BTU/h (550 mm²/kW and 880 mm²/kW), depending on local conditions and the climate zone. Local conditions may necessitate an additional air supply.

3.3.5 Requirements for the heating system

- The whole heating system must be designed in accordance with relevant national and local regulations.
- The boiler's nominal load must be adjusted to the calculated heating requirements of all the consumer loads connected in the heating circuit in summer and winter.
- The heating system must be big enough to transport the heat generated by the boiler and an additional heat source (if present). The pressure throughout the whole system including all heating zones must be even.
- Special equipment must be available for filling and ventilating the heating circuit.
- All fitted pipes must be water-tight and air-tight and insulated for safety reasons.
- If there is a risk of parts of the heating system freezing, add anti-freeze to the water in these heat zones.

3.3.6 Requirements for the installation room (boiler room)

- There must not be a potentially explosive atmosphere in the boiler room as the boiler is not suitable for use in potentially explosive environments!
- The boiler room must be frost-free!
- The boiler does not provide any light, so the customer must ensure sufficient lighting in the boiler room in accordance with national workplace design regulations!
- When using the boiler at an altitude higher than 2,000 meters above sea level the manufacturer must be contacted!
- Fire hazard due to combustible materials!
  Never store flammable substances near the boiler. Never place flammable objects (e.g. clothing, etc.) on the boiler to dry.
- Damage due to impurities in combustion air!
  Do not use any solvents or cleaning agents containing chlorine in the boiler room.
- Keep the air suction opening of the boiler free of dust!

⚠ WARNING **Do not store fuel within installation clearances!**

3.3.7 Requirements for the fuel store

- The fuel store must be protected against the direct effects of weather.
- Before refilling the fuel store, check for pellet dust and clean if necessary.

- When fans are used in the fuel storage area, they should be installed so as not to create negative pressure in the room where the solid-fuel-burning appliance is located.

3.3.8 Hose lines

For the hose lines used with the suction device, the universal suction systems, and the silo delivery unit, please observe the following:

Fuel delivery hose must be supplied by your local Froling boiler representative and must be manufactured according to ISO 3994 (specifies requirements for helical thermoplastic reinforced hoses) and certified to UL 94 HB (flammability of plastic materials).

3.3.9 Combination with a storage tank

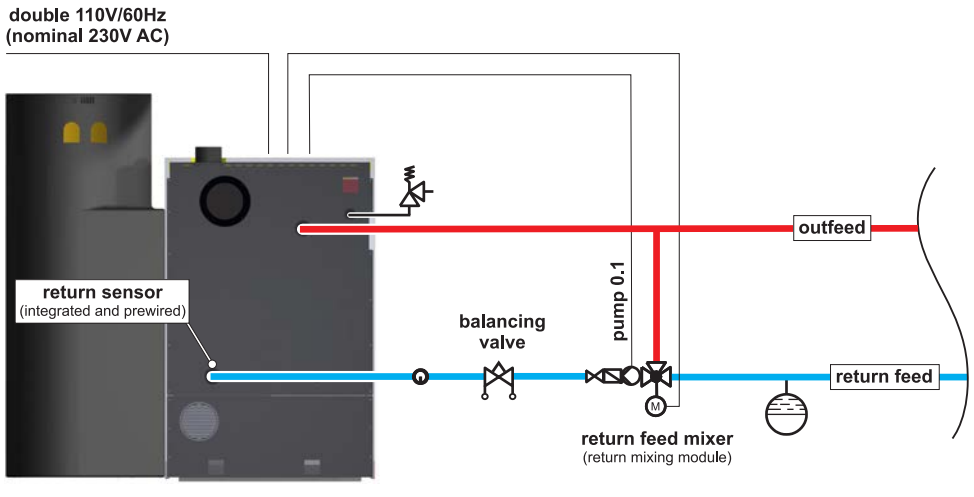
A storage tank does not need to be used for the heating system to run smoothly. However, we recommend that you use the system with a storage tank to ensure a continuous supply of fuel in the boiler's ideal output range.

For the correct dimensions of the storage tank and the line insulation (in accordance with ÖNORM M 7510 or guideline UZ37) please consult your installer or Froling.

3.3.10 Return temperature control for P4 Pellet 80/100

When installing a P4 Pellet 80/100, a return temperature control must be installed. If the hot water return is below the minimum return temperature, some of the hot water outflow will be mixed in via the return temperature control.

Pellet boiler P4 Pellet 80/100 - Return feed lift with mixing valve



Check parameter setting:

Navigate to menu „*System*" ⇨ „*System selection*" ⇨ „*Boiler type*" ⇨ „*P4 Pellet 32 - 100*" and set parameter „*Return flow mixer through external modul*" to „*YES*".

A15390013

3.3.11 Requirements for the chimney connection

The chimney connection must be big enough to channel flue gases from the building. The whole flue gas system must be designed to prevent possible seepage, insufficient feed pressure and condensation.

The manufacturer recommends fitting a draft regulator to limit the pressure to 0.10 mm WC (25 Pa). The draft regulator should be fitted directly below the chimney connection where the pressure is very low.

The boiler must be connected to a brick chimney or a shop-made chimney in accordance with UL 103 HT (ULC S629 in Canada). The chimney must be clean and in good condition at the time of installation.

The pipe unions within the chimney must be made of stainless special steel (with 304, 316 or 321 alloys). The individual pipe sections must be joined together with at least three self-tapping screws and the joins sealed using high-temperature silicone. The flue gas pipe must not contain more than two 90° bends.

All connections must conform to NFPA 211. Consult your local chimney sweep for the installation and install the boiler in accordance with the applicable local regulations.

The chimney connection, ventilation ducts and fresh air openings must not be closed over or blocked.

The flue gas pipe must not be displaced by an attic, loft, fuel store or similar areas.

Basic data for designing the chimney connection

Description		P4 Pellet			
		8	15	20	25
Flue gas temperature at nominal load	°C	140	150	150	150
Flue gas mass flow at nominal load	kg/s	0.007	0,010	0.014	0,018
Flue gas mass flow at partial load		0.003	0,004	0,006	0,007
Required feed pressure at nominal load	mbar	0.08	0,08	0,08	0.08
Required feed pressure at partial load		0,06	0,06	0.06	0,06
Maximum permissible feed pressure		0.25			
Flue spigot diameter	mm	130	130	130	130

Description		P4 Pellet			
		32	38	48	60
Flue gas temperature at nominal load	°C	160	160	160	170
Flue gas mass flow at nominal load	kg/s	0.022	0.025	0,039	0.043
Flue gas mass flow at partial load		0.009	0.011	0.017	0.019
Required feed pressure at nominal load	mbar	0.08	0.08	0.08	0.08
Required feed pressure at partial load		0.06	0.06	0.06	0.06
Maximum permissible feed pressure		0.25			
Flue spigot diameter	mm	150	150	150	150

Description		P4 Pellet	
		80	100
Flue gas temperature at nominal load	°C	160	170
Flue gas mass flow at nominal load	kg/s	0.060	0.076
Flue gas mass flow at partial load		0.021	0.026
Required feed pressure at nominal load	mbar	0.08	0.08
Required feed pressure at partial load		0.06	0.06
Maximum permissible feed pressure		0.25	
Flue spigot diameter	mm	200	200

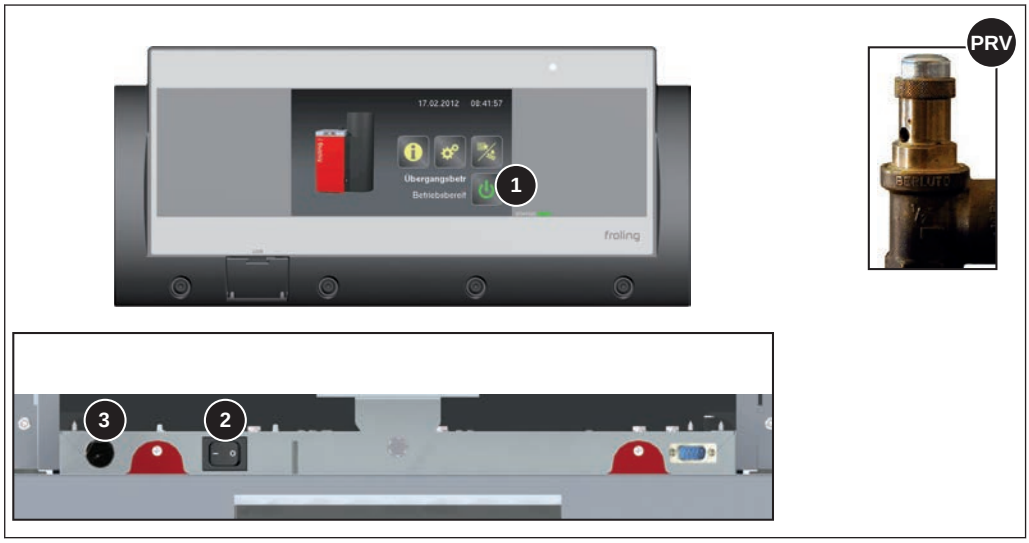
⚠ CAUTION

ADJUSTMENT OF THE FLUE DRAFT HIGHER THAN 0.10 INCHES WATER CLOUMN (25 Pa) COULD CAUSE FIRE TO BURN OUT OF CONTROL AND AN UNSAFE CONDITION!

❒ Maximum permitted setting: 0.10 inches WC (25 Pa)
Ideal setting: 0.04 inches WC (10 Pa)

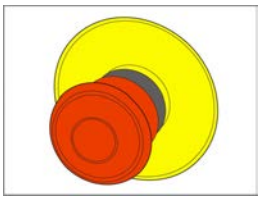
3.4 Safety devices

3.4.1 Position of safety devices



1	Lambdatronic P 3200
2	Main switch
3	High-limit thermostat STL

3.4.2 Description of safety devices



Emergency stop button (optional)

Pressing the emergency stop button stops the entire boiler (fuel infeed, combustion process in the boiler and the blower fan). Only the pump in the heating circuit continues to run to be able to dissipate the residual heat. The emergency stop button is on the same safety chain as the high-limit thermostat.

After an emergency stop button has been pressed, it must be released again by turning it and the fault acknowledged at the SPS so that you can turn the heating system back on again.

The system is controlled via the Lambdatronic P 3200. The "*Boiler OFF*" command allows you to switch off the boiler in the event of overheating. After the boiler has been switched off via the control system, automatic mode is switched off and the control shuts the boiler down according to the shutdown procedure. The pumps continue to run.

Main switch

The system is powered via the main switch. Turning the main switch to the "0" position disconnects the system from the power supply. The main switch is located under the upper insulating cover.

⚠ WARNING

When turning off the main switch in automatic mode:

Serious combustion faults leading to serious accidents are possible.

Before turning off the main switch:

❒ Switch boiler off by tapping “Boiler OFF”.

↪ The boiler follows the shutdown procedure and switches to "Boiler off" status after the cleaning cycle.

Safety valve (provided by the customer)

Depending on the boiler type which is use, different kinds of pressure values of the safety valves are necessary! When the boiler reaches a pressure of 30 psi (2 bar), 43.5 psi (3 bar) or 45 psi (3 bar) the safety valve opens and the heated water is blown off in the form of steam.

⇨ See "Technical specifications" [page 98]

3.5 Safety markers

3.5.1 Mandatory signs

Refer to the operating instructions

Only use the indicated system once you have read the operating instructions.

Wear hearing protection

This sign indicates that hearing protection must be worn in the area concerned.

Wear protective gloves

This sign indicates that protective gloves must be worn in the area concerned.

Wear safety shoes

This sign indicates that safety shoes must be worn in the area concerned.

Wear a dust mask

This sign indicates that a dust mask must be worn in the area concerned.

Keep the doors closed

Keep the doors closed during operation.

Turning off the main switch

Switch off the main switch and take precautions to prevent accidental switching on before carrying out work to the system

Switch off the main switch for the fuel infeed and take precautions to prevent accidental switching on before entering the fuel storage room.

Securing the main switch

Switch off the main switch and secure with a padlock when carrying out maintenance work to the boiler.

3.5.2 Prohibitions

Unauthorized access prohibited

Only persons authorized by the operator may enter the danger zone and fuel storage room. Keep children away! Keep the fuel storage room locked and keep the access key in a safe place. Protect the fuel from moisture.

No fire, open flames or smoking

Areas marked with this are at risk of fire or explosion. Keep ignition sources away from these areas.

3.5.3 Warning signs

Risk of falling

There is a risk of falling when working at heights in the fuel storage room or on components of the fuel infeed. Use a suitable ladder or hoist for all work.

Automatic start-up

This sign indicates that there is a risk of the system starting up automatically. Work may only be carried out in areas with this marking if the system has been secured.

Electric current

Only licensed electricians may work in workspace with this marking.

Unauthorized persons are not permitted to enter work areas with this marking or open the cabinet with this marking.

Risk of collapse

There is a risk of collapse and being buried alive as a result of cavity formation in the fuel storage room. Never step on piles of fuel.

Harmful or irritant materials

These materials can be irreparably harmful to health, trigger allergic reactions or irritate the mucous membranes.

Observe the information on the packaging and containers.

Danger from carbon monoxide

There is a risk of poisoning from a possible concentration of carbon monoxide in the fuel storage room and boiler room. Ventilate the fuel storage room for at least 15 minutes before entering. Two people must always be present when working in the fuel storage room. The access door must be kept open at all times. Also wear a dust mask because of the high dust levels.

Hand injuries

Keep hands away from areas bearing this warning.

There is a risk that your hands could get trapped, pulled in or otherwise injured.

Hot surfaces

Hot surfaces, such as hot system parts, may not always be obvious. Do not touch these parts without protective gloves.

Crushing hazard

Keep hands away from areas bearing this warning.

There is a risk that your hands could get trapped, pulled into or otherwise injured in automatic screws.

Risk of falling

There is a risk of falling in the fuel store because of slippery surfaces or fuel lying about. Take extreme care and wear personal protective equipment.

Risk of injury at fans

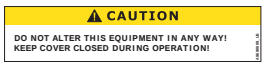
Keep hands away from areas bearing this warning.

There is a risk that your hands could get trapped, pulled into or otherwise injured in automatic fans.

Risk of being buried alive

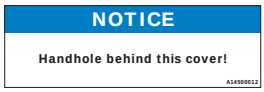
There is a risk of being buried alive in the fuel storage room. Keep out of the fuel storage room, especially during filling.

3.5.4 Additional safety signage



Warning sign for covers

Do not modify the system peripherals. The covers must be kept shut during operation.



Notice for maintenance opening

The opening for the visual inspection of the heat exchanger tubes is behind this cover.

3.5.5 Signage on the boiler

The following signs are located on the boiler. They highlight dangers during operation as well as the correct procedure in hazardous situations.

Notice of risks during installation

P4 PELLET - WOOD PELLET FIRED BOILER

INSTALLATION HAZARDS

Install, modify and use only in accordance with manufacturer's manuals. Refer to authorities having jurisdiction for proper installation. Contact local building and fire officials about restrictions and installation inspection in your area. If there are no applicable local codes, follow ANSI/NFPA 211 and CAN/CSA B365. Special precautions are required for passing the chimney through a combustible wall or ceiling.
Inspect and clean exhaust system, heat exchanger, burner, pellet hopper and ash boxes frequently in accordance with owner's manual.

Basic boiler data for layout of chimney system		P4 PELLET				
Quantity	**Unit**	**8 / 15**	**20 / 25**	**32 / 38**	**48 / 60**	**80 / 100**
Flue gas temperature Rated / partial load	°F °C	300 / 210 150 / 100	300 / 210 150 / 100	320 / 210 160 / 100	340 / 210 170 / 100	340 / 210 170 / 100
Minimum draft at boilers flue gas connection		0.03 inches water column (5 Pa)				
Maximum draft at boilers flue gas connection		0.10 inches water column (25 Pa)				
Flue gas connector Diameter		5 inches (130 mm)		6 inches (150 mm)		8 inches (200 mm)
Maximum water temperature	°F °C	176 80			190 88	
Maximum allowable working pressure according to heat exchanger design:	EN 303-5	30 psi (2 bar)				45 psi (3 bar)
	ASME	not available				43.5 psi (3 bar)

For detailed design information please refer to Installation Manual! For unit specifications, see Listing Label! For supply connections use No. 14 AWG (2.1mm²) or larger wires acceptable for at least 194°F (90°C). Use copper. Use regular overcurrent protection device 15 AMP, two phases (L1 & L2).

DANGER!

- Working on electrical components may cause severe injuries from electric shocks!

WARNING!

- The electrical system of the boiler shall be supplied from a double 115 V 60 Hz (nominal 230 V AC) 15 amp branch circuit including neutral and earth connection. For wiring instructions please refer to Installation Manual!
- Chimney must be 5" (130mm - P4 Pellet 8 - 25), 6'' (150 mm - P4 Pellet 32 - 60) or 8" (200 mm – P4 Pellet 80/100) diameter listed UL-103 HT or ULC-S629 residential all-fuel type or tile-lined masonry. Flue connector pipe must be 5" (130mm - P4 Pellet 8 - 25), 6'' (150 mm - P4 Pellet 32 - 60) or 8" (200 mm – P4 Pellet 80/100) diameter made of a minimum 24 MSG black steel.
- Inadequate design, installation and maintenance of the flue gas system will lead to insufficient chimney draft and could result in Danger of Life or Severe Injury caused by serious faults in combustion, e.g. explosively combustion of carbonization gases and flash fires!
- This boiler requires fresh air for safe operation and must be installed so there are provision for adequate combustion and ventilation air!

CAUTION!

- DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE!
- LOAD FUEL CAREFULLY OR DAMAGE MAY RESULT.
- REFER TO OWNER´S MANUAL. DO NOT ALTER THIS EQUIPMENT IN ANY WAY.
- UNSAFE TO ADJUST FLUE DRAFT HIGHER THAN 0.10 INCHES WATER COLUMN (25 Pa)
- MAY BE CONNECTED TO AN EXISTING BOILER SYSTEM.
- Flooring must be a minimum 3/8'' (10 mm) non-combustible material covering the installation clearance area! The floor must be level and reinforced if required. For construction of the floor beneath the boiler mind the weight of boiler, water content and wood fuel according to the Installation Manual!
- This boiler is for use with an automatic stoker only!
- Use original spare parts only. Installation of non-licensed replacement parts will void the warranty!

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Notice of risks during operation

P4 PELLET - WOOD PELLET FIRED BOILER

OPERATION HAZARDS

NOTICE! Burn Wood Pellets only as specified in Owner's Manual!

Pellet Fuel Institute (PFI) Standard "Premium" recommended.

DANGER! Risk of Fire or Explosion!

- Do not burn garbage, gasoline, drain oil, or other flammable liquids.
- DO NOT BURN GARBAGE, GASOLINE, NAPHTA, ENGINE OIL, OR OTHER INAPPROPRIATE MATERIALS!
- DO NOT USE CHEMICALS OR FLUIDS TO START UP THE FIRE.
- Use of inappropriate fuels can result in Danger of Life or Severe Injury caused by explosive combustion and flash fires!
- Burning fuels other those designated in the manual will void the warranty!

DANGER! Explosive Gases!

- Never open Boiler doors, Covers or Heat Exchanger Cask Cover during operation!
- Faulty operation of boiler system will cause Danger of Life or Severe Injury and Material Damage!
- TO AVOID INJURY FROM MOVING PARTS; SHUT OFF BOILER CONTROL SYSTEM BEFORE OPENING BOILER DOORS; COVERS OR HOPPER CASING!

WARNING! Risk of Fire!

- Do not burn garbage, gasoline, drain oil, or other flammable liquids or materials.
- KEEP ALL BOILER DOORS, FUEL STORAGE DOOR AND ALL COVERS TIGHTLY CLOSED DURING OPERATION!
- AFTER OPENING BOILER DOORS, COVERS OR HOPPER CASING CLOSE ALL DOORS, COVERS AND CASING TIGHTLY!
- DO NOT OPERATE WITH FLUE DRAFT EXCEEDING 0.10 INCHES WATER COLUMN (25 Pa)!
- Do not operate with flue draft exceeding 0.10 inches in water column (25 Pa).
- UNSAFE TO ADJUST FLUE DRAFT HIGHER THAN 0.10 INCHES WATER COLUMN (25 Pa)!
- THE HEAT EXCHANGER, DRAFT INDUCER, FLUE PIPE, AND CHIMNEY MUST BE CLEANED REGULARLY TO REMOVE ACCUMULATED CREOSOTE AND ASH. ENSURE THAT THE HEAT EXCHANGER, FLUE PIPE, AND CHIMNEY ARE CLEANED AT THE END OF HEATING SEASON TO MINIMIZE CORROSION DURING THE SUMMER MONTHS. THE APPLIANCE, FLUE PIPE, AND CHIMNEY MUST BE IN GOOD CONDITION. THESE INSTRUCTIONS ALSO APPLY TO A DRAFT INDUCER IF USED.
- Do not store fuel or other combustible material within marked installation clearances!
- Faulty operating conditions not complying with Owner's Manual, such as insufficient combustion air, incorrect or insufficient cleaning and maintenance or non-permitted fuel could result in Danger of Life or Severe Injury caused by serious faults in combustion (e.g. spontaneous combustion of carbonization gases or flash fires)!
- Inspect and clean flues and chimney regularly!
- First firing during start-up of boiler system shall be carried out in attendance of an authorized installer or manufacturer's representative only! Disregarding of warning may cause damage or explosion of combustion chamber and severe injuries unfavorably!

CAUTION! Hot surfaces!

- Hot parts and the flue pipe can cause serious burns!
- Do not touch during operation.
- Maximum draft marked on nameplate.
- Unauthorized access to the boiler room and pellets store could result in personal injury and damage to property!
- FOR SAFETY KEEP FIRING AND ASHPIT DOORS TIGHTLY CLOSED.
- Keep children away.
- Always use protective gloves during maintenance.
- Always use control handles when open boiler doors.
- Insulate flue pipe and do not touch during operation.
- Do not carry out maintenance when the boiler is hot.
- Do not touch hot surfaces behind Boiler doors, Covers and Hopper casing.

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Notice regarding procedures in an emergency

P4 Pellet – WOOD PELLET FIRED BOILER

EMERGENCY PROCEDURES

⚠ DANGER! In case of strong smell of flue gas!

Flue gases can cause fatal poisoning!
- Do not open any boiler doors or covers, or fuel transportation system door or covers!
- Turn off the boiler by pressing “Boiler OFF” (⏻)
- Air the room where boiler is installed!
- Close the door of the boiler room and doors to living areas!

⚠ DANGER! In the event of loss of electrical power!

- Do not open any boiler doors or covers, or fuel transportation system doors or covers!
- Boiler Control automatically restarts after power fail restart.
- Half an hour after power has returned, check system for normal operation and compare the pressure gauge reading to initial settings. If system pressure is low, replenish water to the heating system according plumber’s instructions.

⚠ DANGER! In the event of runaway fire!

- Call the fire department!
- Turn off Emergency Switch, if installed.
- Do not open any boiler doors or covers, or fuel transportation system doors or covers!
- Do not switch off Main switch at Boiler!
- Evacuate your house.
- If possible, wet your entire roof with a garden hose.
- When there is no more risk of runaway fire, turn on Emergency Switch and resume to normal operation of the system.

To cool overheated boiler (over 220°F / 105°C)!

- Turn off Emergency Switch, if installed.
- Do not open any boiler doors or covers, or fuel transportation system doors or covers!
- Turn off boiler by pressing “Boiler OFF” (⏻)
- Open all mixer taps, switch on all pumps.
- Leave the boiler room and close the door.
- Open all hot water faucets.
- Turn all thermostats in your house to their highest temperature settings and open all windows if room heat is too hot
- When boiler temperature has dropped below 180°F (82°C), reverse the above steps.
- In case Safety Temperature Limit Switch automatically has been activated please refer to Owner’s Manual.

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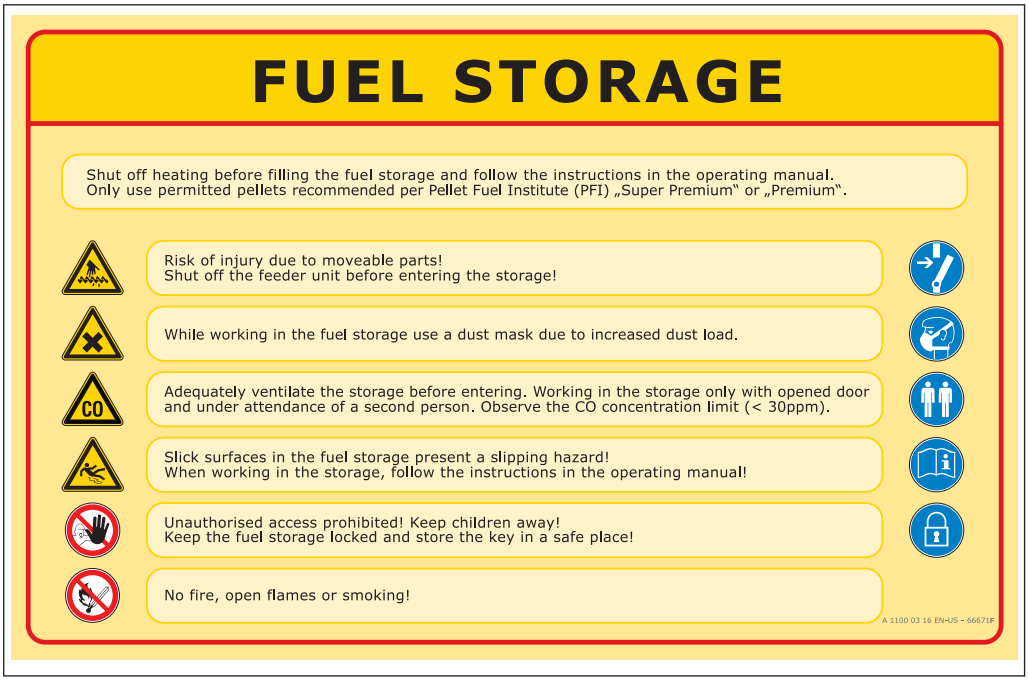
3.5.6 Sign on fuel store

The following signage is to be posted in the access area of the fuel store. It explains the correct fuel store procedures.



3.6 Residual risks

The system has been designed to the state of the art and in accordance with current safety requirements. There are, however, still some residual risks which require care and attention. The residual risks and consequential procedures and measures are listed below.

3.6.1 Basic risks

Incorrect operation

⚠ WARNING

Risk of injury from operating the system incorrectly!

❒ Modifications to the control system must only be undertaken in consultation with the manufacturer.

➥ Modifying parameters on the control system can cause malfunctions.

Noise

⚠ WARNING

Hearing loss from noise!

❒ Always wear hearing protection when working around the discharge system

➥ Depending on the discharge system and fuel, the noise level inside the discharge system can reach over 80 dB(A) during transportation of the fuel.

Risk of falling

WARNING

Risk of falling when working close to the boiler!

- ❒ When working on ladders, always ensure that the ladder is securely positioned on a firm and even surface.
- ❒ Always observe the relevant safety regulations when working with a hoist.
- ❒ Never step on the boiler.
  - ➥ Careless work on ladders or hoists during installation, maintenance and repair work can cause injury.

Working in the fuel store

WARNING

Risk of injury when carrying out work in the fuel store

- ❒ Switch the boiler off at the control system before entering the fuel store.
- ❒ Turn off the boiler's main switch.
- ❒ Never climb onto piles of fuel.
- ❒ For safety reasons never work in the fuel store alone. Take another person with you.
- ❒ Always wear personal protective equipment for work (protective clothing, safety shoes, protective gloves, dust mask, protective goggles).
- ❒ Also observe the information on the notice on the access door to the fuel store.
  - ➥ Piles of fuel are at risk of caving in if you stand on them when working in the fuel store. There is also a risk of poisoning due to an increased concentration of carbon monoxide in the air.

Dirt and objects lying around

CAUTION

Risk of injury from stumbling on dirt or objects lying around!

- ❒ Always keep the boiler room clean and tidy.
- ❒ Take any items no longer required out of the boiler room and, in particular, remove from ground level.
  - ➥ Dirt and objects lying around the boiler room constitute a risk of slipping and tripping. Falling can result in injury.

3.6.2 Risks from electricity

Electric current

DANGER

Risk of death from electrocution!

- ❒ Only allow licensed electricians to carry out electrical work to the electrical system.
- ❒ If the isolation gets damaged, switch off the power supply immediately and have it repaired.
- ❒ Prior to commencing work to active parts, shut off electrical systems and equipment so that they are no longer live and secure so that they remain off for the duration of the work. Follow the five safety rules:
  - Disconnect.
  - Secure against switching back on.
  - Check the system is no longer live.
  - Earth and short circuit.
  - Cover or shield any adjacent live parts.
- ❒ Never bypass or disable fuses. When replacing fuses, use the correct amperage.
- ❒ Always lay lines and cables far away from hot surfaces.
- ❒ Use shielded cables when using frequency converters.
- ❒ Ensure that the system is properly earthed with a protective earth system. Have all component assemblies checked at regular intervals to ensure the correct earthing.
- ❒ Keep moisture away from live parts. This can cause short circuits.
  - ➥ Touching live parts can cause immediate death by electrocution. Damage to the isolation or individual components can be perilous.

Static electricity from charge

CAUTION

Risk of injury from residual electrostatic potential!

- ❒ Always proceed with caution when working in the fuel storage room and wear personal protective equipment (protective clothing, safety shoes, protective gloves).
  - ➥ Electrostatic potential can build up when pellets are being blown in. Touching pellets in the fuel storage room can, therefore, result in injury.

3.6.3 Danger from movement of the system

Automatic start-up

WARNING

Risk of injury from automatic start-up!

- ❒ Before doing any work, switch the boiler off at the control system.
- ❒ Switch off the main switch and take precautions to prevent accidental switching on.
  - ➥ There is a risk of serious injury from the system starting up automatically if it is switched on during inspection and cleaning.

Screw movement

WARNING

Risk of injury from getting crushed, trapped and caught in moving screws!

- ❒ Never step onto the screws (if present) in the fuel store.
- ❒ Never reach into the transport screw of the fuel infeed or the ash discharge screws (if present) when they are running.
- ❒ Never bypass limit switches and fuses.
- ❒ Switch off the boiler at the control system and allow it to cool before carrying out work on the screws.
- ❒ Always wear personal protective equipment for work (protective clothing, safety shoes, protective gloves).
  - ➥ Moving screws can catch on parts of clothing or long hair and clamp or sever body parts, resulting in serious injury or death.

3.6.4 Danger from fire and explosion

Risk of fire and explosion

WARNING

Risk of fire and explosion around the boiler!

- ❒ DO NOT BURN GARBAGE, GASOLINE, NAPHTA, ENGINE OIL OR OTHER INAPPROPRIATE MATERIALS.
- ❒ DO NOT USE CHEMICALS OR FLUIDS TO START THE FIRE.
- ❒ DO NOT OPERATE WITH FLUE DRAFT EXCEEDING 0.10 INCHES WATER COLUMN (25 Pa).
- ❒ UNSAFE TO ADJUST FLUE DRAFT HIGHER THAN 0.10 INCHES WATER COLUMN (25 Pa).
- ❒ THE HEAT EXCHANGER, DRAFT INDUCER, FLUE PIPE, AND CHIMNEY MUST BE CLEANED REGULARLY TO REMOVE ACCUMULATED CREOSOTE AND ASH. ENSURE THAT THE HEAT EXCHANGER, FLUE PIPE, AND CHIMNEY ARE CLEANED AT THE END OF HEATING SEASON TO MINIMIZE CORROSION DURING THE SUMMER MONTHS. THE APPLIANCE, FLUE PIPE, AND CHIMNEY MUST BE IN GOOD CONDITION. THESE INSTRUCTIONS ALSO APPLY TO A DRAFT INDUCER IF USED.
- ❒ DO NOT INSTALL IN A MOBILE HOME.
- ❒ Keep covers on the boiler and the access doors to the fuel store closed during operation.
- ❒ Smoking, fire and open flames are not permitted in the fuel store and boiler room.
- ❒ Do not store flammable materials in the boiler room.
- ❒ Do not set flammable objects on the boiler to dry (e.g. clothing).
- ❒ Always ensure that the boiler room is adequately ventilated.
- ❒ Maintain and inspect the heating system at the prescribed intervals. Ensure that the chimney vent is cleaned regularly.
- ❒ Do not use any hydrogen halides or cleaning agents containing chlorine in the boiler room.
- ❒ Observe the safety signs around the system.
  - ➥ Using the boiler incorrectly can cause fire or explosions.

Fire protection

⚠ WARNING

Risk of injury from limited or incorrect firefighting!

- ❒ Ensure that all fire extinguishers provided are suitable for the fire class.
- ❒ Test that the fire extinguishers are fit for use every two years or in accordance with the regulations set out by the fire authorities.
- ❒ Refill the fire extinguisher after each use.
- ❒ Only use approved extinguishing agents and spare parts that match the prototype on the fire extinguisher.
- ❒ When using the fire extinguisher, follow the safety and operating instructions on it.
- ❒ Note the operating temperature range when using the extinguisher.
  - ➥ If, in the event of a fire, the fire extinguisher is not fit for use or unsuitable for the specific fire class, this can result in serious injuries or even death and significant damage to property.

Flue gas system

⚠ WARNING

Risk of injury and damage to property from obstructing the flue gas system!

- ❒ The chimney is only to be used as an outlet for one heating system.
- ❒ Optimum performance can only be guaranteed if the flue gas system is functioning correctly. It is, therefore, important to have the flue gas system cleaned regularly to ensure that the flue gas can escape properly.
- ❒ Arrange for the chimney sweep to check the chimney connection and chimney for tar oil deposits twice a month during the heating period.
  - ➥ Problems with the flue system, such as poor cleaning of the flue pipe or insufficient chimney escape can cause serious faults in combustion (such as spontaneous combustion of carbonization gases/explosion).

3.6.5 Danger from high temperatures

Hot surfaces

⚠ WARNING

Risk of injury from hot surfaces!

- ❒ FOR SAFETY REASONS, KEEP COVERS AND ASH PIT DOORS TIGHTLY CLOSED.
- ❒ Before carrying out any work on the boiler, switch it off at the control system (“Boiler OFF” status) and allow it to cool down.
- ❒ Protective gloves must usually be worn for work on the boiler. Only touch the boiler using the handles provided.
- ❒ Insulate the flue gas pipes and do not touch them during operation.
- ❒ Do not touch system parts and heating pipes during operation.
- ❒ Keep children and unauthorized persons away from the boiler and fuel store.
- ❒ Allow the boiler to cool before carrying out any maintenance work.
  - ➥ Touching hot surfaces on the boiler, on the flue gas pipe and on heating pipes can cause serious burns.

Hot media

WARNING

Risk of scalding from hot media!

- ❒ Temperature modifications in the control system must only be undertaken in consultation with the manufacturer.
- ❒ Do not touch heating pipes and consumer loads in the heating circuit (radiator etc.) during operation.
- ❒ Allow the system to cool before carrying out any maintenance work. Always wear protective gloves when working on the system.
- ❒ Keep children and unauthorized persons away from the heating system.
  - ➥ Heating pipes and consumer loads in the heating circuit can heat up considerably from the hot water. An incorrect setting in the control system means that the water obtained can be extremely hot. Contact with hot water or hot surfaces can cause scalding to skin.

Hot ashes

WARNING

Risk of injury from hot ashes!

- ❒ Always wear protective clothing and protective gloves when working on the system.
- ❒ Before handling ash, check whether or not it is still hot. Allow to cool if necessary.
  - ➥ Ash is extremely hot after the combustion process. Contact can cause serious burns.

3.6.6 Risks from flue gases, incorrect fuel and other equipment

Lubricants

WARNING

Risk of damage to health from lubricants!

- ❒ Always wear protective gloves when handling lubricants.
- ❒ Do not swallow, do not inhale fumes.
- ❒ If you accidentally get lubricant in your eyes, rinse thoroughly with plenty of water and seek medical advice if necessary.
- ❒ Following skin contact wash off thoroughly with plenty of soap and water.
- ❒ Observe the lubricant manufacturer’s safety data sheets.
  - ➥ Contact with lubricants can cause allergies and skin irritations.

Proposition 65

WARNING

CALIFORNIA Proposition 65

This product may contain chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Leaking flue gas

WARNING

Risk of poisoning from flue gases in the boiler room!

- ❒ If you smell flue gas keep all the doors on the boiler closed.
- ❒ Switch off the boiler under controlled conditions using the controller.
- ❒ Ventilate the boiler room.
- ❒ Close the fire door and doors to living areas.
  - ➥ Contact with flue gases can cause perilous situations.

Carbon monoxide

WARNING

Risk of poisoning from carbon monoxide in the fuel storage room!

- ❒ Ensure that there is adequate ventilation before entering the fuel storage room.
- ❒ For safety reasons never work in the fuel storage room alone. Take another person with you.
  - ➥ Carbon monoxide is an odorless gas and, therefore, goes unnoticed. Carbon monoxide can develop from storing pellets in the fuel storage room, and an increased carbon monoxide concentration in the air can pose a risk of poisoning.

Explosive dusts

WARNING

Risk of death from fire and explosion due to dispersed dust deposits!

- ❒ Do not smoke within or close to the danger zone. Do not work with any kind of naked flame, fire or ignition sources.
- ❒ Keep the danger zone free from dust. Dust deposits over 5 mm thick are not permitted and must be removed.
- ❒ Do not enter the fuel storage room whilst pellets are being blown in.
- ❒ Always wear protective clothing, protective goggles and breathing protection when working in the fuel storage room. Follow the manufacturer's instructions with regard to the requirements of the breathing protection.
- ❒ Stop work immediately in the event of a fire. Leave the danger zone until you get the all-clear and notify the fire brigade.
  - ➥ Dust deposits could catch fire or form an explosive compound if dispersed with the ambient air when blown into the fuel storage room. This can result in serious and even fatal injuries.

Incorrect fuel

WARNING

Risk of injury and damage to the boiler if the incorrect fuel is added.

- ❒ Only use fuel permitted by the boiler manufacturer.
- ❒ Only store permitted fuel in the fuel store.
- ❒ Never burn corn, cereal, coal, coke, garbage, painted or treated wood, bark, petrol, oil or other flammable liquids in the boiler.
- ❒ Never store fuel or other flammable materials in the boiler room.
- ❒ Never use chemicals, kerosene, charcoal, spirits or other flammable liquids to start or reignite the combustion process in the boiler.
  - ➥ Using the incorrect fuel can cause dangerous malfunctions or damage to the system or the discharge system.

3.7 What to do in the case of danger

What to do if the system overheats (at temperatures above 220°F (105°C))

⚠ WARNING

Risk of injury from switching the system off prematurely at the main switch!

❒ To switch the boiler off, switch off automatic mode using “Boiler OFF" at the control system. The boiler follows the controlled shutdown procedure via the control. The system must only be switched off at the main switch once the boiler has cooled down sufficiently.

➥ Switching off the main switch in automatic mode can cause major combustion faults leading to serious accidents.

If the boiler overheats, proceed as follows:

❒ Switch the boiler off at the control system.

❒ Keep all doors on the boiler and all covers closed.

❒ Open all mixing valves; switch on all pumps. The Froling heating circuit control takes on this function in automatic operation.

❒ Leave the boiler room and close the access door.

❒ Ensure that heat is being consumed. To do this, activate all consumer loads.

❒ Open any available radiator thermostat valves.

❒ Once the boiler temperature has fallen to 185°F (85°C), return the heating circuit to normal status.

If the temperature does not drop:

❒ Inform the installer or Froling customer service.

What to do in the event of a power failure

In the event of a power failure proceed as follows:

❒ Keep all the doors and covers on the boiler and on the fuel infeed closed

❒ The boiler controller will start again automatically after the restart.

➥ Half an hour after the boiler restart, compare the values in the controller and the values on the pressure gauges with the original values. If the pressure level is too low, add water to the heating system in accordance with the instructions of the heating installer.

In the event of excessive temperature the high-limit thermostat may have triggered. You may have to release this to allow the boiler to restart.

What to do if there is a smell of flue gas

If you smell flue gas, proceed as follows:

❒ Keep all doors on the boiler and all covers closed.

❒ Switch the boiler off at the control system.

❒ Ventilate the boiler room where the boiler is located.

❒ Close the fire door and doors to living areas.

What to do in the event of fire

In the event of a fire proceed as follows:

- ❒ Press the emergency stop button (if present).
- ❒ Keep all the doors and covers on the boiler and on the fuel infeed closed
- ❒ Leave the main switch on the control cabinet switched on.
- ❒ Close the fire door.
- ❒ Leave the boiler room and the building.
- ❒ Notify the fire brigade.

3.8 Staff requirements

Risk of injury from inadequate qualification of staff!

⚠ WARNING

Risk of injury from inadequate qualification of staff!

If unqualified staff work on the system, or are within the danger zone of the system, this creates hazards which could cause serious injuries and considerable damage to property.

- ❒ All such activities should be carried out only by suitably qualified staff.
- ❒ Keep unqualified staff away from danger zones.

Definition of staff qualifications

The staff qualifications listed here for the United States are based on the descriptions of professional qualifications in the Occupational Outlook Handbook 2011-12 edition of the United States Department of Labor, Bureau of Labor Statistics.

In this manual, staff qualifications for the various activity areas are named as follows:

Operator

The operator is the person who operates the heating system for commercial or economic purposes by himself or cedes use/application to a third party and bears the legal responsibility concerning the product for the protection of the user or third parties during the operation.

He has been trained by the manufacturers and the suppliers in dealing with the system and its components and can independently detect potential hazards and avoid the associated risks.

Froling customer service or an authorized partner

The Froling customer service or its authorized partner is able to perform the tasks assigned to it and recognize and avoid possible dangers thanks to its professional, product-related training, knowledge and experience as well as its knowledge of the relevant local regulations.

Heating system installer

The heating system installer has demonstrably received specific instructions by the manufacturer regarding the tasks entrusted to him and potential dangers associated with improper conduct. The heating system installer must have read and understood these instructions. The heating system installer must have undertaken training and have professional experience of at least one year in his field of application.

The skills of the heating system installer include:

- ❒ Understanding technical contexts
- ❒ Reading and understanding technical drawings and diagrams
- ❒ Installing system components
- ❒ Installing and connecting of heating lines
- ❒ Performing maintenance work
- ❒ Dismantling and repairing or replacing system components, if a problem occurs

Licensed electrician

Thanks to his training, knowledge, experiences and knowledge of relevant standards and provisions the licensed electrician is capable of performing the following tasks on electrical systems professionally and according to safety requirements:

- ❒ Planning and connecting electrical systems based on circuit and current flow diagrams
- ❒ Assembling pipes and connecting electric components
- ❒ Analyzing, measuring and testing electrical systems and functions
- ❒ Performing safety checks on electrical systems, components and devices
- ❒ Troubleshooting electrical systems

The licensed electrician is able to independently recognize and avoid hazards associated with these works.

Chimney sweep

The chimney sweep is able to perform the tasks assigned to him and recognize and avoid possible dangers thanks to his professional training, knowledge and experience as well as his knowledge of the relevant standards and regulations.

The skills of the chimney sweep include:

- ❒ Understanding technical contexts
- ❒ Reading and understanding technical drawings and diagrams
- ❒ Checking heating, flue gas and ventilation systems as well as fuel stores for proper operation and fire safety
- ❒ Cleaning heating plants, smoke ducts and ventilation systems
- ❒ Knowledge of provisions under building law and environmental protection law, as well as knowledge in the field of energy efficiency, fire protection and climate protection
- ❒ Performing seal checks

Basic requirements

Only persons expected to carry out their work reliably are admitted as staff member. Persons whose ability to react is influenced, e.g. by drugs, alcohol or medication, are not permitted.

When choosing staff, observe the applicable age and profession-specific regulations on site.

Unauthorized

⚠ WARNING

Risk of death for unauthorized persons due to hazards in the danger zone and work area!

- ❒ Keep unauthorized persons away from the danger zone and work area.
- ❒ In case of doubt, address the persons and direct them to leave the danger zone and work area.
- ❒ Suspend the work as long as there are unauthorized persons in the danger zone and work area.
  - ➥ Unauthorized persons that do not meet the requirements described here, do not know the dangers in the work area. Therefore, unauthorized persons are exposed to risk of serious injury and even death.

Instruction

The operator must regularly instruct the staff. For the purposes of traceability, you must create a training log containing the following at minimum:

- ❒ Date of training
- ❒ Name of the trainees
- ❒ Contents of the training
- ❒ Name of the instructor
- ❒ Signatures of the trainees and the instructor

3.9 Personal protective equipment

Personal protective equipment is used to protect persons from compromised health and safety at work.

During the various types of work to and with the system the staff must wear personal protective equipment which is set out separately in the individual sections of this manual.

Description of the personal protective equipment

The personal protective equipment is as follows:

Protective workwear:

Protective workwear is tight-fitting work clothing with low tear resistance, narrow sleeves and without any protruding parts.

Protective goggles

Protective goggles are used to protect the eyes from flying parts when cleaning the system.

Protective gloves

Protective gloves are used to protect the hands against friction, abrasion, puncture, or deeper injuries and contact with hot surfaces.

Safety shoes

Safety shoes protect feet from crushing and falling parts as well as from sliding on slippery surfaces.

Dust mask

The dust mask is used for protection against dust when cleaning the system and when working in the fuel store.

3.10 Replacement parts

Incorrect replacement parts

⚠ WARNING

Danger of injury when using incorrect replacement parts!

- ❒ Use only original Froling replacement parts or spare parts approved by Froling.
- ❒ In case of doubt, always contact our customer service.
  - ➥ Hazards for the staff can arise through the use of incorrect or faulty spare parts and cause damage, malfunction or total failure.

Spare parts can be obtained from the manufacturer or importer.

3.11 Environmental protection

NOTICE

Danger to the environment resulting from incorrect handling of environmentally hazardous substances!

- ❒ Always follow the instructions below when handling hazardous substances and their disposal.
- ❒ If hazardous substances are accidentally released into the environment, take appropriate measures immediately. In case of doubt, inform the competent authority about the damage and request that proper measures be taken.
  - ➥ Incorrect handling of environmentally hazardous substances, in particular incorrect disposal, can cause significant damage to the environment.

The following hazardous substances are used:

Ash

Ashes should be placed in a steel container with a tight-fitting lid. The closed container of ashes should be placed on a non-combustible floor on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have thoroughly cooled. For the disposal of ash from the heat exchanger, consult the local chimney sweep or waste disposal service of the municipality or province. Other waste should not be placed in this container.

Lubricants

Lubricants such as greases and oils contain poisonous substances. They must not be released into the environment. Disposal must be carried out by a specialist disposal company. Observe the manufacturer’s safety data sheet.

3.12 The operator's responsibilities

Operator

The operator is the person who operates the system for commercial or economic purposes by himself or cedes use to a third party and bears the legal responsibility concerning the product for the protection of the user, staff or third parties during the operation.

Operator duties

The system is used in the commercial sector. The system operator is therefore subject to the legal obligations for safety at work.

In addition to the safety instructions in this manual, the applicable regulations on safety, safety at work and environmental protection must be observed.

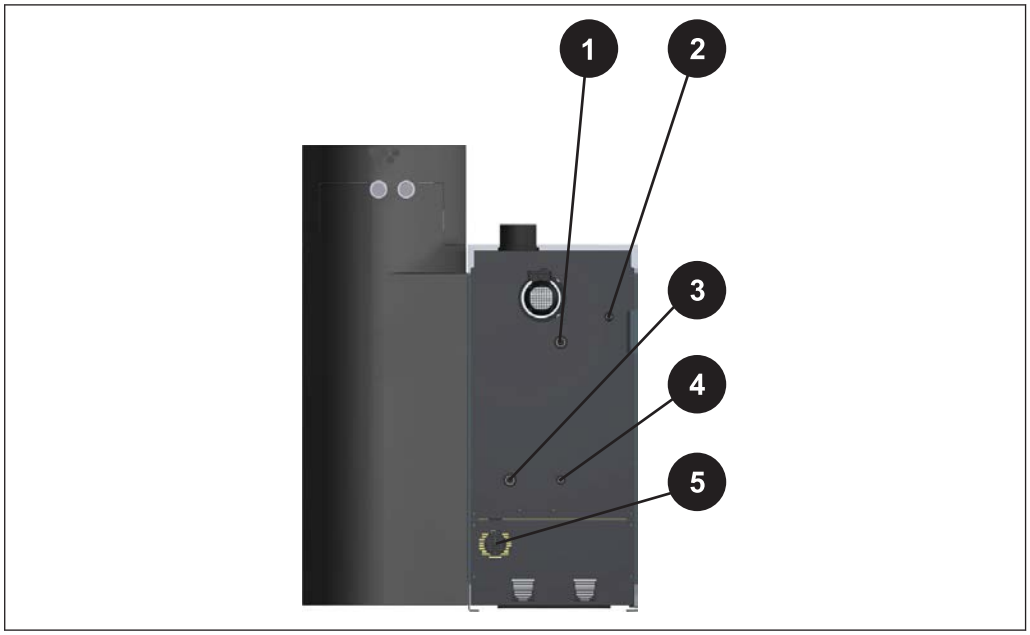
Therefore, in particular, the following applies:

- The "Occupational Safety and Health Act" of 1970 lays down that a safe workplace must be provided at all times during the execution of work.
- The operator must be aware of the applicable occupational safety regulations. Additionally, he must perform a risk assessment to determine hazards arising from special working conditions at the site where the system is used. He must implement these in the form of operating instructions for system operation.
- The operator must check throughout the entire period of use of the system whether the operating instructions created by him correspond to the current version of the regulations, and, if necessary, adjust them.
- The operator must clearly manage and determine the responsibilities for operation, troubleshooting, maintenance and cleaning.
- The operator must ensure that all persons who deal with the system have read and understood this manual. In addition, he must train the staff at regular intervals and inform them about possible dangers. Moreover, the operator must ensure that unauthorized persons do not get close to the system.
- The operator must provide the required protective equipment to staff and instruct them that it is obligatory to wear the necessary protective equipment.
- The operator must ensure that only fuels approved by the manufacturer are used.
- The operator must ensure that the prescribed safety tests are performed.
- The operator must ensure that the regulatory approval requirements are respected.
- The operator must ensure compliance with the requirements of the installation site and the safety measures when working in the fuel storage room.
- Furthermore, the operator is responsible for ensuring that the system is always in full working order. Therefore the following applies:
- The operator must ensure that the maintenance intervals described in these instructions are respected.
- The operator must ensure that the safety devices are regularly checked for proper functioning and completeness.

4 Description of the boiler

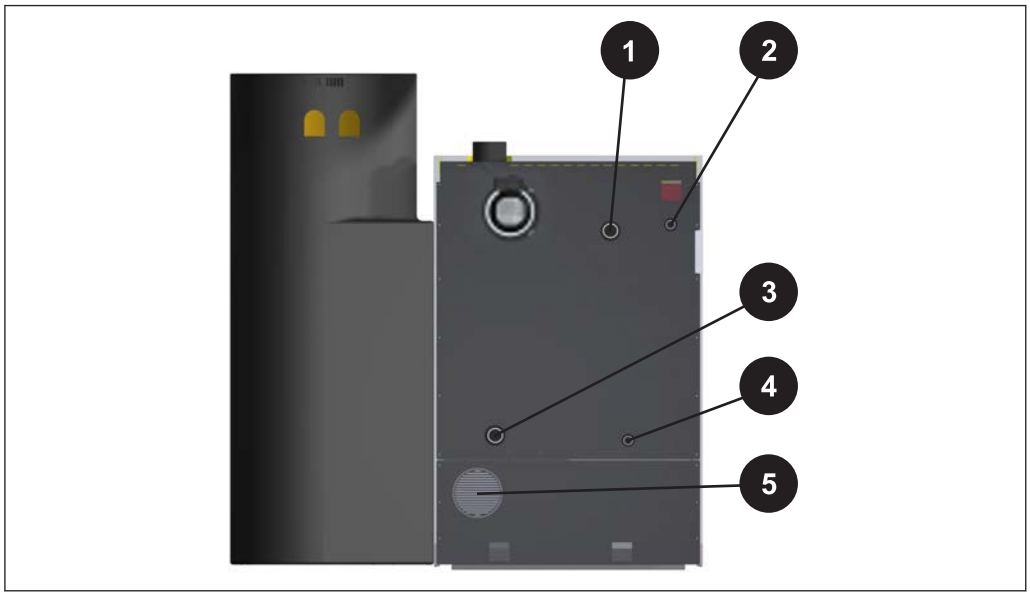
4.1 Back view

4.1.1 P4 Pellet 8-38



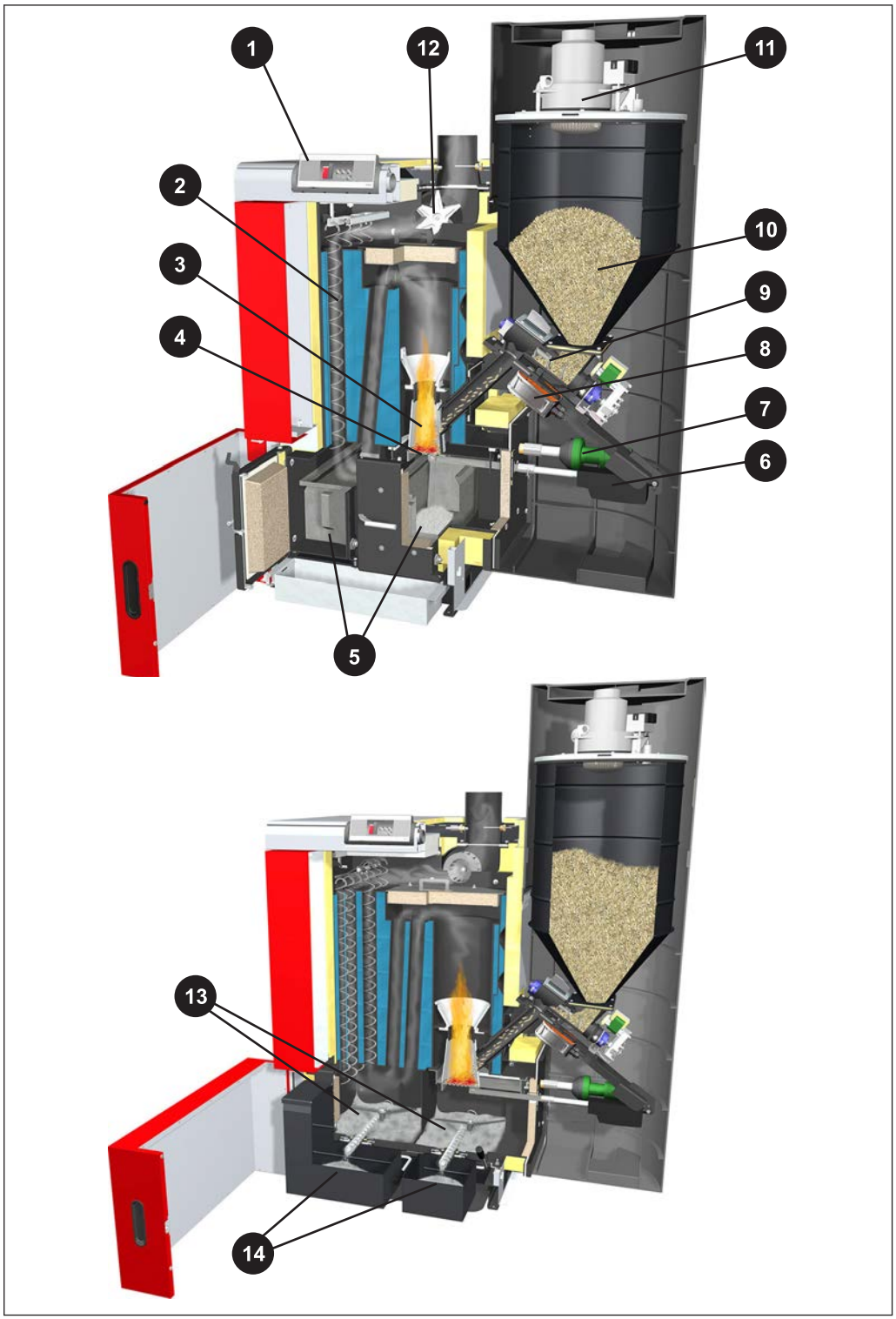
1	Boiler return connection
2	Air vent connection
3	Boiler flow connection
4	Drainage connection
5	Combustion air connection

4.1.2 P4 Pellet 48-100



1	Boiler flow connection
2	Air vent connection
3	Boiler return connection
4	Drainage connection
5	Combustion air connection

4.2 Width



1	Control panel of the Lambdatronic P 3200 Touch control
2	Heat exchanger with integrated spiral springs
3	Steel combustion chamber
4	Combustion grate
5	Comfort ash box (P4 Pellet 8 – 25)
6	Grate output
7	Hot air ignition
8	Burn back flap
9	Stoker screw
10	Hopper
11	Suction turbine
12	Speed-controlled induced draft fan
13	Ash chamber
14	Ash container (P4 Pellet 32-100)

4.3 Functional description

The P4 Pellet boiler is a non-catalytic hydronic heater that produces useful heat for heating space, heating process water and for heating potable hot water. The boiler uses premium wood pellets for fuel. Under specific test conditions this heater has been shown to deliver heat at rates ranging from 35,800 to 341,200 Btu/hr. This appliance meets the 2020 US Environmental Protection Agency´s wood pellets emissions limits for wood pellets heaters sold after May 15, 2020.

This pellets heater has a manufacturer-set minimum low burn rate that must not be altered. It is against federal regulations to alter this setting or otherwise operate this pellets heater in a manner inconsistent with operating instructions in this manual.

4.3.1 General operation

The pellets are transported by the suction turbine via the suction hoses from the fuel store into the large hopper. Either suction probes or pellet screws are used as a discharge system.

The pellets are transported to the downpipe with the stoker screw and fall in a metered quantity through the burn back flap onto the combustion grate of the sturdy steel combustion chamber. Hot air is added by the automatic ignition to ignite the pellets.

Together with the speed-controlled induced draft fan and the stoker screw, the broadband Lambda probe ensures optimum combustion.

Heat generated during combustion moves through the steel combustion chamber to the heat exchanger, where it is used for heating the hot water. Ash contained in the flue gas is deposited in the heat exchanger. An efficiency optimization system in the heat exchanger ensures automatic cleaning by means of turbulators (spiral springs) and the ash falls downwards. On the P4 Pellet 8 – 25 there is one comfort ashcan below the heat exchanger and one below the combustion grate. Starting with the P4 Pellet 32 model, the ash falls into the ash chamber, where it is transported via the ash screw into large ash containers.

4.3.2 Operating modes

Continuous load In the " Continuous load " mode, the boiler runs 24 hours a day and tries to maintain the boiler setpoint temperature set on the control system. The system is shut down for cleaning purposes only.

Automatic If the boiler is combined with a storage tank, the "Automatic" mode must be set. The storage tank is monitored by temperature sensors which are connected to the control system. The boiler only continues to run in automatic with the storage tank until the water in the storage tank is heated to a preset temperature.

If the "Automatic" mode is set even though there is no storage tank connected with the boiler, this operating mode is the same as "Continuous load"; in addition, however, a time period can be specified in which the boiler tries to maintain the set boiler setpoint temperature.

Domestic hot water The heating circuit controller is deactivated in the " Domestic hot water " mode; a cold storage tank, if present, is not part of the starting criteria for the boiler. A boiler start requires only a demand for hot water. When the set hot water temperature is achieved, the boiler shuts off again.

4.3.3 Approved fuels

Pellets

Use only wood pellets made of natural wood in accordance with the specifications of the PFI premium quality class like those of the Pellet Fuel Institute (PFI) Standard Specification for residential/commercial densified fuel.

Note on standards

US/CAN: Fuel acc. "Pellet Fuel Institute (PFI) Standard Specification for Residential / Commercial Densified Fuel": Fuel grade: “Super Premium” or “Premium”

EU: Fuel as per EN 17225 - Part 2: Wood pellets class A1 / D06

Fuel storage room

Before refilling the fuel storage room, check for pellet dust and clean if necessary

5 Transport, installation and commissioning

5.1 Safety

Transport as well as installation and commissioning are carried out exclusively by the manufacturer's employees or staff authorized by the manufacturer.

⚠ WARNING

Risk of death from incorrect transport and faulty installation and commissioning!

- ❒ Transport, installation and commissioning must be carried out exclusively by the manufacturer's employees or staff authorized by the manufacturer.
- ❒ Consult the manufacturer even in case of a subsequent change of location.
- ❒ Refrain from unauthorized transport, unauthorized installation and commissioning, as well as changes of location.
  - ➥ An error during transport and installation/commissioning can lead to perilous situations or cause substantial damage to property.

5.2 Conditions for commissioning

Staff:	❒ Operator
	❒ Froling customer service or an authorized partner
	❒ Chimney sweep
	❒ Licensed electrician
	❒ Heating system installer

The customer is responsible for ensuring the following prior to initial system start-up by Froling customer services:

- Electrical installation
- Installation of water pipes
- Connect flue gas pipes, including all insulation work
- Work must comply with local fire protection regulations

- It is essential that the electrician who carried out the installation work is available when starting up the system for the first time to make any changes to the wiring which may become necessary.
- During initial start-up, operating staff are shown how to use the boiler. This training is provided only once and the respective parties (e.g. operators) must be present for correct customer acceptance of the product.

NOTICE

Escaping condensation during the initial heat-up phase does not indicate a fault.

- ❒ Tip: If this occurs, clean it up with a cleaning rag.

6 Loading fuel

Working in the fuel storage room

⚠ WARNING

Risk of injury when carrying out work in the fuel storage room!

- ❒ Switch the boiler off at the boiler control system before entering the fuel storage room.
- ❒ Never climb onto piles of fuel.
- ❒ Ensure that there is adequate ventilation when entering the fuel storage room.
- ❒ For safety reasons never work in the fuel storage room alone. Take another person with you.
- ❒ Always wear personal protective equipment for work (protective clothing, safety shoes, protective gloves, dust mask, protective goggles).
- ❒ Also observe the information on the notice on the access door to the fuel storage room.
  - ➥ Piles of fuel (wood chips or pellets) are at risk of caving if you stand on them when working in the fuel storage room. There is also a risk of poisoning due to an increased concentration of carbon monoxide in the air.

⚠ CAUTION

Filling the fuel store when the boiler is switched on

Could result in damage and consequential injury!

When filling the fuel store:

- ❒ Switch off the boiler by tapping “Boiler OFF”.
  - ➥ The boiler follows the shutdown procedure and switches to "Boiler off" status.
- ❒ Allow the boiler to cool for at least half an hour.

After the boiler has cooled down:

- ❒ Before refilling the fuel store, check for pellet dust and clean if necessary.
- ❒ Close all openings to the fuel store to seal out dust.
- ❒ Fill the fuel store with pellets.
  - ➥ Only use permitted pellets!
    ⇨ See "Approved fuels" [page 46]

6.1 Notes on filling the fuel stores

When working in the fuel store:

Risk of injury due to moveable parts!
Shut off the feeder unit before entering the fuel store!

When cleaning the fuel store, an increased amount of dust may be generated. Wear a dust mask when working in the fuel store.

Adequately ventilate the fuel store before entering. Keep the door open and always have a second person present. Observe the CO concentration limit (< 30 ppm)!

Slick surfaces in the fuel store present a slipping hazard!

Unauthorized access prohibited! Keep children away!
Keep the fuel store locked and store the key in a safe place!

Fire, open flames, or smoking are prohibited inside the fuel store!

⚠ CAUTION

Filling the fuel store when the boiler is switched on

Could result in damage and consequential injury!

When filling the fuel store:

❒ Switch off the boiler by tapping “Boiler OFF”.

➥ The boiler follows the shutdown procedure and switches to "Boiler off" status.

❒ Allow the boiler to cool for at least half an hour.

When the boiler has cooled down:

❒ Before filling, check the store for fine particles and clean if necessary

❒ Close all openings to the store to seal out dust

❒ Fill the store with pellets

➥ Only use permitted pellets!

7 Heating the boiler

7.1 Safety instructions for heating

Incorrect operation

WARNING

Risk of injury due to incorrect operation! Incorrect operation can cause serious injuries and considerable property damage.

- ❒ Perform all operating steps according to the information and instructions in this manual.
- ❒ Only trained staff may carry out work to the system.
- ❒ Check the system externally for any visible damage or defects at least once a day.
- ❒ Before starting work, make sure that all covers and safety devices are installed and work properly.
- ❒ Never disable or bypass safety equipment during operation.
- ❒ Refrain from modifying the control software.

7.2 Switching on

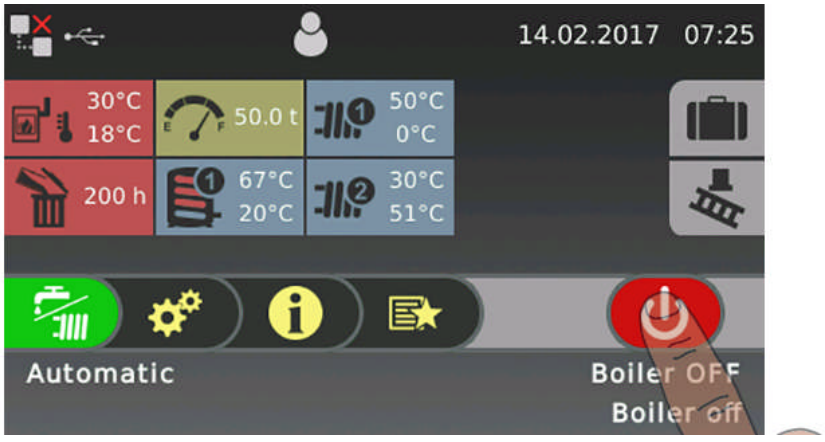
7.2.1 Turn on the main switch

Staff:	❒ Operator

- ❒ Switch on the main switch located under the upper insulating cover.
  - ➥ The control system boots and the basic display appears on the control panel.

7.2.2 Switch the boiler on at the control system.

Staff	❒ Operator



- ❒ Select the "ON/OFF symbol" in the basic display.

❒ Turn the boiler on using the "BOILER ON" command.
➥ Boiler is switched on. The boiler system is controlled according to the set operating mode and time period.

7.2.3 Operation via the control system

Safety instructions for the control system

Incorrect operation

⚠ WARNING

Risk of injury from operating the system incorrectly!

❒ Modifications to the control system must only be undertaken in consultation with the manufacturer.
➥ Modifying parameters on the control system can cause malfunctions.

⚠ WARNING

When turning off the main switch in automatic mode:

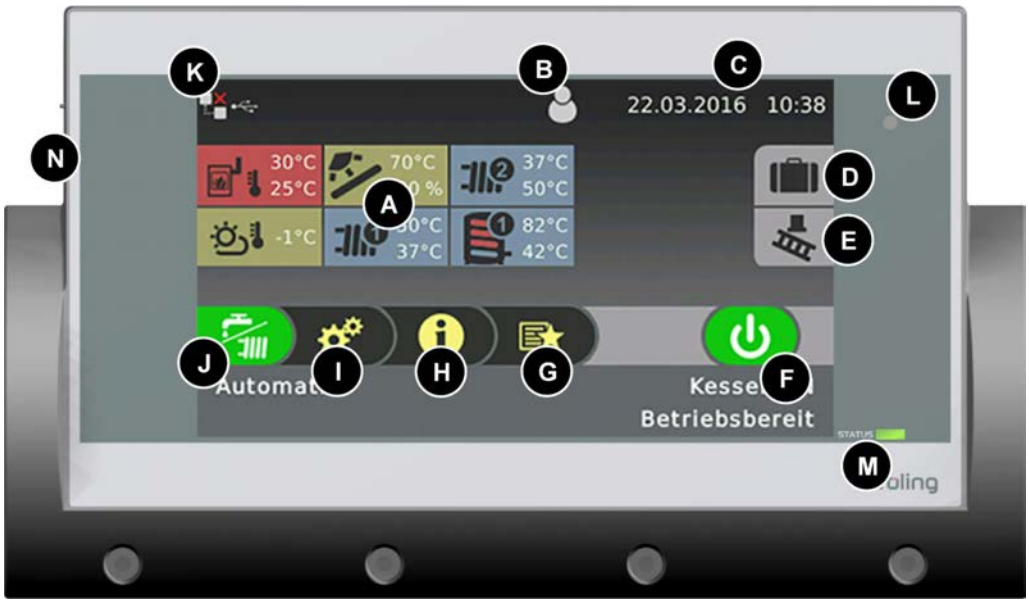
Serious combustion faults leading to serious accidents are possible.

Before turning off the main switch:

❒ Switch boiler off by tapping “Boiler OFF”.
➥ The boiler follows the shutdown procedure and switches to "Boiler off" status after the cleaning cycle.

Overview of the basic screen

Visual display



A	Display of up to six different menu informations (freely selectable)
B	Display and possibility to change user level
C	Date and time display
D	Holiday mode
E	Chimney sweep mode
F	Mode icon for switching the boiler on/off
G	Quick menu icon for viewing the available quick functions
H	Info menu icon for viewing all system information
I	System menu icon for opening the system settings. All parameters can be displayed/ edited depending on the user level
J	Display and possibility to change operation mode of boiler
K	Display icon for using froeling-connect
L	Brightness sensor for automatically adjusting the display brightness
M	Status LED for displaying the current operating status
N	USB port for connecting a USB stick for software updates

Status LED

The status LED shows the operating status of the system:

- GREEN flashing (interval: 5 sec OFF, 1 sec ON): Boiler off
- GREEN constant: **BOILER SWITCHED ON**
- ORANGE flashing: **WARNING**
- RED flashing: **FAULT**

Control icons

Cancel icon

Discards any values entered without saving and closes messages.

Confirm icon

Confirms any values entered and activates parameters.

Home icon

Tapping the Home icon takes you back to the basic display from any menu.

Info menu icon

To access all system information. The information is ordered in a circular buffer. The right and left arrows are used to switch between the individual pages.

Quick menu icon

Opens the quick menu. Various functions are available depending on the user level, system configuration and current status.

Pen icon

If a parameter has the pen symbol beside it, it means that the parameter can be adjusted. If you open the parameter, either the numeric keypad or a list box for changing the value of the parameter will appear.

System menu icon

Opens the system settings. Depending on the operating level and system configuration, the various menu items available are organized in a circular buffer which can be navigated using the right and left arrow.

Back icon

Takes you back up one menu level of the system menu. Can be used to return to the basic display.

Display icons

Depending on the selected settings and current status, additional icons may be shown in the upper left section of the display. Tapping the upper left display section takes the user to the “Connection Center”. Here the online portal “froeling-connect.com” can be activated or deactivated.

froeling-connect.com is not in use or was deactivated by the user.

Command server error; a connection with the froeling-connect.com server was not able to be established.

Connection with the froeling-connect.com server is being established.

froeling-connect.com is available.

Remote control of the boiler can also be activated or deactivated in the “Connection Center”. The prerequisite is that the parameter “`Remote control of the boiler can be activated`” is set to “YES” in the “`System selection`” menu under “`Boiler remote control`”.

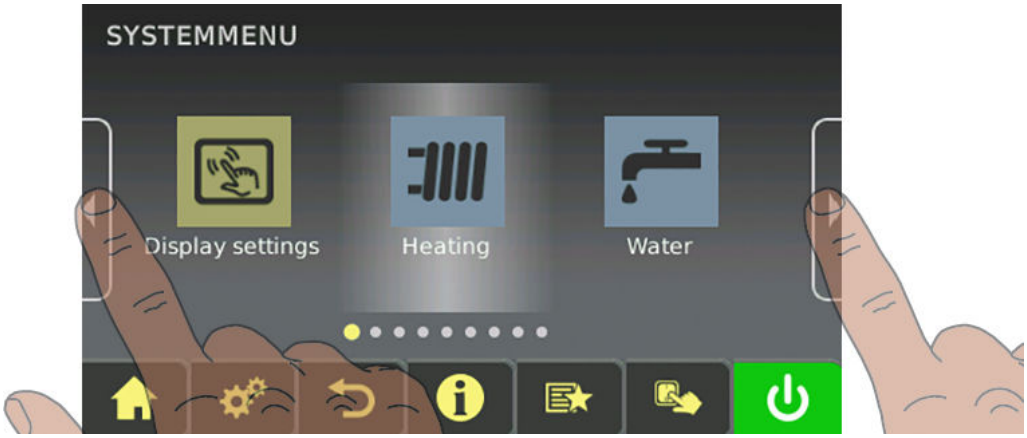
Remote control (switching the boiler on and off) by external operators via froeling-connect.com is permitted.

Remote control (switching the boiler on and off) by external operators via froeling-connect.com is not permitted.

Navigation

Navigation within the system menu

The system menu shows the menu items available depending on the user level and the system configuration. Tap the icon to open the corresponding menu item. The system menu is structured in a circular buffer, which can be navigated using the right and left arrows. The next time you open the system menu, the last page viewed will be displayed.



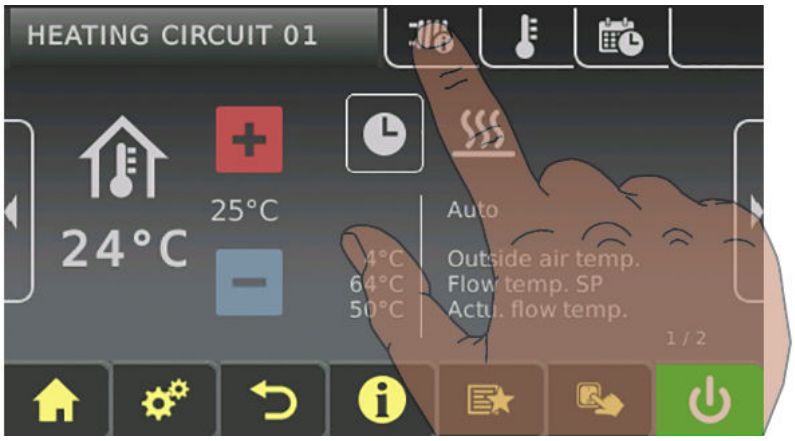
Navigating the menus

After you open a menu item, the corresponding status display with current values will appear. If, for example, several heating circuits are installed, you can use the right and left arrows to navigate to the desired heating circuit. You can open any other menu items available in the same way.

The individual menus are divided into tabs for quicker navigation.

❒ Tap on the desired tab

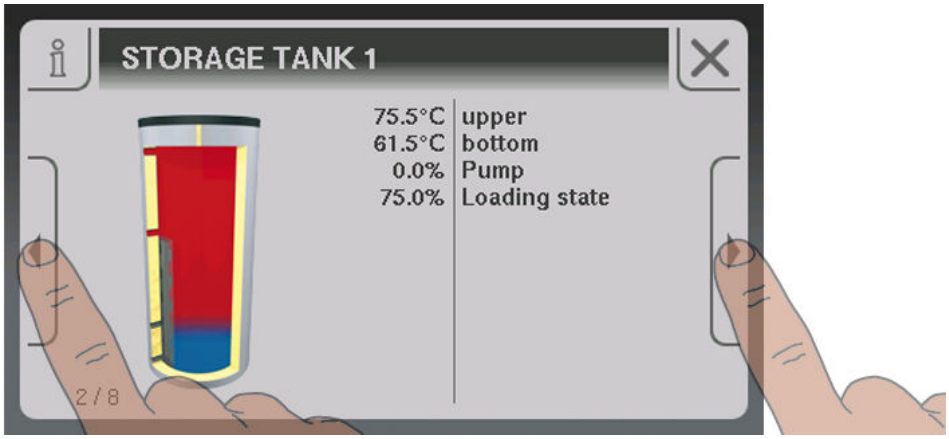
➥ The list of parameters for the selected area will appear



The parameter list shows three parameters. The up and down arrows can be used to scroll through longer lists of parameters. If you have reached the start or end of the parameter list, the relevant arrow symbol will become inactive.

Navigation within the info menu

The info menu displays all the information about the system. Use the right and left arrows to go to the individual menu items for the relevant information. The next time you open the info menu, the last page viewed will be displayed.



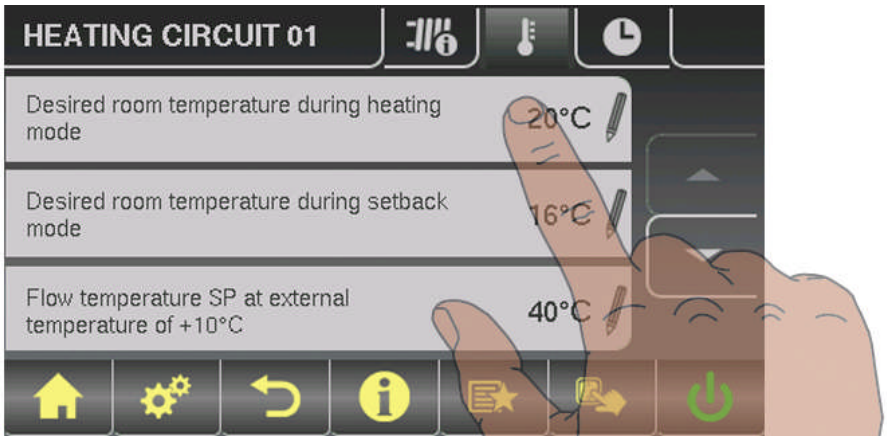
Procedure for changing parameters

Select the parameter

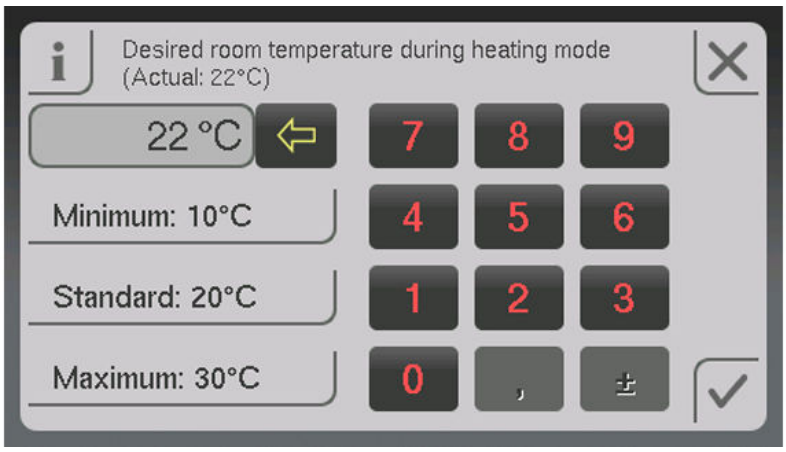
Staff:	❒ Operator

It is only possible to edit parameters if there is a "pen icon" beside the parameter value.

❒ Select the desired parameter



➥ The selected parameter will open for editing.



Adjusting parameters

There are different ways of entering values depending on the type of parameter:

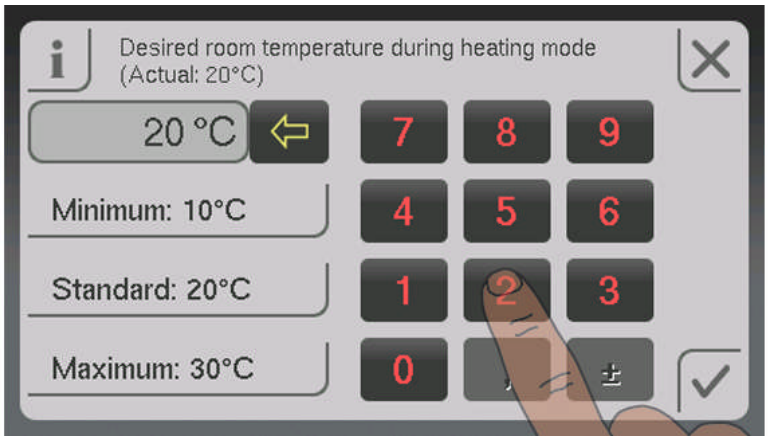
- Enter the value using the numeric keypad.
- Predefined value.
- Select the parameter value from a list box.

In each case, you need to tap the confirm icon to save the entry.

Enter the value using the numeric keypad.

Staff: ❒ Operator

If a numeric keypad appears beside the parameter in the display field, you can enter the value directly.

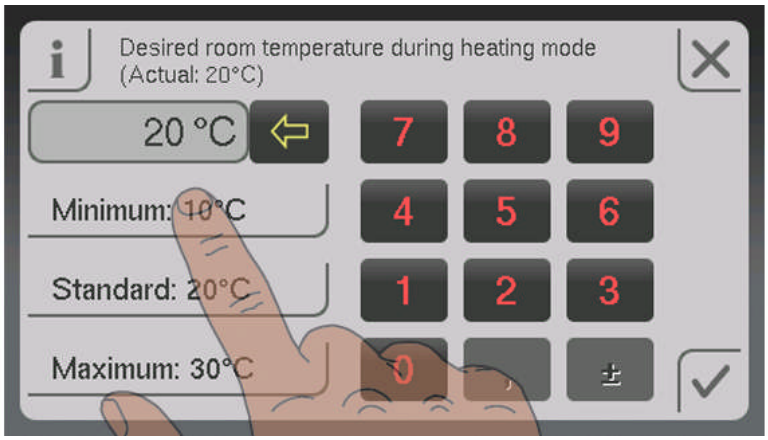


❒ Type in the relevant value on the numeric keypad.
❒ Save your entry by tapping the *"confirm icon"*.

Selecting a predefined value

Staff: ❒ Operator

Below the parameter value, predefined values ("Minimum, "Standard" and "Maximum") are shown as buttons.

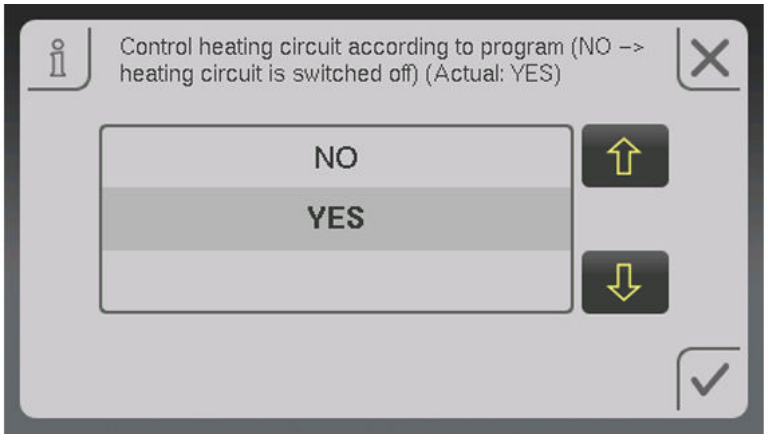


❒ Tap the desired predefined value.
↪ The parameter value is accepted in the value box.
❒ Save your entry by tapping the *"confirm icon"*.

Selecting a parameter value from the list box

Staff:	❒ Operator

Depending on the parameter type, values must be selected from a list box.

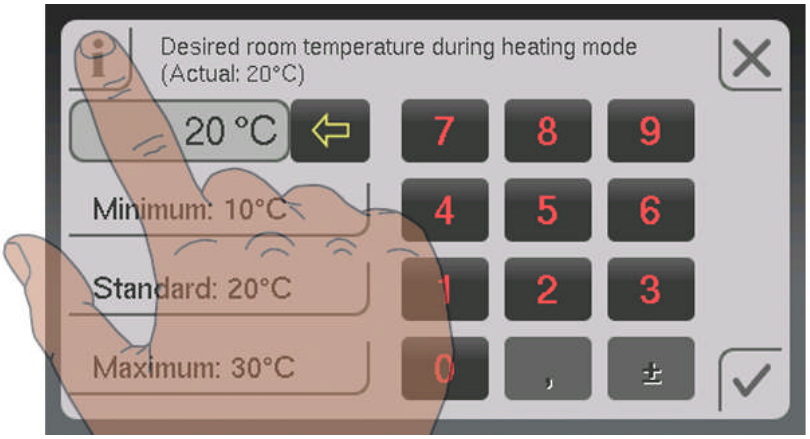


❒ Select the desired value in the list box.
❒ Save your entry by tapping the *"confirm icon"*.

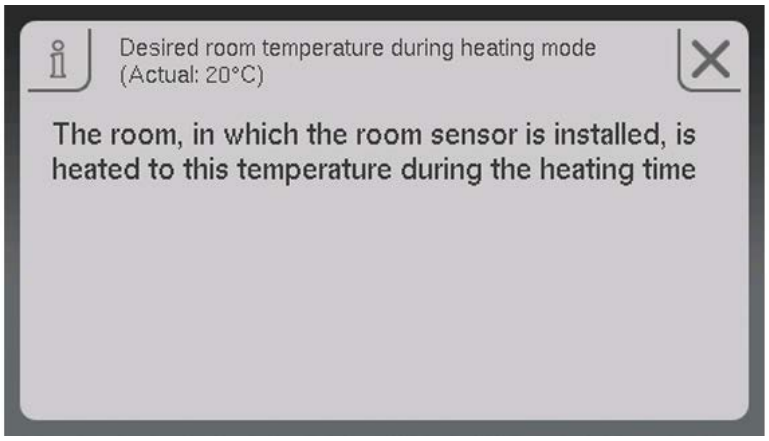
Displaying parameter info

Staff: ❒ Operator

❒ Tap the *"Info icon"* in the parameter view.



➥ The info view opens.

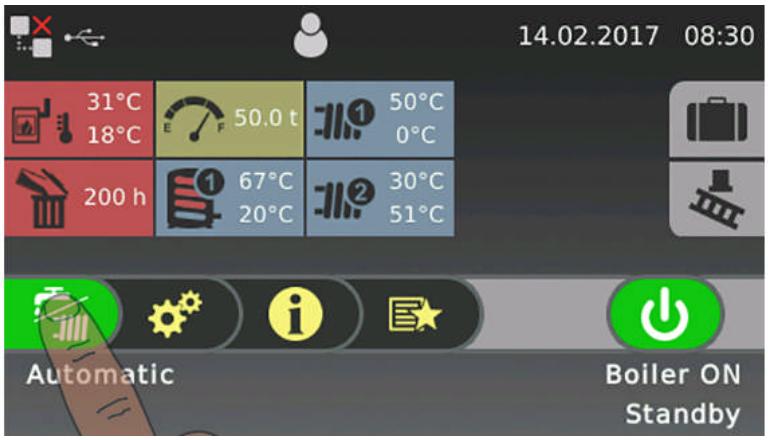


The info view shows a description of the parameter in continuous text.

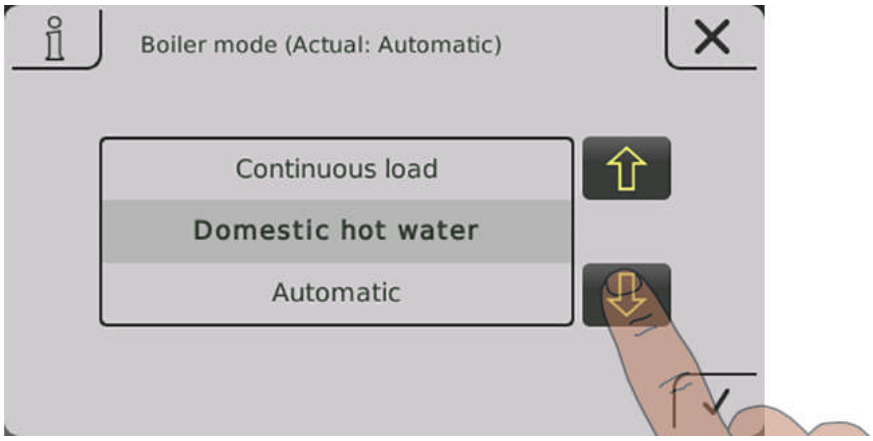
Setting the operating mode

Staff:	❒ Operator

❒ Tap the *"operating mode icon"* In the basic display.



❒ Select the desired operating mode in the list box.

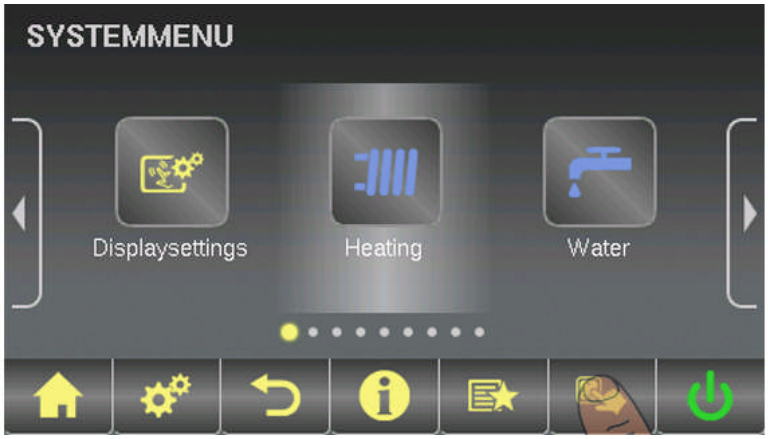


❒ Save your entry by tapping the *"confirm icon"*.

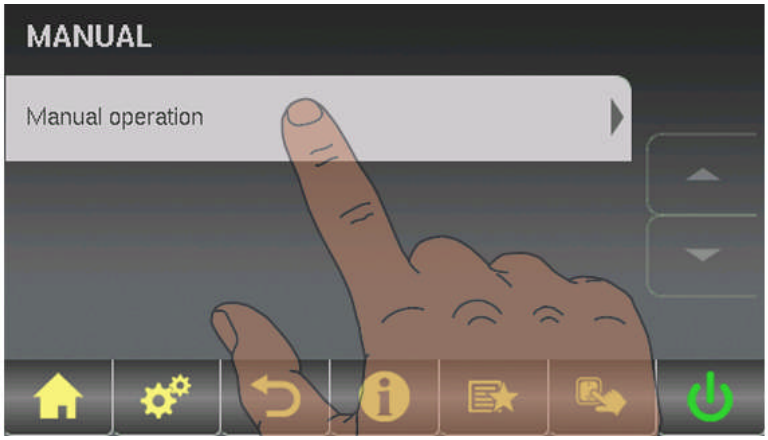
Activating manual operation

Staff: ❒ Operator

No matter where you are in the menu, you can open the "Manual" menu from an icon in the bottom menu bar.

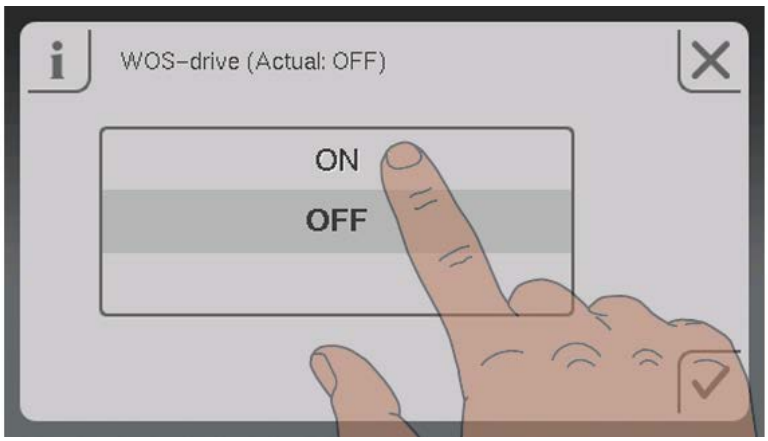


❒ Call up the "Manual" menu.



❒ In the "Manual" menu, call up the "Manual operation" submenu.

❒ Navigate to the desired function using the *"up arrow"* or *"down arrow"* and tap the function to call it.



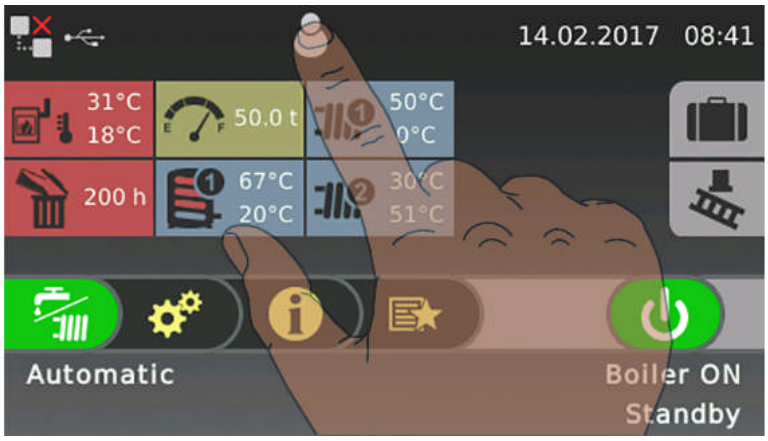
❒ Tap *"ON"* to activate the function.

➥ The drive is configured to the specified value set in the respective menu. The function will remain active until the process is ended by tapping *"OFF"* or the "Manual" menu is closed.

Switching user level

Staff:	❒ Operator

❒ Tap the *"user level icon"* in the basic display.



❒ Enter the user code using the numeric keypad and confirm by tapping the *"Confirm icon"*.

Once you have entered and confirmed the relevant user code, the number of functions available will vary. The “installer" and “service" user levels are also shown on the basic display above the quick menu icon.

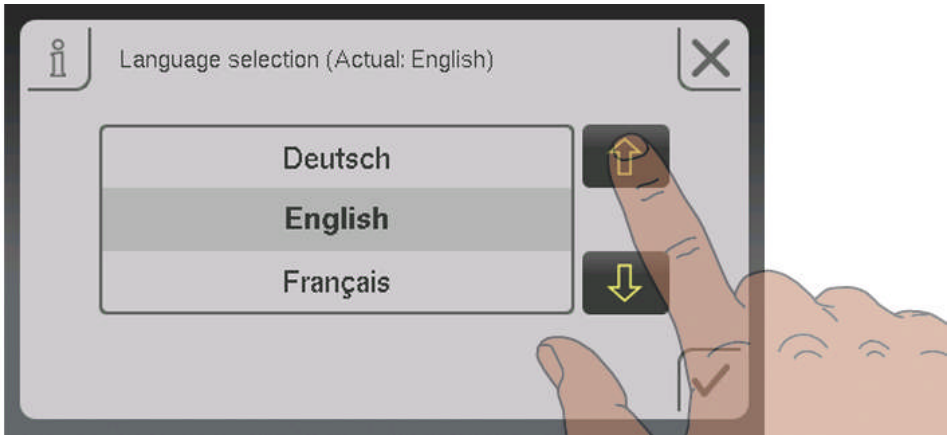
Operating level	Description
Child lock (Code 0)	At “Child lock” level, only the “Status” menu appears. It is not possible to change parameters at this level.
Customer (Code 1)	Standard level for normal operation of the touch display. All customer-specific parameters are displayed and can be changed.
Installer / Service	Releases parameters to adjust the controller to the system components (if configured).

Changing the language

Staff: ❒ Operator

❒ Tap the *"Quick menu icon"* in the basic display.

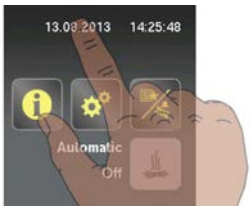
❒ Navigate to the language icon using the *"left arrow"* or *"right arrow"*.
❒ Select the language menu using the *"language icon"*.



❒ Select the desired language using the *"up arrow"* or *"down arrow"*.
❒ Confirm your setting by tapping the *"Confirm icon"*.

Setting the date/time

❒ To set / adjust the date and time displayed, tap on the date/time at the top right of the basic display.



❒ A menu will then appear allowing you to adjust the date and time. To apply the new values you need to confirm the date and time by tapping the “confirm” icon.

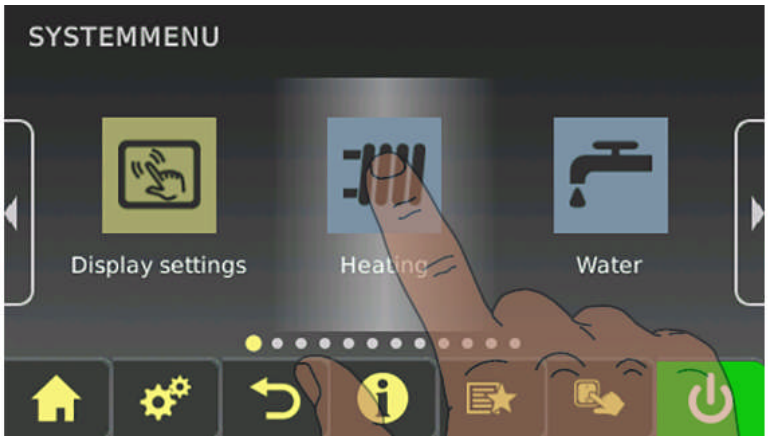
Setting heating times

The desired time window for the component can be set in the "Times" tab in the individual menus of the heating components (e.g. heating). The structure of the time menu and the procedure for changing the times are always the same.

Staff: ❒ Operator

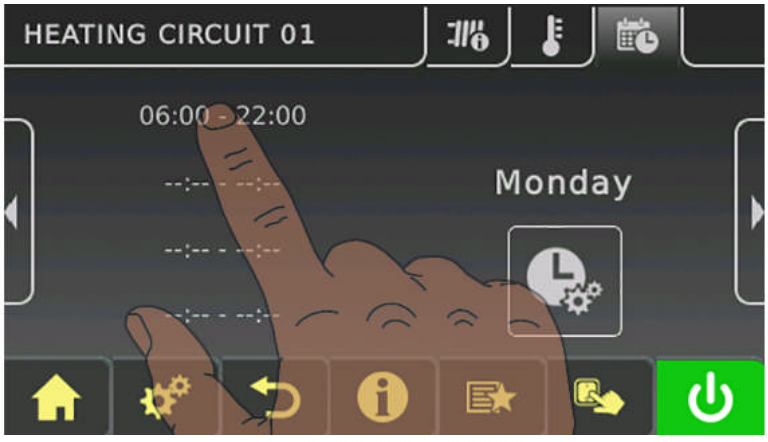
❒ Select the *"System menu icon"* in the basic display.

❒ In the system menu, select *"Heating"*.

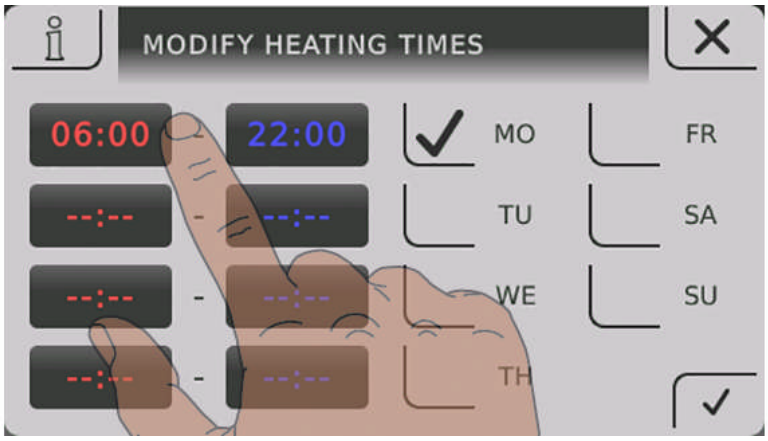


❒ Select the *"Times"* tab in the *"Heating"* window.

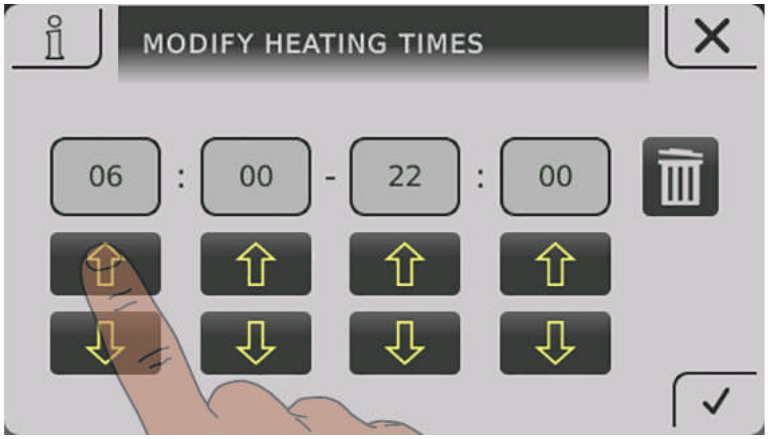
❒ Navigate to the desired day of the week using the *"right arrow"* or *"left arrow"* and tap the time period to edit.



❒ Tap the relevant time window with a maximum of four times.
➥ An editing window will appear.



❒ Set the start and end time for the time window using the *"up arrow"* and *"down arrow"*.
➥ The hours and minutes are set separately for each time.



❒ Apply the set time window by tapping the *"Confirm icon"*.

Applying the time setting for several days

The heating times set for one certain day can be applied to several days:

❒ Tap the desired day with the set heating times and tap the *"confirm icon"* to transfer it to additional days.

Changing the hot water temperature

The desired temperature for the component can be set in the "Temperatures" tab in the individual menus of the heating components (e.g. DHW tank). The structure of the menu and the procedure for changing the temperature are always the same.

Staff:	❒ Operator

Hot media

WARNING

Risk of scalding from hot media!

❒ Temperature modifications in the control system must only be undertaken in consultation with the manufacturer.

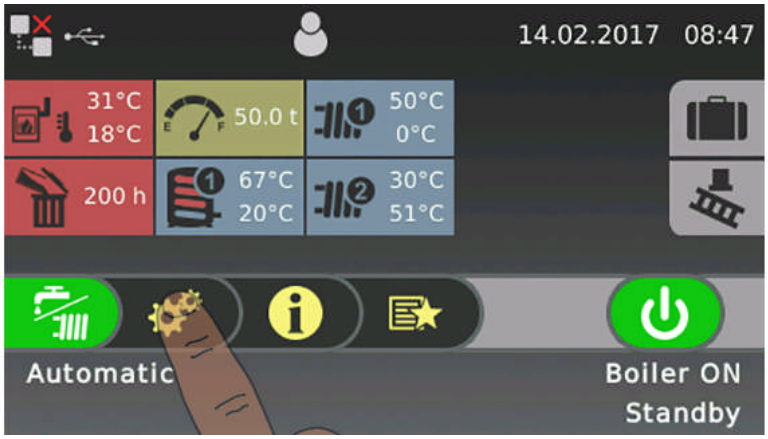
❒ Do not touch heating pipes and consumer loads in the heating circuit (radiator etc.) during operation.

❒ Allow the system to cool before carrying out any maintenance work. Always wear protective gloves when working on the system.

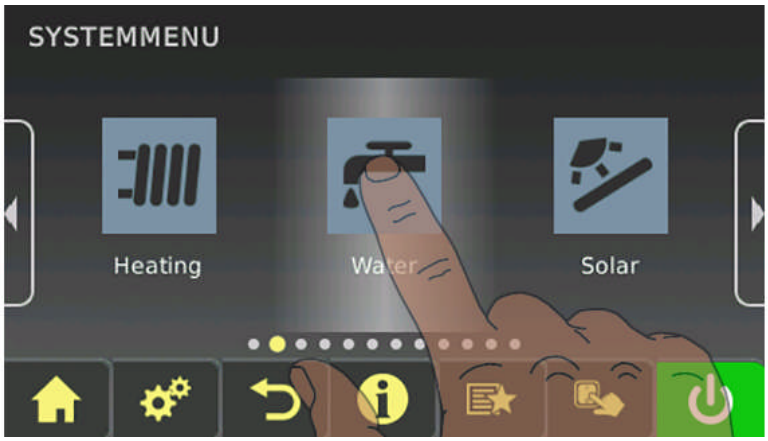
❒ Keep children and unauthorized persons away from the heating system.

➥ Heating pipes and consumer loads in the heating circuit can heat up considerably from the hot water. An incorrect setting in the control system means that the water obtained can be extremely hot. Contact with hot water or hot surfaces can cause scalding to skin.

❒ Select the *"System menu icon"* in the basic display.



❒ In the system menu, select *"Water"*.



❒ Select the *"Temperatures"* tab in the *"Water"* window.

Editable parameters are marked with the "pencil icon".

❒ Select the *"DHW setpoint"* parameter.

➥ The detailed view of the selected parameter will open.

❒ Set parameters.
❒ Save your entry with the *“confirm icon"*.

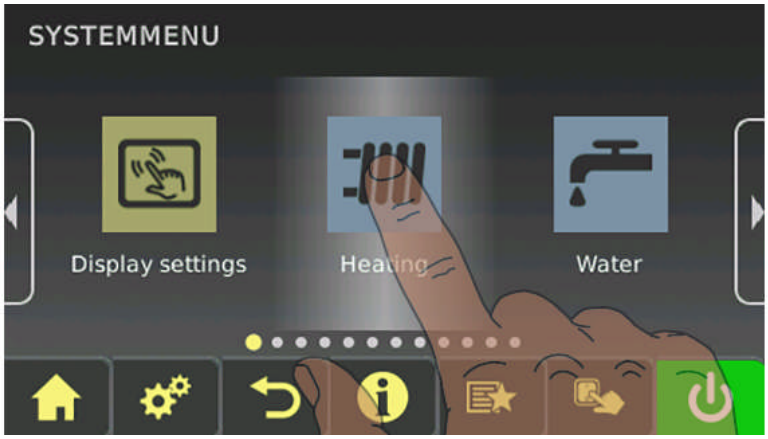
Changing the heating circuit temperatures

The desired time window for the component can be set in the "Times" tab in the individual menus of the heating components (e.g. heating). The structure of the time menu and the procedure for changing the times are always the same.

Staff: ❒ Operator

❒ Select the *"System menu icon"* in the basic display.

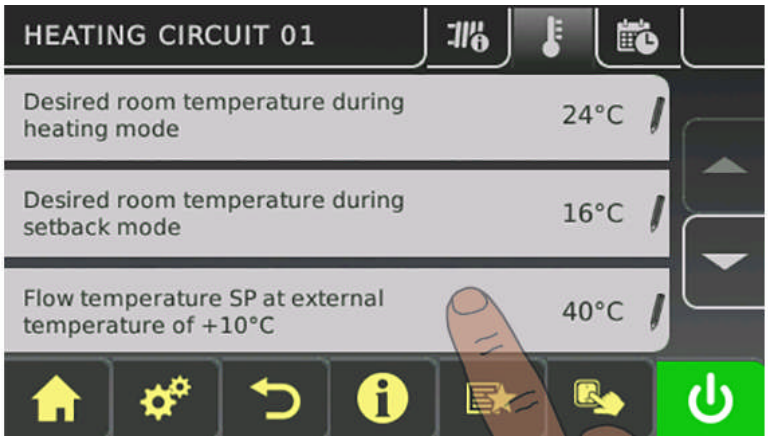
❒ In the system menu, select *"Heating"*.



❒ Select the *"Temperatures"* tab in the *"Heating"* window.

Editable parameters are marked with the "pencil icon".

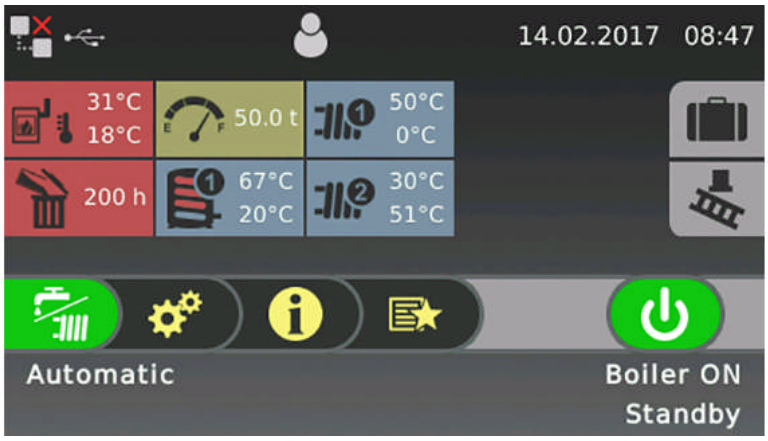
❒ Select the desired parameter.
➥ The detailed view of the selected parameter will open.



❒ Set the parameter by using the arrow keys, the numeric keypad or the specified values.
❒ Confirm the set temperature by tapping the *"Confirm icon"*.

Requesting statuses

Staff: ❒ Operator



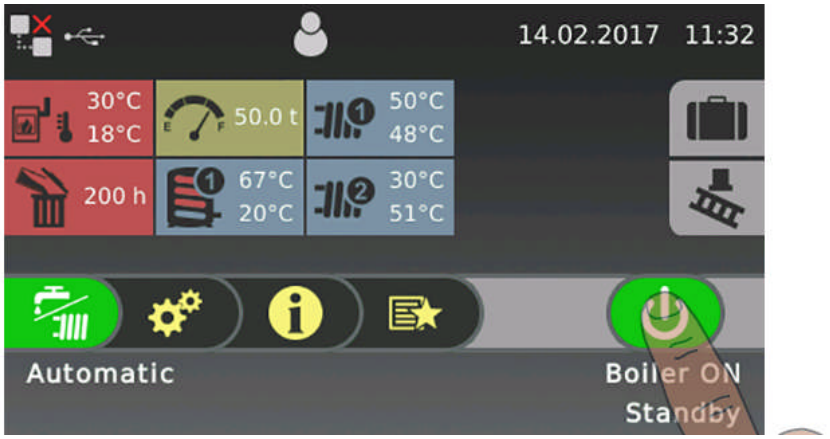
❒ Open the basic display on the control.

The current mode and the current operating status are displayed in the basic display of the control system. The current status will show on the display depending on the operation that the boiler is currently performing. In this example, the boiler is in automatic mode and ready for use.

7.2.4 Switching off

Switch the boiler off using the control system.

Staff:	❒ Operator



❒ Select the *"ON/OFF symbol"* in the basic display.

❒ Switch the boiler off via *"BOILER OFF"*.

➥ The control system shuts down the boiler according to procedure. After the shut down procedure, the boiler switches to "Switched off - Boiler off" status. The control system controls the connected heating system. All parts of the boiler are deactivated. The chamber discharge unit and the entire hydraulic system remain active.

Turning off the main switch

Staff:	❒ Operator

❒ Switch off the boiler via the *"ON/OFF icon"* by tapping *"Boiler OFF"* on the basic display of the control system.

➥ The boiler is shut down according to procedure and starts with the cleaning cycle.

❒ Allow the boiler to cool sufficiently.

❒ Switch off the main switch located under the upper insulating cover.

➥ The power of the system is switched off.

➥ **NOTICE! Risk of frost! When the main switch is off, the frost protection function is no longer active!**

7.2.5 Emptying the ash container

The ash drawers (P4 Pellet 8-25) or ash container (P4 Pellet 32) must be emptied at intervals according to energy requirements and pellet quality.

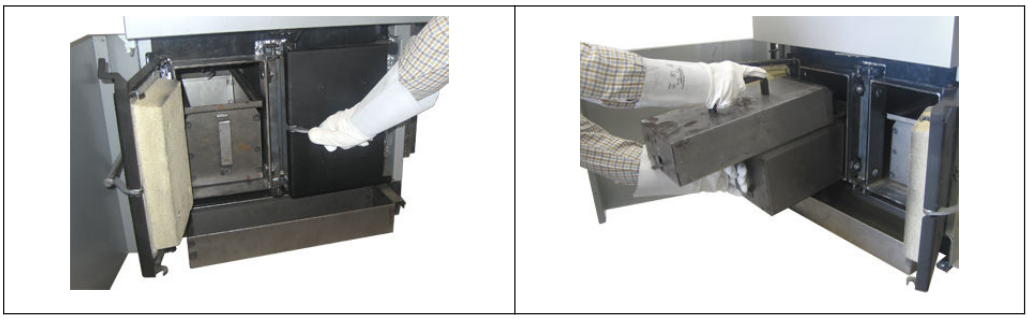
Hot ashes

⚠ WARNING

Risk of injury from hot ashes!

- ❒ Always wear protective clothing and protective gloves when working on the system.
- ❒ Before handling ash, check whether or not it is still hot. Allow to cool if necessary.
  - ➥ Ash is extremely hot after the combustion process. Contact can cause serious burns.

Emptying the ash container (P4 Pellet 8-25)



- ❒ Open the insulated door and position the ash drawer below the ash doors to catch any ash that might overflow.
- ❒ Open ash doors.

- ❒ Pull the ash drawer out slightly.
  - ➥ This pushes the ash lying in front of the drawer into the ash bowl.
- ❒ Put the transport cover on as illustrated and pull out the ash drawer until the transport cover engages.

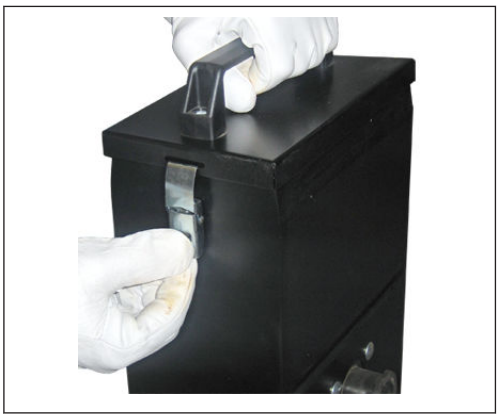
- ❒ Take the ashcan to the emptying point and empty it.
  - ➥ Push up the locking lever to remove the transport cover!

NOTICE

Ashes should be placed in a metal container with a tight-fitting lid. The closed container of ashes should be placed on a noncombustible floor or on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have thoroughly cooled. Other waste shall not be placed in this container.

Emptying the ash container (starting with P4 Pellet 32)

❒ Open the insulated door and push the locking lever up.
❒ Pull out the ash container and put the cover plate provided onto the flange of the ash container.



❒ Take the ash container to the emptying point and empty it.
➥ To remove the cover, the clamp must be unlocked and opened.

8 Maintaining the boiler

8.1 Safety instructions for maintenance

Automatic start-up

WARNING

Risk of injury from automatic start-up!

- ❒ Before doing any work, switch the boiler off at the control system.
- ❒ Switch off the main switch and take precautions to prevent accidental switching on.
  - ➥ There is a risk of serious injury from the system starting up automatically if it is switched on during inspection and cleaning.

Risk of injury due to improperly performed maintenance work!

WARNING

Risk of injury due to improperly performed maintenance work!

- ❒ Before starting any work, switch the boiler off using the control system. Allow the boiler to cool sufficiently. Once the boiler has cooled down, switch off the main switch and take precautions to prevent accidental switching on.
- ❒ Only operate the boiler using the handles provided.
- ❒ Perform all inspection and cleaning work to the boiler in the proper way.
- ❒ Pay attention to order and cleanliness in the boiler room.
- ❒ Any maintenance work not permitted for the operator must be carried out exclusively by Froling customer service or an authorized partner.
- ❒ Always wear personal protective equipment for work (protective clothing, safety shoes, protective gloves, dust mask, protective goggles).
- ❒ Before starting up again, make sure that there is no-one in the danger zone and that all covers and safety devices are installed and work properly.
- ❒ THE HEAT EXCHANGER, DRAFT INDUCER, FLUE PIPE, AND CHIMNEY MUST BE CLEANED REGULARLY TO REMOVE ACCUMULATED CREOSOTE AND ASH. ENSURE THAT THE HEAT EXCHANGER, FLUE PIPE, AND CHIMNEY ARE CLEANED AT THE END OF HEATING SEASON TO MINIMIZE CORROSION DURING THE SUMMER MONTHS. THE APPLIANCE, FLUE PIPE, AND CHIMNEY MUST BE IN GOOD CONDITION. THESE INSTRUCTIONS ALSO APPLY TO A DRAFT INDUCER IF USED.
  - ➥ Incorrect or insufficient inspection and cleaning of the boiler can cause serious faults in combustion (e.g. spontaneous combustion of carbonization gases or explosion) and this can lead to serious accidents and damage.

8.2 Maintenance schedule

Interval	Maintenance work	Staff
Every 100 operating hours	Visually inspect the system	Operator
	Check that safety equipment is functioning properly	Operator
Twice a month during the heating period	Remove soot, anthracene oil and ash deposits from the chimney connection and chimney	Chimney sweep
After every operating period of 2000 hours or once a year	Check the grate and combustion chamber	Froling customer service or an authorized partner
	Check the downpipe for dirt (P4 Pellet 48 and up)	Froling customer service or an authorized partner
	Cleaning the flue gas collection chamber and the heat exchanger	Froling customer service or an authorized partner
	Clean WOS	Froling customer service or an authorized partner
	Clean the induced draft fan	Froling customer service or an authorized partner
	Clean the flue gas temperature sensor	Froling customer service or an authorized partner
	Clean the broadband probe	Froling customer service or an authorized partner

8.3 Maintenance work

8.3.1 Carrying out a visual inspection

Staff:	❒ Operator
Protective equipment:	❒ Protective workwear ❒ Protective gloves ❒ Safety shoes

The operator must check the system at regular intervals. If you detect a damage, contact Froling customer service or an authorized partner immediately.

❒ Check the quantity of fuel in the fuel store.

❒ Check the fuel supply to the boiler.

❒ Visually inspect the seal on the boiler's geared motors.

There should be no significant leakage of lubricant. The presence of a few drops of lubricant may be normal. If a significant quantity of lubricant is leaking, immediately inform the heating system installer, Froling customer service or an authorized partner.

8.3.2 Checking the safety equipment

Staff:	❒ Operator
Protective equipment:	❒ Protective workwear ❒ Protective gloves ❒ Safety shoes

Emergency stop button

❒ Check the emergency-stop button for proper function (if present).

STL (high-limit thermostat)

❒ Check the high-limit thermostat.

Safety valve

❒ Check the safety valve in the heating circuit.

System pressure

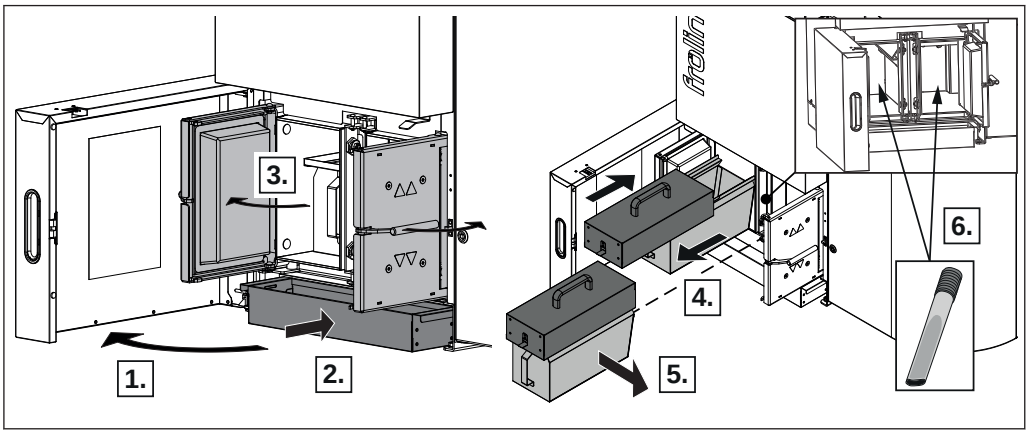
❒ Check the system pressure on the pressure gauge.

Check that the position of the pressure gauge and rated pressure of the expansion tank match your heating system installer's specifications.

❒ If the system pressure is low, the heating system installer must refill water and check the heating system for leaks.

❒ In case of large pressure fluctuations, ask the heating system installer to inspect the expansion tank.

8.3.3 Emptying the ash drawers (for P4 Pellet 8-25)



❒ Open the insulated door and position the ash drawer below the ash doors to catch any ash that might overflow

❒ Open ash doors

❒ Pull the ash drawer out slightly

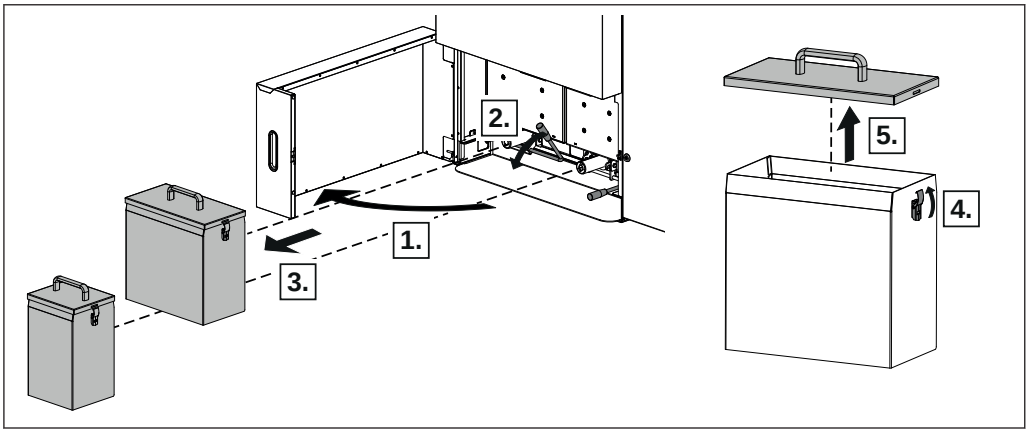
➥ This pushes the ash lying in front of the drawer into the ash bowl

❒ Put the transport cover on as illustrated and pull out the ash drawer until the transport cover engages

❒ Take the ashcan to the emptying point and empty it

➥ Push up the locking lever to remove the transport cover.

8.3.4 Emptying the ash container (for P4 Pellet 32-105)



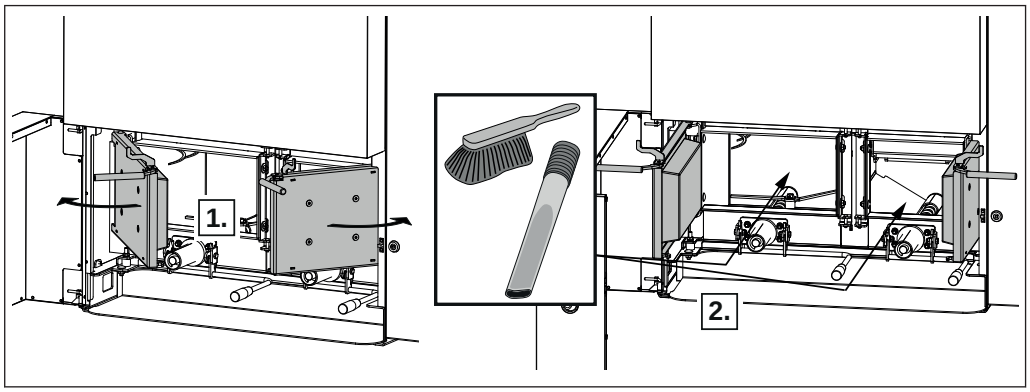
❒ Open the insulated door and push the locking lever up

❒ Pull out the ash container and put the cover plate provided onto the flange of the ash container

❒ Take the ash container to the emptying point and empty it

➥ To remove the cover the clamp must be unlocked and opened

8.3.5 Check the grate and combustion chamber



NOTICE! Only clean the grate and combustion chamber when the boiler has cooled down!

For P4 Pellet 8/15/20/25:

❒ Open the insulating door, open the ash door on the right and pull out the ash drawer

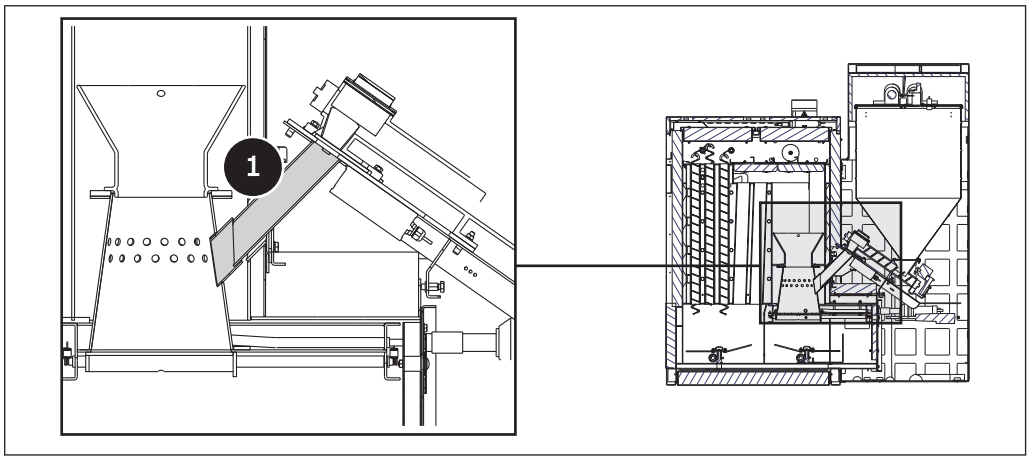
For P4 Pellet 32/38/48/60/80/100/105:

❒ Open the insulating door, take out the ash container on the right and open the ash door

❒ Check the combustion grate and combustion chamber for dirt

❒ If there is a lot of dirt, clean the combustion chamber
Cleaning the flue gas collection chamber and the heat exchanger

8.3.6 Check the downpipe for dirt (P4 Pellet 45 and up)

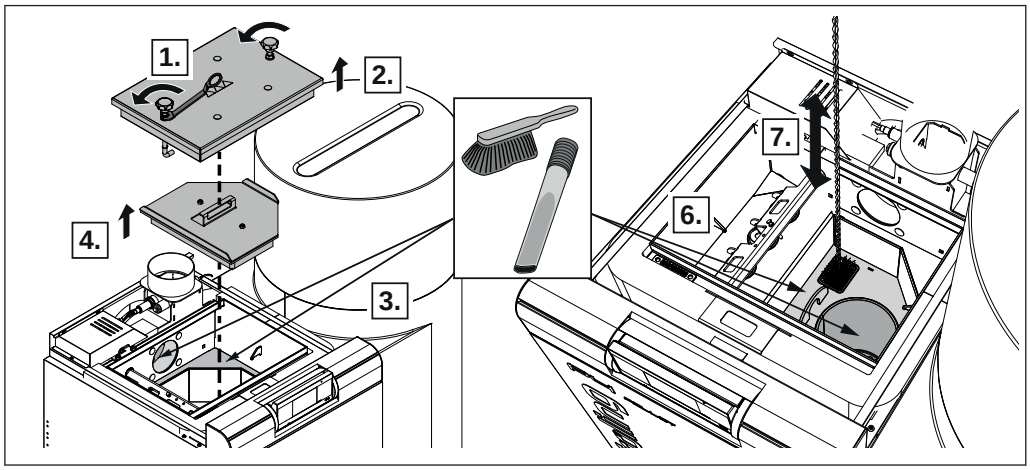


❒ Check the downpipe (1) between the burner gate valve and combustion grate for dirt

❒ If there is a lot of dirt or caking, clean the downpipe

➥ For cleaning use a large crosshead screwdriver and a wire brush, for example.

8.3.7 Cleaning the flue gas collection chamber and the heat exchanger

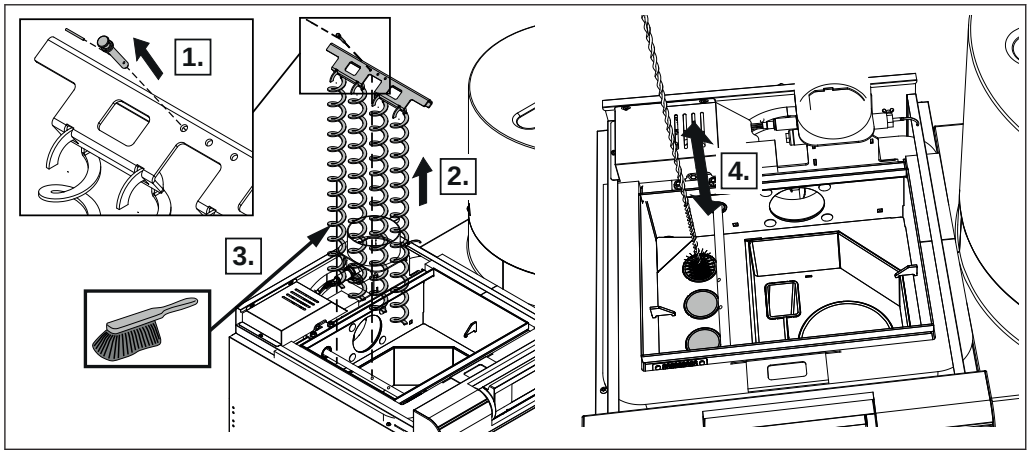


- ❒ Remove the insulating cover and turn the seal screws on the cleaning cover anti-clockwise using the tool supplied to loosen
- ❒ Remove the cleaning cover

- ❒ Clean the flue gas collection chamber and the opening to the induced draught fan with a brush
- ❒ Remove any soot which has accumulated
  ➥ Recommendation: use an ash vacuum

- ❒ Remove the internal heat exchanger cover
- ❒ Clean the flue pipes and the combustion chamber underneath with a cleaning brush

8.3.8 Clean WOS



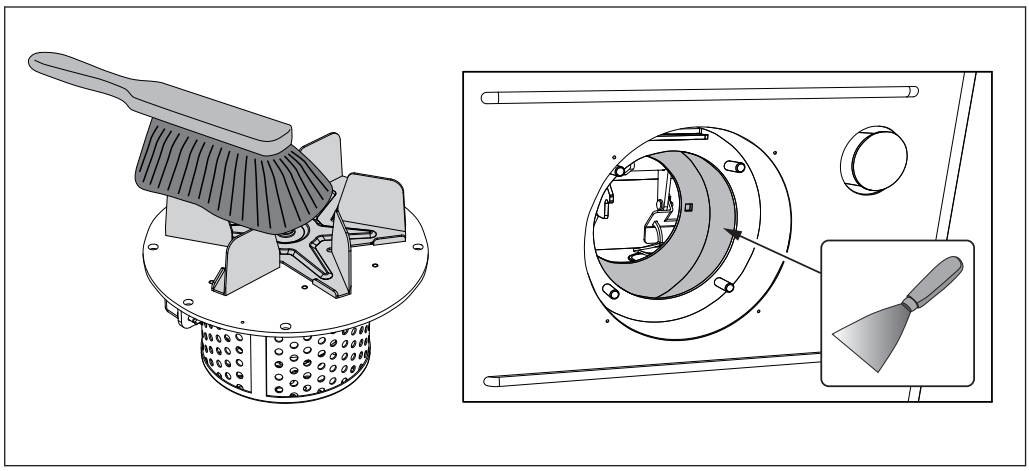
- ❒ Remove the insulating cover and cleaning cover
  Cleaning the flue gas collection chamber and the heat exchanger

- ❒ Remove the retainer at the bottom at the lock bolt, push the lock bolt up and remove
- ❒ Remove the WOS mount along with the springs
- ❒ Clean the heat exchanger pipes with cleaning brush provided

8.3.9 Cleaning the induced draught fan

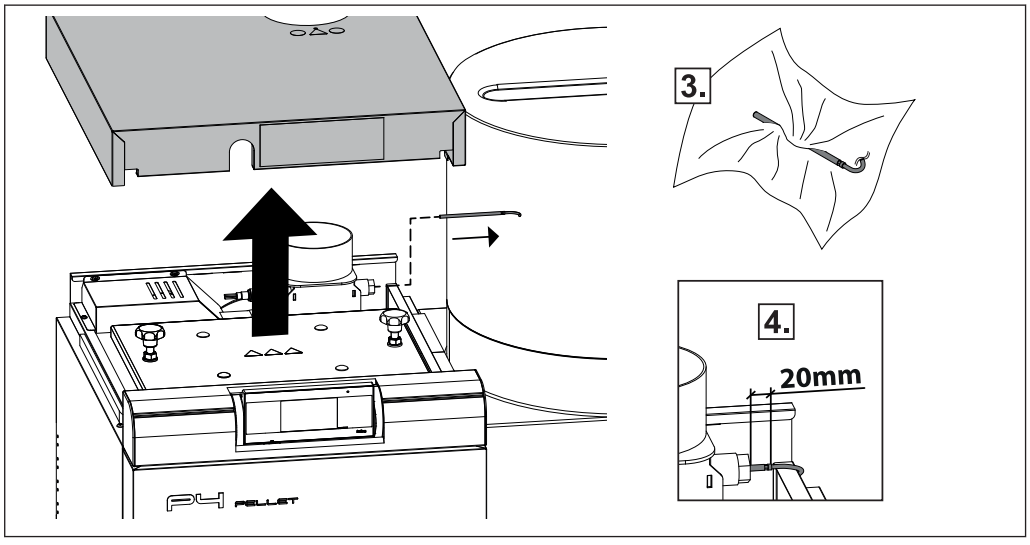
Check the induced draught fan for dirt and deposits and clean if necessary

Reinigung (falls erforderlich):



- ❒ Unplug the connection cable of the induced draught fan
- ❒ Remove the ID fan from the back of the boiler
  - ➥ Take care not to damage the seal
- ❒ Check for damage
- ❒ Clean the fan wheel from the inside out using a soft brush or paint brush
- ❒ Remove dirt and deposits from the induced draught housing using a scraper
- ❒ Remove any ash which has gathered using an ash vacuum
- ❒ Fit the induced draught fan
- ❒ Plug in the connection cable and secure with cable ties

8.3.10 Cleaning the flue gas temperature sensor



1. Remove the insulating cover
2. Release the retaining screw and remove the flue gas temperature sensor from the flue gas pipe
3. Wipe the flue gas temperature sensor with a clean cloth
4. Push in the flue gas temperature sensor until about 20 mm of the sensor remains protruding from the bushing and secure with fixing screw

8.3.11 Disposing of ash

Staff:	❒ Operator
Protective equipment:	❒ Protective workwear ❒ Protective goggles ❒ Protective gloves ❒ Safety shoes ❒ Dust mask

NOTICE

Environmental damage due to improper disposal!

❒ Collect ash in a metal container with a tight-fitting cover until its final disposal.

❒ Use metal containers exclusively for ash.

➥ The improper disposal of ash can lead to environmental damage.

❒ Carry or push the ash container to the metal container.

❒ Open the cover of the metal container.

❒ Empty the ash container.

❒ Close the cover of the metal container again.

Ashes should be places in a metal container with a tight-fitting lid. The closed container of ashes should be placed on a noncombustible floor or on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have thoroughly cooled. Other waste should not be placed in this container.

⚠ WARNING

Soot and flyash – Formation and Need for Removal

The products of combustion will contain small particles of flyash. The flyash will collect in the exhaust venting system and restrict the flow of the flue gases. Incomplete combustion, such as occurs during start-up, shut-down, or incorrect operation of the heater will lead to some soot formation which will collect in the exhaust venting system. The exhaust venting system should be inspected at least once every year to determine if cleaning is necessary.

❒ Establish a routine for the storage of fuel, care of the appliance, and firing techniques.

❒ Check daily for creosote buildup until experience shows how often cleaning is necessary.

❒ Be aware that the hotter the fire, the less creosote is deposited, and that weekly cleanings can be necessary in mild weather, even though monthly cleanings can be enough in the coldest months.

❒ Have a clearly understood plan to handle a chimney fire.

⚠ WARNING

Creosote – Formation and Need for Removal
When wood is burned slowly, it produces tar and other organic vapors, which combine with expelled moisture to from creosote. The creosote vapors condense in the relatively cold chimney flue of a slow-burning fire. As a result, creosote residue accumulates on the flue linig. When ignited this creosote makes an extremely hot fire. The chimney connector and chimney should be inspected at least twice monthly during the heating season to determine if a creosote buildup has occured.
If creosote has accumulated it should be removed to reduce the risk of a chimney fire.

8.4 After maintenance

After completion of maintenance work and before switching on the system perform the following steps:

- ❒ Check that all previously loosened screw connections are tightened.
- ❒ Check whether all previously removed safety devices and open doors and covers are closed again properly.
- ❒ Make sure that all tools, materials and other equipment used have been removed from the work area.
- ❒ Clean the work area and remove any substances that may have leaked such as liquids, processing materials or similar.
- ❒ Make sure that all safety devices on the system are functioning properly.

9 Boiler faults

9.1 Safety instructions for troubleshooting

Improperly performed troubleshooting operations

⚠ WARNING

Risk of injury due to incorrect troubleshooting!

- ❒ Before starting work, ensure that there is sufficient space for assembly.
- ❒ Pay attention to order and cleanliness at the assembly site. Loosely overlapping or scattered components and tools are sources of accident.
- ❒ If components have been removed, pay attention to correct assembly, refit all fasteners and observe tightening torques for screws.
- ❒ Do not release the blockage until you have ensured that the release will not lead to a dangerous movement of system components.
- ❒ Do not acknowledge the fault until it is eliminated or its cause is resolved.
- ❒ In case of doubt contact Froling customer service.
- ❒ Before starting up again, please note the following:
  - ↪ Make sure that all troubleshooting operations have been performed and completed according to the instructions in this manual.
  - ↪ Make sure that there is no-one in the danger zone.
  - ↪ Make sure that all covers and safety devices are installed and work properly.
  - ↪ Improperly performed troubleshooting operations can cause serious injuries and considerable property damage.

9.2 Fault messages

Faults that occur are displayed on the basic display of the control system. The fault messages are divided into categories and marked in different colors. The faults are marked with a number and the date and time when they occurred.

If there is a fault that has not yet been eliminated, a warning symbol blinks in the basic display on the quick menu icon.

Calling up fault messages

❒ In the basic display, select the *"Quick menu icon"* to open the available quick functions.

❒ Select the *"Error display"* menu in the quick menu.

➥ The current fault list is displayed.

Acknowledging a fault message

Tap on the fault message to display additional information in the "Error display" menu.

❒ Open the current fault list.

❒ Tap on the fault message to acknowledge it.

Once all faults have been eliminated and acknowledged, the warning symbol will disappear from the basic display.

Fault message categories

The term "fault" is a collective term for warnings, errors and alarms. The boiler reacts differently to the three types of message:

Type of fault	Character	Boiler behavior
WARNING	Status LED: YELLOW	In case of warnings, the boiler initially continues controlled operation, giving the option of resolving the error quickly to prevent a shutdown.
ERROR	Status LED: Orange	The boiler follows shutdown procedure and remains in "Boiler off" status until the problem is resolved.
ALARM	Status LED: Red	An alarm triggers a system emergency stop. The boiler shuts down immediately; the heating circuit controller and pumps remain active.

9.3 Table for troubleshooting

Fault description	Cause	Remedy	Staff
Nothing is shown on the display	General power failure	Check power supply and, if necessary, restart boiler.	Operator
No power to the control system	▪ Main switch is turned off	▪ Turn on the main switch	Operator
	▪ FI-protective circuit breaker, power line protection tripped	▪ Switch the protective circuit breaker on the control cabinet back on.	Operator
High-limit thermostat has activated.	Over-temperature	▪ Allow system to cool. ▪ Check status of the system (note the fault messages). ▪ Reset the high-limit thermostat.	Operator
System does not start.	Insufficient combustion air	Check the air inlet to the boiler room and clean, if necessary.	Operator
	Covers on the boiler not closed	Check the covers and close, if necessary.	Operator
Boiler combustion fault	Insufficient chimney escape due to deposits in the chimney	Have a chimney sweep clean soot, ash and tar oil deposits from the chimney connection and chimney.	Chimney sweep

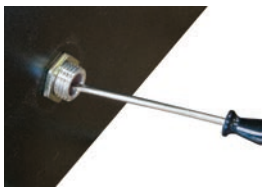
9.4 Operations for troubleshooting

9.4.1 Reset the high-limit thermostat.

Staff:	❒ Operator
Protective equipment:	❒ Protective workwear ❒ Protective gloves ❒ Safety shoes
Special tools:	❒ Screwdriver

The high-limit thermostat switches off the boiler at a temperature of 203-212°F (95-100°C). The pumps continue to run.

Once the temperature falls below approx. 185°F (approx. 85°C), the high-limit thermostat can be reset mechanically.



❒ Unscrew the cap of the high-limit thermostat.
❒ Unlock the high-limit thermostat by pressing with a screwdriver.
❒ Refit the cap of the high-limit thermostat.

9.5 After troubleshooting

Once the fault is eliminated, perform the following steps to start the boiler up again:

❒ Reset the emergency stop devices.
❒ Acknowledge the fault message via the control system.
❒ Make sure that there is no one in the danger zone.
❒ Start according to the instructions in the "Operation” chapter.

10 Dismantling and disposal

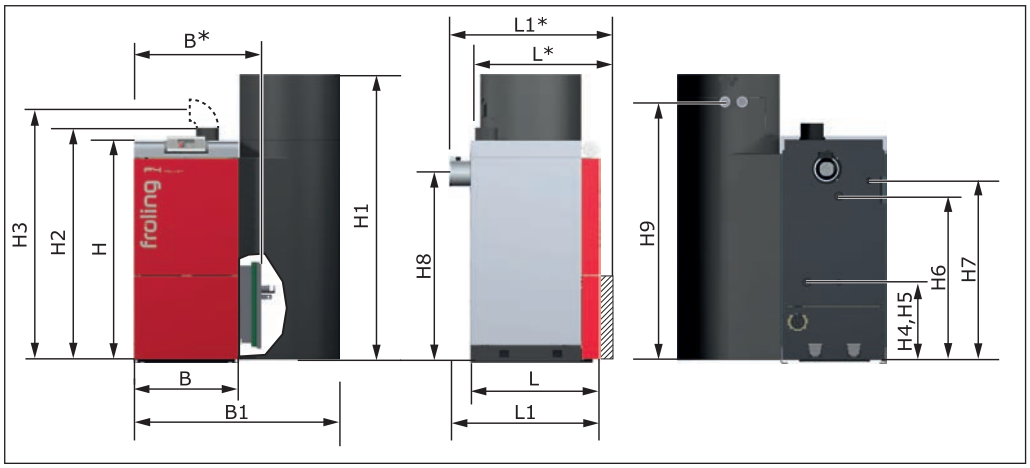
⚠ WARNING

Risk of death from improper dismantling!

- ❒ Dismantling must be carried out exclusively by employees of the manufacturer or staff authorized by the manufacturer.
- ❒ Consult the manufacturer even in case of a subsequent relocation.
- ❒ Refrain from unauthorized dismantling and relocation.
  - ➥ An error during dismantling can lead to life-threatening situations or cause substantial damage to property.

11 Technology

11.1 Dimensions P4 Pellet 8-38



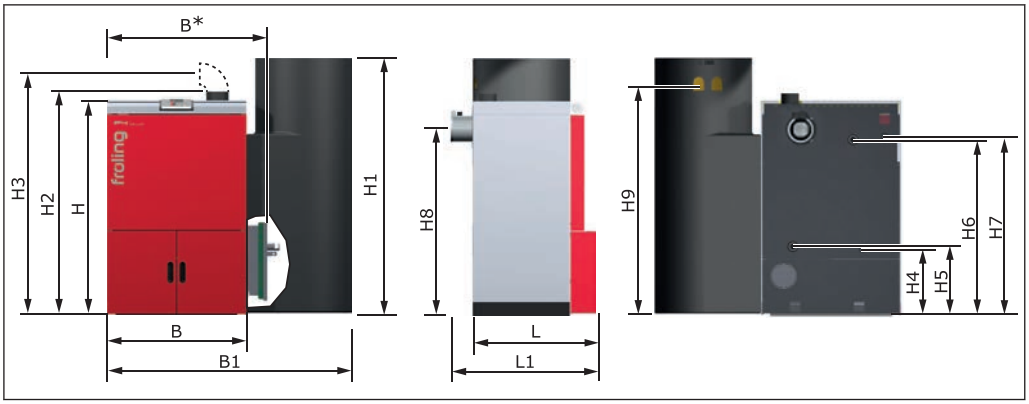
Item	Description	Unit	8 - 15	20 - 25	32 - 38
L	Length, boiler	mm	740	740	-
L*	Length, boiler	mm	-	-	820
L1	Total length incl. induced draught fan	mm	940	940	-
L1*	Total length incl. induced draught fan	mm	-	-	1020
B	Width, boiler	mm	600	770	860
B*	Width, boiler, incl. support for positioning unit [1)]	mm	705	875	965
B1	Total width including suction cyclone	mm	1185	1355	1445
H	Height, boiler [2)]	mm	1280	1280	1430
H1	Total height incl. suction cyclone	mm	1660	1660	1900
H2	Height, flue gas pipe connection	mm	1350	1350	1530
H3	Height, drainage connection	mm	460	460	460
H4	Height, flow connection	mm	460	460	460
H5	Height, return connection	mm	940	955	1085
H6	Height, ventilation connection	mm	1030	1030	1155
H7	Height, induced draught fan connection	mm	1090	1090	1215
H8	Height, suction system connection	mm	1480	1480	1720

1. Corresponds to the minimum positioning width after removing the stoker assembly, suction cyclone and positioning unit
2. Corresponds to the minimum positioning height after removing the stoker assembly, suction cyclone and positioning unit

11.2 Dimensions P4 Pellet 48-100

NOTICE

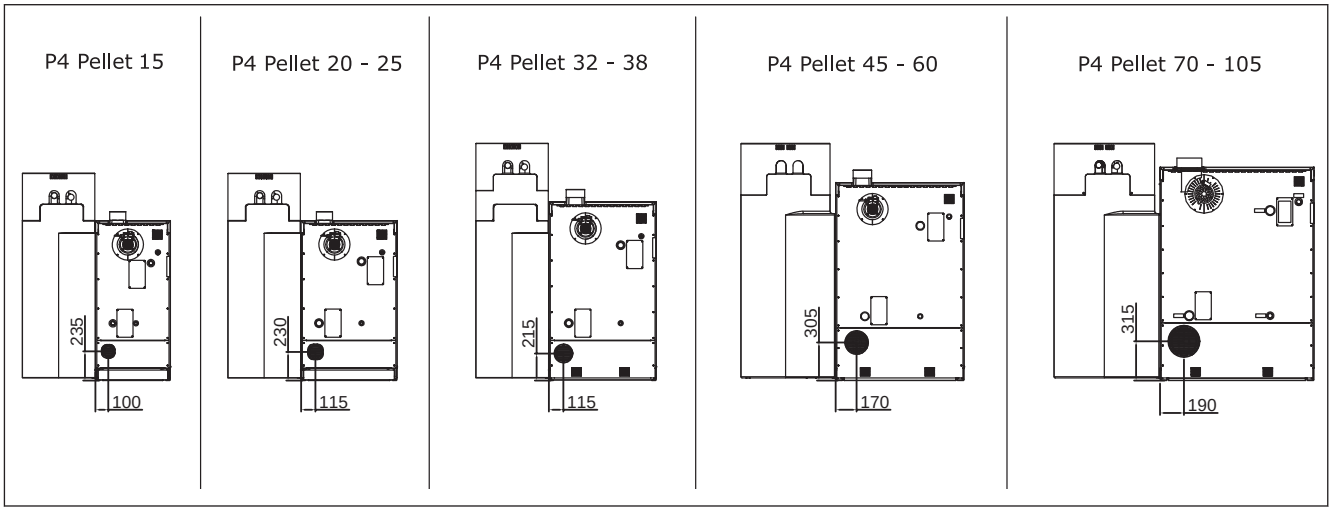
CAUTION: Note the modified flow connection / return connection starting with P4 Pellet 48!



Item	Description	Unit	48 - 60	80 - 100
L	Length, boiler	mm	900	1000
L1	Total length incl. induced draft fan	mm	1100	1070
B	Width, boiler	mm	1030	1235
B*	Width, boiler incl. support for positioning unit [1)]	mm	1275	1480
W1	Total width incl. suction cyclone	mm	1790	2085
H	Height, boiler [2)]	mm	1585	1710
H1	Total height incl. suction cyclone	mm	1900	1900
H2	Height, flue gas pipe connection	mm	1685	1785
H3	Height of drainage connection	mm	490	500
H4	Height, return connection	mm	515	520
H5	Height of flow connection	mm	1290	1410
H6	Height, ventilation connection	mm	1310	1430
H7	Height, ID fan connection	mm	1375	1495
H8	Height, suction system connection	mm	1720	1720

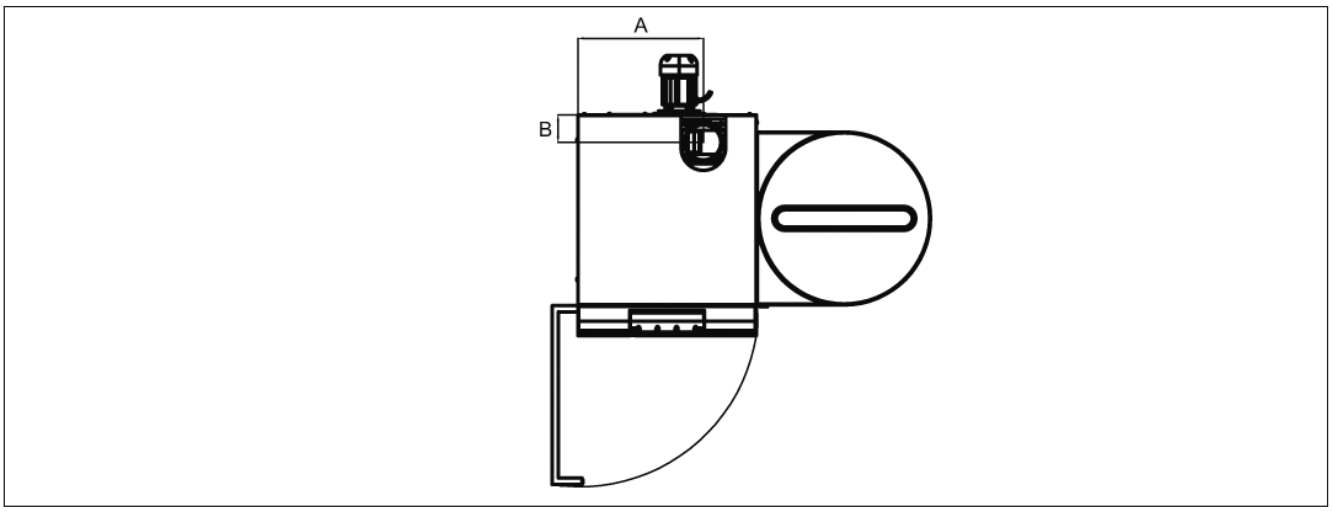
1. Corresponds to the minimum positioning width after removing the stoker assembly, suction cyclone and positioning unit
2. Corresponds to the minimum positioning height after removing the stoker assembly, suction cyclone and positioning unit

11.3 Supply air connections for room air-independent operation



Description	Unit	8/15	20/25	32/38	48/60	80/100
Supply air connection pipe (external diameter)	mm	80	100	125	160	200

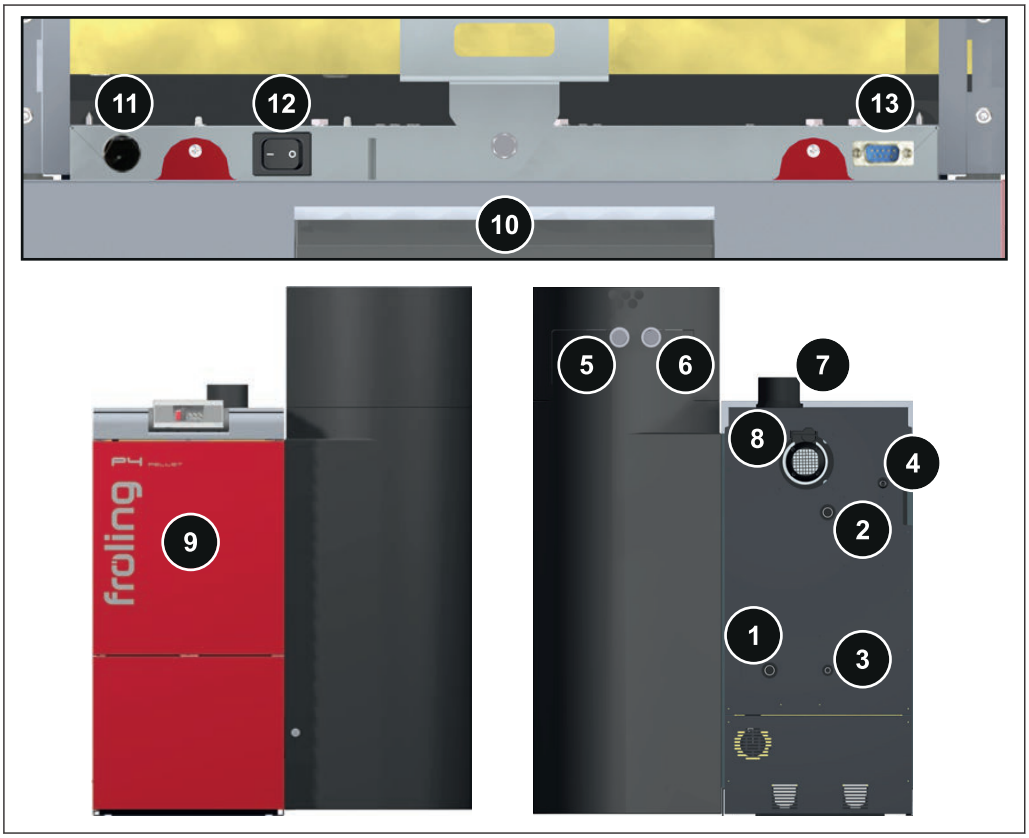
11.4 Flue gas pipe position



Description	Unit	8/15	20/25	32/30	48/60	80/100
A – Lateral distance	mm	420	585	650	815	1000
B – Depth distance	mm	90	90	85	90	80

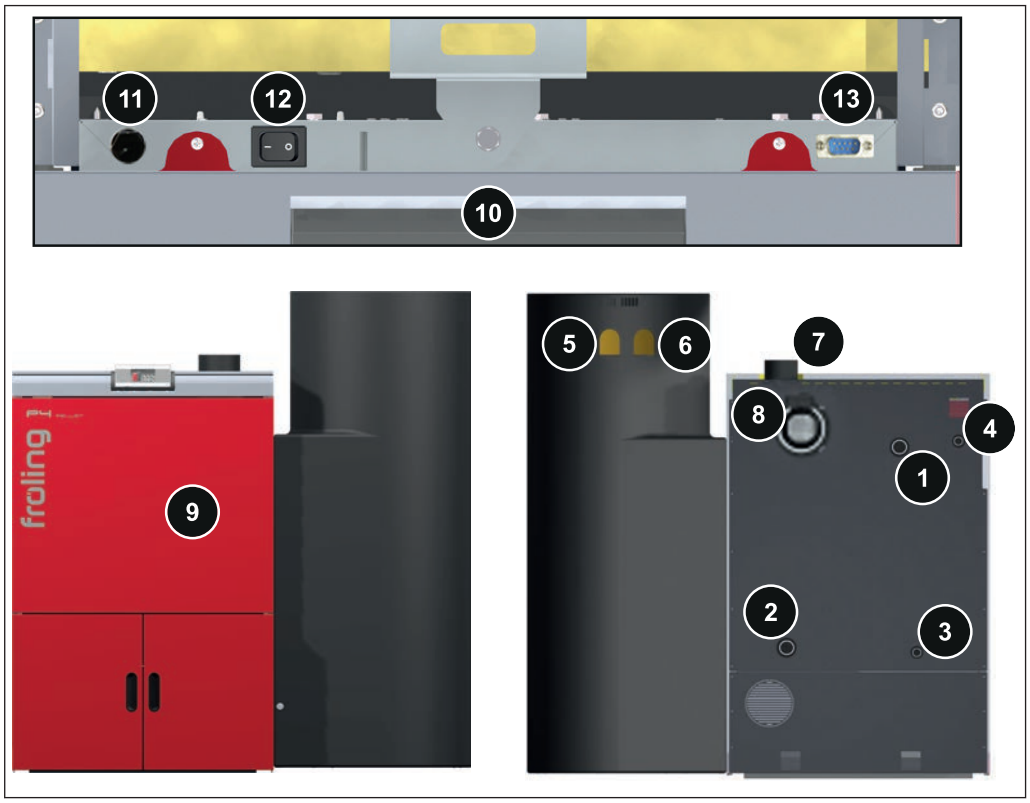
11.5 Components and connections

11.5.1 P4 Pellet 8-38



Item	Description	Unit	8 - 15	20 - 25	32 - 38
1	Boiler flow connection	inches	1	6/4	6/4
2	Boiler return connection	inches	1	6/4	6/4
3	Drainage connection	inches	1/2	1/2	1/2
4	Air vent connection	inches	1/2	1/2	1/2
5	Pellet suction line	mm	DA 60	DA 60	DA 60
6	Pellet return air line	mm	DA 60	DA 60	DA 60
7	Flue gas pipe connection (DM)	mm	130	130	150
8	Induced draught fan				
9	Controller box				
10	Lambdatronic P 3200 control				
11	High-limit thermostat (STL)				
12	Main switch				
13	Service interface				

11.5.2 P4 Pellet 48-100



Item	Description	Unit	48 - 60	80 - 100
1	Boiler flow connection	inches	6/4	2
2	Boiler return connection	inches	6/4	2
3	Drainage connection	inches	1/2	1
4	Air vent connection	inches	1	1
5	Pellet suction line	mm	DA 60	DA 60
6	Pellet return air line	mm	DA 60	DA 60
7	Flue gas pipe connection (DM)	mm	150	200
8	Induced draught fan			
9	Controller box			
10	Lambdatronic P 3200 control			
11	High-limit thermostat (STL)			
12	Main switch			
13	Service interface			

11.6 Technical specifications

11.6.1 P4 Pellet 8 - 25

Description		P4 Pellet			
		8	15	20	25
Heat exchanger design standard		EN 303-5			
Nominal heat output	kW	8	15	20	25
Heat output range		3,2-10,5	4,5-14,9	6,0-20,0	7,5-25,0
Electrical connection		230V / 50Hz / C16A			
Power consumption NL / PL	W	48 / 34	55 / 34	71 / 49	87 / 63
Boiler weight	kg	350	350	430	430
Boiler capacity (water)	l	70	70	80	80
Content ashcans heat exchanger / combustion chamber	l	13 / 13	13 / 13	25 / 15	25 / 15
Water pressure drop (ΔT = 20 K / 10K)	mbar	4,3 / 17,2	6,1 / 24,4	4,5 / 17,9	2,8 / 11,5
Min. boiler return temperature	°C	Not applicable due to internal return temperature control			
Max. permitted operating temperature	°C	80			
Min. operating temperature setting	°C	40			
Permitted operating pressure	psi bar	30 2			
Boiler class as per EN 303-5:2012		5			
Airborne sound level	dB(A)	< 70			
Permitted fuel as per EN 14961 [1)]		Part 2: Wood pellets class A1 / D06			

11.6.2 P4 Pellet 32 - 60

Description		P4 Pellet			
		32	38	48	60
Heat exchanger design standard		EN 303-5			
Nominal heat output	kW	32,0	38,0	48,0	58,5
Heat output range		9,6-32,0	11,4-38,0	14,4-48,0	17,6-58,5
Electrical connection		230V / 50Hz / C16A			
Power consumption NL / PL	W	104 / 78	110 / 78	114 / 45	119 / 80
Boiler weight	kg	530	530	760	760
Boiler capacity (water)	l	125	125	170	170
Content ash containers heat exchanger / combustion chamber	l	33 / 19	33 / 19	33 / 33	33 / 33
Water pressure drop (ΔT = 20 K / 10K)	mbar	1,5 / 6,2	2,1 / 8,7	3,7 / 10,5	5,3 / 12,3
Min. boiler return temperature	°C	Not applicable due to internal return temperature control			
Max. permitted operating temperature		80		88	
Min. operating temperature setting		40			
Permitted operating pressure	psi bar	30 2			
Boiler class as per EN 303-5:2012		5			
Airborne sound level	dB(A)	< 70			
Permitted fuel as per EN 14961 [1)]		Part 2: Wood pellets class A1 / D06			

11.6.3 P4 Pellet 80 - 100

Description		P4 Pellet			
		80	100	80	100
Heat exchanger design standard		EN 303-5		ASME	
Nominal heat output	kW	80,0	100,0	80,0	100,0
Heat output range		24-80	30-100	24-80	30-100
Electrical connection		230V / 50Hz / C16A			
Power consumption NL / PL	W	115 / 49	112 / 49	115 / 49	112 / 49
Boiler weight	kg	1090	1100	1090	1100
Boiler capacity (water)	l	280	280	280	280
Content ash containers heat exchanger / combustion chamber	l	33 / 33	33 / 33	33 / 33	33 / 33
Water pressure drop (ΔT = 20 K / 10K)	mbar	4,8 / 14,3	4,3 / 14,3	4,8 / 14,3	4,3 / 14,3
Min. boiler return temperature	°C	60			
Max. permitted operating temperature		88			
Min. operating temperature setting		40			
Permitted operating pressure	psi bar	45 3		43.5 3	
Boiler class as per EN 303-5:2012		5			
Airborne sound level	dB(A)	< 70			
Permitted fuel as per EN 14961 [1)]		Part 2: Wood pellets class A1 / D06			

11.6.4 Airborne sound level

The sound levels specified in the following table are based on a sound measurement on a P4 Pellet 15. (measuring device: Omega HHSL 1)

The sound level of the individual units was plotted at a distance of 1 m from the sound source.

Ambient level for measurement: 32 dBA

Unit	Measurement
Units in continuous operation:	
Induced draught fan (activation: 50%)	41 dBA
Induced draught fan (activation: 65%)	44 dBA
Induced draught fan (activation: 90%)	50 dBA
Units in non-continuous operation:	
Suction turbine	68 dBA
Grate motor	42 dBA
Stoker motor / Stoker screw	33 dBA
Ignition fan	53 dBA
WOS motor / WOS system	60 dBA
Burn back slide valve actuator (open)	34 dBA
Burn back slide valve actuator (close)	50 dBA

Please note that all the measurements were taken in-house and do not come from a certified test centre. This data should, therefore, be viewed as individual guideline measurements.

Please also note the sound levels required in the standards listed below, which must be fulfilled by planning and construction measures:

ÖNORM B 8115-2	Sound insulation and room acoustics in building construction - Requirements for sound insulation
ÖNORM H 5190	Heating systems - Acoustic insulation

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FROLING
Heizkessel- und Behälterbau GesmbH

Industriestraße 12
A-4710 Grieskirchen
AUSTRIA

TEL 0043 (0)7248 606 0
FAX 0043 (0) 7248 606 600
INTERNET www.froeling com

12.1.2 Address of importer

STAMP

12.1.3 Address of Local Dealer

STAMP

Service manual

Lambdatronic P 3200 for pellet boiler

Core module version 50.04 - Build 05.17 | Touch control version 60.01 - Build 01.35

Translation of the original German installation instructions for technicians

Read and follow the instructions and safety information!

Technical changes, typographical errors and omissions reserved!

B1440619_en | Edition 19/04/2019

Froling GesmbH | A-4710 Grieskirchen, Industriestraße 12 | www.froeling.com

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1 General

1.1 About these instructions

Please read and follow the operating instructions, in particular the safety information contained therein. Keep them available next to the boiler.

These operating instructions include important information about operation, electrical connection and troubleshooting. The parameters shown depend on the set boiler type and the system configuration!

The constant further development of our products means that there may be minor differences from the pictures and content. If you discover any errors, please let us know: doku@froeling.com.

1.2 Safety information

⚠ DANGER

When working on electrical components:

Risk of electrocution!

When work is carried out on electrical components:

- ❒ Always have work carried out by a qualified electrician
- ❒ Observe the applicable standards and regulations

  ➥ Work must not be carried out on electrical components by unauthorised persons

⚠ WARNING

When touching hot surfaces:

Severe burns are possible on hot surfaces and the flue gas pipe!

When work is carried out on the boiler:

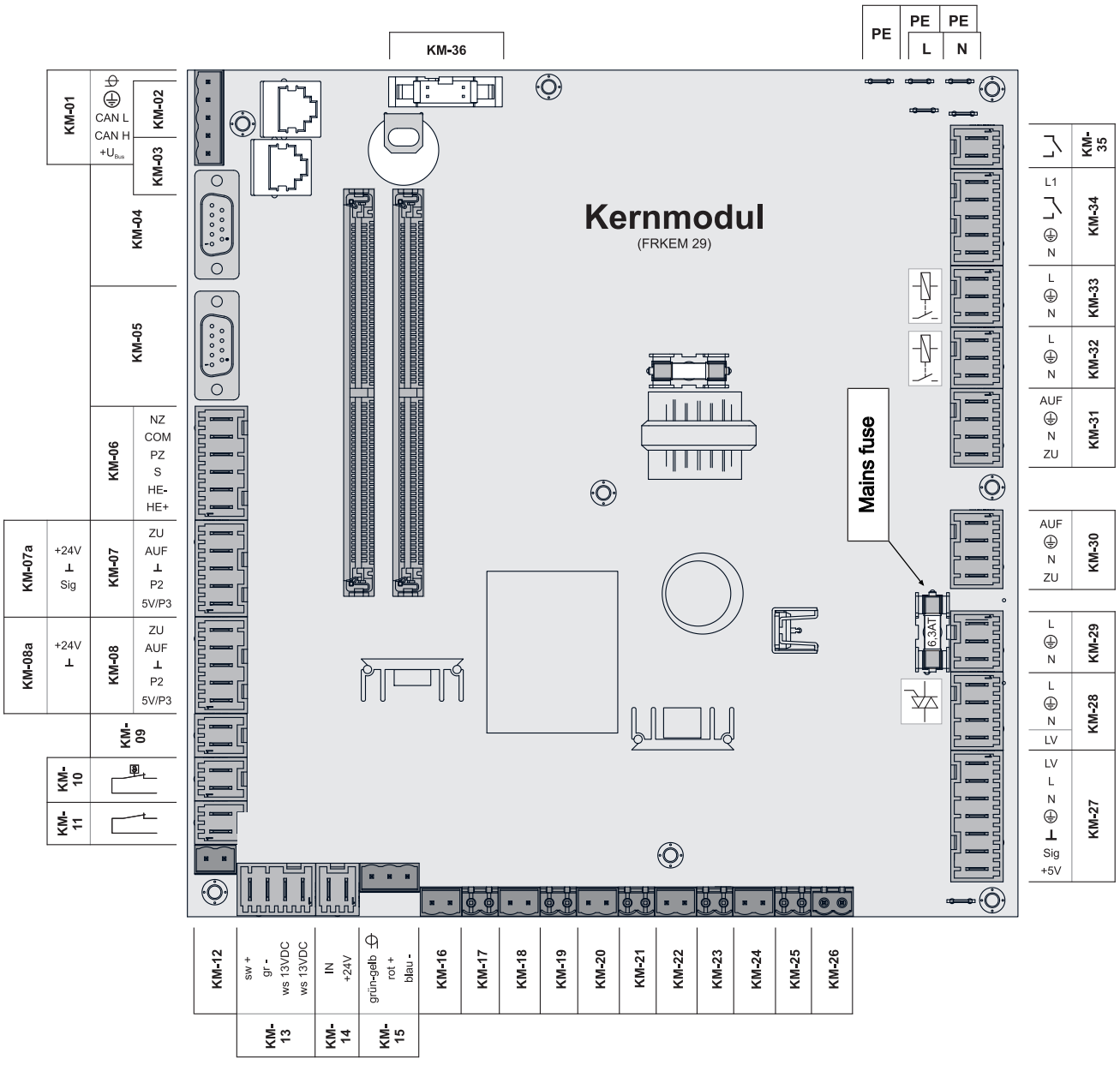
- ❒ Shut down the boiler according to procedure (“Boiler off” operating status) and allow it to cool down
- ❒ Protective gloves must usually be worn for work on the boiler, and it should only be operated using the handles provided
- ❒ Insulate the flue gas pipes and do not touch them during operation

The information on safety, standards and guidelines in the assembly and operating instructions for the boiler should also be observed!

2 Power connection and wiring

2.1 Core module and connection options

2.1.1 Board view - core module



Connection instructions

Connection / Name		Note
KM-01	BUS	Connection with cable – LIYCY paired 2x2x0.5; ⇨ See "Connecting the bus cable" [page 22] Caution! CAN L and CAN H must not be connected to $+U_{BUS}$!
KM-02	BUS	Patch cable CAT 5 RJ45 SFTP 1:1 configuration; pellet module connection
KM-03		

Connection / Name			Note
KM-04	COM 2		Null modem cable 9-pin SUB-D; Connection is used e.g. as MODBUS interface
KM-05	COM 1		Null modem cable 9-pin SUB-D; Service interface for software update and connection to visualisation software
KM-06	Broadband probe		Connection cable[1] 5 x 0.75 mm² Connection of a BOSCH or NTK broadband Lambda probe
KM-07	Pellets-Box Comfort 1-2-3 suction module	PE1 Pellet P4 Pellet	Refer to the respective documentation of the suction system for details on the connection!
KM-08			
KM-07a	Underpressure transmitter	PE1c Pellet	Connection cable[1] 3 x 0.75 mm²
KM-08a	Solenoid valve	PE1c Pellet	Connection cable[1] 2 x 0.75 mm²
KM-09	Lock		Connection cable[1] 2 x 0.75 mm²
KM-10	High-limit thermostat		
KM-11	EMERGENCY STOP		Caution! Do not connect the emergency stop/shutdown switch to the boiler power supply line. The switch must be a N/C switch and it must be linked to the 24V safety chain of the STL at this terminal.
KM-12	Flowmeter		Connection cable[1] 2 x 0.75 mm²
KM-13	Lambda probe		Connection cable[1] 4 x 0.75 mm² Connection of a Bosch switching-type sensor (LSM11) or NTK switching-type sensor (OZA685)
KM-14	Boiler enable		Connection cable[1] 2 x 0.75 mm² Caution! The connection must be a floating connection. ⇨ See "Boiler enable contact" [page 9]
KM-15	Flue gas temperature sensor		Connection cable[1] 3 x 0.75 mm²
KM-16	Door switch		Connection cable[1] 2 x 0.75 mm²
KM-17	Sensor 2		Connection cable[1] 2 x 0.75 mm²
KM-18	Sensor 1		Connection cable[1] 2 x 0.75 mm², sensor 1 in the STL housing
KM-19	Outside temperature sensor		Connection cable[1] 2 x 0.75 mm², shielded from 25 m cable length
KM-20	Room temperature sensor heating circuit 2		
KM-21	Room temperature sensor heating circuit 1		
KM-22	Flow temperature sensor heating circuit 2		
KM-23	Flow temperature sensor heating circuit 1		
KM-24	Return sensor		Connection cable[1] 2 x 0.75 mm²
KM-25	Boiler sensor		
KM-26	PWM / 0-10V pump 1		
KM-27	ID fan		Connection cable[1] 3 x 1.5 mm² for power supply, Connection cable[1] 3 x 0.75 mm² for analysis of current speed
KM-28	Pump 1		Connection cable[1] 3 x 1.5 mm², max. 1.5A / 280W / 230V
KM-29	Mains connection		Connection cable[1] 3 x 1.5 mm², fuse provided by customer: C16A
KM-30	Mixing valve heating circuit 2		Connection cable[1] 4 x 0.75 mm², max. 0.15A / 230V

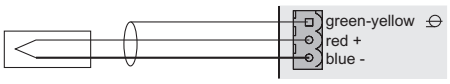
Connection / Name		Note
KM-31	Mixing valve heating circuit 1	
KM-32	Heating circuit pump 2	Connection cable[1)] 3 x 1.5 mm², max. 2.5A / 500W
KM-33	Heating circuit pump 1	
KM-34	Heating circuit pump 0 / burner relay	Connection cable[1)] 3 x 1.5 mm², max. 3A / 600VA
KM-35	Operating signal	Connection cable[1)] 2 x 0.75 mm² ⇨ See "Operating signal" [page 11]
KM-36	Optional module	
1. YMM as per ÖVE-K41-5 or H05VV-F as per DIN VDE 0881-5		

2.1.2 Mains connection

Connect the power supply at the "Mains connection" plug

❒ Flexible sheathed cable must be used for the wiring; this must be of the correct size to comply with applicable regional standards and regulations.

2.1.3 Connecting the flue gas temperature sensor

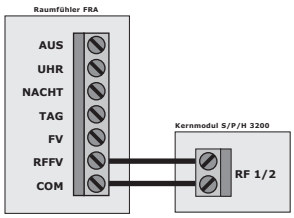


Core module

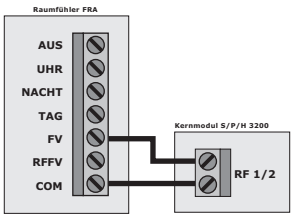
2.1.4 Connecting the remote control

A room temperature sensor is included in the remote control, which sends the current room temperature to the control.

affecting room:



not affecting room:



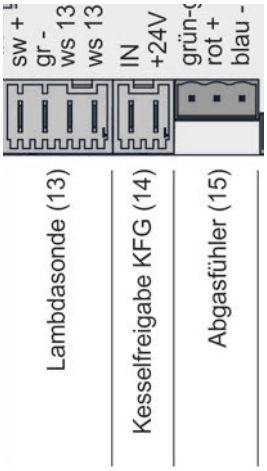
Switch settings:

⏻	**Boiler off**	Heating circuit deactivated, only frost protection!
🕒	**Automatic**	Heating phases according to setback program
☾	**Setback mode**	Ignores the heating phases
☀	**Party switch**	Ignores the setback
Handwheel…	Allows you to adjust the temperature by +/- 3°C	

IMPORTANT! See assembly instructions/functional description for room temperature sensor FRA

2.1.5 Boiler enable contact

When commissioning the boiler system using the settings wizards, the parameter “How is the boiler enable contact on the core module being used?” is called up to enable potential analysis of an external floating release or start contact. The following functions are possible depending on the setting and electrical connection:

Connection position	Setting	Description
	not in use	No effect on boiler operation (contact must not be clamped/bridged)
	Enable/disable boiler	As long as the boiler enable contact is closed, the boiler controller operates according to the specified parameters (mode, time window, etc.). If the boiler enable contact is opened, the boiler loses the enable and follows the shutdown procedure. As long as the boiler enable contact is open, heating requirements are ignored. (e.g. flue gas thermostat of a supply boiler, house distribution box)
	Extra heating	As long as the boiler enable contact is open, the boiler controller operates according to the specified parameters. If the boiler enable contact is closed, the boiler starts in continuous load operation (e.g. heat requirements of a heating fan).

Boiler request via external control system

The boiler is used as a heat source for charging a storage tank without Froling storage tank management and heat is requested from an external control system. The loading pump to the storage tank must be activated by the boiler controller!

❒ Set the “Boiler enable input available” parameter to YES

Boiler enable input

❒ Configure hydraulic system 0

Setting the system selection

❒ Connect the loading pump to the storage tank at the core module at HCP 0

⇨ See "Board view - core module" [page 5] or ⇨ See "Heating circuit pump 0 / burner relay" [page 11]

The speed of the HCP 0 is not controlled. (Observe the pump dimensions!)

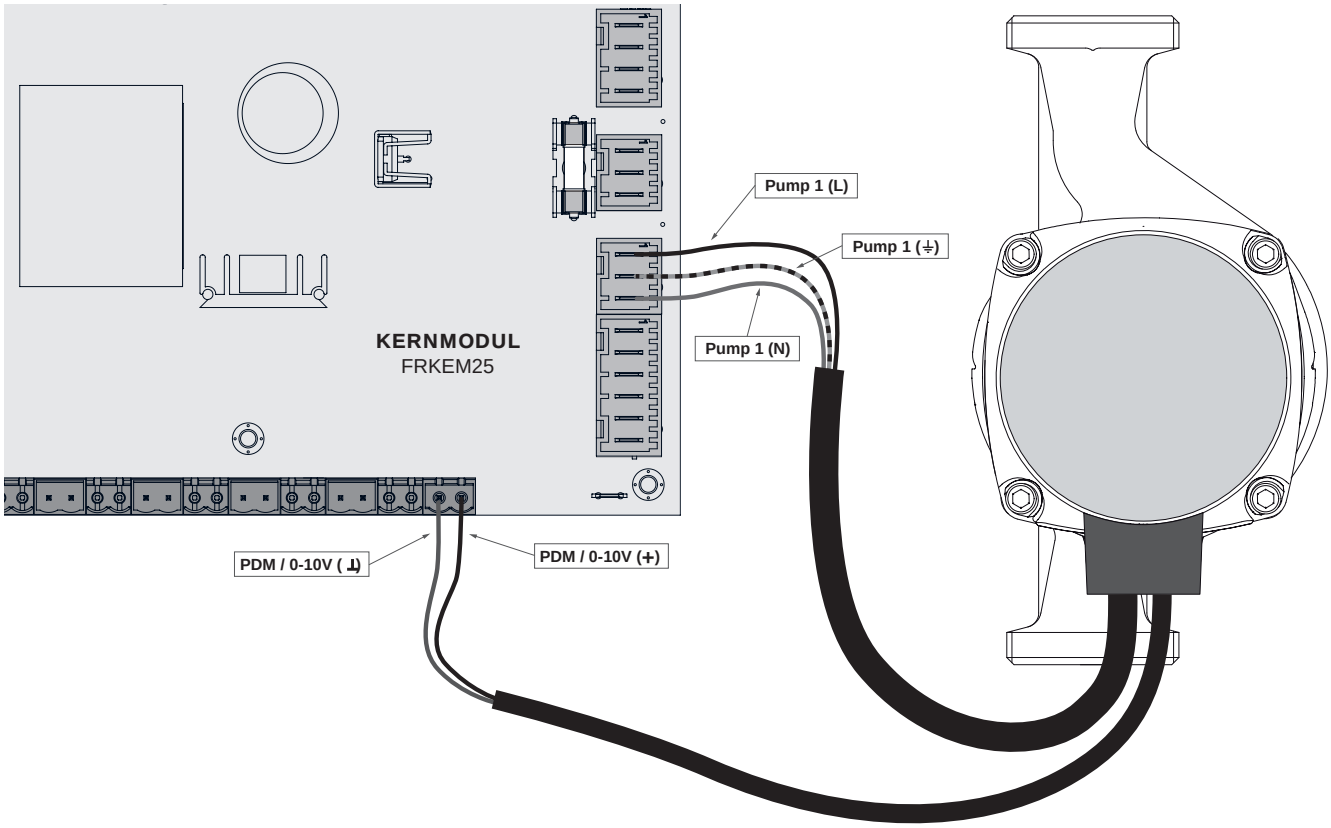
❒ Setting the “Continuous load” mode

System - Boiler mode

The higher level control system should ensure a minimum activation time of 15 minutes for the pellet boiler.

2.1.6 Connecting a high efficiency pump to the core module

Wire the high efficiency pump as shown in the connection diagram below:



- ❒ Connect the power supply for the high efficiency pump to output "Pump 1" of the core module
- ❒ Connect the PDM cable of the high efficiency pump to the corresponding port “PDM / 0-10V”
  - ➥ Make sure that the cables are configured correctly (polarity) in accordance with the connection diagram of the pump!

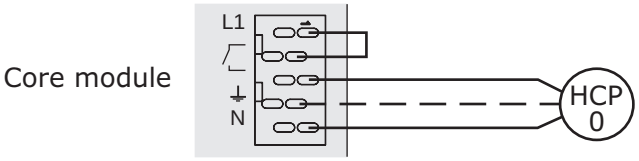
Important! When using a Froling pump assembly:

⇨ See "Connection diagrams according to pump types" [page 24]

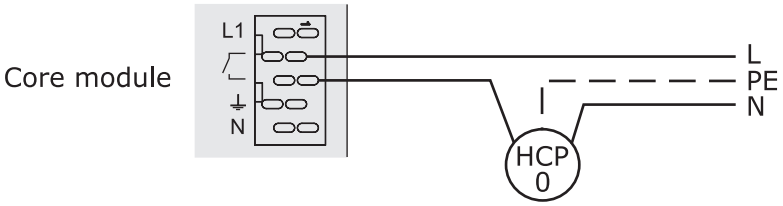
2.1.7 Heating circuit pump 0 / burner relay

The connection “Heating circuit pump 0”, can be used for heating circuit pump 0 or as burner relays depending on the system setting.

Connecting a HCP 0 up to max. 2 Ampere:



Connecting a HCP 0 up to max. 5 Ampere:



Connection as burner relays:

2.1.8 Operating signal

On the core module, connection position 35, it is possible to issue an operating signal potential-free. In the menu “Manual” -> “Digital outputs” the status can be viewed under parameter “*Standby relay*”.

⇨ See "Manual - Digital outputs" [page 74]

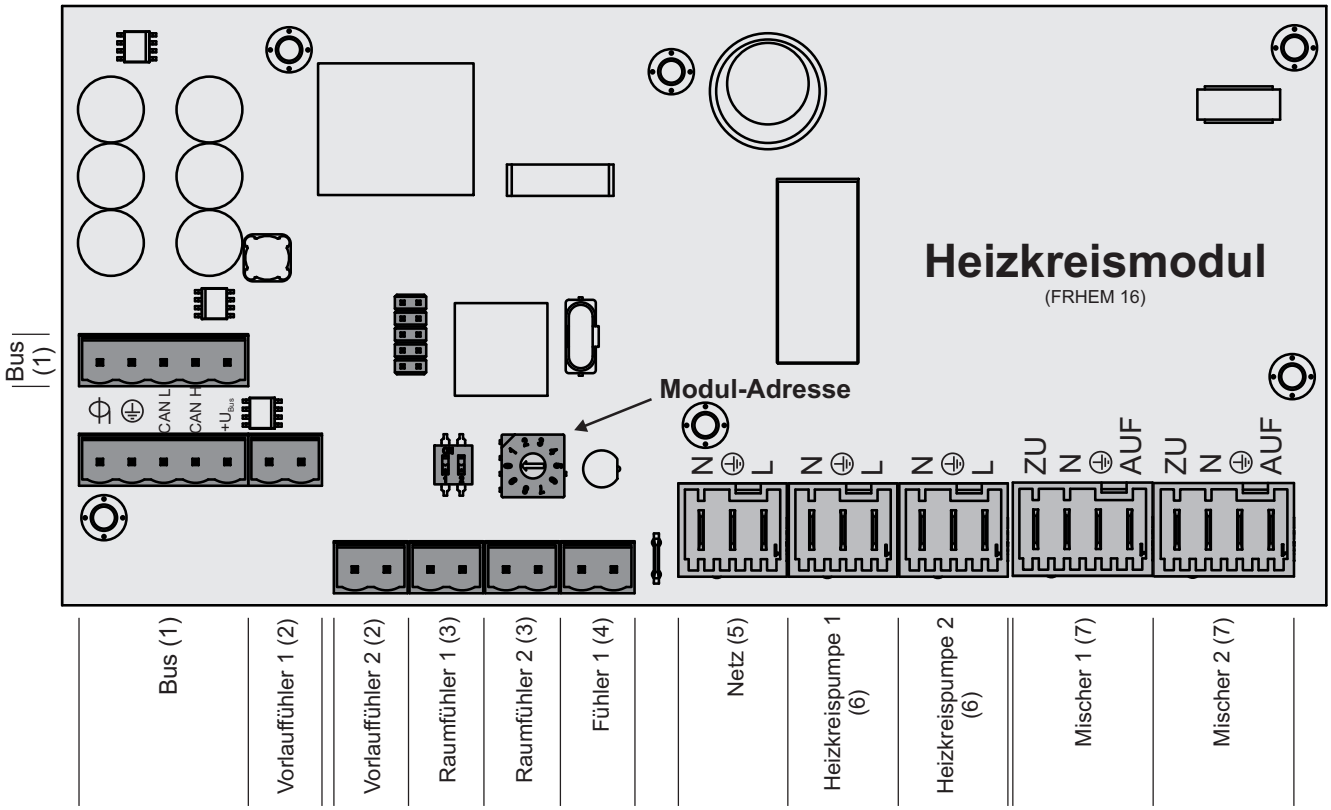
Operating status	Relay status
Boiler off, standby, fault	0
All other operating statuses (e.g. preparation, heating up, pre-heating, ignition, heating, slumber, cleaning, shutdown wait 1, shutdown wait 2, etc.)	1

2.2 Expansion modules

2.2.1 Heating circuit module

Two heating circuits can be controlled as standard with the core module.
To extend the heating circuit control, the heating circuit module boards must be expanded. Eight heating circuit modules (addresses 0 to 7) can be added, and the module address must be set correctly.

⇨ See "Setting the module address" [page 23]



Connection instructions

Connection	Cable dimensions / Specifications / Information
Bus (1)	Connection with cable – LIYCY paired 2x2x0.5; ⇨ See "Connecting the bus cable" [page 22] ❒ Caution! CAN L and CAN H must not be connected to $+U_{BUS}$!
Flow temperature sensor 1/2 (2)	Connection cable[1)] 2 x 0.75 mm²
Room temperature sensor 1/2 (3)	Connection cable[1)] 2 x 0.75 mm², shielded from 25 m cable length
Sensor 1 (4)	Connection cable[1)] 2 x 0.75 mm² ❒ Connection of the outside temperature sensor if this should not be connected to the core module. The address of the heating circuit module to which the outside temperature sensor is connected must be set in the "*Heating - General settings*" menu.
Mains (5)	Connection cable[1)] 3 x 1.5 mm², fuse 10A
Heating circuit pump 1/2 (6)	Connection cable[1)] 3 x 1.5 mm², max. 2.5A / 230V / 500W
Mixing valve 1/2 (7)	Connection cable[1)] 4 x 0.75 mm², max. 0.15A / 230V

1. YMM as per ÖVE-K41-5 or H05VV-F as per DIN VDE 0881-5

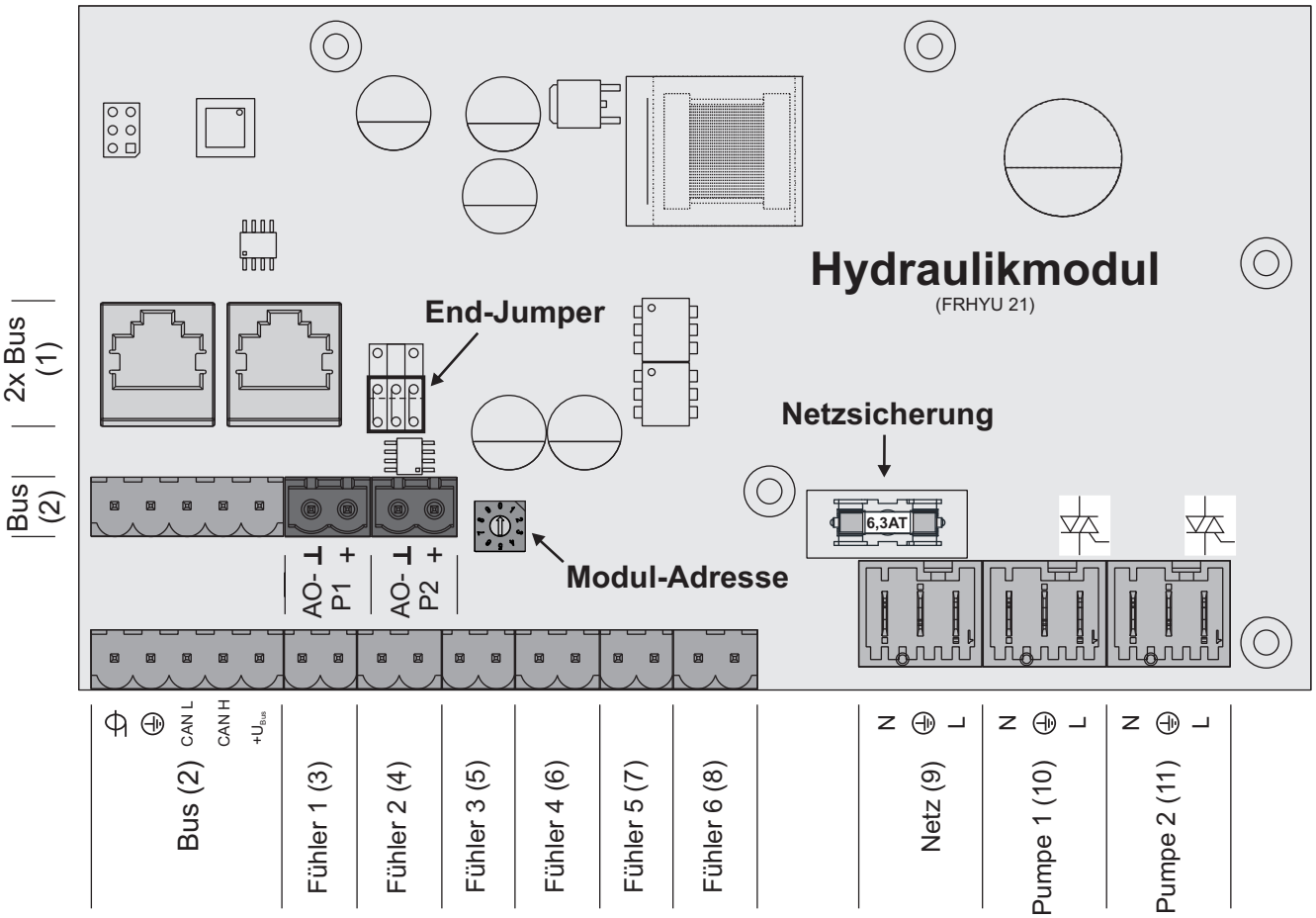
2.2.2 Hydraulic module

The hydraulic module makes the connections of sensors and pumps available for the hydraulic components of the system (buffer tank, DHW tank etc.).

A hydraulic module is included in the delivery as standard (address 0). A further seven modules (addresses 1 to 7) can be retrofitted.

You must ensure that the module address is given correctly.

⇨ See "Setting the module address" [page 23]



Connection instructions

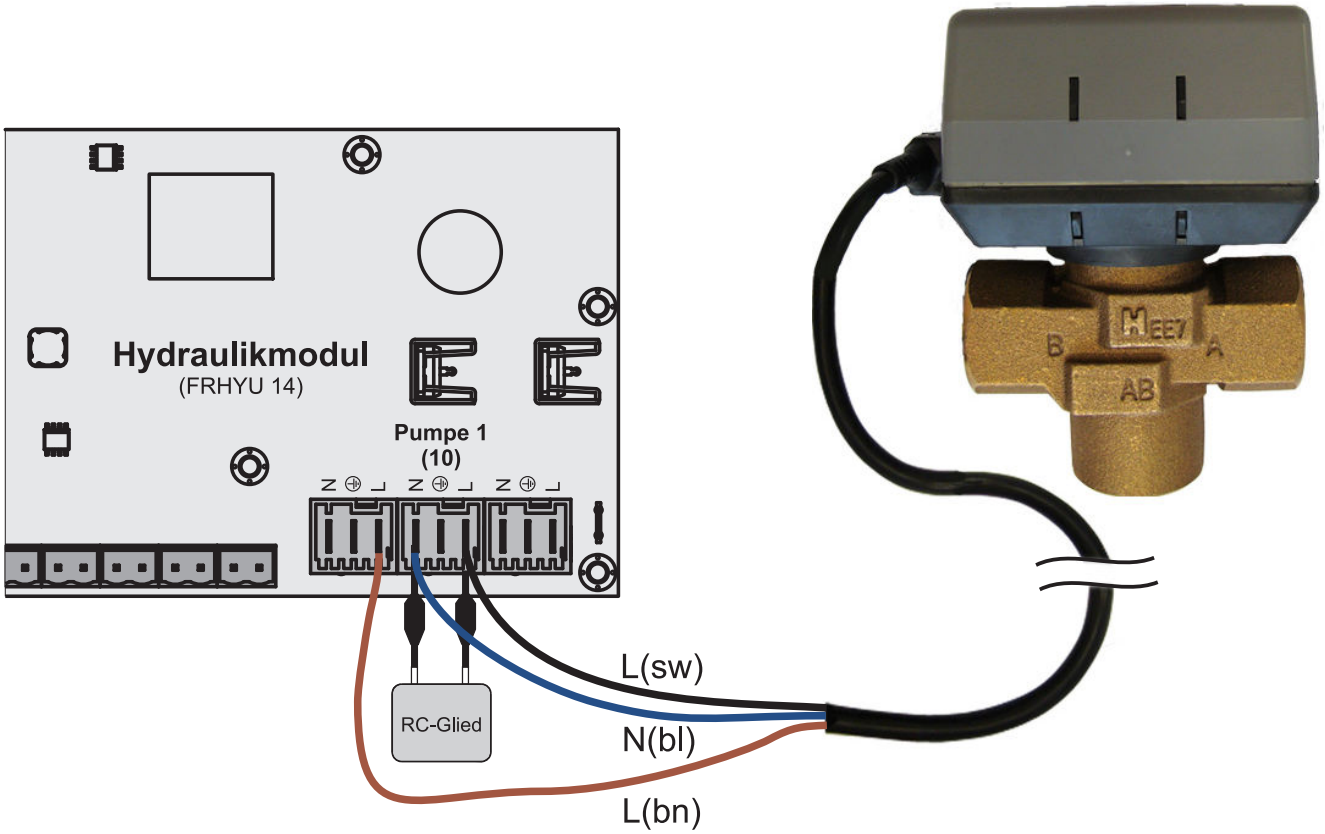
Port	Cable dimensions / Specifications / Information
2 x Bus (1)	Patch cable CAT 5 RJ45 SFTP 1:1 configuration
Bus (2)	Port with cable – LIYCY paired 2x2x0.5; ⇨ See "Connecting the bus cable" [page 22] ❒ Important! CAN L and CAN H must not be connected to $+U_{BUS}$!
Sensors 1 – 6 (3-8)	Connection cable[1)] 2 x 0.75 mm², shielded from 25 m cable length
Mains (9)	Connection cable[1)] 3 x 1.5 mm², fuse 10A
Pump 1/2 (10/11)	Connection cable[1)] 3 x 1.5 mm², max. 1.5A / 230V / 280W
1. YMM as per ÖVE-K41-5 or H05VV-F as per DIN VDE 0881-5	

Connecting an isolating valve

If an isolating valve is connected to a speed-controlled pump outlet, an RC element must be used.

Furthermore, the minimum speed for the pump outlet in use must be set to 100% in the boiler control system.

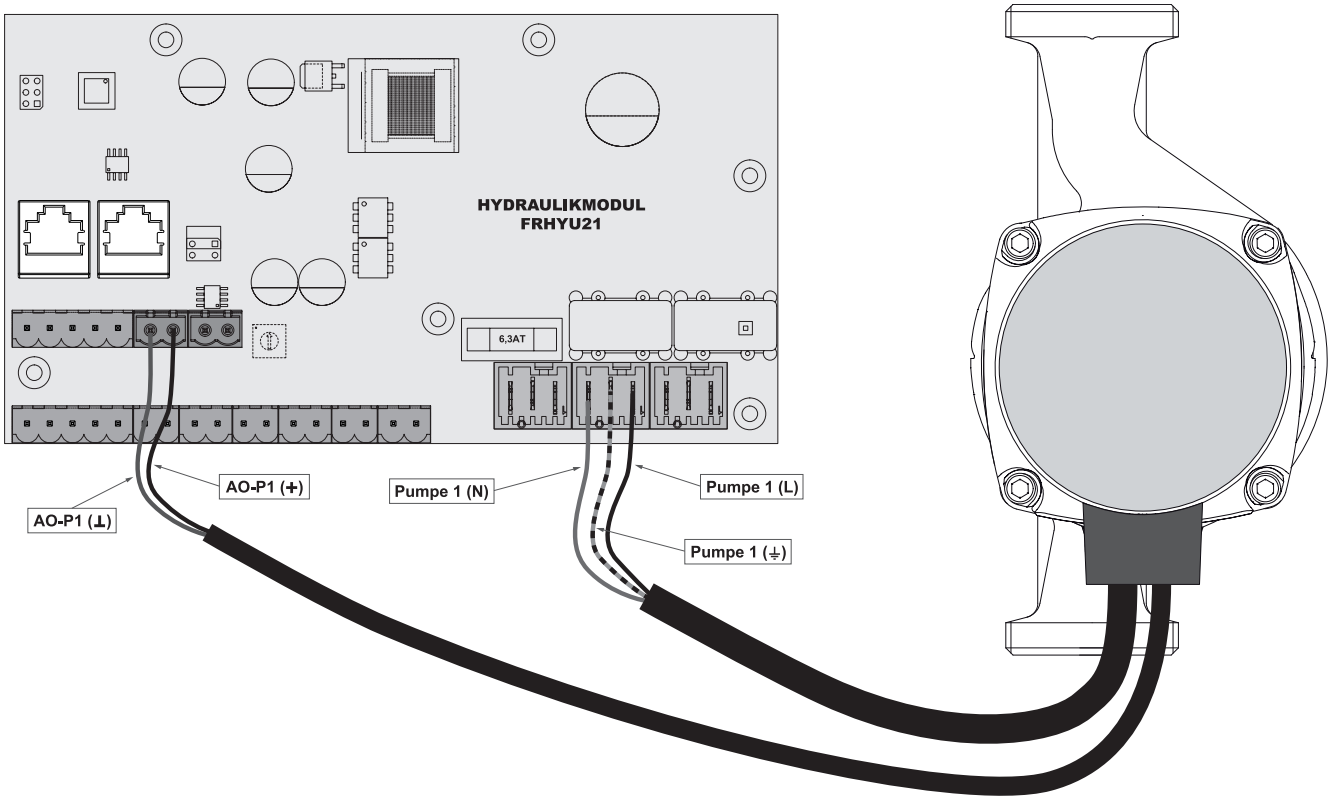
Connection example:



The outer cable L(bn) should be connected to the outer cable of the respective mains supply of the module or to the core module, HCP0/burner relay output at pin “LV”.

Connecting a high efficiency pump to the hydraulic module

Wire the high efficiency pump as shown in the connection diagram below:



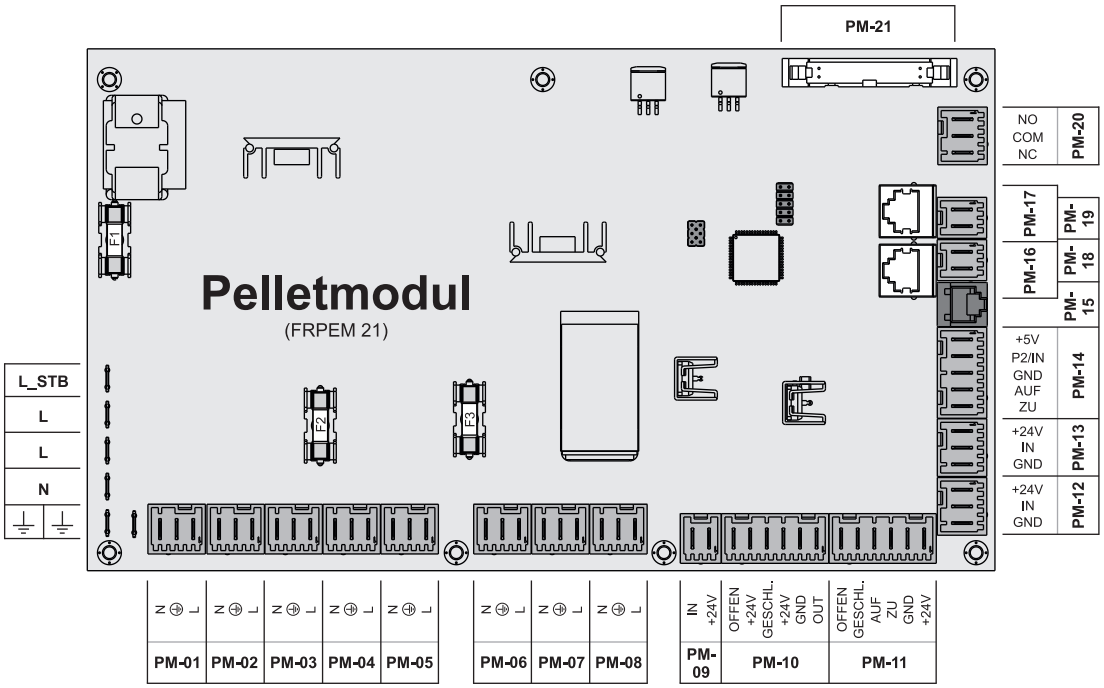
❒ Connect the power supply for the high efficiency pump to output "Pump 1" or "Pump 2" of the hydraulic module

❒ Connect the PDM cable of the high efficiency pump to the corresponding port "AO-P1" or "AO-P2"

➥ Make sure that the cables are configured correctly (polarity) in accordance with the connection diagram of the pump!

2.2.3 Pellet module

The pellet module is included in standard delivery and provides the connections of the hardware components for the pellet feed and pellet combustion:



Connection instructions

Connection / Name			Note
PM-01	Ignition		Use connection cable of the component
PM-02	WOS drive	PE1 Pellet P4 Pellet	
	Vibrator	PE1c Pellet	
PM-03	Ash screw		
PM-04	Ash screw		
PM-05	Mains connection		Connection cable[1)] 3 x 1.5 mm²
PM-06	Pellets suction turbine		Connection cable[1)] 3 x 1.5 mm²
PM-07	Stoker motor		Use connection cable of the component
PM-08	Vibrator	PE1 Pellet P4 Pellet	Connection cable[1)] 3 x 1.5 mm²
	Feed screw	PE1c Pellet	Use connection cable of the component
PM-09	Lock		Connection cable[1)] 2 x 0.75 mm²
PM-10	Burn back flap		Use connection cable of the component
PM-11	Grate drive		
PM-12	Min level	P4 Pellet	
	Gravity shaft	PE1c Pellet	
PM-13	Max level		

Connection / Name			Note
PM-14	Underpressure transmitter	PE1 Pellet	
	Gate valve	PE1c Pellet P4 Pellet	
PM-15	Flow sensor	P4 Pellet	
PM-16	BUS		Patch cable CAT 5 RJ45 SFTP 1:1 configuration
PM-17			
PM-18	Door switch		Use connection cable of the component
PM-19			
PM-20	Fault message		Connection cable[1)] 3 x 1.5 mm², max. 1A
PM-21	Pellet module expansion		Connection cable of the respective unit
1. YMM as per ÖVE-K41-5 or H05VV-F as per DIN VDE 0881-5			

Fuses

F1	3.15 AT	24 V
F2	10 AT	Stoker motor, blower fan
F3	10 AT	Suction unit

Connection configuration for max level S1 and min level S4

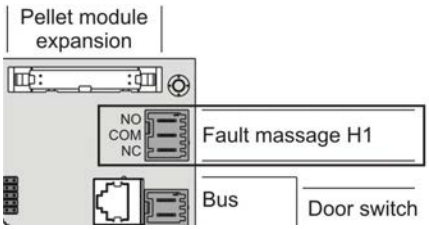
❒ The black wire of the sensor is not used.

Common fault relay (on the pellet module)

Two floating switch contacts are available ("normal open" and "normal closed") for control of external warning devices (signal lights, signal horn, SMS box, …).

If a fault occurs both contacts are activated, and the "normally open" closes and the "normally closed" opens.

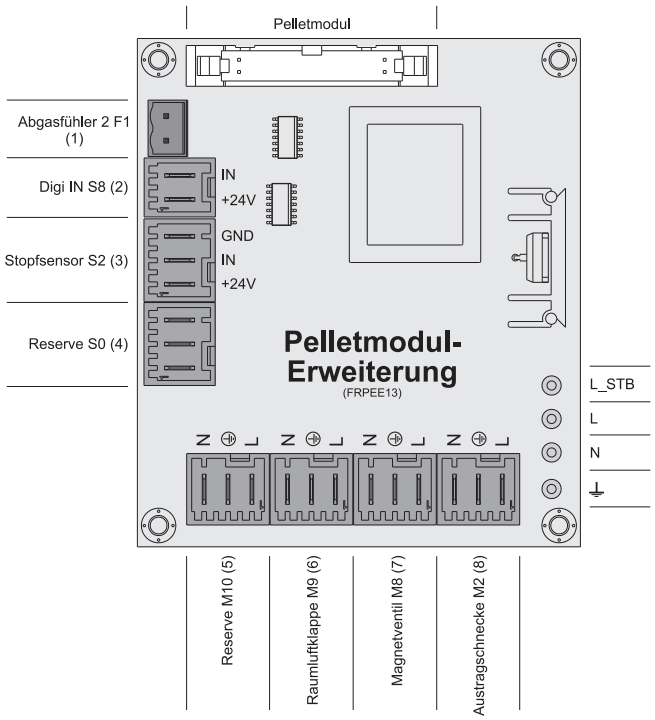
❒ Maximum load of the contact: 1A

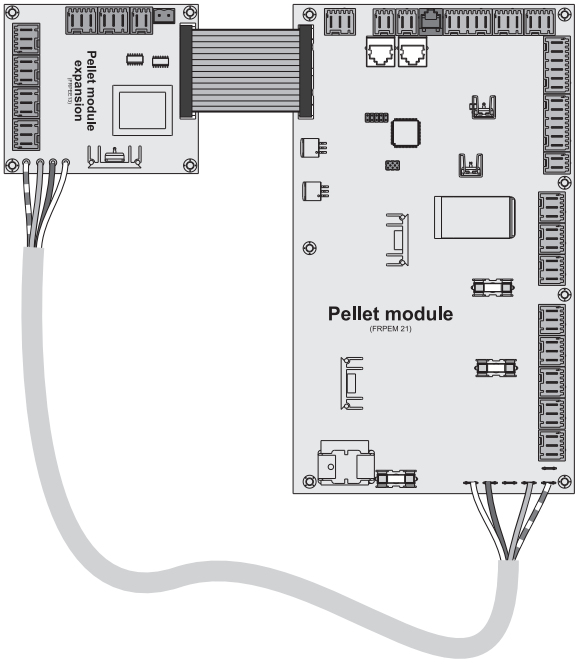


2.2.4 Pellet module expansion

The pellet module controls a suction delivery unit by default. The pellet module expansion is necessary if the suction screw systems or other discharge systems or system components from third-party manufacturers are used.

The power supply line and the communication line must be connected to the pellet module.





Connection instructions

Port	Cable dimensions / Specifications / Information
Flue gas temperature sensor 2 F1 (1)	Connection cable[1] 2 x 0.75 mm² Connection of a second flue gas temperature sensor in conjunction with the condensing boiler heat exchanger.
Digi IN S8 (2)	Connection cable[1] 2 x 0.75 mm², 24VDC 24V digital input that determines the open position of the room air flap: ▪ Digital input = 1 when the flap is open ▪ Digital input = 0 when the flap is closed
Jam sensor S2 (3)	For connection, see below. Jam sensor in conjunction with a suction screw as the discharge system.
Reserve (4/5)	Not in use!
Room air flap (6)	Connection cable[1] 3 x 1.5 mm², max. 1A / 230V
Delivery screw (8)	Connection cable[1] 3 x 1.5 mm², max. 4A / 230V / 900W

1) YMM as per ÖVE-K41-5 or H05VV-F DIN VDE 0881-5

Jam sensor S2 connection configuration

❒ The white wire of the sensor is not used.

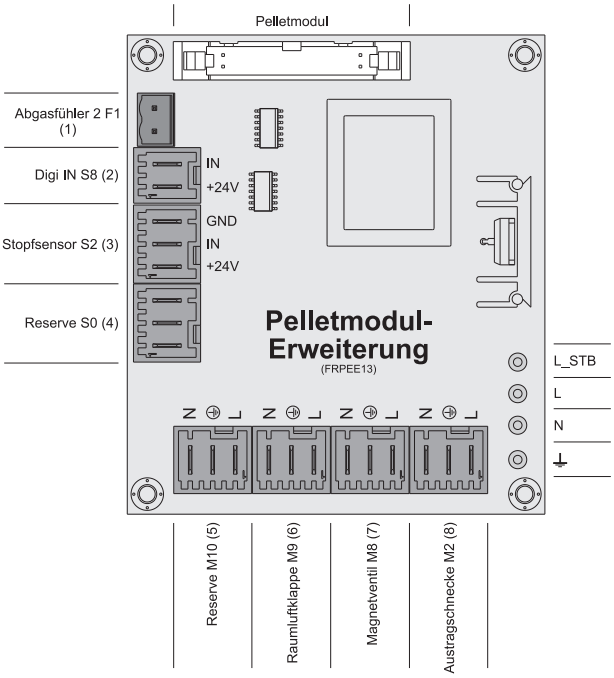
Automatic room air flap

An output for controlling an automatic room air flap is available on the pellet module expansion board. When the boiler starts the output is switched and the flap is opened. This function is monitored by the input, "Digi IN S8".

- Digital input = 1 when the flap is open
- Digital input = 0 when the flap is closed

If the room air flap is activated and the controller receives no confirmation that the flap is open, after 5 minutes the notice, "`Automatic room air flap will not open`" appears on the display and the boiler does not start.
If this input fails in "Heating" mode, the boiler follows shutdown procedure.

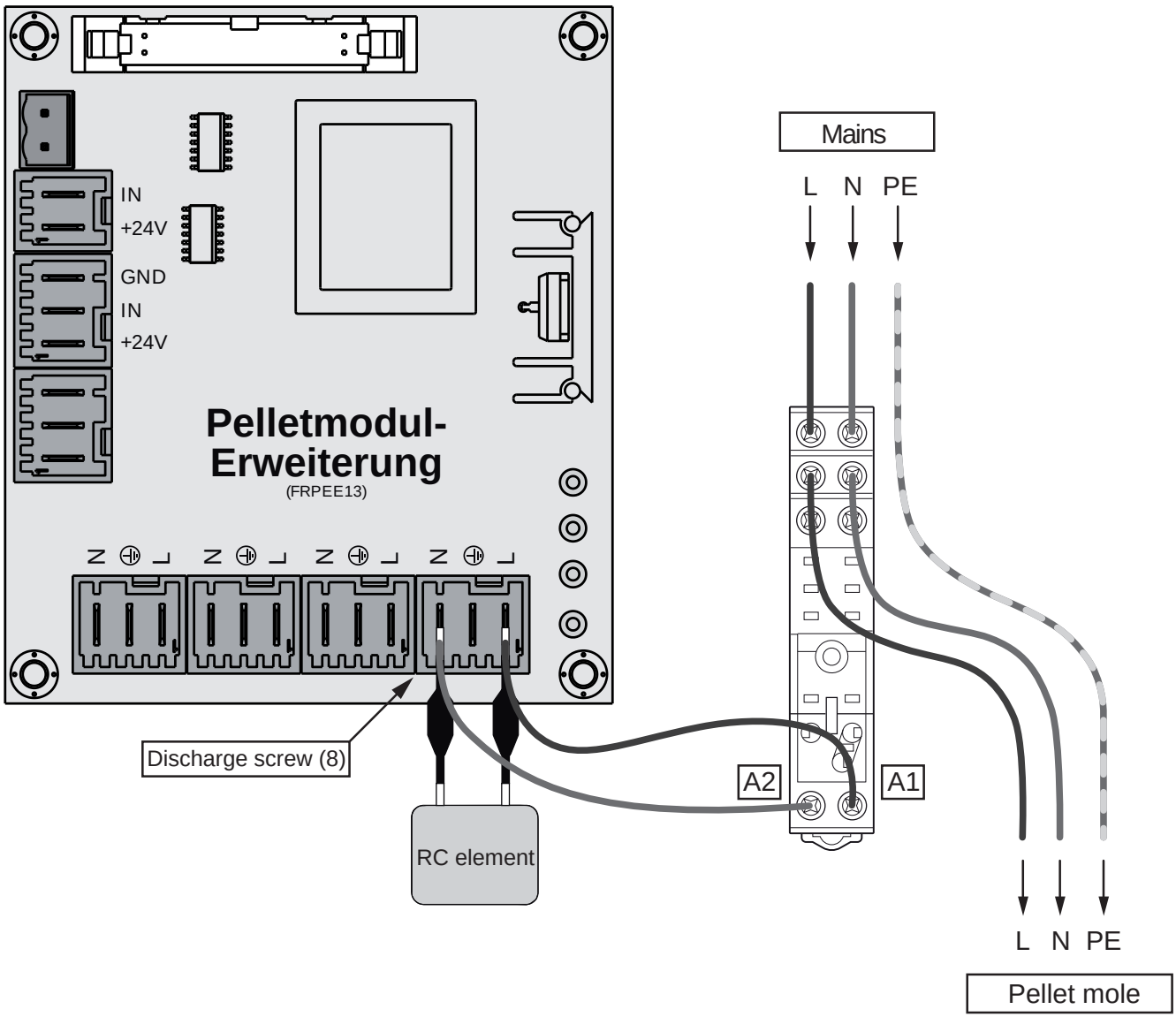
If the boiler stops, this output is no longer activated and the room air flap closes again.



❒ The confirmation signal from the room air flap for the input, Digi IN S8, must be potential free.

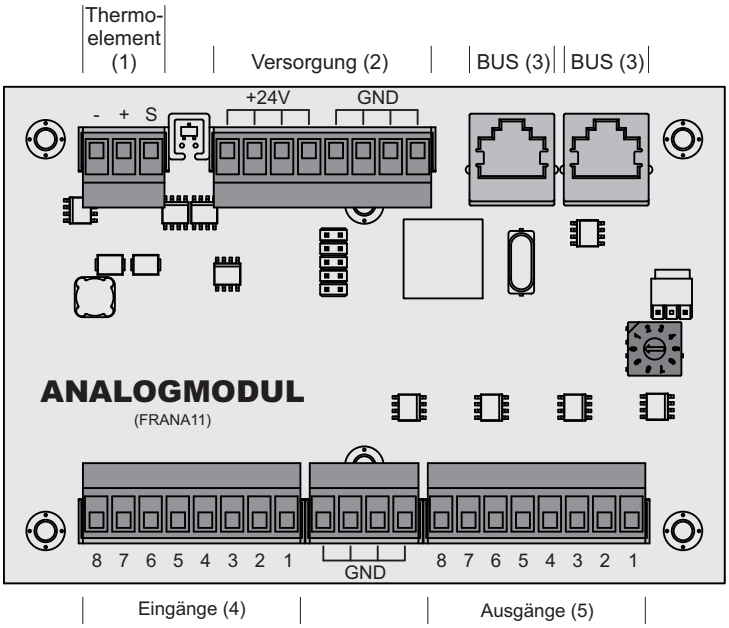
Connection instructions for pellet mole

The diagram below shows the electrical connection of the Schellinger pellet mole to the Froling Lambdatronic 3200 boiler controller. The pellet module expansion board is required for operation.



- ❒ Connect terminals A1 and A2 of the relay base to ports L and N on the “discharge screw M2” output of the pellet module expansion board as illustrated using the RC element provided
- ❒ Connect L and N of the power supply line for the pellet mole to the "COM" terminals of the relay switch contacts and wire from the "NO" terminals to the pellet mole

2.2.5 Analogue module



Connection instructions

Port	Cable dimensions / Specifications / Information
Thermocouple (1)	Connect sensor under moving grate (TI wood chip boiler)
Power supply (2)	Connection cable[1)] 2 x 1.0 mm²
2 x Bus (3)	CAT 5 patch cable grey RJ45 SFTP 1:1 configuration
Input 1 … 8 (4)	Connection cable[1)] 1 x 0.75 mm²
Output 1 … 8 (5)	Connection cable[1)] 1 x 0.75 mm²

YMM as per ÖVE-K41-5 or H05VV-F as per DIN VDE 0881-5

External power demand 0-10V

You can define an external power demand for the boiler via the analogue module using a 0-10V signal. The type of power demand can be set using the "`Source for ext. power demand (0 – off, 1 – 0-10V, 2 – modbus)`" parameter. If 0-10V is selected as the source, the boiler enable mechanism can be controlled via an adjustable input at the analogue module. If the signal at the input is above 35%, the boiler starts in continuous load mode; if the signal drops below 30%, the boiler shuts down. By default 0V = 0% and 10V = 100%. This can be changed using the "`Invert ext. power demand via analogue input`" parameter.

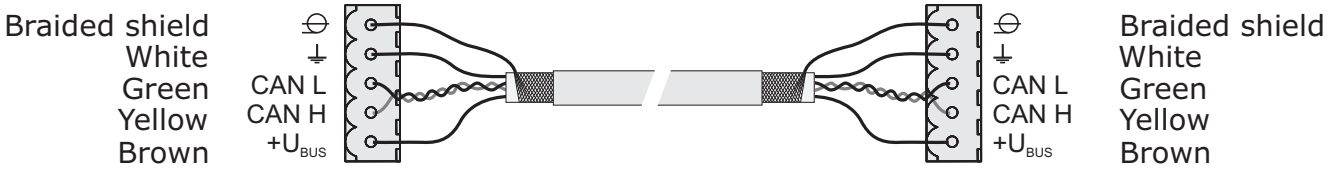
In order to start the boiler via the power request, "Automatic" mode must be set and the release contact (if in use) must be closed.

Necessary parameters for the parameterisation of the power demand are in the menu "*Boiler – General settings*"

Boiler type	Connection
PE1 Pellet, P4 Pellet, T4, TX	Module address: 0 input: 3
TI	Module address: 1 input: 8

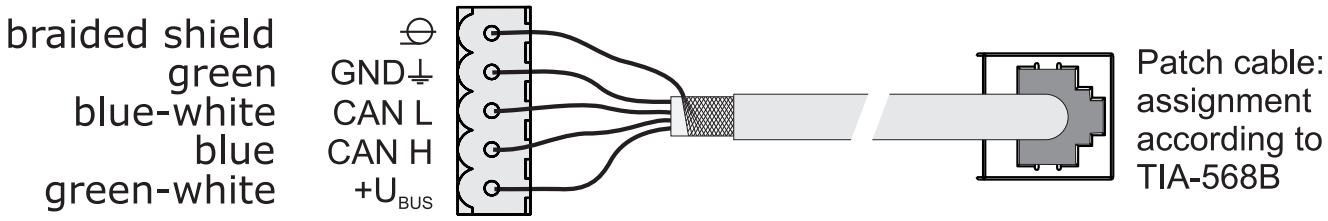
2.2.6 Connecting the bus cable

For the bus connections between the individual modules cable type **LIYCY paired 2x2x0.5** should be used. The connection to the 5-pin plugs should be carried out according to the following diagram:



2.2.7 Connect the patch cable to the bus plug

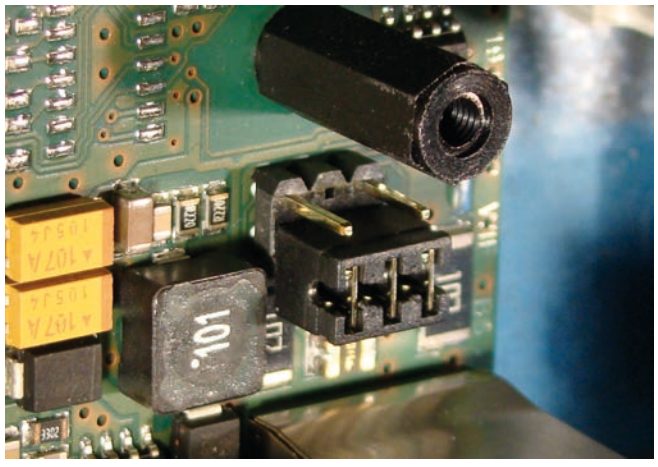
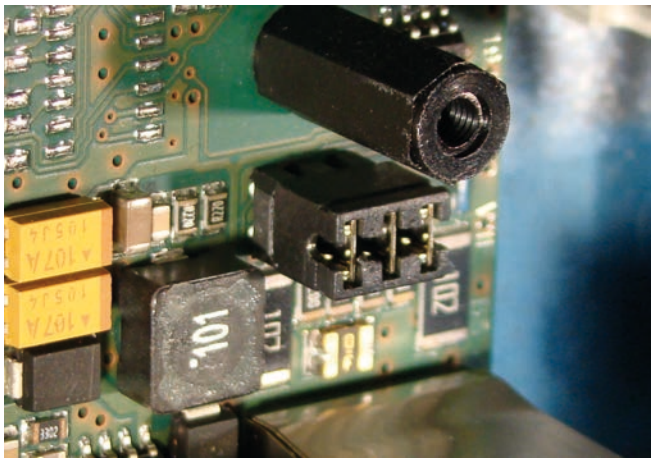
To connect a patch cable to a RJ45 bushing and a 5-pin plug, follow the connection diagram below:



2.2.8 Setting end jumpers

To ensure smooth running of the bus system, the jumper must be set on the last module.

To ensure smooth running of the bus system, the jumper must be placed on the last module.

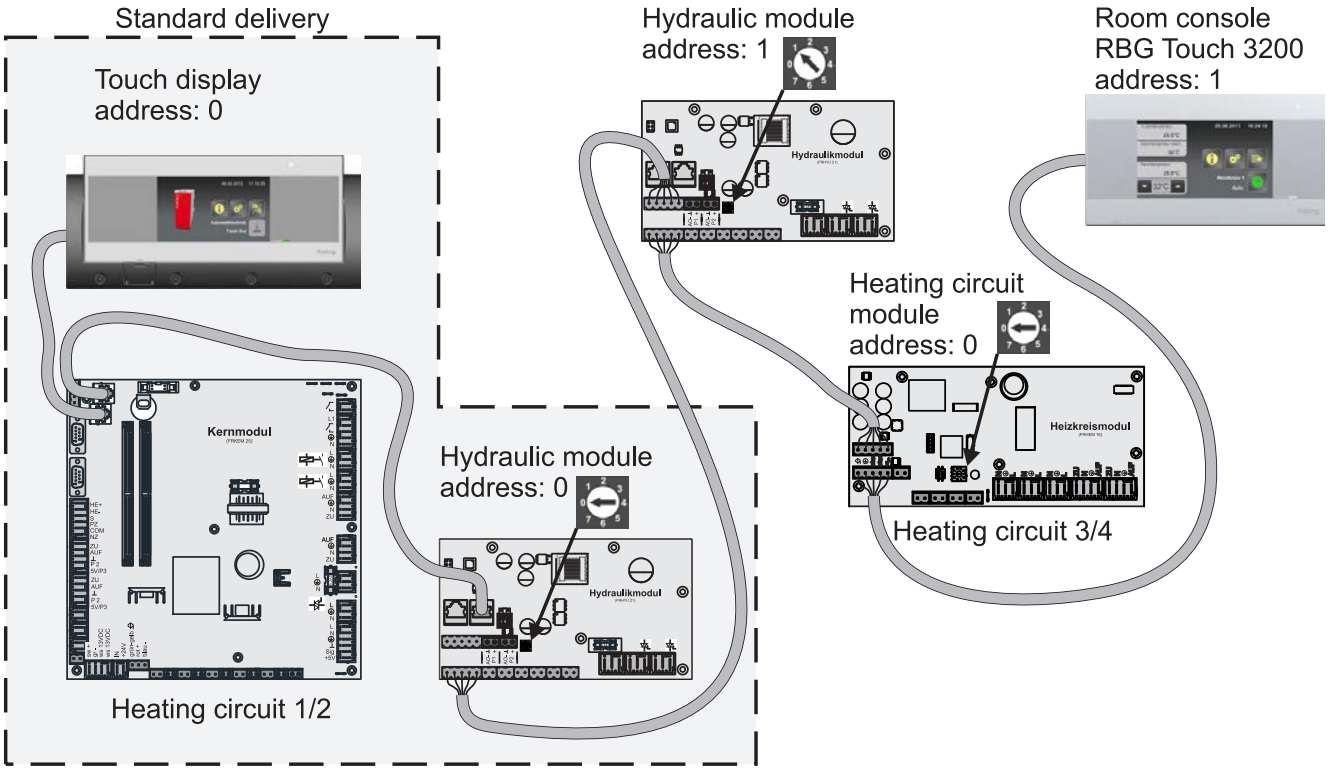
End jumper not set	End jumper set
	

If the contacts at the base of the end jumper are not bridged (image left), it is referred to as “not set". In this case there is no bus termination. If the contacts are closed (image right), the end jumper is set and the bus connection is terminated.

2.2.9 Setting the module address

For hydraulic modules or heating circuit modules it is necessary to set the necessary order with the module addresses. The first board of a module type should always have the address 0, so that the standard hydraulic systems set do not have to be subsequently configured. For further module types rising module addresses (address 1 - 7) are set.

Important! Only set the module address when the device is disconnected from the power supply!



Module address set	Heating circuit module	Hydraulic module	
	Heating circuit	Sensors	Pump
0	03 – 04	0.1 – 0.6	0.1 – 0.2
1	05 – 06	1.1 – 1.6	1.1 – 1.2
2	07 – 08	2.1 – 2.6	2.1 – 2.2
3	09 – 10	3.1 – 3.6	3.1 – 3.2
4	11 – 12	4.1 – 4.6	4.1 – 4.2
5	13 – 14	5.1 – 5.6	5.1 – 5.2
6	15 – 16	6.1 – 6.6	6.1 – 6.2
7	17 – 18	7.1 – 7.6	7.1 – 7.2

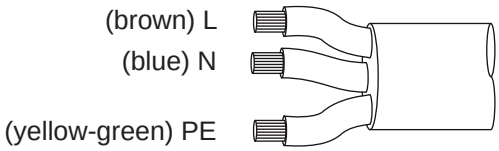
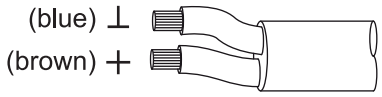
2.3 Connection diagrams according to pump types

Three different pump types are used in all depending on the pump assembly used:

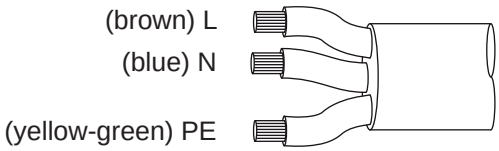
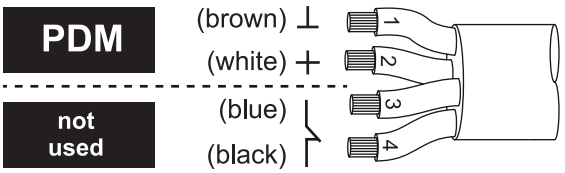
WILO Stratos Para	WILO Stratos TEC	WILO Yonos Para

Either a 2-pin control cable (WILO Stratos TEC, WILO Yonos Para) or a 4-pin control cable (WILO Stratos Para) is used for the connection depending on the pump type. Please follow the connection instructions below for the wiring depending on the pump type used:

Pump type with 2-pin control cable

Power supply	2-pin control cable
	
Wire the power supply to the pump outlet on the board	Connect the control cable to the board's PDM output, making sure that the polarity is correct: - blue wire to earth - brown wire to plus

Pump type with 4-pin control cable

Power supply	4-pin control cable
	
Wire the power supply to the pump outlet on the board	Connect the control cable to the board's PDM output, making sure that the polarity is correct: - brown wire to earth - white wire to plus Do not use the other two wires (blue, black) and insulate if necessary

3 Initial start-up with settings wizards

3.1 Before switching on for the first time

NOTICE

You should have the initial startup carried out by the authorised heating engineer from Froling customer services.

3.1.1 Controller check

- ❒ Check boards for foreign bodies (pieces of wire, washers, screws …)
- ❒ Carry out a wiring check:
  Check for loose, uninsulated wires, which could cause a short-circuit
- ❒ Check plug configuration of pumps, mixing valves and other units, which have NOT been prepared by Froling
- ❒ Check the connection of the BUS cable for short-circuits
- ❒ Check the specified addresses and terminal jumpers on the individual modules (heating circuit modules, hydraulic modules, displays…)

3.1.2 Check on the connected units

- ❒ Check that all units that are used are connected correctly
- ❒ Carry out wiring check:
  Check for loose or uninsulated wires in the terminal boxes of the pumps, mixing valve and switch valve, which could cause a short-circuit

3.1.3 System check

- ❒ Check that the main fuse for the boiler has a sufficient rated amperage

⇨ See "Mains connection" [page 7]

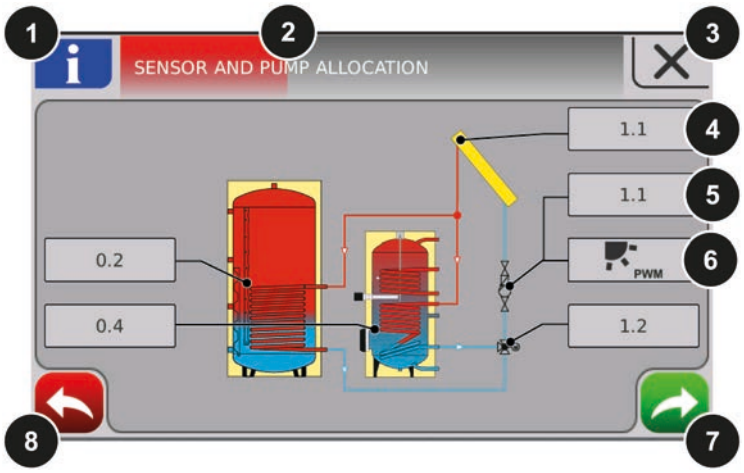
3.2 General information about the settings wizard

A wide variety of settings wizards are available for the initial start-up of the boiler system. A small selection of these can be found on the “Customer” operating level in the “Quick selection menu”; the rest are only on the “Service” operating level. The settings wizards can be used to set various sections of the boiler system (boiler, lambda probe, hydraulic system, …) with guided queries of the controller.

The following settings wizards are available for specific systems. Because they are interdependent, the sequence is automatically determined by the controller.

Icon	Designation
	Switching on for the first time Queries are made regarding language, production number, date and time
	Boiler Setting for boiler type, boiler output, fuel, return temperature control and boiler-specific options (ignition, filter, calorific value heat exchanger)
	Lambda probe Selection and calibration of the existing broadband lambda probe
	Feed system Selection of the existing discharge system (only for boilers with automatic loading)
	Hydraulic system Selection of the hydraulic system (hydraulic system 1, 2, 3, …)
	Additional components Selection and activation of the existing load and control components (heating circuits, DHW tank, solar, difference controller, …)
	Heating up Initial filling of the pellet container for pellet and dual fuel boilers; filling of the discharge screw and defining the loading times for the start process for wood chip boilers
	Connect Setting parameters required for the boiler to use the “froeling-connect.com” online control (IP address, display password, …)
	Heating up program Activation and selection of a heating up program.

Navigation as well as sensor and pump settings



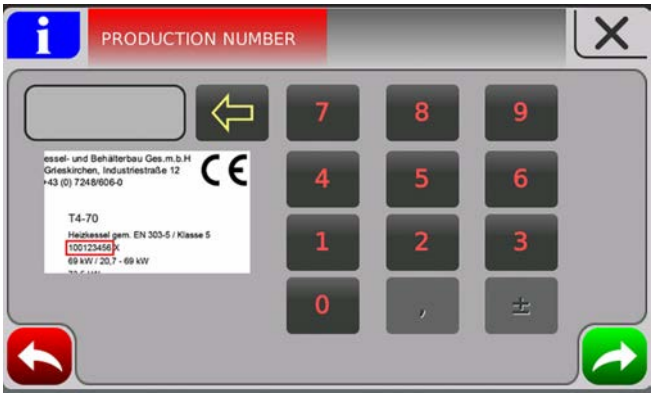
Number	Description	
1	If the Info button has a blue background, more information is available for this overview page.	
2	Progress bar for the respective settings wizards	
3	Cancel setting wizard	
4	Setting the address to which the respective sensor was connected	
5	Setting the address to which the respective pump was connected	
6	Defining the control signal of the respective pump. The following options are available depending on the selected menu:	
		Pump without control line
		HE pump without control line
		Field pump / PDM
		Solar pump / PDM
		Field pump PDM + valve
		Solar pump PDM + valve
		Field pump / 0 - 10 V
		Solar pump / 0 – 10 V
		Field pump 0-10V+valve
		Solar pump 0-10V + valve
		Isolating valve
	⇨ See "PDM / 0 - 10V settings" [page 102]	
7	Continue to the next step	
8	Go back one step	

3.3 Switching on for the first time

Once you have connected the device to the power supply and switched on the main switch, the display begins with a query regarding the basic settings of the system (language, production number of the boiler system, date, and time). Then the basic screen of the touch display is shown.

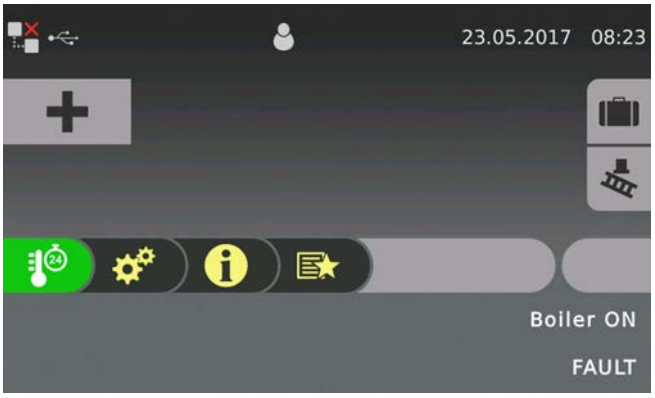
1: Selection of the controller language

2: Setting the production number (see identification plate)



3: Setting the date and time

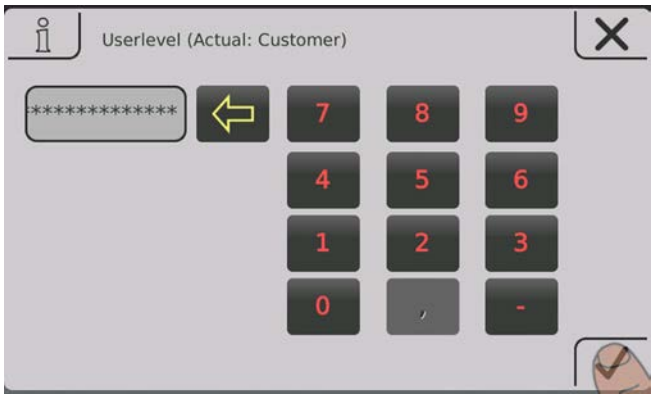
4: Display of the basic screen



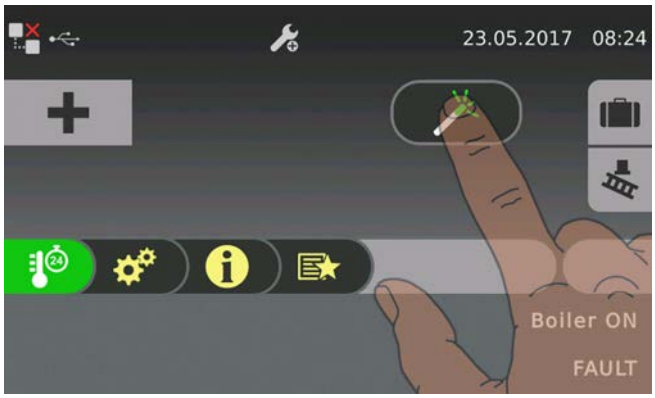
3.4 Starting the setting wizard

1: Tap the icon to change the user level

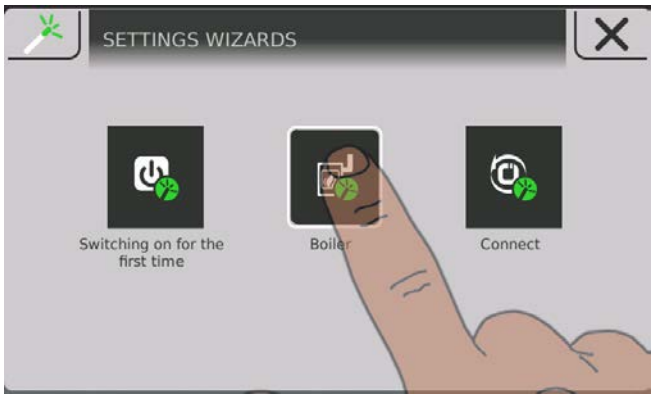
2: Type in the service code and confirm



3: Tap the icon of the settings wizard

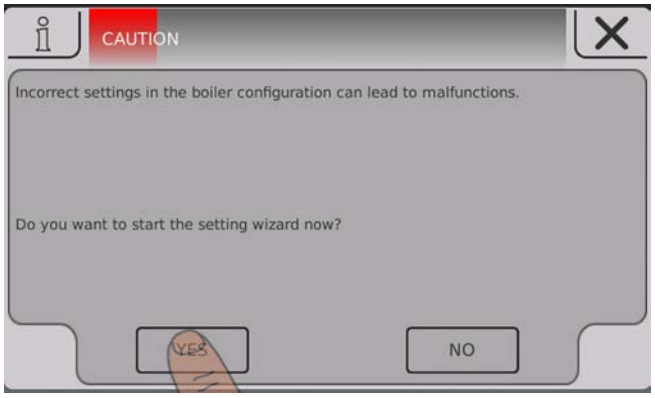


4: Tap the “Boiler” setting wizard



5: The settings wizard loads

6: Read the information text and continue with “YES” to start



4 Parameters overview

4.1 Heating

4.1.1 Heating - Status

System menu Heating

Heating circuit mode

Display and setting the heating circuit mode:

- **Auto:** Automatic: heating phases according to the set heating times
- **Extra heating:** heating circuit is activated for 6 hours.
- **Setback**: Setback mode; the heating phases are ignored
- **Continuous setback mode:** Heating circuit is reduced until activation of another mode.
- **Party:** party mode; the current or next setback program is ignored
- **OFF:** switched-off; heating circuit deactivated, only frost protection!

Actual flow temperature

Display of the current flow temperature.

Flow temperature setpoint

Display of the calculated flow temperature setpoint.

Room temperature

Prerequisite: Heating circuit used in conjunction with remote control

Display of the current room temperature.

Outside air temperature

Display of the current outside air temperature.

4.1.2 Heating – Temperatures

System menu Heating

Desired room temperature during heating mode

Prerequisite: Heating circuit used in conjunction with remote control

Room temperature which is regulated during the set heating times

Desired room temperature during setback mode

Prerequisite: Heating circuit used in conjunction with remote control

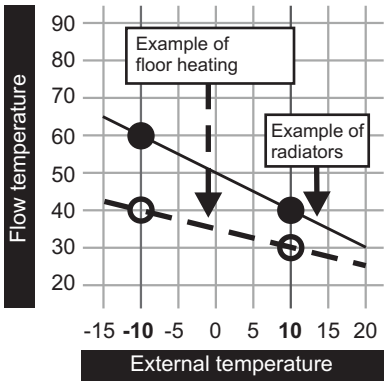
Room temperature which is regulated outside of the set heating times

Flow temperature SP at outside air temperature of +10°C

First setting point for definition of heating curve

Flow temperature SP at outside air temperature of -10°C

Second setting point for definition of heating curve



Controller gain room temperature Kp-Rm

Prerequisite: Heating circuit used in conjunction with remote control

Influencing factor of room temperature on the flow temperature of the heating circuit. If there is a deviation in the room temperature of +/- 1°C the set value of the flow temperature is corrected by this value. (Only in conjunction with remote control)
Recommended values:

- Floor heating: 2-3
- Radiators (new build): 4-5
- Radiators (old build): 6-7

NOTICE! Observe external influences on the remote control!

Reduction of flow temperature in setback mode

The flow temperature is reduced by this value during setback mode.

External temperature, at which heating circuit pump switches off in heating mode

If the outside air temperature exceeds this value during heating, the heating circuit pumps and mixing valve are deactivated.

External temperature, at which heating circuit pump switches off in setback mode

If the outside air temperature falls below this value in setback mode, the heating circuit pumps and mixing valve are activated.

Maximum heating circuit flow temp.

Maximum temperature for limiting outfeed temperature at which the heating circuit is supplied.

Maximum DHW tank flow temp.

If DHW tank 1 is supplied directly from heating circuit 1, you can limit the maximum flow temperature for the duration of DHW tank loading.

Frost protection temperature

If the room temperature or the flow temperature is lower than the set value, the heating circuit pump will be switched on and the heating circuit mixer keeps to the maximum heating circuit flow temperature that is set.

From which temperature at storage tank top should the overheating protection be activated

If the temperature at top storage tank exceeds the set value, the heating circuit is activated regardless of mode (boiler, remote control) and set heating times. The flow temperature is controlled to the value set in the parameter “Flow temperature SP at outside air temperature of -10°C”. The function will remain active until the value falls below 2°C.

Recommendation: The overheating protection should be assigned to a high temperature heating circuit (e.g. radiators).

4.1.3 Heating - Times

System menu Heating

⇨ See "Setting times" [page 109]

4.1.4 Heating - Service

System menu Heating

Heating circuit pump

Used for testing the pump output:

- **A 0**: Automatic, Off; **A 1**: Automatic, On
- **1**: Manual, On
- **0**: Manual, Off

Heating circuit mixer OPEN

Used for testing the mixing valve output:

- **A 0**: Automatic, Off; **A 1**: Automatic, On
- **1**: Manual, On
- **0**: Manual, Off

Heating circuit mixer CLOSED

Used for testing the mixing valve output:

- **A 0**: Automatic, Off; **A 1**: Automatic, On
- **1**: Manual, On
- **0**: Manual, Off

Mixer runtime

Here you can set the mixer runtime of the mixer in use.

NOTICE! To avoid mixer vibration, do not set value < 150s!

Switch off heating circuit pump when outfeed setpoint is lower than

Prerequisite: Heating circuit is operated without remote control

If a flow temperature setpoint is calculated below the value set, the heating circuit pump switches off the heating circuit pump and the mixing valve closes.

Should this heating circuit heat when there is DHW tank priority?

- **NO**: During DHW tank loading this heating circuit is deactivated.
- **YES**: Despite active DHW tank priority, this heating circuit is supplied with heat during DHW tank loading.

From which buffer tank or distributor is the heating circuit supplied (0 = boiler)

Prerequisite: Parameter can only be used in conjunction with multiple house systems (variants)

This parameter defines the allocation of the heat source for this heating circuit.

- **0** = boiler
- **1** = buffer tank 01, …

High temperature requirement because of DHW tank 1 loading

- **NO**: The heating circuit is operated according to the selected heating curve.
- **YES**: Loading of DHW tank from the heating circuit. If there is a requirement from the DHW tank and the criteria for DHW tank loading have been met, the isolating valve immediately clears the way for boiler loading. The heating circuit pump starts running as soon as the "`Load if temperature difference between boiler and DHW tank is`" criterion is reached. Once DHW tank loading is complete, the heating circuit pump will stop, the isolating valve will remain active for a specified period of time and the heating circuit mixer will close. If time has run out, the heating circuit will go back to being supplied on a weather-compensated basis.

Parameter only available with "heating circuit 1" and generally only used in conjunction with the unit model of the PE1 Pellet pellet boiler!

High temperature requirement because of DHW tank loading

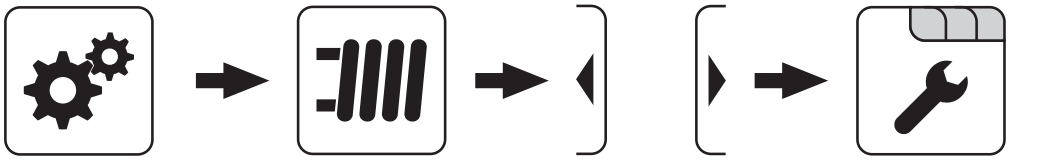
- NO: The heating circuit is operated according to the selected heating curve.
- YES: The heating circuit is operated according to the selected heating curve. Whilst the DHW tank is loading, the heating circuit is operated at a higher temperature for the duration of the DHW tank loading. Once the DHW tank is loaded, the heating circuit is supplied again according to the heating curve.

NOTICE! Parameters for "heating circuit 2" only!

For high temperature requirement don't look at DHW tank 1

- NO: DHW tank 1 is not supplied with heat from the lines of heating circuit 2
- YES: DHW tank 1 is supplied with heat from the lines of heating circuit 2 and requires a higher temperature for the duration of the DHW tank loading.

4.1.5 Heating - Heating up program



Heating up program active

- NO: Heating up program deactivated, all heating circuits are operated according to the selected heating times.
- YES: The 30-day heating up program that has been set starts. After the 30 days, the heating circuit that has been selected operates based on the set heating times again.

– The heating times of the selected heating circuit, as well as the boiler/buffer tank loading times are automatically set to 0:00-24:00 and the outside air temperature heating limit is ignored.

– When using a firewood boiler, a corresponding heat supply must be ensured.

– If the actual flow temperature setpoint required cannot be reached or maintained (e.g. boiler output, …), then no warning is displayed!

– In the event of a power failure, the program continues from the point at which it was interrupted.

If the current room temperature falls below the set frost protection temperature setpoint, this influences the set flow temperature setpoint of the heating up program.
NOTE: Only in conjunction with remote control!

Current day of the heating up program

Shows the current day of the heating up program that is running. By adjusting this parameter, you can jump forward or return to a specific day of the program.

Which heating up program is used

There are set options for the progression of the flow temperature in heating up programs 1 – 6. With heating up program 7 the flow temperature can be selected freely over the entire 30 days.

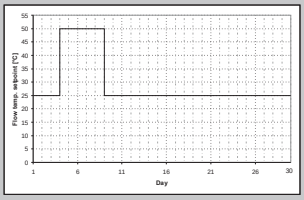
Heating up program 8 allows you to pre-define the progression of the flow temperature for each individual day.

Outfeed setpoint for all days in program 7

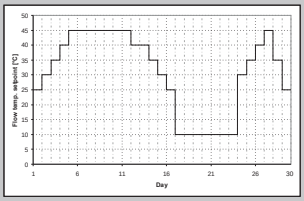
If heating up program 7 is active, the selected heating circuit is adjusted to the specified flow temperature.

Heating up programs

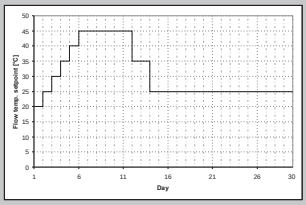
Heating up program 1:



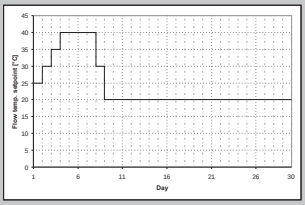
Heating up program 2:



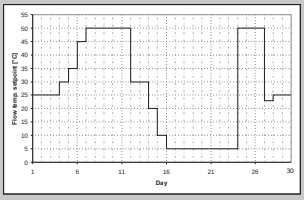
Heating up program 3:



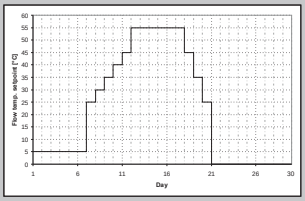
Heating up program 4:



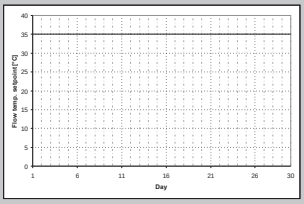
Heating up program 5:



Heating up program 6:



Heating up program 7:



The heating up programs listed are non-binding recommendations. If the heating up program is to be used for floor screed drying, you must consult the manufacturer of the floor finish and/or the installer!

Configure program 8

Configure program 8

Heating up program
Service

Outfeed temperature setpoint on day 1
Outfeed temperature setpoint on day 2
:
Outfeed temperature setpoint on day 30

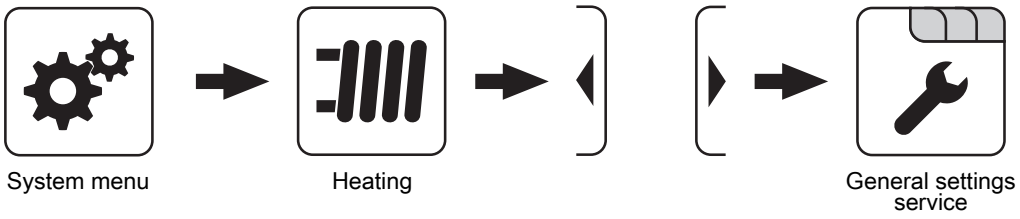
If “heating up program 8” is selected, the flow temperature setpoint can be preset for each day using this setting.

Heating circuits used

Use heating circuit 01
Use heating circuit 02
:
Use heating circuit 18

The number of heating circuits used depends on the system configuration. If only 2 heating circuits are installed, then only 2 heating circuits will be available for selection.
The heating up program selected will be used for all heating circuits!

4.1.6 Heating - General settings



Correction value for external sensor

If the outside temperature sensor shows an incorrect value, the value can be adjusted using this parameter.

Heating circuit module to which the external sensor is connected (0 = core module)

If the outside temperature sensor is not connected to the core module, the address of the relevant heating circuit module +1 must be set here. (Sensor 1 on relevant module)

Use room sensor input for room thermostat

NOTICE! This parameter influences all sensor connections which an analogue room temperature sensor can be connected to!

- **NO**: At the sensor connector of the room sensor, a room sensor must be connected to control the room temperature.
- **YES**: At the sensor connector of the room sensor, room thermostats can be connected to control the room temperature.

– Contact of room thermostat open: Heating circuit pump deactivated, mixing valve is closed

– Contact of room thermostat closed: Heating circuit pump and mixer control active

4.2 Water

4.2.1 Water - Status

System menu Water

DHW tank top temperature

Current temperature of the DHW tank. The DHW tank is heated when the time window for the DHW tank loading is reached and the current temperature of the DHW tank has fallen below the value using the parameter "`Reload if DHW tank temperature is below`". A loading of the DHW tank takes place when either the time window has elapsed or the temperature value which is set under "`Set DHW temperature`" is reached.

DHW tank bottom temperature

Prerequisite: Solar panel system is regulated by Froling!

Current temperature in the area of the reference sensor of the solar panel system.

DHW tank pump control

Specifies the speed of the DHW tank pump as a percentage of maximum speed.

4.2.2 Water - Temperatures

System menu Water

Set DHW temperature

When this DHW temperature is reached, DHW tank loading is stopped.

Reload if DHW tank temperature is below

If the DHW tank temperature falls below the value set here, the time window is active and the loading source (boiler or buffer tank) indicates the set loading increase, and the DHW tank loading is started.

Load if temperature difference between buffer tank and DHW tank is

When the buffer tank top temperature is above the current DHW tank temperature by this value and the time window is active, the DHW tank loading is started. (Only for systems with buffer tanks)

Load if temperature difference between boiler and DHW tank is

When the boiler temperature is above the current DHW tank temperature by this value and the time window is active, the DHW tank loading is started. (Only for systems with buffer tanks)

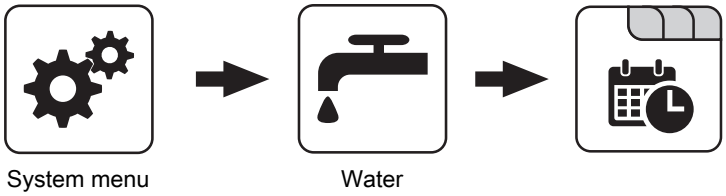
Setpoint for temperature difference between boiler and DHW tank

Adjusting the boiler temperature setpoint to reach the desired DHW tank temperature.

Boiler temperature setpoint = Set DHW temperature + difference

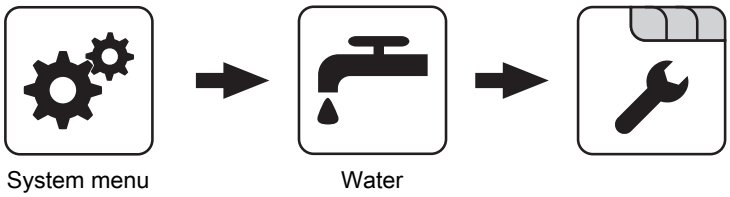
If the current boiler temperature setpoint calculated is higher than the result from the above calculation, the boiler temperature setpoint is maintained. (Only for systems without buffer tank)

4.2.3 Water - Times



⇨ See "Setting times" [page 109]

4.2.4 Water - Service



Residual heat use

Prerequisite: Hydraulic system 0 and return temperature control with mixing valve

- **YES**: Diverts the residual heat to the DHW tank, the "Minimum boiler temperature to release all pumps" parameter is ignored. The pump set to minimum speed until the boiler temperature is lower than the DHW tank temperature + 3°C.

Only load DHW tank once a day

- **NO**: A DHW loading takes place always when the DHW tank temperature falls below the value, which is set under "Reload if DHW tank temperature is below", and the time window is active and the heat source (boiler or buffer tank) indicates sufficient temperature.
- **YES**: If the DHW tank has already been loaded once on the current day, a further DHW tank loading is prevented.

Legionella heating activated

- **NO**: A legionella heating of the DHW tank is not carried out.
- **YES**: The DHW tank is heated to the temperature once a week, which is set under the parameter "DHW tank temp. setpoint for legionella heating (same for all DHW tanks)".

When should the Legionella heating be carried out?

Determines the day of the week on which the Legionella heating of the domestic hot water is carried out.

DHW tank temp. setpoint for legionella heating (same for all DHW tanks)

If the parameter "Legionella heating activated" is set to "YES", the DHW tank is heated to the set temperature on the specified day of the week.

Which buffer tank or heat distributor supplies the heat to this DHW tank (0 = boiler)

Prerequisite: Parameter can only be used in conjunction with multiple house systems (variants)

This parameter defines the allocation of the heat source for this DHW tank.

- **0** = boiler
- **1** = buffer tank 01, …

DHW tanks run-on (this parameter applies for all DHW tanks)

When DHW tank loading has finished, the DHW tank loading pumps continue to run for the time set here.

Sensor input of DHW tank 01 top sensor

Sensor input to which the DHW tank sensor is connected.

Sensor input of DHW tank 01 solar reference sensor

Sensor input to which the sensor for the DHW tank solar reference is connected.

Pump output of DHW tank 01 pump

Pump outlet to which the boiler loading pump is connected.

Control of DHW tank pump

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum DHW tank speed

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum DHW tank pump speed

If you need to limit the maximum speed of the boiler loading pump for systemic reasons, you can do so by adjusting this parameter.

4.3 Solar

4.3.1 Solar - Status

System menu → Solar

Collector temperature

Display of the current temperature at the solar collector.

Top storage tank solar sensor

Display of the current temperature at the solar reference sensor in the top part of the buffer tank.

Solar temperature buffer tank bottom

Display of the current temperature at the solar reference sensor in the lower part of the buffer tank.

Collector return temperature

Prerequisite: Hydraulic system 12 or 13

Display of the current temperature at the collector return.

Actual power from solar heat meter [kW]

Display of the current output which is generated by the solar collector. The calculation of the output is only performed either when a per litre output of the collector pump has been set or an external volume pulse transmitter is used. In order to perform the calculation more precisely, the use of a collector return sensor is recommended.

Flow through [l/h]

Prerequisite: External volume pulse transmitter installed

Display of the water quantity currently being pumped through the solar collector.

Todays yield [kWh]

Display of the heat quantity that has been supplied by the solar panel system today.

Daily yield 1 day ago [kWh]

Daily yield 2 days ago [kWh]

Daily yield 3 days ago [kWh]

Daily yield 4 days ago [kWh]

Daily yield 5 days ago [kWh]

Daily yield 6 days ago [kWh]

Shows the historical progression of the solar panel system. The yields of the last 6 days are available.

Daily yield 2 days ago [kWh]

Daily yield 3 days ago [kWh]

Daily yield 4 days ago [kWh]

Daily yield 5 days ago [kWh]

Daily yield 6 days ago [kWh]

Total yield [kWh]

Display of the heat quantity which has been supplied by the solar panel system since activation of the heat meter.

DHW tank bottom temperature

Current temperature in the area of the reference sensor of the solar panel system.

Heat exchanger sec. return temperature (line to buffer tank)

Prerequisite: Hydraulic system 12 or 13

Current temperature at heat exchanger flow on the secondary side.

Collector pump runtime

Display of the total runtime of the collector pump.

Collector pump control

Display of the current speed of the collector pump as a percentage of maximum speed.

Pump between heat exchanger and buffer tank

Prerequisite: Hydraulic system 12 or 13

Display of the current speed of the pump between heat exchanger and buffer tank.

Pump between heat exchanger and DHW tank

Prerequisite: Hydraulic system 12

Display of the current speed of the pump between heat exchanger and DHW tank.

Diverter valve for top/bottom coils

Prerequisite: Hydraulic system 12 or 13

Current control of the isolating valve on the solar side.

- **0%** … bottom buffer tank
- **100%** … top buffer tank

4.3.2 Solar - Temperatures

System menu Solar

Boiler target temperature during solar charging

Up to this temperature the DHW tank is heated by the solar system. If the solar panel system is equipped with an isolating valve for switching between DHW tank and buffer solar coil, then this parameter is responsible for switching between both of these solar coils.

Temp differential to start collector pump

The collector pump activates when the collector temperature exceeds the reference temperature in the DHW tank or buffer tank by this value.

Temp difference to stop collector pump

The collector pump switches off when the difference between the collector temperature and reference temperature in the DHW tank or buffer tank is lower than this value.

Maximum buffer tank bottom temperature during solar charging

Prerequisite: Hydraulic system 12 or 13

If the sensor for the solar reference temperature in the buffer tank exceeds the specified value, the collector pump is switched off.

Minimum collector temperature

Minimum temperature at collector which must be reached in order for the solar control to start.

Collector/pump protection from a collector temp.

If the measured value of the solar collector sensor exceeds the set value, then the solar collector must cool down by 20°C within 15 minutes, otherwise the solar collector pump stops in order to protect the pump.

Heat exchanger - buffer tank pump start delay

Prerequisite: Hydraulic system 12 or 13

Delay for switching on the pump between heat exchanger and buffer tank.

Heat exchanger – buffer tank pump stop delay

Prerequisite: Hydraulic system 12 or 13

Delay for switching off the pump between heat exchanger and buffer tank.

Buffer tank top solar setpoint (fast loading until this temperature)

Prerequisite: Hydraulic system 12 or 13

When the upper sensor in the buffer tank reaches the specified value, the solar isolating valve switches to the lower area of the buffer tank.

Collector - buffer tank top differential

Prerequisite: Hydraulic system 12 or 13

This is the overcharge for the collector pump controller for the top or bottom temperature in the buffer tank.

Top buffer tank – secondary HE flow difference

Prerequisite: Hydraulic system 12 or 13

This parameter specifies how much the heat exchanger secondary outfeed temperature should be below the collector temperature. If the difference is less than the set value, the speed of the pump between heat exchanger, DHW tank and buffer tank is reduced.

4.3.3 Solar - Times

System menu Solar

The solar panel system pump is allowed to start from

If the criteria for starting the collector pump have been reached from the set time, the collector pump starts.

The solar panel system pump is allowed to run until

Also when the criteria for starting the collector pump have been reached, the collector pump is only active up to the set time.

4.3.4 Solar - Service

System menu Solar

Solar system

- **1**: The solar panel system supplies only the DHW tank
- **2**: The solar panel system supplies only the buffer tank
- **3**: The solar panel system is expanded with a switch valve and is used to supply two different heat sinks. For example: Switch from domestic hot water tank to buffer tank, or between top and bottom solar coils with the hygienic solar layered tank or modular solar layered tank with 2 solar coils)

NOTICE! This parameter is not displayed when hydraulic system 12 or 13 is set.

Pump output of collector pump

Pump outlet to which the collector pump is connected.

Control of collector pump

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum collector pump speed

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum collector pump speed

If you need to limit the maximum speed of the collector pump for systemic reasons, you can do so by adjusting this parameter.

Collector monitoring

- **YES:** The collector pump is switched on at regular intervals for 10 seconds. The time can be defined using the following parameter. If the collector sensor detects an increase in temperature, the pump is kept on. This function is active from 10:00am - 7:00pm and the threshold value of the collector temperature, from which this function is active, is dynamically adjusted.
- **NO:** The collector pump only starts when the criteria which is defined under parameter "`Temp differential to start collector pump`" is reached.

Collector monitoring every

If the collector pump is not active within the time window between 10:00am – 19:00pm, this is activated for 10 seconds at the end of the specified time set here. If the collector sensor detects an increase in temperature, the pump is kept on. If no temperature increase on the collector sensor is detected, the collector pump switches off and the time starts to run afresh.

For solar to buffer and DHW tank, the DHW tank has priority

- **YES**: The DHW tank is loaded until the temperature is reached, which is set under "`Set DHW temperature during solar charging`", and only then switched to the buffer tank by means of the switch valve.
- **NO**: The DHW tank is charged until the temperature difference between the sensor on the solar collector and the solar reference sensor in DHW tank is no longer sufficient. The isolating valve then switches to the buffer thank and supplies it for 20 minutes. Afterwards the collector pump is stopped for 20 minutes and a check is carried out to see if the temperature difference is now sufficient for DHW tank charging.

Solar charging to which buffer tank

This parameter defines the buffer tank to which the solar charging takes place.

Solar charging to which DHW tank

This parameter defines the DHW tank to which the solar charging takes place.

Sensor input of solar collector sensor

Sensor input to which the collector sensor is connected.

Sensor input of solar reference storage tank top sensor

Prerequisite: Hydraulic system 12 or 13

Sensor input to which the solar reference sensor in the top part of the buffer tank is connected.

Sensor input of solar reference storage tank bottom sensor

Sensor input to which the solar reference sensor in the lower part of the buffer tank is connected.

Sensor input of secondary HE Sensor flow

Prerequisite: Hydraulic system 12 or 13

Sensor input to which the sensor at heat exchanger flow on the secondary side is connected.

Sensor input of collector return sensor

Sensor input to which the sensor for the collector return is connected.

Pump output of solar isolating valve

Pump outlet to which the solar isolating valve is connected.

Pump output of storage tank – heat exchanger pump

Prerequisite: Hydraulic system 12 or 13

Pump outlet to which the pump between the solar heat exchanger and buffer tank is connected.

Control of storage tank – heat exchanger pump

Prerequisite: Hydraulic system 12 or 13

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Pump outlet of DHW tank – heat exchanger pump

Prerequisite: Hydraulic system 12

Pump outlet to which the pump between the solar heat exchanger and DHW tank is connected.

Control of DHW tank – heat exchanger pump

Prerequisite: Hydraulic system 12

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Invert isolating valve

Prerequisite: Solar system 3

- **NO**: The pump output, which the solar isolating valve is connected to, is supplied with 230V when the solar panel system supplies energy to the DHW tank solar coil. If there is no 230V at this output, then the valve clears the way for the buffer solar coil.
- **YES**: If the solar isolating valve switches incorrectly, the way it is controlled can be adjusted using this parameter.

Prerequisite: Hydraulic system 12 or 13

- **NO**: The pump output, which the solar isolating valve is connected to, is supplied with 230V when the solar panel system supplies energy to the top part of the buffer tank. If there is no 230V at this output, then the valve clears the way for the lower area of the buffer tank.
- **YES**: If the solar isolating valve switches incorrectly, the way it is controlled can be adjusted using this parameter.

Is a PT1000 sensor used as a solar sensor?

- **NO**: A KTY81 sensor is used as a collector sensor
- **YES**: A PT1000 sensor is used as a collector sensor

Collector pump control Kp value

Control parameter for the speed control of the collector pump.

Collector pump control Tn value

Control parameter for the speed control of the collector pump.

Secondary HE pumps control Kp value

Prerequisite: Hydraulic system 12 or 13

Control parameter for the speed control of the pump between the solar heat exchanger and buffer tank, as well as for the pump between the solar heat exchanger and DHW tank (if installed).

Secondary HE pumps control Tn value

Prerequisite: Hydraulic system 12 or 13

Control parameter for the speed control of the pump between the solar heat exchanger and buffer tank, as well as for the pump between the solar heat exchanger and DHW tank (if installed).

Minimum pump speed secondary HE

Prerequisite: Hydraulic system 12 or 13

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

This parameter applies for the pump between the solar heat exchanger and buffer tank, as well as for the pump between the solar heat exchanger and DHW tank (if installed).

4.3.5 Solar - Heat meter

System menu → Solar

Collector temperature

Display of the current temperature at the solar collector.

Collector return temperature

Prerequisite: Hydraulic system 12 or 13

Display of the current temperature at the collector return.

Actual power from solar heat meter [kW]

Display of the current output which is generated by the solar collector. The calculation of the output is only performed either when a per litre output of the collector pump has been set or an external volume pulse transmitter is used. In order to perform the calculation more precisely, the use of a collector return sensor is recommended.

Flow through [l/h]

Prerequisite: External volume pulse transmitter installed

Display of the water quantity currently being pumped through the solar collector.

Todays yield [kWh]

Display of the heat quantity that has been supplied by the solar panel system today.

Daily yield 1 day ago [kWh]

Daily yield 2 days ago [kWh]

Daily yield 3 days ago [kWh]

Daily yield 4 days ago [kWh]

Daily yield 5 days ago [kWh]

Daily yield 6 days ago [kWh]

Shows the historical progression of the solar panel system. The yields of the last 6 days are available.

Daily yield 2 days ago [kWh]

Daily yield 3 days ago [kWh]

Daily yield 4 days ago [kWh]

Daily yield 5 days ago [kWh]

Daily yield 6 days ago [kWh]

Total yield [kWh]

Display of the heat quantity which has been supplied by the solar panel system since activation of the heat meter.

Nominal flow of collector pump for heat meter [L/h]

If no external volume pulse transmitter is used, the pump of the heat meter can be activated by entering the per litre output. The flow rate at 100% collector pump speed must be entered here.

NOTICE! This parameter can be ignored if using an external volume pulse transmitter.

Litres per pulse of flow through meter

If an external volume pulse transmitter is used, adjust this value according to the volume pulse transmitter used. [0.5 – 5 pulses/L]

Sensor input of collector return sensor

Sensor input to which the sensor for the collector return is connected.

Sensor input of heat meter flow temperature sensor

Sensor input to which the sensor for the heat meter flow temperature is connected.

Is an external flow through counter used

- **YES:** An external volume pulse transmitter is in use.

4.4 Buffer tank

4.4.1 Buffer tank - Status

System menu → Buffer tank

Buffer tank top temperature

Display of the current temperature in the top part of the buffer tank.

Buffer tank temperature, sensor 2

Prerequisite: Master boiler in the cascade or hydraulic system 4 or fuel amount calculation

Display of the current temperature in the top part of the buffer tank.

Buffer tank temperature, sensor 3

Prerequisite: Master boiler in the cascade or hydraulic system 4 or fuel amount calculation

Display of the current temperature in the lower part of the buffer tank.

Buffer tank middle temperature

Prerequisite: Middle buffer tank temperature sensor installed

Display of the current temperature in the mid area of the buffer tank.

Buffer tank bottom temperature

Display of the current temperature in the lower part of the buffer tank.

Buffer tank pump control

Display of the current speed of the buffer loading pump.

Buffer tank charge

Prerequisite: Master boiler in the cascade or hydraulic system 4 or fuel amount calculation

Display of the current buffer tank charge.

4.4.2 Buffer tank - Temperatures

System menu Buffer tank

Heating circuit release from following buffer tank temperature

Temperature value which must be reached to release the heating circuit pumps in the top part of the buffer tank.

NOTICE! This parameter applies for all available heating circuits!

Boiler start if difference between boiler setpoint and top buffer is larger

If the difference between the upper buffer tank temperature and the boiler temperature setpoint is greater than the specified value, the boiler starts.

Start of buffer tank charging from charge

Prerequisite: Master boiler in the cascade or hydraulic system 4

If the buffer tank charge is below the specified value, the boiler starts.

100% boiler control output when buffer charge is lower than

Prerequisite: Master boiler in the cascade or hydraulic system 4

If the buffer tank charge is below the specified value, the boiler system runs at nominal load.

0% boiler output if buffer charge is over

Prerequisite: Master boiler in the cascade or hydraulic system 4

If the buffer tank charge is greater than the specified value, the boiler system follows the shutdown procedure.

Buffer tank charge is 100% at boiler setpoint parameter

Prerequisite: Master boiler in the cascade or hydraulic system 4

The buffer tank charge is 100% if the average temperature of the buffer tank is below the specified boiler temperature setpoint by the specified value. This parameter defines the end point of the charging curve of the buffer tank.

Buffer tank charge is 0% at the following temperature (absolute value)

Prerequisite: Master boiler in the cascade or hydraulic system 4

The buffer tank charge is 0% if the average temperature of the buffer tank reaches the specified value. This parameter defines the base point of the charging curve of the buffer tank.

Buffer tank fully loaded if temperature difference between boiler and bottom buffer tank

From this difference between the boiler temperature setpoint that has been set and the current temperature in the lower part of the buffer tank, buffer tank loading is stopped.

Buffer tank – Buffer difference

Prerequisite: Variant 3

Difference, which must be given for loading a storage tank e.g. in an adjacent building. If this difference is not reached, the storage tank loading stops.

4.4.3 Buffer tank - Times

System menu Buffer tank

⇨ See "Setting times" [page 109]

4.4.4 Buffer tank - Service

System menu Buffer tank

Enable heating circuit pump 0 according to top buffer temp.

- **NO:** Release of heating circuit pump 0 according to the boiler temperature parameter "`Minimum boiler temperature to release all pumps`"
- **YES:** Release of heating circuit pump 0 according to the temperature in the top part of the buffer tank parameter "`Heating circuit release from following buffer tank temperature`"

In pellet mode stop buffer tank loading bec. of middle buffer tank sensor

- **NO:** The sensor in the lower area of the buffer tank is used as the loading criterion.
- **YES:** The sensor in the mid area of the buffer tank is used as the loading criterion.

Control buffer tank requests according to system environment

- **NO**: The start criterion of the boiler is defined via the parameter "`Boiler start if difference between boiler setpoint and top buffer is larger`".
- **YES**: All heating circuits and DHW tanks that are connected to the boiler system and activated report requirements back to the controller on the basis of temperature specifications or according to the outside air temperature. These requirements are compared with the current temperature in the top buffer tank and if this temperature is too low the boiler is started. If there is no requirement from the system or if the loading criterion is fulfilled, the boiler switches off.

According to system environment, buffer tank request shutdown delay of

If there is no requirement from the heating circuit and DHW tank, the boiler system stops at the end of the specified time.

NOTICE! Parameter only if "Control buffer tank requests according to system environment" parameter is relevant.

Sensor input of storage tank top sensor

Sensor input to which the sensor in the top part of the buffer tank is connected.

Sensor input of storage tank sensor 2

Sensor input to which the sensor in the top part of the buffer tank is connected.

Sensor input of storage tank sensor 3

Sensor input to which the sensor in the bottom part of the buffer tank is connected.

Sensor input of storage tank middle sensor

Sensor input to which the sensor in the mid area of the buffer tank is connected.

Sensor input of storage tank bottom sensor

Sensor input to which the sensor in the bottom part of the buffer tank is connected.

Pump output of storage tank pump

Pump outlet to which the buffer loading pump is connected.

Control of storage tank pump

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum buffer tank pump speed

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum buffer tank pump speed

If you need to limit the maximum speed of the store loading pump for systemic reasons, you can do so by adjusting this parameter.

If the boiler is active then charge all buffer tanks

Prerequisite: Variant 3 or variant 4

- **YES:** Starting the boiler due to a heating requirement by the storage tank in the boiler system not only loads this storage tank, but all of the storage tanks in sub-stations. This increases the runtime related to a boiler system start.

4.5 Boiler

4.5.1 Boiler - Status

System menu Boiler

Boiler temperature

Display of the current boiler temperature.

Flue gas temperature

Display of the current flue gas temperature.

Flue gas setpoint

Display of the calculated flue gas setpoint.

Boiler control variable

Display of the signal for the combustion controller.

ID fan control

Display of the current ID fan control.

ID fan speed

Display of the current ID fan speed.

Boiler request via heating circuit or DHW tank pending

- **0**: There is currently no requirement from the heating circuit and DHW tank to start the boiler.
- **1**: A heating circuit or DHW tank requires heat. The start criterion must be fulfilled for a boiler start (e.g. boiler times active, boiler is not in “Boiler off” status, …)

Residual oxygen content

Display of the current residual oxygen content.

Air speed at suction opening

Display of the current air speed at suction opening.

Flue gas temperature after calorific value heat exchanger

Shows the current flue gas temperature after calorific value heat exchanger. Only displayed for calorific value boiler PE1c Pellet.

Calculated boiler setpoint

Display of the current boiler temperature setpoint depending on the specified hydraulic system.

Sensor 1

Display of the current temperature at sensor 1.

Return sensor

Prerequisite: Return temperature control with mixing valve or bypass pump

Display of the current temperature at the boiler return.

4.5.2 Boiler - Temperatures

System menu Boiler

Boiler temperature setpoint

The boiler temperature is regulated to this temperature.
Setting range PE1c Pellet 15 – 20: 20 – 90 °C

Boiler temperature setpoint

The boiler temperature is regulated to this temperature.
Setting range PE1 Pellet 7 – 20: 40 – 90°C

Setting range PE1 Pellet 25 – 35: 50 – 90°C

Recommendation:

- System without buffer tank: 40°C/50°C
- System with buffer tank: 70 °C

Boiler temperature setpoint

The boiler temperature is regulated to this temperature.
Setting range P4 Pellet 8 – 38: 40 – 80°C

Setting range P4 Pellet 45 – 105: 40 – 90°C

Recommendation:

- System without buffer tank: 40°C
- System with buffer tank: 70 °C

Shutdown if current boiler temperature is higher than boiler setpoint +

If the boiler temperature setpoint is exceeded by this value, the boiler follows the shutdown procedure. The boiler starts up again below the boiler temperature setpoint.

Always shutdown when boiler maximum setpoint is exceeded by

If the maximum boiler temperature setpoint is exceeded by this value, the available heating circuit pumps and DHW tank loading pumps are also activated for cooling the boiler. If the current boiler temperature falls below the boiler temperature setpoint, the boiler starts up again.

Minimum boiler temperature to release all pumps

When the current boiler temperature reaches this value, the buffer loading pump is started. (Hysteresis: 2°C)

Recommendation for PE1 Pellet and P4 Pellet: For systems with a buffer tank, this value should be about 20°C below the specified boiler temperature setpoint. (Prevention of cold through flow!)

Minimum return temperature

Prerequisite: Return temperature control with mixing valve

The minimum temperature value required of the return to the boiler.

Enable return mixer only with active storage tank pump

Prerequisite: “Variant 2 and 5” or “Variant 3”

Return mixer is controlled only when the store loading pump is active. If the pump stops, the mixer closes the total return / opens the bypass.

Temperature in the hi-limit stat housing at which all pumps run

When the current temperature on the safety temperature limiter reaches this value, the buffer loading pump is activated and also the heating circuit pumps and boiler loading pumps.

Start emergency skimming from STL sensor temperature

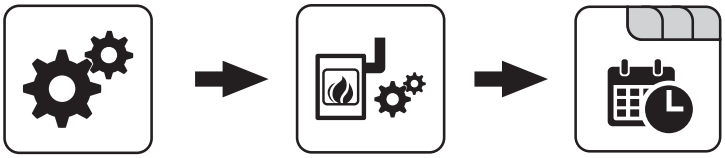
If the current temperature on the safety temperature limiter exceeds this value, the heating circuit pumps, the DHW tank loading pumps and the buffer tank pump are also activated for cooling the boiler.

Heating circuit overheat invariable mode

Prerequisite: Variable mode activated or boiler system in the cascade

The boiler setpoint temperature in heating mode is increased by this value compared to the required flow temperature.

4.5.3 Boiler - Times



System menu Boiler

⇨ See "Setting times" [page 109]

4.5.4 Boiler - Service

System menu Boiler

Variable mode activated

- **NO:** The boiler temperature is regulated to the boiler temperature setpoint that is set. When used in conjunction with a storage tank, this parameter should be set to “NO”.
- **YES:** The boiler temperature is regulated according to the calculated flow value for the heating circuit/DHW tank.

Pump output for skimming

If there is no option of skimming via heating circuits or boiler, a pump or a valve can be controlled via the assigned pump output to cool the boiler.

Skim pump

Shows the current control of the pump output for skimming.

Mixer runtime

Prerequisite: Return temperature control with mixing valve

Setting the runtime of the mixer used for the return temperature control.

Recommendation: To reduce mixer vibration, do not set value below 150s!

Control boiler loading pump using pump 1

Prerequisite: Variant 4

- **NO:** Connection of boiler loading pump at output “HKP0” on core module
- **YES:** Connection of boiler loading pump at output “Pump 1 on core module

Control of boiler loading pump

Prerequisite: Variant 4

- Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Control of boiler loading pump in operation

Prerequisite: Variant 4

Variant 4 has no speed control of the boiler loading pump. If you need to limit the speed of the boiler loading pump for systemic reasons, you can do so by adjusting this parameter.

4.5.5 Boiler - General settings

System menu Boiler

Room air independent operation

- **NO:** The boiler is operated in open flue mode.
- **YES:** The boiler is operated independently of room air.

Remaining hours in heating mode till "ash box full" warning appears

Display of the remaining heating hours until the warning "`Ash box full, please empty`" appears on the display.

Reset the remaining heating hours until ash removal warning

- **NO:** The service hours counter until ash removal warning continues to run.
- **YES:** The service hours counter is set to the value in menu "`Pellet feed`" under parameter "`Heating hours until ash removal warning`".

Modem installed

- **NO:** The boiler does not have a modem for data transfer installed.
- **YES:** The boiler has a modem for data transfer installed.

Memory cycle of data logger

If the boiler is equipped with a data logger the most important boiler data is stored on a SD card. This parameter specifies at what intervals the recording should be started.

Interrupt cleaning mode

- **NO:** The boiler goes through "Cleaning" status until the end.
- **YES:** The "Cleaning" status is interrupted and depending on the setting the boiler switches to "Preparation", "Standby" or "Boiler Off" status.

Output warnings through fault message relays

- **NO:** When there is an "error" or "alarm" the common fault relay closes.
- **YES:** In addition to an "error" or "alarm", the common fault relay closes when a "warning" is present on the boiler.

Which temperature scale should be used

- **Celsius (°C):** Displayed temperature values and settings are shown in °C.
- **Fahrenheit (°F):** Displayed temperature values and settings are shown in °F.

Always log data in °C

- **YES:** In conjunction with a data logger, all temperature values are saved in °C.
- **NO:** In conjunction with a data logger, all temperature values are saved in °F.

Send a line break when ASCII data output on COM2

- **NO:** When a new data set is issued it will be added to the previous one.
- **YES:** A line break for better visualisation is sent between the individual data sets.

Reset counter since last maintenance

- **NO:** The service hours counter since last maintenance continues to run.
- **YES:** The service hours counter since last maintenance is set to "0".

The system is filled with frost protection

Source for ext. power demand (0 - off, 1 - 0-10V, 2 - Modbus)

Invert ext. power demand via analogue input

Input external power demand

Current external power demand

Adopt specified boiler values

YES: The preset boiler parameters for the selected boiler type are adopted. When the process is completed the parameter changes back to "NO".

Adopt standard settings (all values are reset)

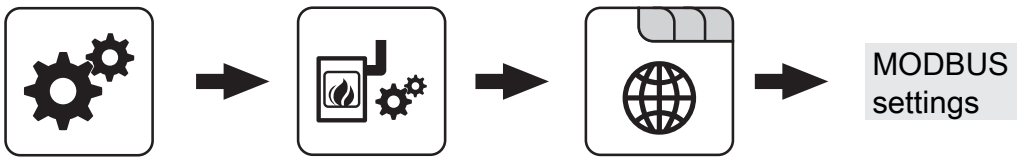
- **YES:** Adopting standard factory settings. This resets all parameters! Once the settings have been applied, the parameter automatically switches to “NO” and the boiler must be reset; otherwise, boiler functioning is no longer guaranteed.

EEPROM reset

- **YES:** All boiler settings and system configurations are deleted. The boiler is only functional again once it has been recommissioned by Froling customer services or authorized installer.

Analogue module input for external power demand

Boiler - General settings - MODBUS settings



System menu Boiler

COM 2 is used as a MODBUS interface

- NO: The COM 2 interface sends the most important boiler values every second.
- YES: The COM 2 interface can be used to connect a MODBUS (RTU/ASCII)

MODBUS address

Defines the address of the boiler in the Modbus network.

MODBUS protocol (1 – RTU / 2 – ASCII)

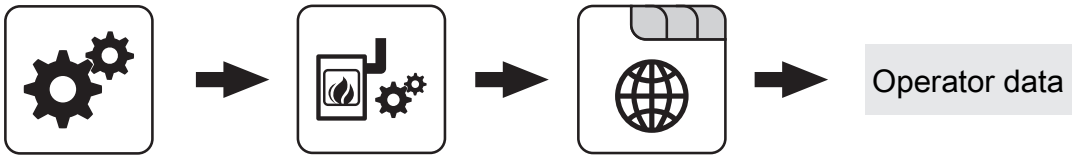
Indicates which Modbus protocol is to be used for the transfer. Which protocol must be used can be found in the documentation of the Modbus system used on site.

Use MODBUS protocol 2014?

Indicates whether the Modbus protocol 2014 is to be used for communication. In this version, parameters can be written at the customer level. In addition to the previous version, the element addresses are newly grouped thematically.

If the parameter is set to “NO”, the functionality and the element addresses remain the same as in the previous version to ensure compatibility with existing systems in the event of software updates.

Boiler - General settings - Operator data



Production number

For unique identification of the boiler on the froeling-connect server, the facility number listed on the identification plate must be set here.

Customer number

By setting the customer number, this is automatically transferred into the commissioning report when it is saved.

Boiler number

By setting the boiler number, this is automatically transferred into the commissioning report when it is saved.

4.6 Boiler 2

4.6.1 Boiler 2 - Status

System menu Boiler 2

Temperature of secondary boiler

Display of the current boiler temperature of the secondary boiler.

Burner relay status

Shows the current status of the burner relay:

- **0:** Secondary boiler not active
- **1:** Secondary boiler active

Secondary boiler pump

Prerequisite: “Isolating valve installed” parameter set to “NO”

Display of the current pump control for the secondary boiler.

Secondary boiler switching valve

Prerequisite: “Isolating valve installed” parameter set to “YES”

Display of the current isolating valve control of the secondary boiler.

Manual start of secondary boiler (only when ID fan is switched off)

- **OFF:** Secondary boiler is controlled according to the program that is set
- **ON:** Secondary boiler is activated immediately

NOTICE! Burner blockage noted.

4.6.2 Boiler 2 - Temperatures

System menu → Boiler 2

Secondary boiler start delay

If there is a requirement from the heating circuit or DHW tank and the buffer tank or boiler has insufficient temperature, the secondary boiler starts after the specified delay time set here.

Disable startup delay in case of fault?

Indicates whether the startup delay is ignored in the event of a boiler fault and whether the standby boiler is activated immediately on request.

Deactivate startup delay when boiler is switched off?

Indicates whether the startup delay is ignored when the boiler is switched off and whether the standby boiler is activated immediately on request.

Secondary boiler start, if buffer tank top temperature is below

If the temperature in the top part of the buffer tank falls below the specified value, the secondary boiler is started once the set duration has elapsed.

Start standby boiler only after storage tank top

Standby boiler enabled after temperature decreases below minimum temperature on top storage tank. No consumers are taken into consideration.

Secondary boiler minimum runtime

If the secondary boiler is started, it will run for at least the length of time set here.

Minimum temperature of secondary boiler

When the secondary boiler reaches the specified temperature, the loading pump is started and switches the isolating valve.

Temperature difference between secondary boiler and buffer tank

Temperature difference between secondary boiler and upper temperature in layered tank to activate the loading pump of the secondary boiler.

Oil valve shut delay

If the current boiler temperature of the secondary boiler falls below the value that is set under "`Minimum temperature of secondary boiler`", the isolating valve only switches once the set duration has elapsed.

4.6.3 Boiler 2 - Service

System menu Boiler 2

Control secondary boiler variably to the target value

- **NO:** The secondary boiler is operated with the boiler temperature that is set on the secondary boiler thermostat.
- **YES:** The boiler temperature of the secondary boiler is regulated to the target temperature specified from the heating circuit or DHW tank.

Sensor input of backup boiler sensor

Sensor input to which the sensor for the secondary boiler is connected.

Pump output of secondary boiler unloading

Pump outlet to which the loading pump of the secondary boiler or the secondary boiler switch valve is connected.

Control of boiler 2 pump

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Maximum speed of boiler 2 pump

If you need to limit the maximum speed of the loading pump of the secondary boiler for systemic reasons, you can do so by adjusting this parameter.

Invert secondary boiler isolating valve

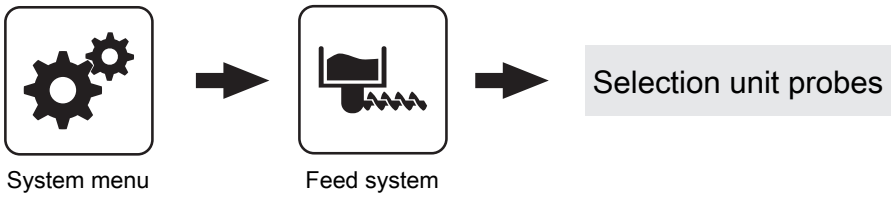
YES: If the valve switches incorrectly, the way it is controlled can be adjusted using this parameter.

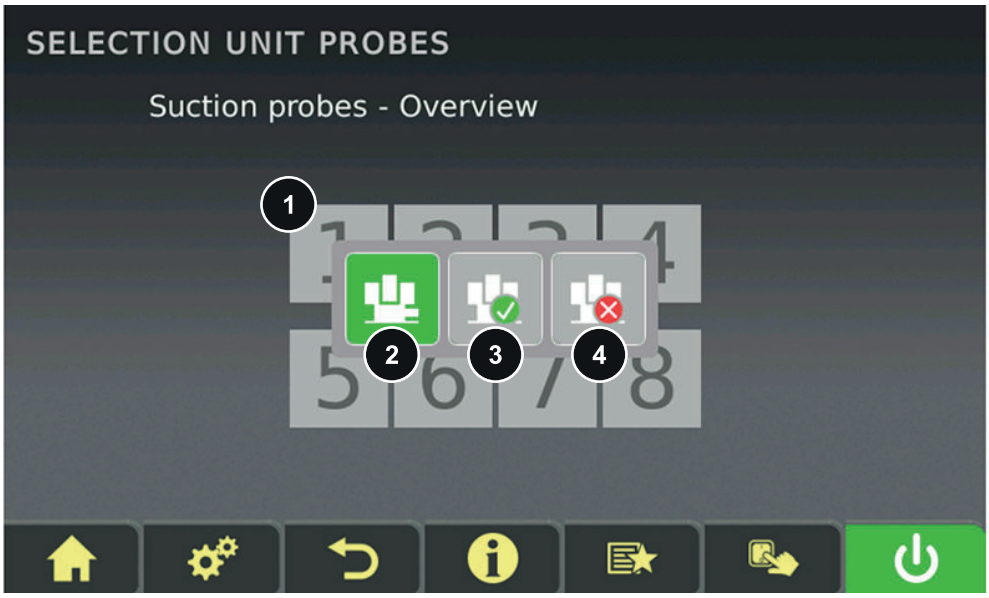
Burner relay

- **A:** Secondary boiler is controlled according to the program that is set
- **1:** Secondary boiler was started manually.
- **0:** Secondary boiler was stopped manually.

4.7 Feed system

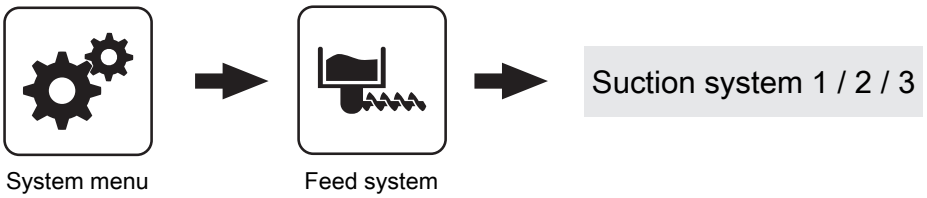
4.7.1 Feed system - Selection unit probes

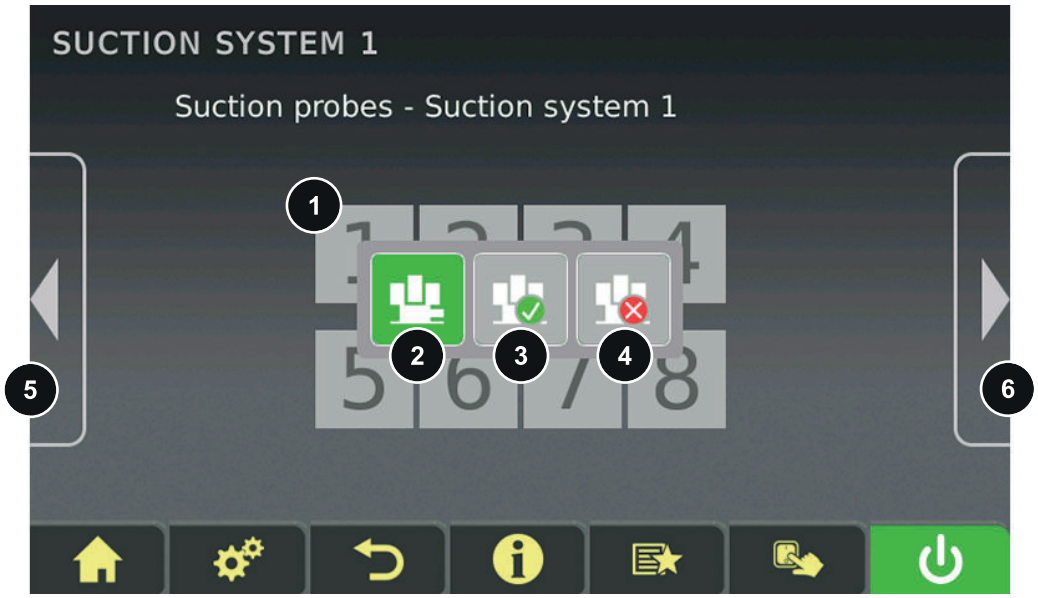




Number	*Description*
1	Overview of the maximum available suction probes. If the RS4 suction system is selected, only four positions are shown. Tap the respective suction point to open a window in which various functions can be called up.
2	Selected suction point should be started by the selection unit probes. The area of the suction point flashes alternately grey/green until the desired position is reached
3	Selected suction point is available.
4	If the selected suction point is generally not in use or should not be used due to a problem (suction hose, blockage by pellets, etc.) the suction point can be locked by tapping on this area.

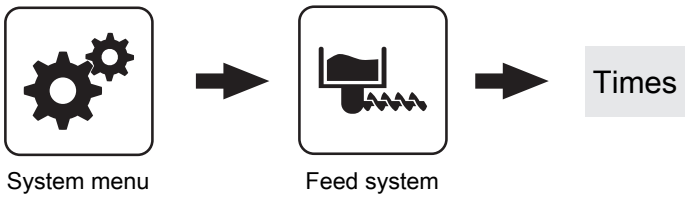
4.7.2 Feed system - Suction system 1/2/3





Number	*Description*
1	Overview of the maximum available suction probes. If the RS4 suction system is selected, only four positions are shown. Tap the respective suction point to open a window in which various functions can be called up.
2	Selected suction point should be started by the selection unit probes. The area of the suction point flashes alternately grey/green until the desired position is reached
3	Selected suction point is available.
4	If the selected suction point is generally not in use or should not be used due to a problem (suction hose, blockage by pellets, etc.) the suction point can be locked by tapping on this area.
5, 6	If a combination of several RS4/RS8 pellet discharge systems is being used, then these buttons can be used to switch to the other suction systems.

4.7.3 Feed system - Times



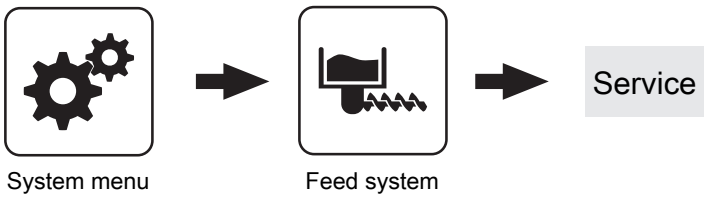
Start of 1st pellet filling

First start for a filling process. A filling process is only carried out if the fill level in the pellet container is below 85%.

Start of 2nd pellet filling

Second start for a filling process. This is likewise only carried out if the pellet container level is below 85%. If you only want one filling time, then set the second filling time to the same time as the first filling time.

4.7.4 Feed system - Service



Refill of cyclone from

When set to “0%” the filling process is started according to the filling times that are set. If there is a shortage of pellets during the “Heating” status, the pellet container is filled regardless of the current time.

Maximum time until switching of probe

Prerequisite: Feed system, universal suction, automatically operated

Time period, during which the cyclone must reach a fill level of 100% from a probe. If this time is exceeded, the change-over unit automatically changes to the next probe. If all probes are started and the fill level of 100% in the cyclone is not reached, an error message appears on the display.

Probe suction reversal

Prerequisite: Feed system, universal suction, automatically operated

Before switching to the next probe, each probe that was last used is back-flushed for the time set.

NOTICE! This parameter is not in use for feed system “3 probe switch”!

Suction run-on

When the fill level sensor detects fuel in the cyclone, the suction turbine remains active for the time set.

Refill cyclone after buffer charging

- **NO:** A filling process of the pellet container is carried out according to the filling times that are set.
- **YES:** If the boiler shuts down once buffer tank loading is complete, this parameter can then be used to fill the cyclone without having to wait for the next filling start point.

Refill at grate cleaning over heating hours

- **NO:** A filling process of the pellet container is carried out according to the filling times that are set.
- **YES**: If the boiler cleans the grate because the number of heating hours has been reached (“Clean after how many hours heating” parameter), the pellet container is filled regardless of the time.

Gate valve status

Shows the status of the gate valve on the cover of the pellet container. The following displays are possible:

- **Stop:** The gate valve has reached the defined position and stopped
- **Moving up:** The gate valve moves to a defined position where the opening for filling the container with pellets is open.
- **Closing:** The gate valve moves to a defined position where the opening to the pellet suction hose is closed. The boiler does not start until this position has been reached.
- **Clear the blockage:** If the gate valve is blocked (defined position not reached), an attempt is made to clear the blockage. The sliding valve moves for a short time in the opposite direction and tries again to reach the defined position.
- **Blocked:** Displayed if the gate valve is unable to clear the blockage despite repeated attempts. In addition, a fault message is displayed in the fault list.
- **Manual:** The gate valve is actuated in manual operation

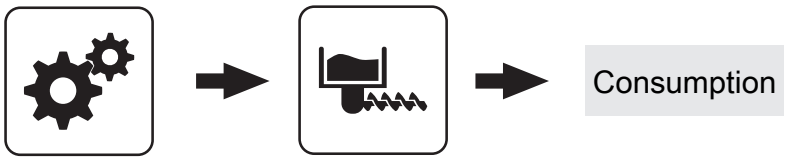
Vibration motor installed

- **YES:** The vibration motor for improving the discharge rate of the bag silo is installed.

Vibration timing

The default vibration interval timing is 60%:
time basis: 100 sec. → 60 sec. on / 40 sec. pause

4.7.5 Feed system - Consumption



System menu → Feed system → Consumption

Resettable t-counter

Display of the amount of pellets used in tonnes since counting started or since the last counter reset.

Resettable kg-counter

Display of the amount of pellets used in kilograms since counting started or since the last counter reset. When the counter reaches 1000 kg, this value is reset to “0” and the “t-counter” is increased by one.

Counter RESET

- **NO:** The pellet consumption counter continues to run.
- **YES:** The “resettable t-counter” and also the “resettable kg-counter” is set to “0”.

Remaining pellet amount in store room

Countdown from the set value in 100 kg increments. The value displayed is the reference point for the remaining amount of fuel in the storeroom.

Minimum pellet level fuel storeroom

If the minimum level setting in the storeroom is not reached, a warning appears on the display. When set to “0.0t” the function is deactivated and no warning appears on the display.

Total pellet consumption

Display of the total calculated pellet consumption. Upon start-up or after a software update to at least software “version 50.04 – Build 05.09”, the counter is automatically activated.

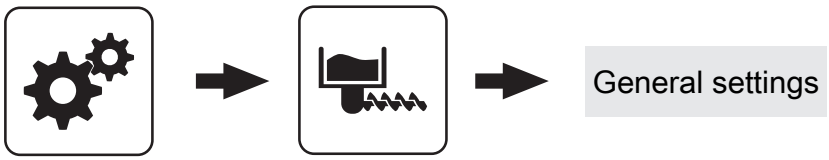
Start the process for determining the pellet feed rate

Used to determine the amount of pellets conveyed for the calculation of pellet consumption. Before starting, place a suitable container in the combustion chamber to collect the pellets, only then set the parameter to “ON”. Combustion grate and back burn flap are opened, then the stoker screw is controlled for 3 minutes with 100%% feed rate. Set the weight (in grams) for the delivered amount of pellets as the value for the “`Delivered amount of pellets at 100%% feed`” parameter.

Delivered amount of pellets at 100% feed

Values have already been predefined based on the boiler type and boiler rating. If the required amount of pellets was recalculated, this setting can be used to adjust the pellet amount for calculating pellet consumption.

4.7.6 Feed system - General settings



System menu → Feed system → General settings

Disable automatic pellet discharge system

- **NO:** The pellet discharge system is operated according to the selected times.

Disable automatic pellet discharge system

- **YES:** If there are no pellets left in the store, this parameter can be used to disable the discharge system and use firewood for heating instead.

4.8 Network pump

4.8.1 Network pump - Status

System menu Network pump

Network return temperature

Display of the current return temperature of the remote line.

Network pump speed

Specifies the current speed of the network pump.

Return temperature distributor 1

Prerequisite: Variant 1 and feeder pump for distributor 1 installed

Display of the current return temperature from distributor 1.

Speed, distributor 1 pump

Prerequisite: Variant 1 and pump for distributor 1 installed

Display of the current speed of distributor 1 pump.

Return temperature distributor 2

Prerequisite: Variant 2 or variant 3 and pump for distributor 2 installed

Display of the current return temperature from distributor 2.

Speed, distributor 2 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 2 installed

Display of the current speed of distributor 2 pump.

Return temperature distributor 3

Prerequisite: Variant 2 or variant 3 and pump for distributor 3 installed

Display of the current return temperature from distributor 3.

Speed, feeder 3

Prerequisite: Variant 2 or variant 3 and pump for distributor 3 installed

Display of the current speed of distributor 3 pump.

Return temperature distributor 4

Prerequisite: Variant 2 or variant 3 and pump for distributor 4 installed

Display of the current return temperature from distributor 4.

Speed, distributor 4 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 4 installed

Display of the current speed of distributor 4 pump.

4.8.2 Network pump - Temperatures

System menu Network pump

Network return setpoint

Prerequisite: Network pump installed

The network return setpoint is regulated to the value set here. When the network return temperature reaches the specified value, the network pumps starts up at minimum speed.

Return temperature setpoint distributor 1

Prerequisite: Variant 1 and pump for distributor 1 installed

The return temperature from distributor 1 is regulated to the value set here. When the return temperature from distributor 1 reaches the specified value, the pump for distributor 1 starts up at minimum speed.

Return temperature setpoint distributor 2

Prerequisite: Variant 2 or variant 3 and pump for distributor 2 installed

The return temperature from distributor 2 is regulated to the value set here. When the return temperature from distributor 2 reaches the specified value, the pump for distributor 2 starts up at minimum speed.

Return temperature setpoint distributor 3

Prerequisite: Variant 2 or variant 3 and pump for distributor 3 installed

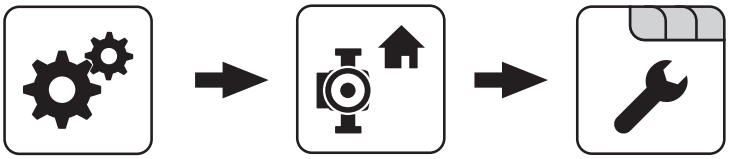
The return temperature from distributor 3 is regulated to the value set here. When the return temperature from distributor 3 reaches the specified value, the pump for distributor 3 starts up at minimum speed.

Return temperature setpoint distributor 4

Prerequisite: Variant 2 or variant 3 and pump for distributor 4 installed

The return temperature from distributor 4 is regulated to the value set here. When the return temperature from distributor 4 reaches the specified value, the pump for distributor 4 starts up at minimum speed.

4.8.3 Network pump - Service



System menu Network pump

Only switch on the network pump when required by the buffer tank (variant 3 / 4)

Prerequisite: Variant 3 or variant 4

- **NO**: The network pump is activated as soon as a consumer in the hydraulic system requires heat.
- **YES**: The network pump is only activated when one or more layered tanks require heat.

NOTICE! Parameter only relevant if a layered tank is installed in all buildings to be supplied!

Sensor input of network return temperature sensor

Sensor input to which the sensor for the network return temperature is connected.

Pump output of network pump

Pump outlet to which the network pump is connected.

Control of network pump

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum speed of network pump

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum speed for network pump

If you need to limit the maximum speed of the network pump for systemic reasons, you can do so by adjusting this parameter.

Sensor input of distributor 1 return sensor

Prerequisite: Variant 1 and pump for distributor 1 installed

Sensor input to which the sensor for the return distributor 1 is connected.

Pump output of distributor 1 pump

Prerequisite: Variant 1 and pump for distributor 1 installed

Pump outlet to which the pump for distributor 1 is connected.

Control of distributor 1 pump

Prerequisite: Variant 1 and pump for distributor 1 installed

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum speed for distributor 1 pump

Prerequisite: Variant 1 and pump for distributor 1 installed

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum speed for distributor 1 pump

Prerequisite: Variant 1 and pump for distributor 1 installed

If you need to limit the maximum speed of the distributor 1 pump for systemic reasons, you can do so by adjusting this parameter.

Sensor input of distributor 2 return sensor

Prerequisite: Variant 2 or variant 3 and pump for distributor 2 installed

Sensor input to which the sensor for the return distributor 2 is connected.

Pump output of distributor 2 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 2 installed

Pump outlet to which the pump for distributor 2 is connected.

Control of distributor 2 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 2 installed

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum speed for distributor 2 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 2 installed

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum speed for distributor 2 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 2 installed

If you need to limit the maximum speed of distributor 2 pump for systemic reasons, you can do so by adjusting this parameter.

Sensor input of distributor 3 return sensor

Prerequisite: Variant 2 or variant 3 and pump for distributor 3 installed

Sensor input to which the sensor for the return distributor 3 is connected.

Pump output of distributor 3 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 3 installed

Pump outlet to which the pump for distributor 3 is connected.

Control of distributor 3 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 3 installed

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum speed for distributor 3 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 3 installed

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum speed for distributor 3 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 3 installed

If you need to limit the maximum speed of the distributor 3 pump for systemic reasons, you can do so by adjusting this parameter.

Sensor input of distributor 4 return sensor

Prerequisite: Variant 2 or variant 3 and pump for distributor 4 installed

Sensor input to which the sensor for the return distributor 4 is connected.

Pump output of distributor 4 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 4 installed

Pump outlet to which the pump for distributor 4 is connected.

Control of distributor 4 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 4 installed

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum speed for distributor 4 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 4 installed

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum speed for distributor 4 pump

Prerequisite: Variant 2 or variant 3 and pump for distributor 4 installed

If you need to limit the maximum speed of the distributor 4 pump for systemic reasons, you can do so by adjusting this parameter.

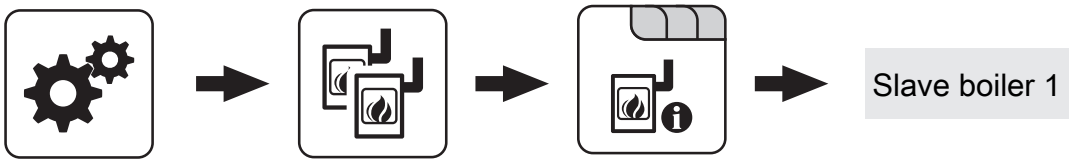
4.9 Cascade

4.9.1 Cascade - Status

Buffer tank charge

Display of the current buffer tank charge.

4.9.2 Cascade - Backup boiler



Slave boiler boiler temperature

Display of the current boiler temperature of the backup boiler.

Slave boiler OK

Display of whether the backup boiler is ready for operation.

Slave boiler is heating

Display of whether the backup boiler is in “Heating” operating status.

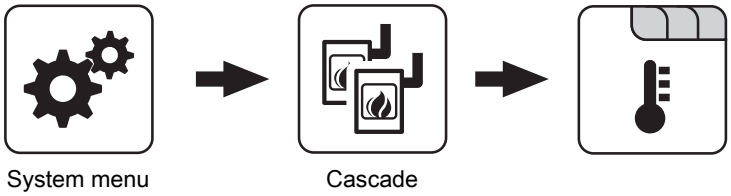
Slave boiler control variable

Display of the signal for the combustion controller.

Boiler charging pump speed

Display of the current speed of the boiler loading pump.

4.9.3 Cascade - Temperatures



Buffer tank charge is 100% at boiler setpoint parameter

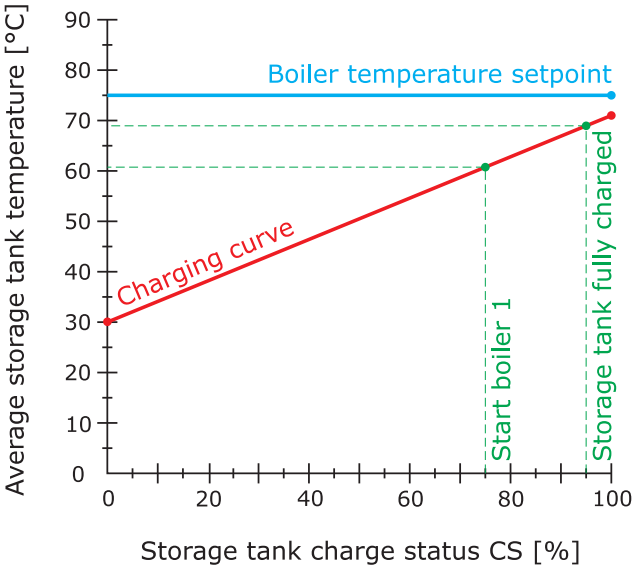
The buffer tank charge is 100% if the average temperature of the buffer tank is below the specified boiler temperature setpoint by the specified value. This parameter defines the end point of the charging curve of the buffer tank.

Buffer tank charge is 0% at the following temperature (absolute value)

The buffer tank charge is 0% if the average temperature of the buffer tank reaches the specified value. This parameter defines the base point of the charging curve of the buffer tank.

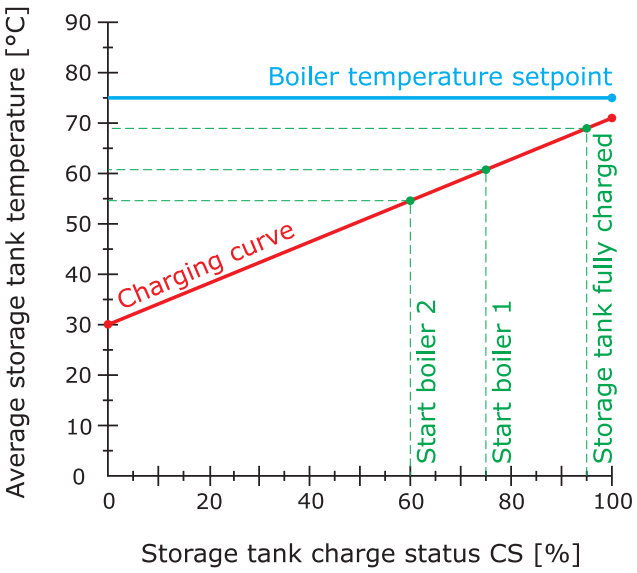
Start point 1 at buffer tank charge

If the buffer tank charge is lower than this value, the first boiler is started. This can be the boiler with the highest priority or with the fewest operating hours and consequently both the master and the slave boiler.



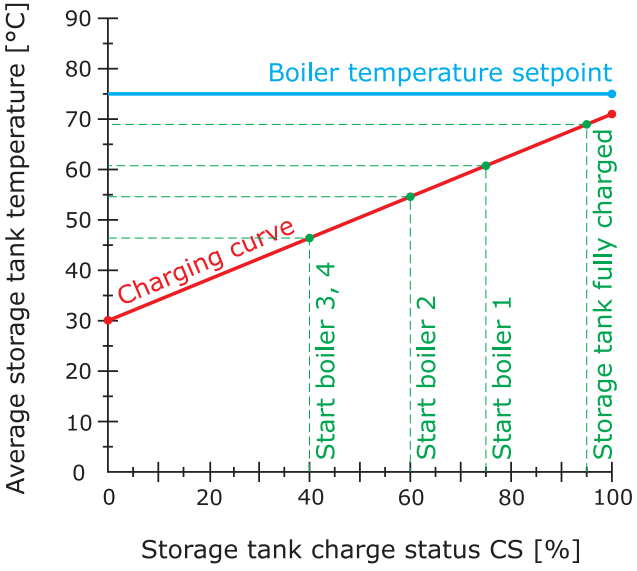
Start point 2 at buffer tank charge

If the buffer tank charge is lower than this value, the second boiler is started.



Start point 3 at buffer tank charge

If the buffer tank charge is lower than this value, slave boilers 3 and 4 are started.



Quick start if buffer tank discharge is greater than (% / 10min)]
If the storage tank discharge is greater than the set value within 10 minutes, the boiler with the greatest rated heat output will be started (quick start).

Reduce the overall output of the cascade before the storage tank is fully loaded
When the buffer tank charge exceeds the value which is set under “Start point 1 at buffer tank charge”, the boiler control variable for the boilers that are still active will be reduced using the boiler loading pump.

4.9.4 Cascade - Service

System menu Cascade

Boiler priorities are used to specify the order in which the boilers start. Where boilers have the same priority, the boiler currently with the fewest operating hours always starts first.

With this setting the master boiler always starts first as it has the **highest priority**; the boilers then start in numerical order.

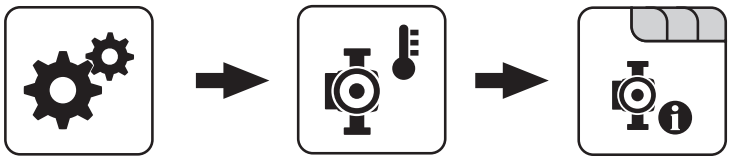
Start priority of the master boiler	*1*
Start priority of slave boiler 1	*2*
Start priority of slave boiler 2	*3*
Start priority of slave boiler 3	*4*

With this setting the current **number of operating hours** is used as the start criterion as all boilers have equal priority.

Start priority of the master boiler	*1*
Start priority of slave boiler 1	*1*
Start priority of slave boiler 2	*1*
Start priority of slave boiler 3	*1*

4.10 Difference regulator

4.10.1 Difference regulator - Status



System menu Diff. control

Heat source sensor

Display of the current heat source temperature of the differential controller (e.g. tiled stove with water pocket, …)

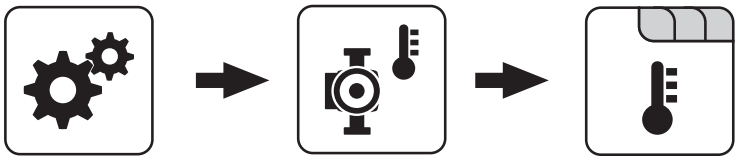
Heat sink sensor

Display of the current temperature of the heat sink for the differential controller (e.g. layered tank, …)

Pump speed

Specifies the current speed of the differential controller pump.

4.10.2 Difference regulator - Temperatures



System menu Diff. control

Startup difference

Temperature difference between heat source and heat sink which must be reached to activate the pump of the differential controller.

Shutdown difference

If the temperature difference between the heat source and the heat sink falls below this value, the pump of the differential controller is deactivated.

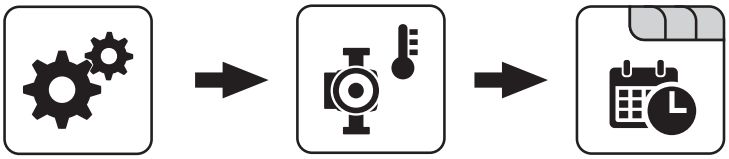
Minimum temperature for heat source

If the temperature in the heat source falls below this value the differential controller will be deactivated.

Maximum temperature for heat sink

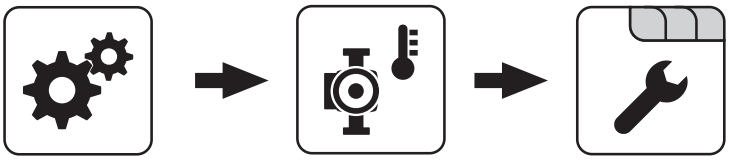
When the heat sink reaches this value, the pump of the differential controller is deactivated.

4.10.3 Difference regulator - Times



⇨ See "Setting times" [page 109]

4.10.4 Difference regulator - Service



Pump output of diff. control pump

Pump outlet to which the pump of the differential controller is connected.

Control of diff. control pump

Definition of control signal for pump type used.

⇨ See "PDM / 0 - 10V settings" [page 102]

Minimum pump speed

Adjustment of the minimum speed to the pump type. (Set the pump mode according to pump manufacturer's instructions)

Maximum pump speed

If you need to limit the maximum speed of the pump of the differential controller for systemic reasons, you can do so by adjusting this parameter.

Sensor input of heat source sensor

Sensor input to which the heat source sensor is connected.

Sensor input of heat sink sensor

Sensor input to which the heat sink sensor is connected.

Sensor monitoring

- **YES:** If temperatures around freezing point occur, an error message appears on the display.
- **NO:** The error messages of the differential controller sensor are suppressed.

4.11 Circulation pump

4.11.1 Circulation pump - Status

System menu Circ. Pump

Return temperature in secondary circulation line

Display of the current temperature at the return feed sensor of the circulation line.

NOTICE! If the parameter “Return sensor present” is set to “NO”, 0°C is permanently displayed.

Flow switch on the domestic hot water line

- **0:** Flow switch detects no flow rate.
- **1:** Flow switch detects flow rate.

Speed of the circulation pump

Specifies the current speed of the circulation pump.

4.11.2 Circulation pump - Temperatures

System menu Circ. Pump

Return sensor present

- **NO:** The circulation pump is controlled according to time program. In conjunction with the use of a flow valve, the circulation pump is also activated at a signal from the flow valve.
- **YES:** The circulation pump is controlled according to time program and temperature at the return circulation line. In conjunction with the use of a flow switch, the circulation pump is also activated at a signal from the flow switch.

NOTICE! Connect the flow sensor as the return sensor!

Switch off the pump at what return temperature in the circulation line

If the set temperature at the return circulation line is reached, the circulation pump will be deactivated.

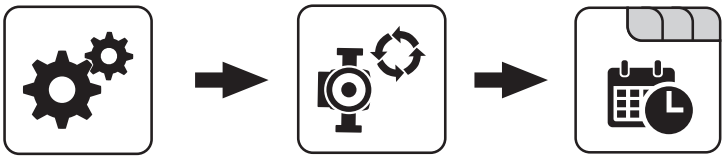
NOTICE! Parameter only relevant when using a return feed sensor in the circulation line!

Circulation pump run-on

If the flow-through stops at the flow switch, the circulation pump remains active for the time set.

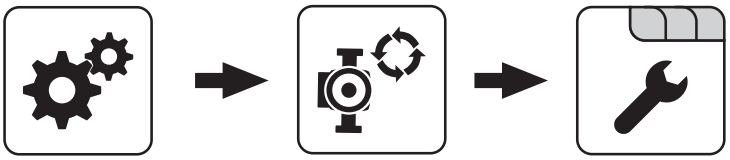
NOTICE! Parameter only relevant when using a flow switch!

4.11.3 Circulation pump - Times



⇨ See "Setting times" [page 109]

4.11.4 Circulation pump - Service



Sensor input of circulation return sensor

Sensor input to which the sensor at the return line of the circulation is connected.

Which sensor is used for the flow switch

Sensor input to which the flow switch is connected.

Pump output of circulation pump

Pump outlet to which the circulation pump is connected.

Control of circulation pump

Definition of control signal for pump type used.

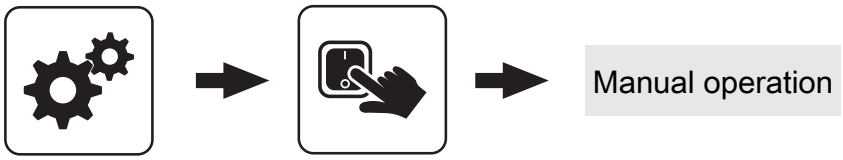
⇨ See "PDM / 0 - 10V settings" [page 102]

Maximum speed of the circulation pump

If you need to limit the maximum speed of the circulation pump for systemic reasons, you can do so by adjusting this parameter.

4.12 Manual

4.12.1 Manual - Manual operation



System menu → Manual

When exiting the “Manual operation” menu, all active parameters are automatically set to “OFF”! The parameters displayed depend on the boiler configuration!

Manual fuel feed

- **ON:** Grate closes, back-fire flap slide valve opens, then the stoker screw starts.

WARNING! Overfilling hazard!

Ash screw manual

- **ON:** Both ash screw drives are activated.

NOTICE! Parameter only for P4 Pellet 32 – 105 in use!

Ash screw drive

- **ON:** Ash screw drive is activated.

Prerequisite: Boiler with ash screw.

WOS drive

- **ON:** The heat exchanger cleaning system is activated.

NOTICE! With PE1c Pellet, the WOS is activated via a combined drive with the ash screw!

Ignition

- **ON:** The hot air blower / ignition rod for igniting the fuel is activated.

Back burn flap drive

- **ON:** Burn back flap is opened.

Manual filling of pellet container (only starts when gate valve is open)

- **ON:** The gate valve of the pellet container opens, the container is then filled with pellets until the switch point of the level sensor is reached. If the container is full the “Pellet container level” value is set to 100%.

Grate - Drive

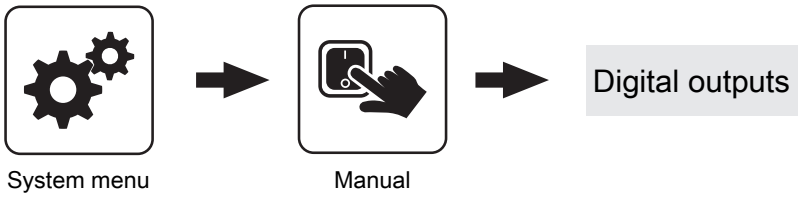
- **FORWARD:** Close grate
- **BACK:** Open grate

Rinse the condenser manually – only possible if boiler off / on standby

- **ON**: The solenoid opens and the calorific value heat exchanger is cleaned.

NOTICE! This parameter can only be activated when the boiler is in “Standby” or “Boiler off” status.

4.12.2 Manual - Digital outputs

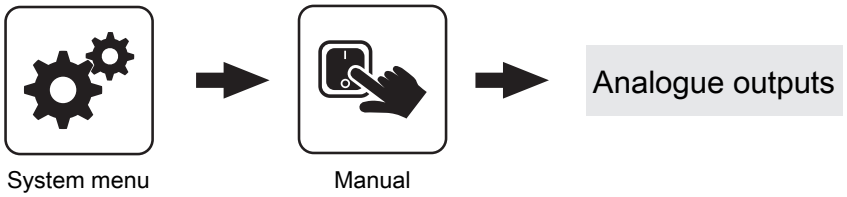


The parameters displayed depend on the boiler configuration!

- **A 0**: Automatic, Off; **A 1**: Automatic, On
- **1**: Manual, On
- **0**: Manual, Off

Heating Circuit 1 Mixer OPEN
:
Standby relay
:
Ignition
:

4.12.3 Manual - Analogue outputs

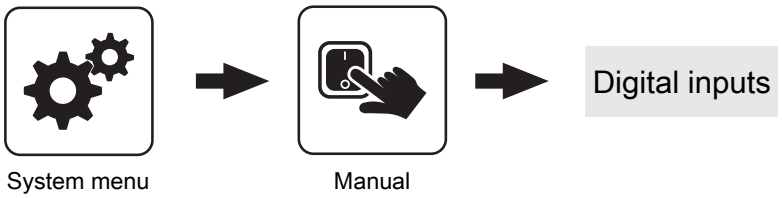


The parameters displayed depend on the boiler configuration!

- **A 0**: Automatic, Off; **A 1-100%**: Automatic, with % value ON
- **1-100%**: Manual, with % value ON
- **0%**: Manual, Off

Primary air
:
Pump 0.1
:

4.12.4 Manual - Digital inputs



The parameters displayed depend on the boiler configuration!

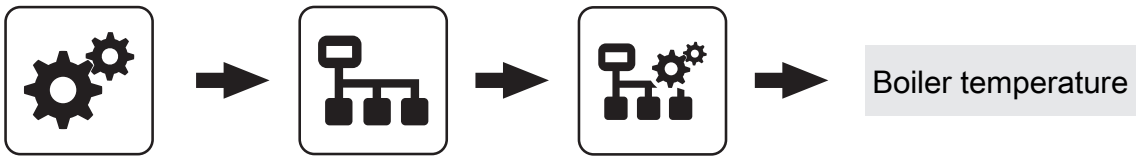
- **A 0**: Automatic, Off; **A 1**: Automatic, On
- **1**: Manual, On
- **0**: Manual, Off

Cyclone 1 max sensor
:
Door switch
:
Hi-limit stat input
E-stop input
:

4.13 System

4.13.1 System - Settings

Setting - Boiler temperature



Boiler temperature setpoint

The boiler temperature is regulated to this temperature.
Setting range PE1c Pellet 15 – 20: 20 – 90 °C

Boiler temperature setpoint

The boiler temperature is regulated to this temperature.
Setting range PE1 Pellet 7 – 20: 40 – 90°C

Setting range PE1 Pellet 25 – 35: 50 – 90°C

Recommendation:

- System without buffer tank: 40°C/50°C
- System with buffer tank: 70 °C

Boiler temperature setpoint

The boiler temperature is regulated to this temperature.
Setting range P4 Pellet 8 – 38: 40 – 80°C

Setting range P4 Pellet 45 – 105: 40 – 90°C

Recommendation:

- System without buffer tank: 40°C
- System with buffer tank: 70 °C

Shutdown if current boiler temperature is higher than boiler setpoint +

If the boiler temperature setpoint is exceeded by this value, the boiler follows the shutdown procedure. The boiler starts up again below the boiler temperature setpoint.

Always shutdown when boiler maximum setpoint is exceeded by

If the maximum boiler temperature setpoint is exceeded by this value, the available heating circuit pumps and DHW tank loading pumps are also activated for cooling the boiler. If the current boiler temperature falls below the boiler temperature setpoint, the boiler starts up again.

Minimum boiler temperature to release all pumps

When the current boiler temperature reaches this value, the buffer loading pump is started. (Hysteresis: 2°C)

Recommendation for PE1 Pellet and P4 Pellet: For systems with a buffer tank, this value should be about 20°C below the specified boiler temperature setpoint. (Prevention of cold through flow!)

Minimum return temperature

Prerequisite: Return temperature control with mixing valve

The minimum temperature value required of the return to the boiler.

Enable return mixer only with active storage tank pump

Prerequisite: “Variant 2 and 5” or “Variant 3”

Return mixer is controlled only when the store loading pump is active. If the pump stops, the mixer closes the total return / opens the bypass.

Temperature in the hi-limit stat housing at which all pumps run

When the current temperature on the safety temperature limiter reaches this value, the buffer loading pump is activated and also the heating circuit pumps and boiler loading pumps.

Start emergency skimming from STL sensor temperature

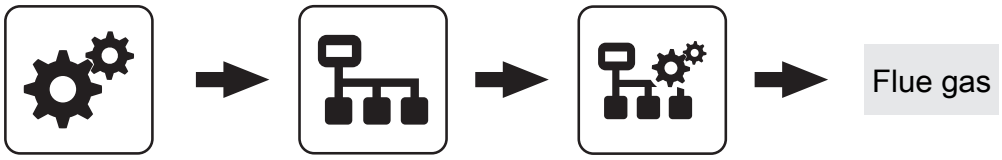
If the current temperature on the safety temperature limiter exceeds this value, the heating circuit pumps, the DHW tank loading pumps and the buffer tank pump are also activated for cooling the boiler.

Heating circuit overheat invariable mode

Prerequisite: Variable mode activated or boiler system in the cascade

The boiler setpoint temperature in heating mode is increased by this value compared to the required flow temperature.

Setting - Flue gas



System menu → System → Setting → Flue gas

Minimum flue gas temperature

Lowest operation point of flue gas temperature for continuous operation.

Maximum flue gas temperature

Highest operation point of flue gas temperature for continuous operation.

Boiler output at flue gas temperature of 20°C

Lower point of the start ramp of boiler controller at system startup.

100% boiler output from a flue gas temperature of

Upper point of the start ramp of boiler controller. If the flue gas temperature reaches the value set here, the fuel output should reach 100%.

Minimum difference between flue gas temperature and boiler temperature in HEATING

As a condition for the “Heating” operating status, the difference between the current flue gas temperature and the current boiler temperature must at least exceed the value set here.

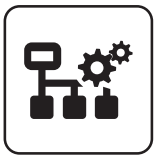
Flue gas - Flue gas difference for start process

When the boiler controller changes to “Pre-heating” status the current value of the flue gas temperature is stored. When the flue gas temperature rises by the specified value set here during “Pre-heating” or “Ignition” status, the boiler controller switches to “Heating” status.

Safety time

If the condition “Minimum difference between flue gas- and boiler temperature in HEATING” is not fulfilled for the set duration, the message “Safety time expired, flue gas temperature too low for too long” appears on the display.

Condenser



Setting → Flue gas → Condenser

Condensation heat exchanger present

- **NO:** A calorific value heat exchanger is not in use.
- **YES:** A calorific value heat exchanger is in use.

Condenser cleaning interval (Heating hours)

Once the specified operating hours have elapsed, in which the boiler was in “Heating” status, the calorific value heat exchanger is rinsed.

Condenser cleaning duration

For the indicated period of time, the solenoid valve is actuated and the calorific value heat exchanger is rinsed.

On-time of spray valve. Overall cycle 20 sec

The entire washing process is set with the “Condenser cleaning duration” parameter. The cleaning time is regarded as the time in which the spray valve is active. Pause times (spray valve off) are not included in the cleaning time.

Example:
100% = spray valve active for the specified time
75% = spray valve active for 15 sec and 5 sec pause

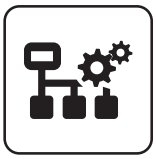
Calorific value heat exchanger cleaning possible from

Time from which the washing process can be activated.

Calorific value heat exchanger cleaning possible until

Time to which the washing process can be activated.

E-filter external



Setting → Flue gas → E-filter external

State

Filter status

Displays the current operating status of the E-filter as a numeric code. The following statuses are possible:

- Status “0”: Filter deactivated
- Status “1”: Filter off
- Status “2”: Filter on
- Status “3”: Measuring mode
- Status “4”: RFI
- Status “5”: Wait for bypass flap
- Status “6”: Cleaning - Pause
- Status “7”: Cleaning - Rinse
- Status “8”: Wait for water sensor
- Status “9”: Waiting for drying time
- Status “10”: Filter error
- Status “11”: Quick cleaning
- Status “12”: Waiting for drying time
- Status “13”: Cleaning – Waiting
- Status “14”: Cleaning – Shaking
- Status “15”: Cleaning – Waiting

Filter return signal

Shows the filter status as a numeric code. Following status values are possible:

- Status "0": No error
- Status "1": Power supply fault
- Status "2": RS485 error
- Status "3": Temperature box error
- Status "4": High voltage error
- Status "5": Wait for ready-to-measure state
- Status "6": Values critical
- Status "7": Measure
- Status "8": Measuring mode error

Water detected

Shows the status of the water sensor in the ash drawer. If the water sensor detects a water level that is too high, the E-filter is deactivated.

Time until next cleaning

Shows the remaining time (in minutes) until the next cleaning process.

E-filter service hours

Shows the operation hours since the E-filter was first activated.

Number of cleaning processes

Shows the total number of cleaning processes since the E-filter was first activated.

Output HV module 1
Output HV module 2
Output HV module 3
Output HV module 4

Displays the current output of the respective HV module as a numeric code. The following displays are possible:

- Output “0”: The current output of the HV module is between 0 - 25%
- Output “1”: The current output of the HV module is between 25 - 50%
- Output “2”: The current output of the HV module is between 50 - 75%
- Output “3”: The current output of the HV module is above 75%

Service

E-filter function active

Used to activate/deactivate the electrostatic filter function. When the filter is deactivated, the bypass flap is open and the flue gas is fed directly into the chimney.

Time until bypass flap is open

Specifies the time for opening the bypass flap in seconds. The specified time must correspond at least to the actuating time of the flap drive.

Close bypass flap when filter switched off

This parameter is set to “NO” by default and should only be changed after consultation with the manufacturer.

Cleaning interval

Specifies after how many operation hours of the E-filter a cleaning cycle should be started. Depending on the raw dust content, this value is set between 4 and 8 hours.

Duration of cleaning cycle

Defines the total time for a cleaning process. Via this duration, the spray valve is periodically switched on and off.

On-time of spray valve. Overall cycle 10 sec

Defines the cycle of the spray valve, which is repeated until the total time (parameter “Duration of cleaning cycle”) has elapsed. The cycle of the spray valve is set in percentages of 10 seconds.

Example: On-time of spray valve: 60%, duration of cleaning cycle: 23s;
Spray value is switched on for 6 seconds, waits for 4 seconds. This cycle is repeated until the total time is reached. (6s ON - 4s OFF - 6s ON - 4s OFF - 3s ON)

Dry time

Defines the waiting time after a cleaning cycle before the HV electrodes are activated again.

Is there a siphon fitted?

By default this parameter is set to “YES” and cleaning of the filter is performed according to the specified interval. In case of problems with the drain system (e.g. blocked duct) this parameter can be set to “NO” in the interim. The cleaning times are then adjusted so that the collection tank is not overfilled.

Quick/compulsory cleaning active?

Specifies whether the function of the quick/compulsory cleaning should be active.

Quick/compulsory cleaning: If the output of the HV module is below 25% for a defined period, a quick cleaning is carried out during operation. If the output of the HV module remains below 25%, then a set waiting time is observed until the next quick cleaning.

Duration of quick cleaning

Defines the on-time of the spray valve during a quick cleaning.

Minimum time between quick/compulsory cleaning

Specifies the waiting time between two quick cleanings in minutes.

Cleaning possible from

In conjunction with the parameter “Cleaning possible till”, this defines a time window in which the automatic filter cleaning may be activated.

Cleaning possible till

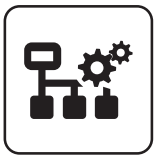
In conjunction with the parameter “Cleaning possible from”, this defines a time window in which the automatic filter cleaning may be activated.

IO allocation

Address HV in 1
Address HV in 2
Address water sensor 1
Address water sensor 2
Safety switch address
Address HV out 1
Address HV out 2
Address bypass flap open
Address washer valve 1
Address washer valve 2

Setting of the relevant address for the respective component for the inputs and outputs on the digital module.

E-filter internal



Setting → Flue gas → E-filter internal

State

Filter status

Displays the current operating status of the E-filter as a numeric code. The following statuses are possible:

- Status “0”: Filter deactivated
- Status “1”: Filter off
- Status “2”: Filter on
- Status “3”: Measuring mode
- Status “4”: RFI
- Status “5”: Wait for bypass flap
- Status “6”: Cleaning - Pause
- Status “7”: Cleaning - Rinse
- Status “8”: Wait for water sensor
- Status “9”: Waiting for drying time
- Status “10”: Filter error
- Status “11”: Quick cleaning
- Status “12”: Waiting for drying time
- Status “13”: Cleaning – Waiting
- Status “14”: Cleaning – Shaking
- Status “15”: Cleaning – Waiting

Filter return signal

Shows the filter status as a numeric code. Following status values are possible:

- Status "0": No error
- Status "1": Power supply fault
- Status "2": RS485 error
- Status "3": Temperature box error
- Status "4": High voltage error
- Status "5": Wait for ready-to-measure state
- Status "6": Values critical
- Status "7": Measure
- Status "8": Measuring mode error

Current response HV module 1

Power response HV module 1

Time until next cleaning

Shows the remaining time (in minutes) until the next cleaning process.

E-filter service hours

Shows the operation hours since the E-filter was first activated.

Number of cleaning processes

Shows the total number of cleaning processes since the E-filter was first activated.

Number of flashovers

Shows the total number of flashovers since the E-filter was first activated.

Absorbed energy

Shows the total amount of absorbed energy since the E-filter was first activated.

Output HV module 1

Displays the current output of the respective HV module in watts.

Output level HV module 1

The output of the HV module is divided into four levels. The following output levels are displayed: <25% / 25-50% / 50-75% / >75%

Service

E-filter function active

Used to activate/deactivate the electrostatic filter function.

Max. output HV modules

For setting the output power in watts of the HV module used. If two modules are used, the output of one module must be set here. If more than one module is used, HV modules with the same output power should always be

Max. output HV modules

used.

Startup criteria for HV modules - Flue gas temperature

If the flue gas temperature of the boiler exceeds the set value, the HV modules are switched on. If the flue gas temperature falls below the set value during heating mode, the HV modules remain switched on.

Start ramp HV controller

As soon as the start-up criterion (parameter "`Start-up criterion for HV modules - Flue gas temperature`") is reached, the high voltage is activated with the start value (parameter "`Start value HV controller`"). Within this set start ramp, the set times of the parameters for standard operation ("`Interval voltage increase HV module`" and "`Interval voltage decrease HV controller`") are reduced by a defined factor in order to achieve a rapid increase in the target voltage in the start phase.

Dry time

Defines the waiting time after a cleaning cycle before the HV electrodes are activated again.

Quick/compulsory cleaning active?

Specifies whether the function of the quick/compulsory cleaning should be active.

Quick/compulsory cleaning: If the output of the HV module is below 25% for a defined period, a quick cleaning is carried out during operation. If the output of the HV module remains below 25%, then a set waiting time is observed until the next quick cleaning.

Duration of quick cleaning

Defines the on-time of the spray valve during a quick cleaning.

Minimum time between quick/compulsory cleaning

Specifies the waiting time between two quick cleanings in minutes.

Minimum target control for HV module(s)

Defines the output of the HV module up to which it can be reduced in the event of flashovers. If the controller detects a defined number of flashovers at the minimum setpoint control, the HV module switches to standby mode for a certain period of time.

Maximum target control HV module 1

Determines the maximum output of the HV module up to which the voltage is increased in a defined interval (parameter "`Interval voltage increase HV controller`").

Interval voltage increase HV controller

If the controller does not detect a flashover within this set time, the voltage is increased by 1 percent.

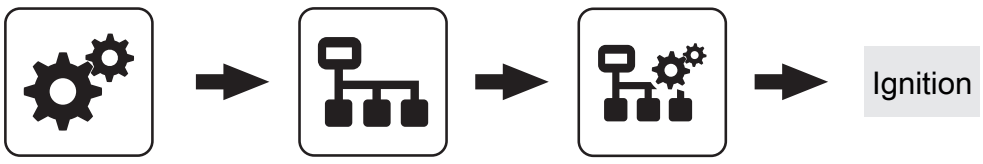
Interval voltage decrease HV controller

A voltage reduction occurs after a flashover. Within the set interval, the voltage can only be reduced by 1 percent. If at least one flashover occurs again at the next interval, the voltage is reduced again by 1 percent.

Start value HV controller

Defines the starting point of the HV controller start ramp (parameter "`Start ramp HV controller`").

Setting - Ignition



System menu → System → Setting → Ignition

Duration of pre-heating

Time during which only the ignition is activated. The fuel slide-in is not active for this duration.

Maximum ignition duration

Specifies how long the ignition procedure should last. "Heating" status must be reached within this time.

Infeed time without ignition

Specifies how long fuel is fed in onto the combustion grate before "Pre-heating" operating status.

Infeed during ignition

Defined fuel slide-in for the "Ignition" status duration.

Ignition Off during heating up

NOTICE! When using the P1 Pellet 7/10 pellet boiler in conjunction with 270/280W heating cartridges, this parameter must be set to "YES". (The power rating of the heating cartridges is located on the metallic cable entry)

Oxygen decrease for heating status

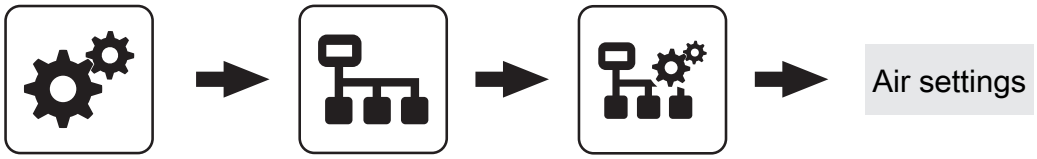
If the oxygen drops by the set value from the "Pre-heating" operating state, the system changes directly to the "Heating" operating state.

Factor for feed pulse

Parameter for the calculation of the feed pulse during ignition. If the oxygen does not drop in the first 900 seconds, a feed pulse with 100% feed rate is started. The duration of this pulse results from the feed time without ignition and this factor:

Feed time without ignition / Factor for feed pulse

Setting - Air settings



System menu → System → Setting → Air settings

Minimum ID fan speed

Lower operation point of the ID fan characteristic line.

ID fan min

Base point for setting the ID fan characteristic line.

ID fan max

End point for setting the ID fan characteristic curve.

ID fan during heating up

In "Heating up" status, the induced draught blower fan is operated with the specified control.

ID fan during pre-heating

In "Pre-heating" status, the induced draught blower fan is operated with the specified control.

ID fan during shutdown

In "Shutdown" status, the induced draught blower fan is operated with the specified control.

ID fan during ignition

In "Ignition" status, the induced draught blower fan is operated with the specified control.

Electrical room air flap on pellet module present

- **NO:** If the boiler is not in "Off" or "Boiler off" status, then an output of 230 V will be provided at the "room air flap" output on the "pellet module expansion" board. The corresponding input "Digi IN S8" is not analysed.
- **YES:** If an electrical room air flap is used, it is supplied with 230V via the "Room air flap" output on the "pellet module expansion" board. The room air flap function is monitored by the input, "Digi IN S8".

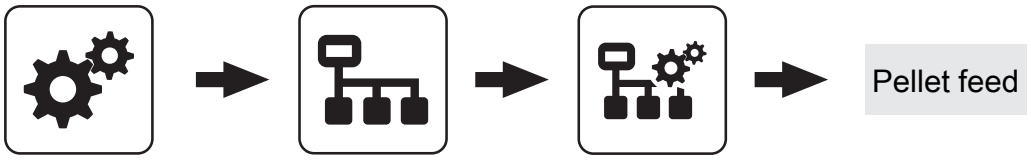
Opening of primary air when boiler is off

The primary air flap is set to this value in the "Boiler off", "Standby" and "Fault" operating statuses.

Boiler underpressure setpoint

Desired underpressure which is to be maintained during the operation of the boiler.

Setting - Pellet feed



Maximum infeed

Feed rate in percent at maximum output.

NOTICE! Parameter only available if no Lambda probe is installed!

Minimum infeed

Minimum infeed of stoker screw.

Time feed screw is on until stoker screw

Runtime ratio between feed screw and stoker screw.

Shutdown wait 1

During this time period the boiler is ventilated by the induced draught fan.

The time until the stoker is empty is

Theoretical runtime of the feed screw until there is no more fuel in the stoker.

Shutdown wait 2

Time between the operating statuses “Shutdown wait 1” and “Cleaning”. In this operating status the induced draught fan is not active.

Duration of LW Heat/Shut down

If firewood is ignited via the pellet unit, then the pellet unit starts the cleaning process of the pellet unit at the end of the specified time.

WOS start time

Time from which the heat exchanger cleaning system can be activated.

WOS stop time

Time to which the heat exchanger cleaning system can be activated.

Heating hours until ash removal warning

Once the specified heating hours have elapsed (the hours in which the system was in “Heating” status), a message indicating that the ash box must be emptied appears on the display.

WOS runtime

Time which the heat exchanger cleaning system is activated.

Cycle of ash screw

Ash screw runtime

Time which the ash screw drive is activated.

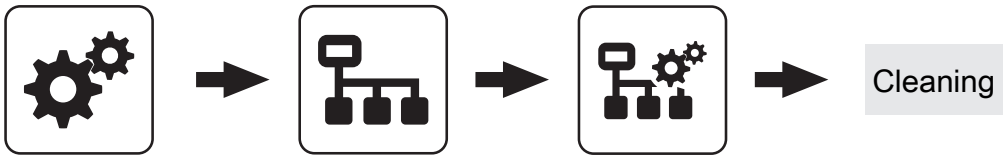
Clean after how many hours heating?

If the boiler has passed the set time in “Heating” status, the boiler shuts down for a cleaning cycle.

Clean after how many shutdowns

This parameter defines the number of shutdowns after which the “Cleaning” operating status is carried out.

Set - Cleaning



The cleaning may start from

Time from which cleaning (ash removal, WOS) may be activated. For efficient operation of the system, a time limit for the WOS heat exchanger is not recommended and so the parameter should be set to 00:00.

The cleaning may run until

Time from which cleaning (ash removal, WOS) may no longer be activated. For efficient operation of the system, a time limit for the WOS heat exchanger is not recommended so the parameter should be set to 24:00.

Ash screw runtime

Time which the ash screw drive is activated.

Ash screw positioning active

YES: The function of the ash screw is monitored

NO: Function monitoring of the ash screw is deactivated

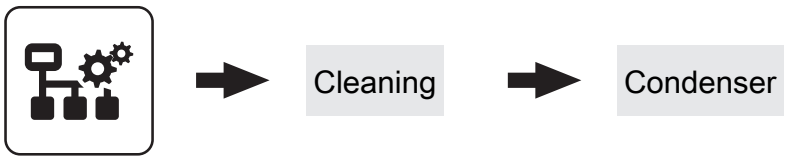
Clean after how many hours heating?

If the boiler has passed the set time in “Heating” status, the boiler shuts down for a cleaning cycle.

Clean after how many shutdowns

This parameter defines the number of shutdowns after which the “Cleaning” operating status is carried out.

Condenser



Time elapsed since last heat exchanger cleaning

Shows the hours the boiler has been in “Heating” status since the last rinsing process of the cleaning system of the condensing boiler heat exchanger.

Number of rinsing processes

Number of rinsing processes of the cleaning system of the condensing boiler heat exchanger.

Condenser cleaning interval (Heating hours)

Once the specified operating hours have elapsed, in which the boiler was in “Heating” status, the calorific value heat exchanger is rinsed.

Condenser cleaning duration

For the indicated period of time, the solenoid valve is actuated and the calorific value heat exchanger is rinsed.

On-time of spray valve. Overall cycle 20 sec

The entire washing process is set with the “Condenser cleaning duration” parameter. The cleaning time is regarded as the time in which the spray valve is active. Pause times (spray valve off) are not included in the cleaning time.

Example:
100% = spray valve active for the specified time
75% = spray valve active for 15 sec and 5 sec pause

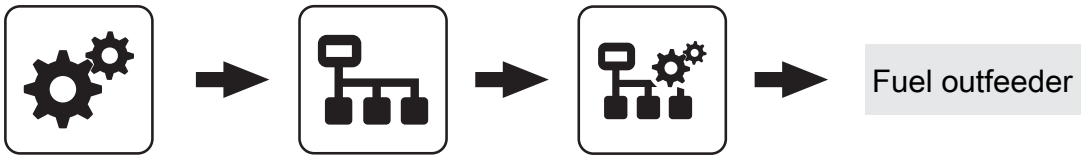
Calorific value heat exchanger cleaning possible from

Time from which the washing process can be activated.

Calorific value heat exchanger cleaning possible until

Time to which the washing process can be activated.

Setting - Fuel outfeeder



First start of cleaning

Prerequisite: Supply bin installed

Second start of cleaning

Prerequisite: Supply bin installed

Start of 1st pellet filling

First start for a filling process. A filling process is only carried out if the fill level in the pellet container is below 85%.

Start of 2nd pellet filling

Second start for a filling process. This is likewise only carried out if the pellet container level is below 85%. If you only want one filling time, then set the second filling time to the same time as the first filling time.

Refill of cyclone from

When set to “0%” the filling process is started according to the filling times that are set. If there is a shortage of pellets during the “Heating” status, the pellet container is filled regardless of the current time.

Refill cyclone after buffer charging

- **NO:** A filling process of the pellet container is carried out according to the filling times that are set.
- **YES:** If the boiler shuts down once buffer tank loading is complete, this parameter can then be used to fill the cyclone without having to wait for the next filling start point.

Refill at grate cleaning over heating hours

- **NO:** A filling process of the pellet container is carried out according to the filling times that are set.
- **YES**: If the boiler cleans the grate because the number of heating hours has been reached (“Clean after how many hours heating” parameter), the pellet container is filled regardless of the time.

Preliminary suction time

Duration before the vacuum screw delivery system starts. Used to clear the lines before start of suction.

Screw cycle

The runtime of the delivery screw plus the preliminary suction time equals the screw cycle.

Vacuum + screw filling run-on after reaching the MAX fill level

Specifies how long the suction screw should deliver material after reaching the maximum fill level in the cyclone. After this runtime, the run-on time of the suction turbine starts (parameter “`Suction run-on`”)

Suction run-on

When the fill level sensor detects fuel in the cyclone, the suction turbine remains active for the time set.

Max. runtime of suction fan

Prerequisite: Vacuum + screw filling system installed or vacuum + screw filling system automatically operated installed

If the 100% fill level has not been reached within the specified runtime, the suction turbine switches off.

Maximum current for delivery screw

Prerequisite: Vacuum + screw filling system installed or vacuum + screw filling system automatically operated installed

Set parameter according to the identification plate of the discharge screw drive used.

Maximum time until switching of probe

Prerequisite: Universal suction, automatically operated

Time period, during which the pellet container must reach a fill level of 100% from a probe. If this time is exceeded, the change-over unit automatically changes to the next probe. If all probes are started and the fill level of 100% in the pellet container is not reached, an error message appears on the display.

Position 1 of change-over unit is used?

Prerequisite: Universal suction, automatically operated

Position 2 of change-over unit is used?

Prerequisite: Universal suction, automatically operated

Position 3 of change-over unit is used?

Prerequisite: Universal suction, automatically operated

Position 4 of change-over unit is used?

Prerequisite: Universal suction, automatically operated

Position 5 of change-over unit is used?

Prerequisite: Universal suction, automatically operated

Position 6 of change-over unit is used?

Prerequisite: Universal suction, automatically operated

Position 7 of change-over unit is used?

Prerequisite: Universal suction, automatically operated

Position 8 of change-over unit is used?

Prerequisite: Universal suction, automatically operated

Priority of suction position 1

Prerequisite: Vacuum + screw filling system, automatically operated

- **1:** Off times for the weekdays and also weekends are active
- **2:** Suction point is always active

Priority of suction position 2

Prerequisite: Vacuum + screw filling system, automatically operated

- **1:** Off times for the weekdays and also weekends are active
- **2:** Suction point is always active

Priority of suction position 3

Prerequisite: Vacuum + screw filling system, automatically operated

- **1:** Off times for the weekdays and also weekends are active
- **2:** Suction point is always active

Start of locking window for suction positions with priority 1 (Mon-Fri)

Prerequisite: Vacuum + screw filling system, automatically operated

From this point in time, the suction points with priority 1 are not available on weekdays.

End of locking window for suction positions with priority 1 (Mon-Fri)

Prerequisite: Vacuum + screw filling system, automatically operated

Until this point in time, the suction points with priority 1 are not available on weekdays.

Start of locking window for suction positions with priority 1 (Sat-Sun)

Prerequisite: Vacuum + screw filling system, automatically operated

From this point in time, the suction points with priority 1 are not available on weekends.

End of locking window for suction positions with priority 1 (Sat-Sun)

Prerequisite: Vacuum + screw filling system, automatically operated

Until this point in time, the suction points with priority 1 are not available on weekdays.

Slide valve installed on pellet cyclone

Measured path of slide valve

Display of the measured path during initialisation of the gate valve.

Minimum path for slide valve

This value is automatically set 5% below the measured path of the gate valve after initial startup of the gate valve.

P4 Pellet 32/38 with small cyclone installed

- **NO:** The P4 Pellet 32/38 standard pellet container is in use.
- **YES:** The P4 Pellet 32/38 has been equipped with the P4 Pellet 20/25 pellet container.

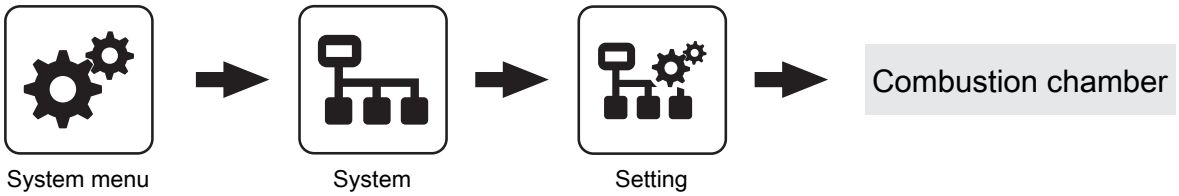
Vibration motor installed

- **YES:** The vibration motor for improving the discharge rate of the bag silo is installed.

Vibration timing

The default vibration interval timing is 60%:
time basis: 100 sec. → 60 sec. on / 40 sec. pause

Setting - Combustion chamber



Boiler underpressure setpoint

Desired underpressure which is to be maintained during the operation of the boiler.

Under-pressure at minimum output

At minimum boiler output the specified underpressure must be kept.

Control pressure during preparation (seal control)

In “Preparation” status, the minimum underpressure specified must be reached.

Control pressure tolerance during preparation (seal control)

In “Preparation” status, a maximum deviation for the parameter “`Control pressure during preparation (seal control)`” can be reached.

The duration of the preparation is

Duration of the seal check during “Preparation” status.

Under-pressure during pre-heating

In “Pre-heating” status, the specified underpressure is required as a minimum.

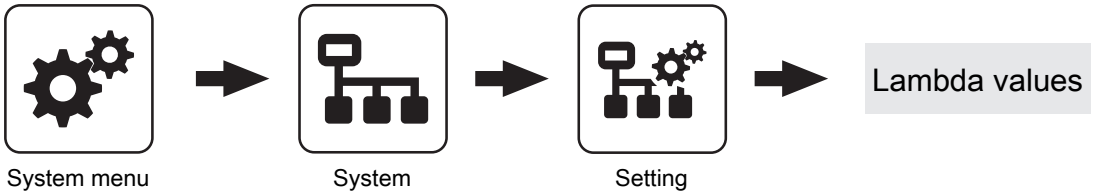
Under-pressure during shutdown

In “Shutdown” status, the specified underpressure is required as a minimum.

Monitoring for decline in underpressure active

If the underpressure decreases sharply, after a brief period the message “Boiler door open or underpressure transmitter defective” appears on the display.

Setting - Lambda values



Residual oxygen content setpoint

Residual oxygen content which is regulated during “Heating” status.

No feed when residual O2 below

If the current residual oxygen content falls below the set value, the fuel slide-in stops.

Residual oxygen content, above which fire is out

If the current residual oxygen content in “Heating” status exceeds the specified value, the safety time begins to run.

O2 Controller max

Adjustable parameters for the residual oxygen controller.

NOTICE! Factory setting - do not change!

O2 control release in heating from:

When the ignition process has been successfully carried out, the residual oxygen controller is limited for the specified time.

O2 control limit when it is not released

If the residual oxygen controller is not yet released, it is limited to the specified value.

Influencing factor for O2 controller

Adjustable parameters for the residual oxygen controller.

NOTICE! Factory setting - do not change!

Air quantity, which should be reached during preparation with PE1

Minimum air speed which must be reached in the “Preparation” status to perform a start-up.

Minimum underpressure in combustion chamber during heating

Prerequisite: Underpressure transmitter installed

In “Heating” status, the minimum underpressure specified in the combustion chamber must be reached.

Maximum underpressure in combustion chamber during heating

Prerequisite: Underpressure transmitter installed

In “Heating” status, the maximum underpressure specified in the combustion chamber can be reached.

Minimum underpressure in combustion chamber during preparation

Prerequisite: Underpressure transmitter installed

In “Preparation” status, the minimum underpressure specified in the combustion chamber must be reached.

Maximum underpressure in combustion chamber during preparation

Prerequisite: Underpressure transmitter installed

In “Preparation” status, the maximum underpressure specified in the combustion chamber can be reached.

Air quantity, which should be reached during preparation with P4 Pellet 8/15

Minimum air speed which must be reached in the “Preparation” status to perform a start-up.

Air quantity, which should be reached during preparation with P4 Pellet 20/25

Minimum air speed which must be reached in the “Preparation” status to perform a start-up.

Air quantity, which should be reached during preparation with P4 Pellet 32-100

Minimum air speed which must be reached in the “Preparation” status to perform a start-up.

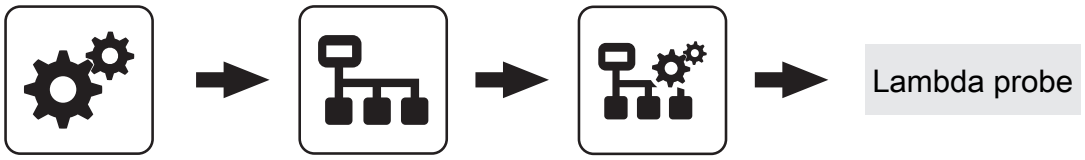
Minimal air quantity during operation

Minimum air speed which must be reached in the “Heating” status.

Residual oxygen above which the lambda probe is allowed to switch off

If the boiler switches to “Boiler off” or “Off” mode, the lambda probe heating remains active for at least 1 hour, up to a maximum of 24 hours. If the residual oxygen content exceeds the value set here, the lambda probe heating is switched off.

Set - Lambda probe



System menu → System → Setting → Lambda probe

Residual oxygen content

Display of the current residual oxygen content.

Lambda probe status

The following status displays are possible:

- Off
- Pre-heating
- Normal operation
- Cooling
- Reheating
- Error

Lambda probe type

Setting the Lambda probe type used:

- Bosch broadband probe
- NTK broadband probe
- Bosch switching-type sensor (LSM11)
- NTK switching-type sensor (OZA685)

Lambda probe heating

- **A 0:** Automatic, Off; **A 1**: Automatic, On
- **1:** Manual, On
- **0:** Manual, Off

Lambda probe calibration (probe must be at 21% O2)

- **YES:** After activation of the Lambda probe heating, the Lambda probe can be calibrated.
- **NOTICE! The Lambda probe must be at 21% oxygen (air)!**

Automatic lambda probe calibration active

- **YES**: If the boiler is in one of these statuses (*"Boiler off"*, *"Off"*, or *"Standby"*) for a minimum period, which can be set (*"*`Minimum time at standstill`*"*), the broadband probe will be calibrated to 21%.
  For boilers with automatic loading, calibration is carried out at the next start (status *"Preparation"*).
  For boilers with manual loading, the boiler changes to the "sensor check" status after this time has elapsed (additional indication on the display). The ID fan is activated and the secondary air is completely opened. If the insulated door is opened in this status, the process is aborted.
  The prerequisite for calibration is that the probe provides a stable measurement for one minute. If the measurement exceeds 21% for more than one minute, the probe is also calibrated, independent of the standstill times.

Automatic lambda probe calibration active

provides a stable measurement for one minute. If the measurement exceeds 21% for more than one minute, the probe is also calibrated, independent of the standstill times.

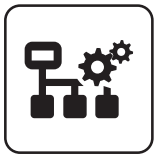
Minimum time at standstill

Defines the duration that the boiler must be in "*Boiler Off*", "*Off*" or "*Standby*" mode to start automatic Lambda sensor calibration.

Residual oxygen above which the lambda probe is allowed to switch off

If the boiler switches to "Boiler off" or "Off" mode, the lambda probe heating remains active for at least 1 hour, up to a maximum of 24 hours. If the residual oxygen content exceeds the value set here, the lambda probe heating is switched off.

Switching-type sensor



Setting → Lambda values → Switching-type sensor

Residual oxygen content

Display of the current residual oxygen content.

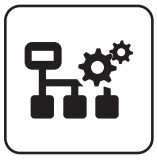
Lambda probe voltage measured

Display of the current measured Lambda probe voltage.

Lambda probe voltage corrected

Display of the measured Lambda probe voltage, at which the "`Lambda probe correction value`" is taken into account.

Broadband probe



Setting → Lambda values → Broadband probe

Residual oxygen content

Display of the current residual oxygen content.

Broadband probe heating current

Display of the measured broadband probe heating current.

Broadband probe heating voltage

Display of the measured broadband probe heating voltage.

Broadband probe Nernst voltage

Display of the measured broadband probe Nernst voltage.

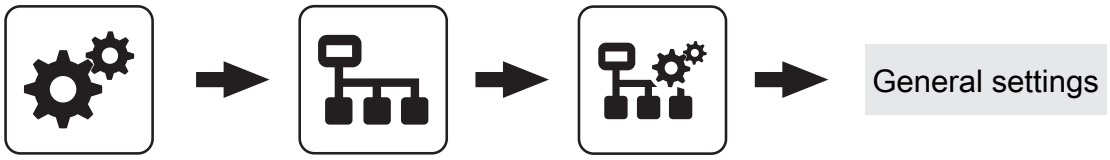
Broadband probe pump current

Display of the measured broadband probe pump current.

Broadband probe internal resistance

Display of the measured broadband probe internal resistance.

Setting - General settings



Room air independent operation

- **NO:** The boiler is operated in open flue mode.
- **YES:** The boiler is operated independently of room air.

Remaining hours in heating mode till "ash box full" warning appears

Display of the remaining heating hours until the warning "`Ash box full, please empty`" appears on the display.

Reset the remaining heating hours until ash removal warning

- **NO:** The service hours counter until ash removal warning continues to run.
- **YES:** The service hours counter is set to the value in menu "`Pellet feed`" under parameter "`Heating hours until ash removal warning`".

Modem installed

- **NO:** The boiler does not have a modem for data transfer installed.
- **YES:** The boiler has a modem for data transfer installed.

Memory cycle of data logger

If the boiler is equipped with a data logger the most important boiler data is stored on a SD card. This parameter specifies at what intervals the recording should be started.

Interrupt cleaning mode

- **NO:** The boiler goes through "Cleaning" status until the end.
- **YES:** The "Cleaning" status is interrupted and depending on the setting the boiler switches to "Preparation", "Standby" or "Boiler Off" status.

Output warnings through fault message relays

- **NO:** When there is an "error" or "alarm" the common fault relay closes.
- **YES:** In addition to an "error" or "alarm", the common fault relay closes when a "warning" is present on the boiler.

Which temperature scale should be used

- **Celsius (°C):** Displayed temperature values and settings are shown in °C.
- **Fahrenheit (°F):** Displayed temperature values and settings are shown in °F.

Always log data in °C

- **YES:** In conjunction with a data logger, all temperature values are saved in °C.
- **NO:** In conjunction with a data logger, all temperature values are saved in °F.

Send a line break when ASCII data output on COM2

- **NO:** When a new data set is issued it will be added to the previous one.
- **YES:** A line break for better visualisation is sent between the individual data sets.

Reset counter since last maintenance

- **NO:** The service hours counter since last maintenance continues to run.
- **YES:** The service hours counter since last maintenance is set to "0".

The system is filled with frost protection

Source for ext. power demand (0 - off, 1 - 0-10V, 2 - Modbus)

Invert ext. power demand via analogue input

Input external power demand

Current external power demand

Adopt specified boiler values

YES: The preset boiler parameters for the selected boiler type are adopted. When the process is completed the parameter changes back to "NO".

Adopt standard settings (all values are reset)

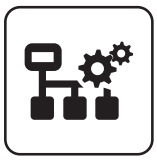
- **YES:** Adopting standard factory settings. This resets all parameters! Once the settings have been applied, the parameter automatically switches to “NO” and the boiler must be reset; otherwise, boiler functioning is no longer guaranteed.

EEPROM reset

- **YES:** All boiler settings and system configurations are deleted. The boiler is only functional again once it has been recommissioned by Froling customer services or authorized installer.

Analogue module input for external power demand

MODBUS settings



Setting → General settings → MODBUS settings

COM 2 is used as a MODBUS interface

- NO: The COM 2 interface sends the most important boiler values every second.
- YES: The COM 2 interface can be used to connect a MODBUS (RTU/ASCII)

MODBUS address

Defines the address of the boiler in the Modbus network.

MODBUS protocol (1 – RTU / 2 – ASCII)

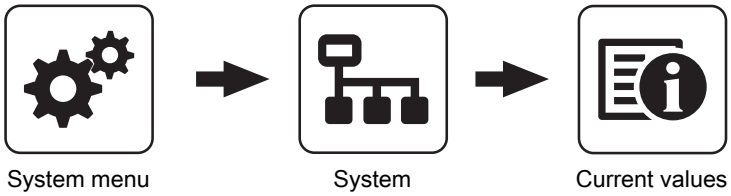
Indicates which Modbus protocol is to be used for the transfer. Which protocol must be used can be found in the documentation of the Modbus system used on site.

Use MODBUS protocol 2014?

Indicates whether the Modbus protocol 2014 is to be used for communication. In this version, parameters can be written at the customer level. In addition to the previous version, the element addresses are newly grouped thematically.

If the parameter is set to “NO”, the functionality and the element addresses remain the same as in the previous version to ensure compatibility with existing systems in the event of software updates.

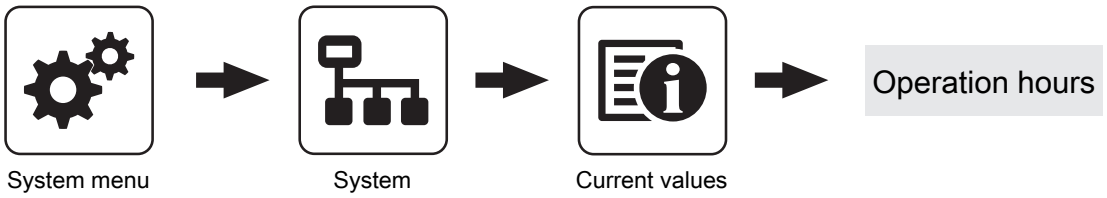
4.13.2 System - Current values



Display of the current value for the relevant parameter. The parameters displayed depend on the boiler configuration!

Current status runtime
:
Software version
:

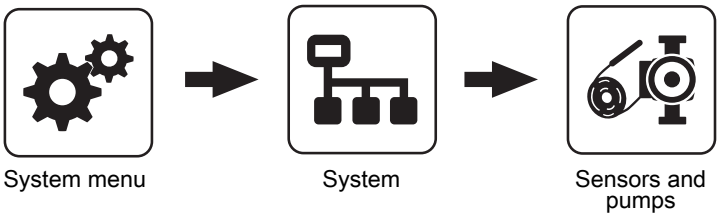
Operation hours



Display of the current number of operation hours of the respective unit and respective components. The parameters displayed depend on the boiler configuration!

Hours since last maintenance
:
Operation hours delivery screw

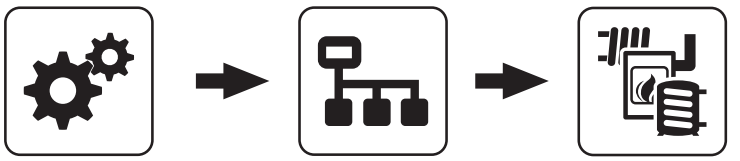
4.13.3 System - Sensors and pumps



In the “Sensors and pumps” menu, all sensor inputs and pump outputs available in the hydraulic system can be allocated. The number of parameters depends on the configuration.

Which sensor is used for buffer tank top
Which sensor is used for bottom buffer tank
Which pump is used for the buffer tank
:

4.13.4 System - System selection

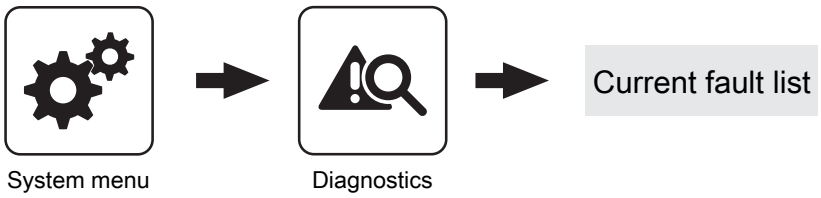


System menu → System → System selection

Menu for setting the configuration for systems that have not been configured with the setting wizard.

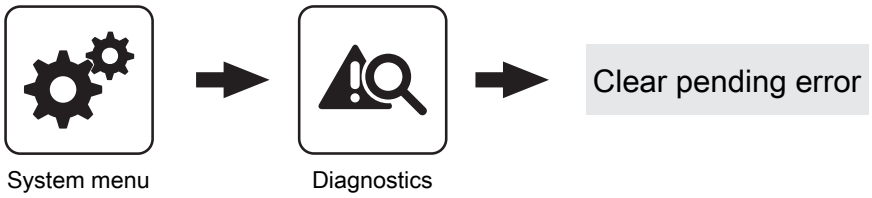
4.14 Diagnostics

4.14.1 Diagnosis – Current fault list

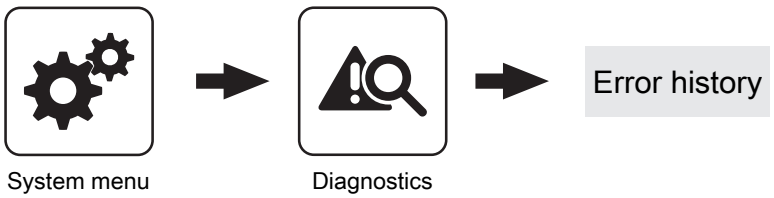


Display of the current fault messages. In addition, you can also invoke time information here, such as when the fault occurred, when the fault was acknowledged and when the fault was cleared.

4.14.2 Diagnosis – Clear pending error

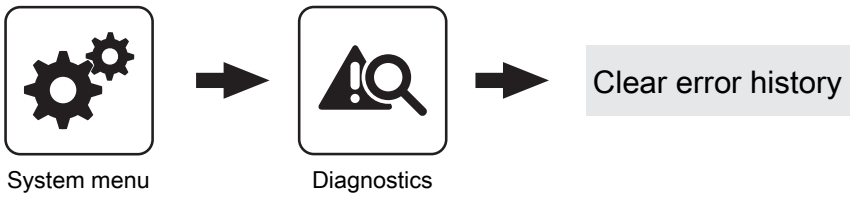


4.14.3 Diagnostics - Error history



Up to 50 fault indication entries are stored in the error history. A fault can consist of up to 3 fault indication entries. You can determine what type of fault message it is, when the fault occurred (appeared), when the fault was acknowledged and when the fault was eliminated (cleared). If all 50 fault indication entries are in use and there is another fault indication entry, the oldest entry will be deleted to make room for the current one.

4.14.4 Diagnostics - Clear error history

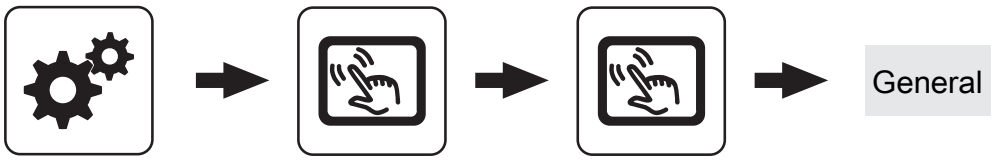


The entire error history can be deleted using this function. From this point onwards the error history is populated with fault indication entries which have occurred since clearing the error history.

4.15 Touchscreen

4.15.1 Touchscreen - Display settings

Display settings - General



System menu → Touchscreen → Display settings → General

Brightness

Display of the light sensor's evaluation of the current brightness in the room for adjusting the backlight.

Maximum backlight

The brighter it is in the room, the more the background of the touch display is illuminated. This is where you can limit the maximum backlight.

Minimum backlight

The darker it is in the room, the less the background of the touch display is illuminated. This is where you can set the minimum backlight.

Delay time for screen saver (0 deactivates the screensaver)

If the screen of the touch display is not touched within the set time, the screensaver will activate and the display will go dark. To disable the screensaver, set the delay time to "0".

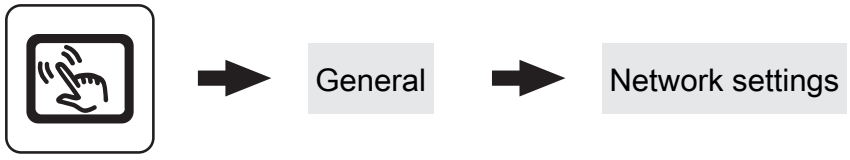
Module address

This is where you can change the module address if it is incorrectly set.

Module address 0: Boiler console
Module address 1-7: respective RBG Touch

NOTICE! Once you have changed the module address, you will need to restart the boiler controller! (switch main switch on boiler off and on).

Network settings



Display settings → General → Network settings

Obtain IP address automatically

- **On:** IP address of touch control is automatically obtained from the network
- **Off:** IP address, subnet mask, standard gateway and DNS server can be manually set.

IP address

Subnet mask

Standard gateway

DNS server

Display settings - Basic display

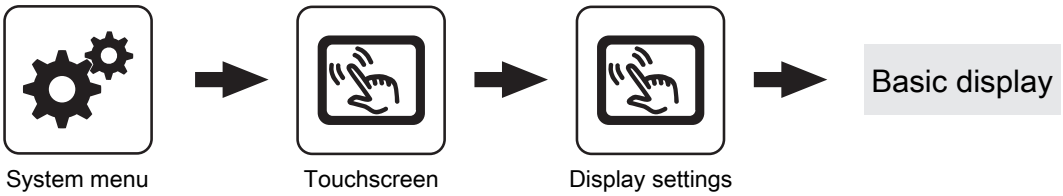
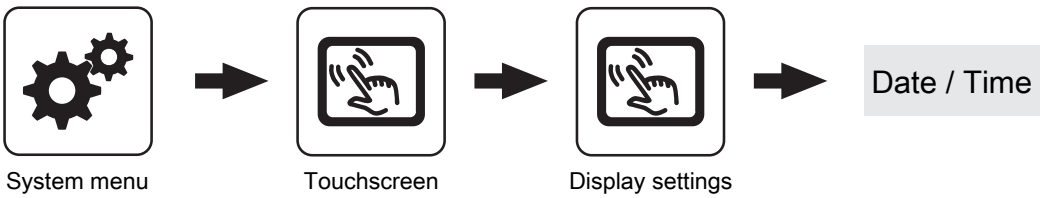


Image 1
:
Image 6

On the basic display, up to six different information displays can be freely selected. The selection depends on the system configuration.

Display settings - Date / Time



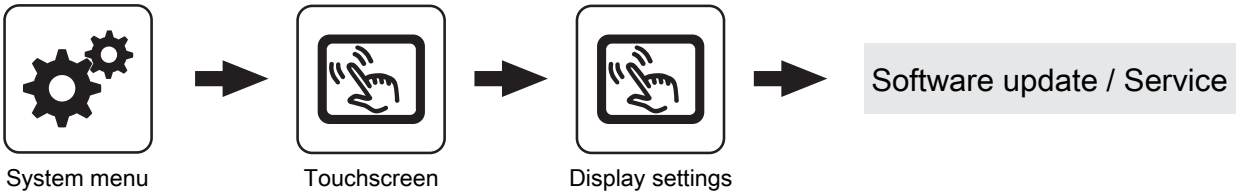
Date

Display and setting of current date.

Time

Display and setting the current time.

Display settings - Software update / Service



Calibrate screen

⇨ See "Calibrating the touchscreen" [page 111]

Restart control
Carry out update

⇨ See "Software update Lambdatronic 3200" [page 113]

Restart display

Touch control unit is restarted and the data is reloaded from the core module.

Restore control device to factory settings (restart is carried out)

The touch display is reset to the factory setting. Data stored on the touch display (e.g. setting wizard) is completely deleted. Only perform if the system must be completely reconfigured (e.g. when replacing the core module).

4.15.2 Touchscreen - Display operating rights

In this menu the operating rights for the individual room consoles are allocated. If access from a room console to a heating system component is permitted, then the corresponding parameter must be set to “YES”. The number of menus as well as the parameter entries depend on the system configuration!

NOTICE! The operating rights of the room consoles should be allocated from the boiler console, as unrestricted access is only possible here.

“Touch display with address 1 – 7” and “Button display with address 1 – 7”

Heating system:

Allow access to heating circuit 01?
Allow access to heating circuit 02?
:
Allow access to heating circuit 18?

DHW tank system:

Allow access to DHW tank 01?
Allow access to DHW tank 02?
:
Allow access to DHW tank 08?

Buffer tank system:

Allow access to buffer tank 01?
:
Allow access to buffer tank 04?

Solar panel system:

Allow access to solar 01?

Heating system:

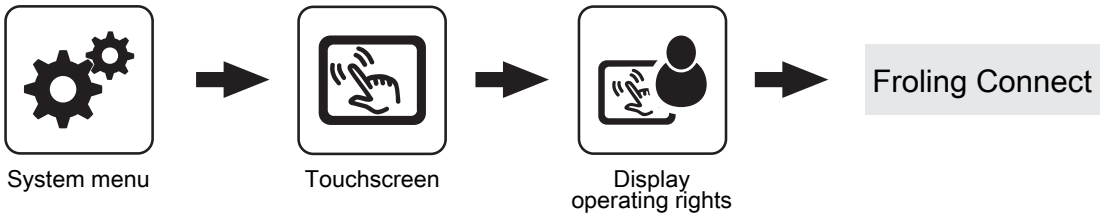
Additional freely programmable differential controller installed
Network pump installed
Circulation pump installed
Is any secondary boiler installed? (oil, gas, wood...)
Feeder pump for distributor 1 installed
:
Feeder pump for distributor 4 installed
In the cascade, this boiler is the MASTER

Boiler:

Switch boiler on/off via room console

If this function is activated, the respective room console is enabled for switching the boiler on and off. In order to be able to operate the boiler, remote switching on the boiler display must also be activated.

Froling Connect



For connection via the froeling-connect.com online platform using a touch display, the issue of a password is required.

NOTICE! The same password can be assigned for each touch display!

Password for boiler display
Password for Touch display with address 1
:
Password for Touch display with address 7

4.15.3 Touchscreen - Display allocation

Heating system:

To assign a room console to a heating circuit, the respective heating circuit number with its address must set on the room console. The parameters are set to “none” at the factory!

Touch display with address 1 is allocated to the following heating circuit:
:
Touch display with address 7 is allocated to the following heating circuit:
Button display with address 1 is allocated to the following heating circuit:
:
Button display with address 7 is allocated to the following heating circuit:

DHW tank system:

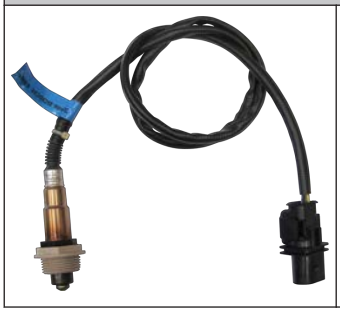
To assign a room console to a DHW tank, the respective DHW tank number with its address must set on the room console. The parameters are set to “none” at the factory!

Touch display with address 1 is allocated to the following DHW tank:
:
Touch display with address 7 is allocated to the following DHW tank:
Button display with address 1 is allocated to the following DHW tank:
:
Button display with address 7 is allocated to the following DHW tank:

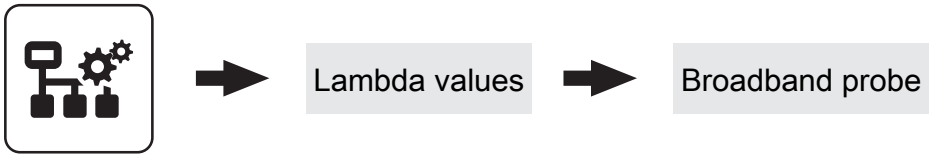
5 FAQ

5.1 Calibrate the broadband probe

The type of probe installed must be determined before starting calibration. To this end, coloured stickers (BOSCH = blue, NTK= yellow) are affixed to the connection cable of the probe, as well as to each end of the extension cable.

BOSCH broadband probe		NTK broadband probe	
			

Once the type of probe has been determined, the parameters need to be adjusted accordingly in the controller.



Setting

❒ Set the type of probe used
  ➥ BOSCH = 1, NTK = 2

For boilers with manual loading:

❒ Open the insulated door
  ➥ Before starting calibration, the insulated door must be open for at least 3 - 4 minutes so that the probe is warm enough and the boiler is sufficiently ventilated

For boilers with automatic loading:

❒ Boiler must be switched off
  ➥ Status "`Boiler OFF`" or "`Standby`"
❒ Set the "`Lambda probe heating`" parameter to "1"
  ➥ Heat broadband probe for at least 2 minutes

Calibrate probe:

NOTICE! The broadband probe must be at 21% oxygen (air)!

❒ Go to parameter "`Broadband probe calibration`"
❒ Set parameter to "`YES`" and press the enter key
  ➥ Automatic calibration of the broadband probe begins

Once calibration is complete the parameter is automatically set to "`NO`" and the broadband probe is ready for use

5.2 PDM / 0 - 10V settings

- **Pump without control line)**
  Set when a standard pump is run at the respective output. This is controlled at the 230V output using pulse packets.
- **HE pump without control line**
  Set when a high efficiency pump without control line (e.g. Grundfos Alpha, WILO Yonos Pico, etc.) is run at the respective output.
- **Field pump / PDM**
  There is a permanent power supply of 230V at the output for the high efficiency pump. The pump is controlled using pulse duration modulation at the respective PDM output.
- **Solar pump / PDM**
  Here again, the pump is controlled by means of pulse duration modulation at the respective PDM output. In this case, however, the characteristic line is inverted and can only be used for specially marked high efficiency solar pumps.
- **Field pump PDM +valve**
  The signal for the field pump is emitted at the PDM output. If the signal exceeds 2%, the 230V output is switched on. If the signal is below 2% for more than 4 minutes, the output is switched off again.
- **PDM sol.pump +valve**
  The signal for specially marked high efficiency solar pumps is emitted at the PDM output. If the signal exceeds 2%, the 230V output is switched on. If the signal is below 2% for more than 4 minutes, the output is switched off again.
- **Field pump / 0 – 10 V**
- **Solar pump / 0 – 10V**
- **Field pump 0–10 +valve**
- **Sol. pump 0–10V +valve**
  The same functions that apply with PDM apply to the parameter values with 0-10V. The only difference is that instead of pulse duration modulation, a 0-10V signal is used to control the pump.
- **Isolating valve**
  When set to “Isolating valve” the output is activated either with 0% or 100%. This setting value is only available in the “Water” or “Boiler 2” menu.

5.3 Boiler operating statuses

Preparation	The boiler is ventilated, the grate is closed, the sealing slider is opened and the Lambda probe is heated.
Heating up	The combustion chamber is filled with pellets.
Pre-heating	The ignition switches on and the pellets are preheated until a bed of embers is formed. For this period infeed is deactivated.
Ignition	The pellets are ignited with the ignition. The flame is distributed throughout the entire combustion chamber. Infeed is controlled according to the settings in the "Ignition" parameter menu.
Heating	The boiler controller controls combustion according to the boiler setpoints.
Slumber	The boiler has no power consumption. ID fan and infeed are deactivated.
Cleaning	The Lambdatronic carries out the cleaning program. The grate and, if necessary, the heat exchanger are cleaned.
Shutdown wait	When the boiler is interrupted during the heating up procedures (heating up, pre-heating, ignition), it waits for a specified period of time until the next start attempt.
Shutdown wait 1	The ID fan runs to burn the remaining pellets. Infeed is deactivated.
Shutdown wait 2	The system is still ventilated by chimney draught. Infeed is deactivated.
Fault	CAUTION - There is a fault!
Standby	The Lambdatronic controls the connected heating components. The boiler waits for a start request from the hydraulic system.
Boiler off	The boiler controller controls the connected heating components. All parts of the boiler are deactivated. Chamber discharge system active!

5.4 Boiler modes

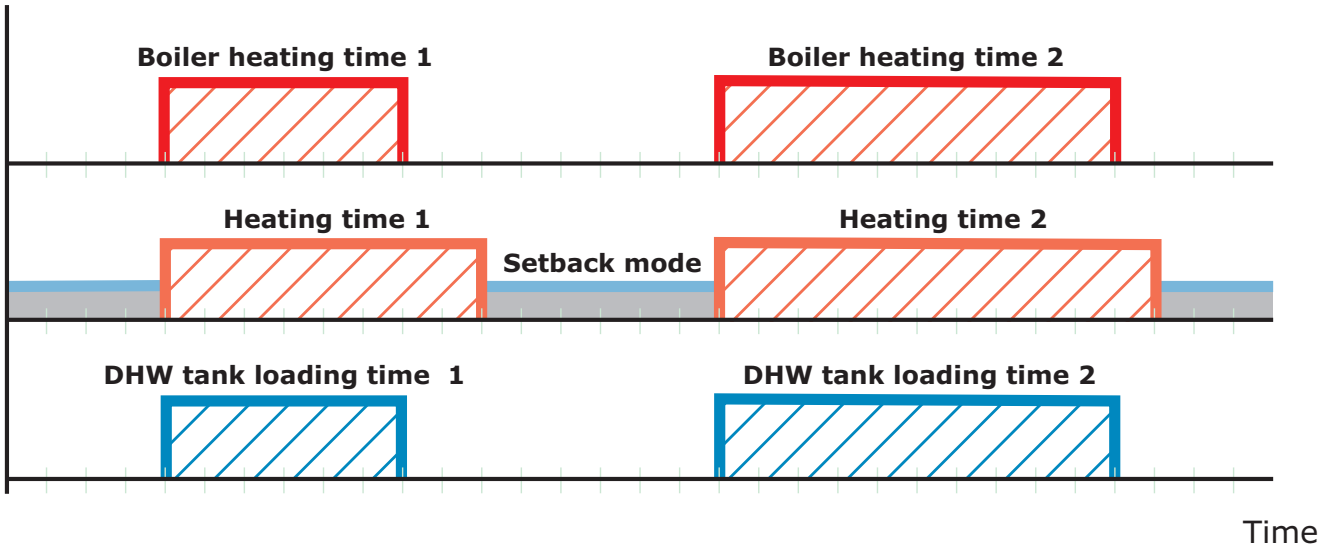
5.4.1 "Automatic" mode without storage tank

When “Automatic” is selected without a storage tank the boiler only produces heat during the specified boiler times. Outside these times the boiler follows the shutdown procedure and switches to "`Standby`" status. It is, therefore, important to note that in this mode the heating circuits and DHW tank are only supplied with heat during the boiler times.

In Example 1 the boiler times have been set to cover the necessary heat requirement. The heating times and DHW tank loading times have been set within the boiler time range, with the heating time being extended approximately one hour beyond the boiler time. This allows the residual energy in the boiler to be used by the heating circuits after the end of the boiler time.

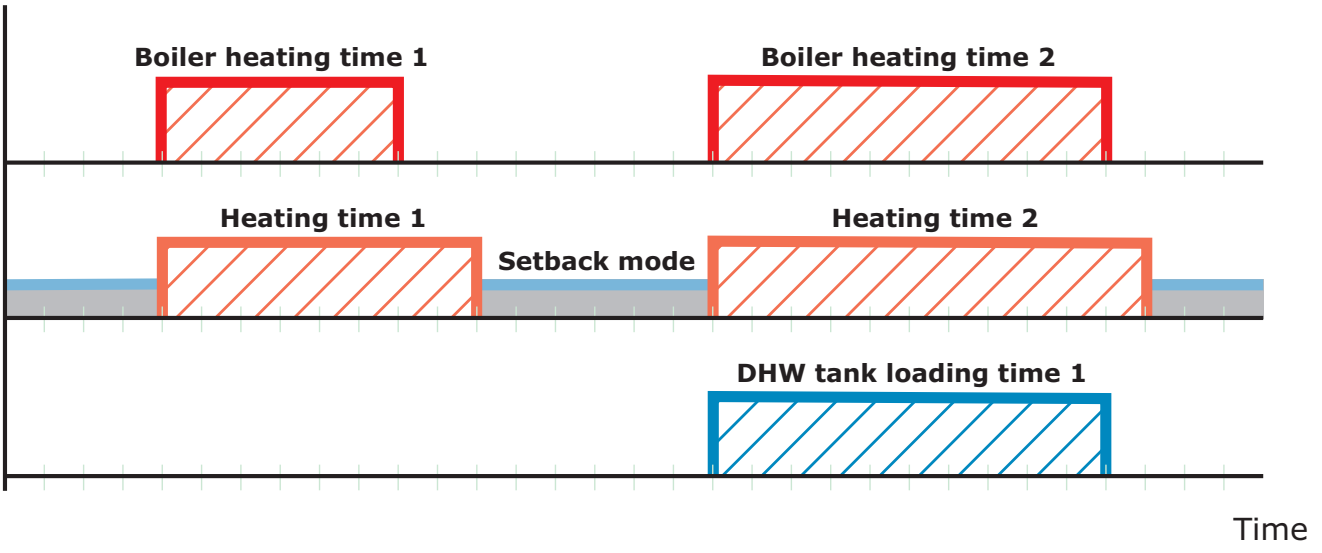
Note that outside the boiler times for setback mode, heat is only available until the boiler temperature falls below the setting value (parameter "`Minimum boiler temperature to release all pumps`").

Example 1: "Automatic” mode without storage tank



Tip: In systems with solar panels, choose the DHW tank loading time so that solar energy can be used.

Example 2: "Automatic” mode without storage tank with solar panel system



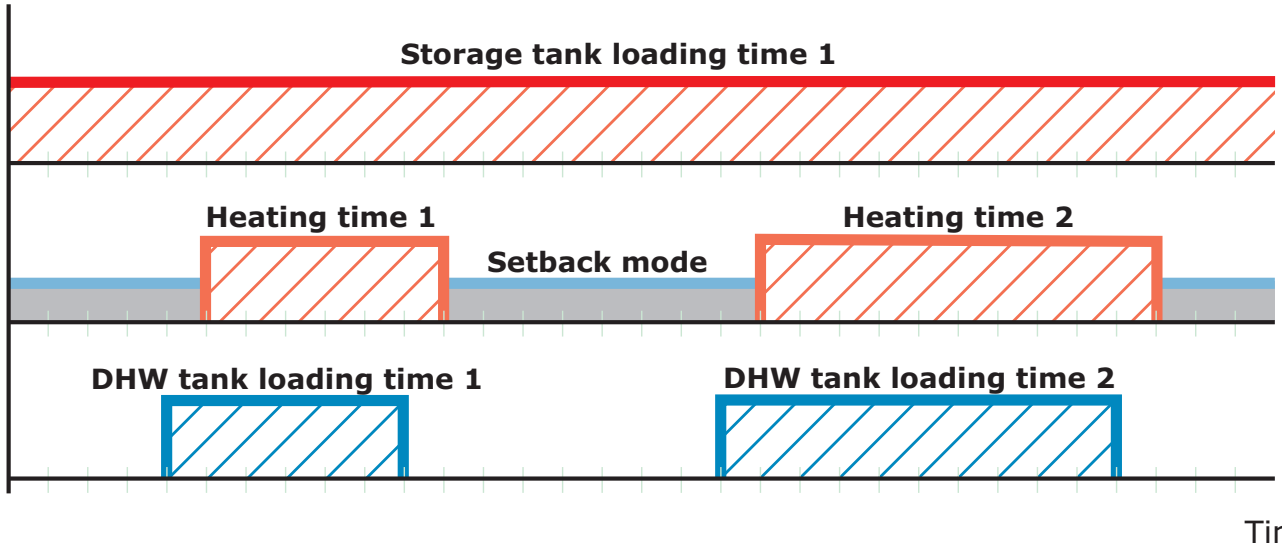
5.4.2 “Automatic” mode with storage tank

When “Automatic” is selected with storage tank the boiler only produces heat if the storage tank actually requests heat within the specified storage tank loading time. Outside these times the boiler is in "Standby" status.

The heating times should be set within the storage tank loading times so that the provision of heat is guaranteed over the entire heating time.

Note that the heating circuit and DHW tank are only supplied with heat if the storage tank temperature is sufficient for the requirement.

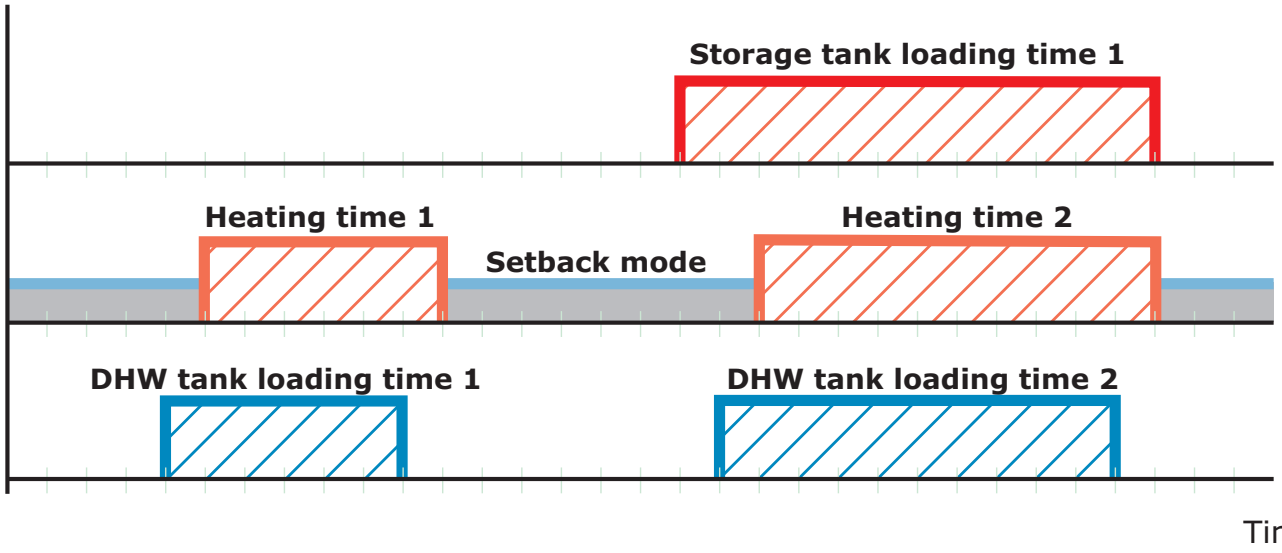
Example 1: “Automatic” mode with storage tank



Tip: In systems with a storage tank and solar panels, choose the storage tank loading time so that solar energy can be used.

In order to ensure that there is sufficient heat at the start of the DHW tank loading time and heating time, we recommend setting the storage tank charging time to begin before the start of the DHW tank time or heating time.

Example 2: “Automatic” mode with storage tank and solar panel system

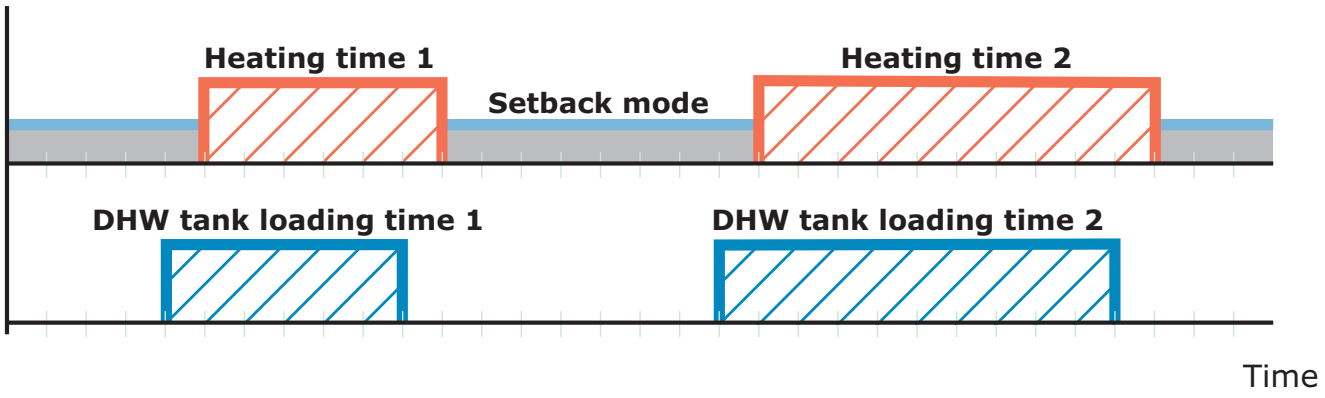


5.4.3 “Continuous load” mode without storage tank

When “Continuous load” is selected the boiler produces heat around the clock, in other words it tries to maintain its boiler temperature setpoint 24 hours a day. The boiler time settings are ignored in this mode.

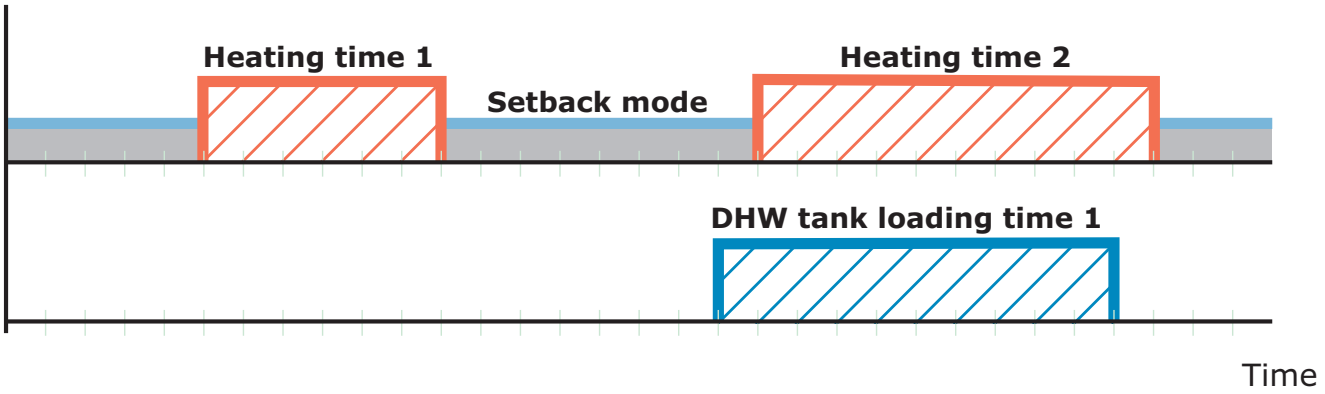
The heating times and DHW tank loading times can be distributed throughout the day as required.

Example 1: “Continuous load” mode



Tip: In systems with solar panels, choose the DHW tank loading time so that solar energy can be used.

Example 2: “Continuous load” mode with solar panel system



5.4.4 “Continuous load” mode with storage tank

To ensure efficient operation, set systems with a storage tank to “Automatic” mode rather than “Continuous load” mode.

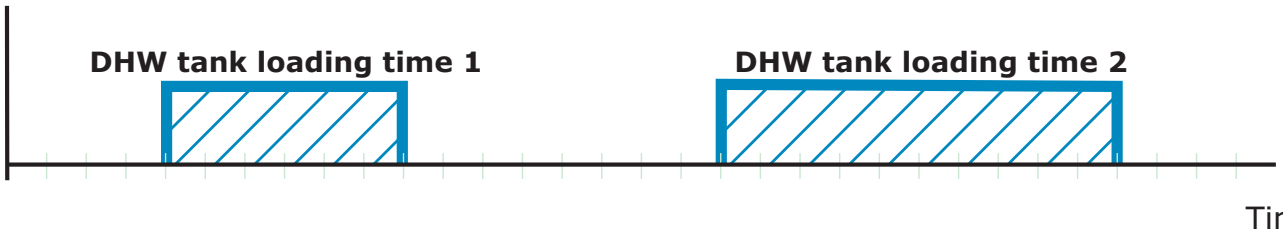
Set systems with a storage tank to “Automatic” mode!

⇨ See ""Automatic” mode with storage tank" [page 105]

5.4.5 “Domestic hot water” mode without storage tank

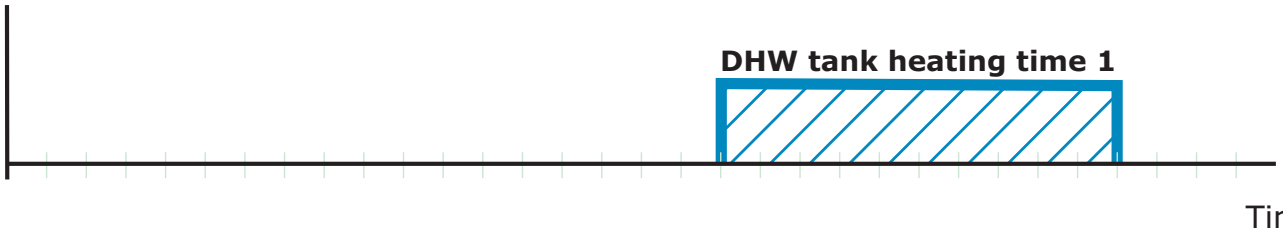
When “Domestic hot water” is selected the boiler only produces heat if the DHW tank actually requests heat within the specified DHW tank loading time.

Example 1: “Domestic hot water” mode without storage tank



Tip: In systems with solar panels, choose the DHW tank loading time so that solar energy can be used.

Example 2: “Domestic hot water” mode without storage tank with solar panel system

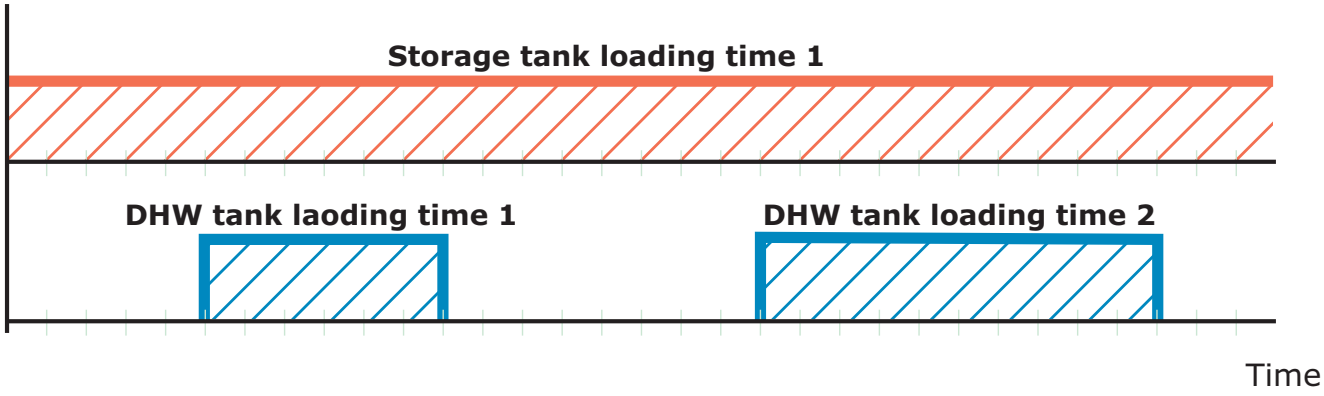


5.4.6 “Domestic hot water” mode with storage tank

In systems with a storage tank, note that in “Domestic hot water” mode the storage tank loading times remain active as the DHW tank is supplied with heat from the storage tank.

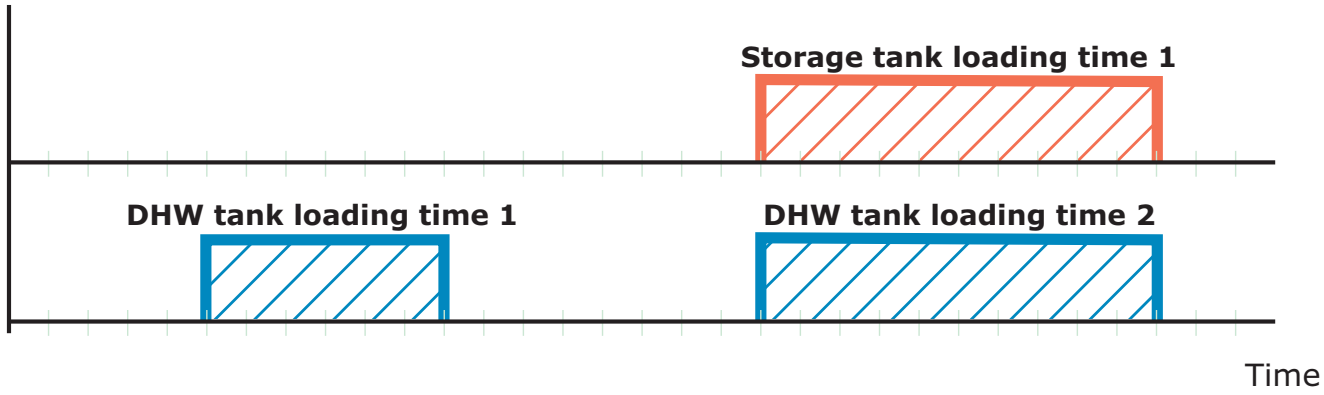
Within the storage tank loading time the boiler only produces heat if the storage tank temperature is below the minimum value and the DHW tank is requesting heat.

Example 1: “Domestic hot water” mode with storage tank



Tip: In systems with a storage tank and solar panels, choose the storage tank loading time so that solar energy can be used.

Example 2: “Domestic hot water” mode with storage tank and solar panel system



5.5 Setting times

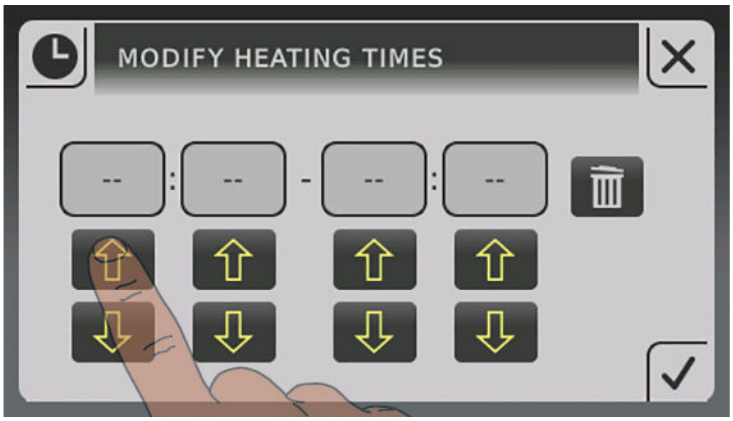
The desired time window for the component can be set in the "Times" tab in the individual menus of the heating components (heating circuits, DHW tanks etc.). The structure of the time menu and the procedure for changing the times are always the same.

❒ Use the left or right arrow to navigate to the desired day of the week
❒ Tap the symbol under the day of the week
↳ The edit window will appear

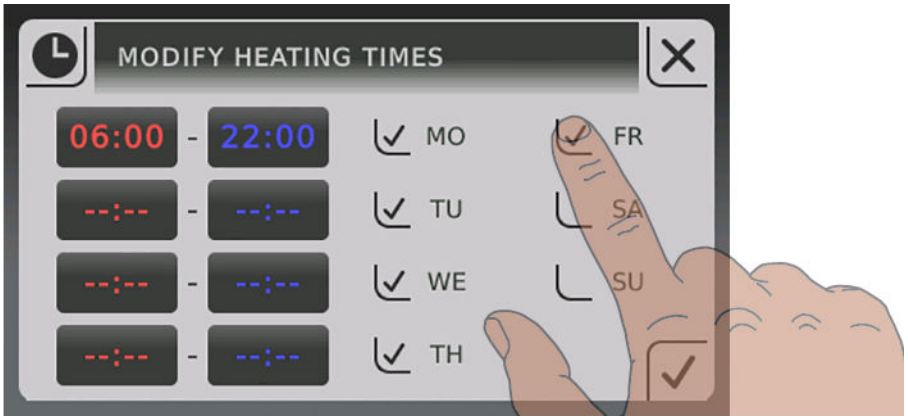
You can specify up to four time windows per component and day.

❒ Tap the desired time window

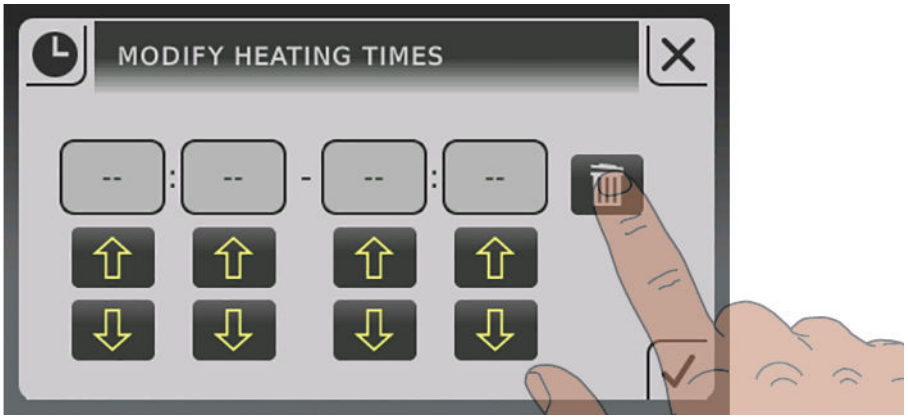
❒ The time window will open for editing
❒ Set the start and end time for the time window using the up and down arrows
❒ Save the time window setting by tapping on the confirm icon



If you want to apply the time window setting to another day in addition, you can do this by activating the relevant day.



A set time window can be deleted by tapping on the “Recycle bin” symbol.

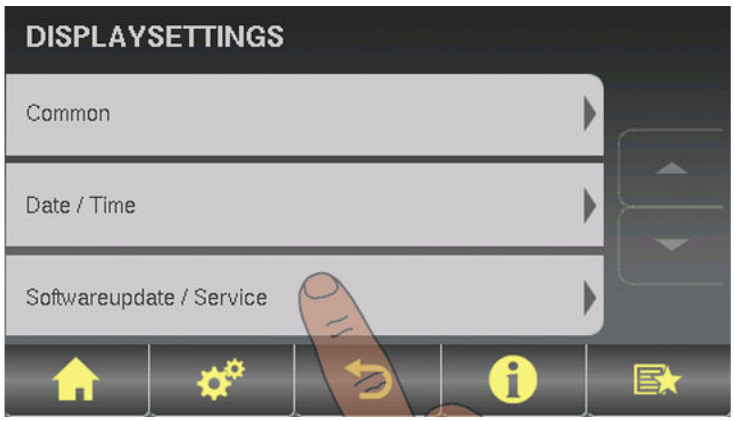


5.6 Calibrating the touchscreen

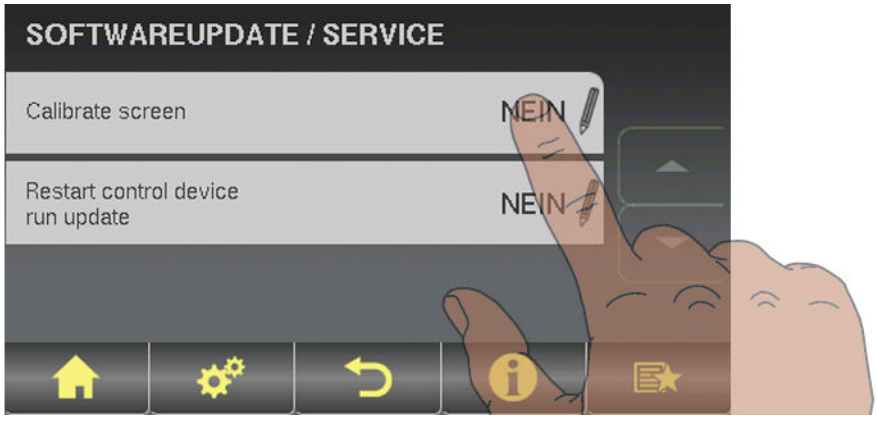
If the touchscreen stops working properly, it will need to be calibrated.

❒ Go to the “Display settings” menu

❒ Scroll down with the down arrow until the “Software update / Service" submenu appears and open the submenu

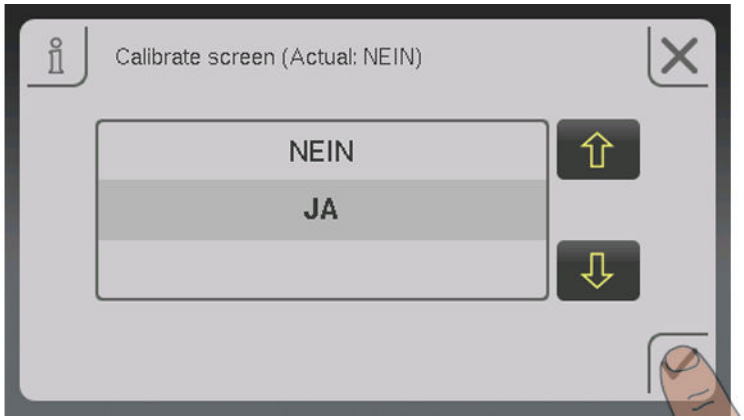


❒ In the “Software update / Service" menu open the “Recalibrate touch control” parameter



❒ Set the parameter to “YES” and confirm at the bottom right

➥ The touchscreen will restart and begin calibrating



To calibrate the touchscreen, you much press five points indicated by a crosshair in the order shown. The control will restart after calibration.

NOTICE

Inaccurate calibration

If you do not tap the indicated points accurately, the control may stop working properly and a software update may be required.

5.7 Software update Lambdatronic 3200

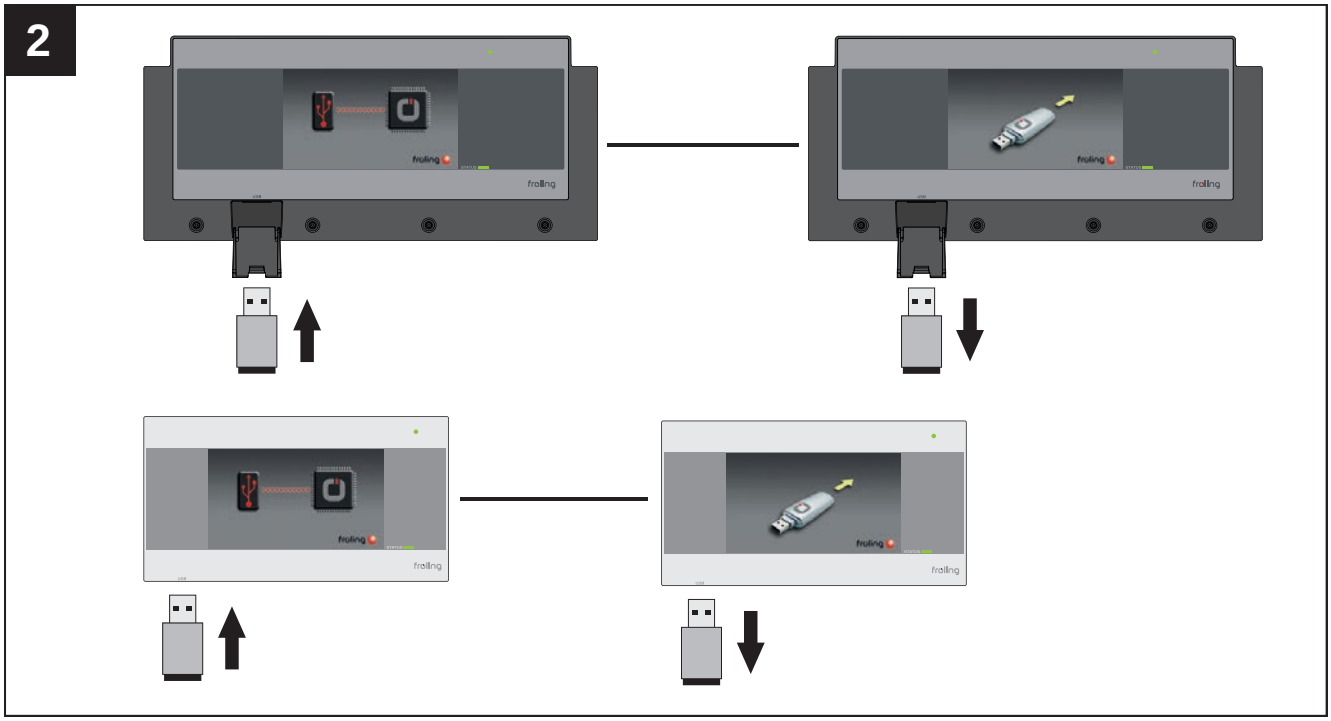
The following description shows the software update process for systems with Lambdatronic 3200 and a touch control in the system environment (also applies to systems with button boiler console and touch room console). The Froling Flash Update Wizard (core module) as well as a USB storage device is necessary to perform the software update. The procedure for establishing a connection and any necessary bootloader update is described in the documentation of the Flash Update Wizard.

Overview of main steps during a software update

Perform flash update - but do not close the Wizard

⇨ See "Carrying out a software update on the boiler controller" [page 114]

Perform software update of all touch controls



⇨ See "Carrying out a software update on the touch control" [page 116]

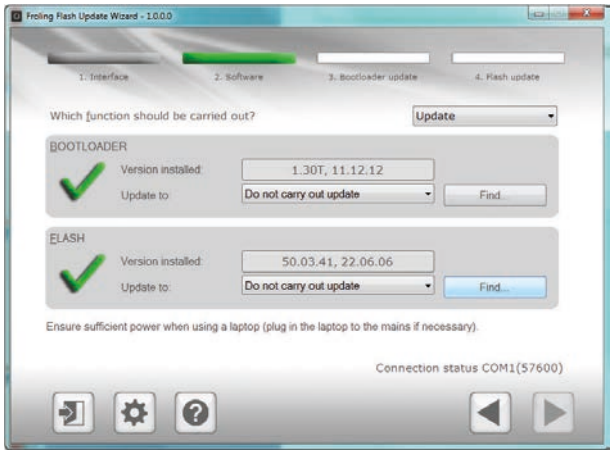
Close Flash Update Wizard - restart controller

⇨ See "Finishing a software update" [page 117]

5.7.1 Carrying out a software update on the boiler controller

Selecting a Flash file

Once the connection has been established, the main window displays the update files which can be installed:



- The "Version installed" field displays the Flash version which is currently installed on the boiler controller
- There is a drop-down list next to the "Update to:" field which shows the Flash files available in the standard folder

If the Flash file is located in the standard folder:

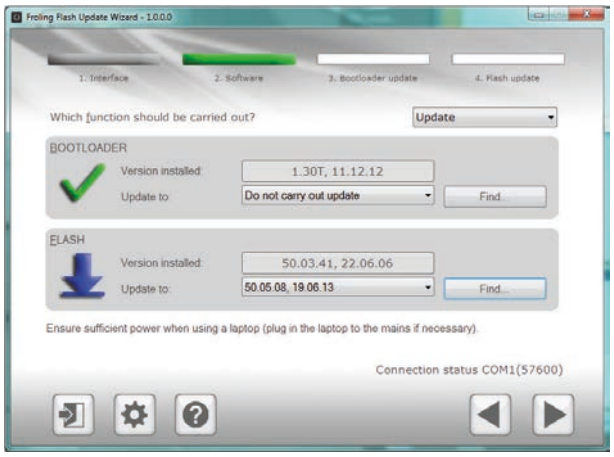
❒ Select the required Flash file from the drop-down list

If the Flash file is not located in the standard folder:

❒ Click on the "`Find`" button in the "FLASH" section
  ➥ A window is displayed where you can search for the Flash file
❒ Navigate to the folder where the file is saved
❒ Select the Flash (*.s19) file and click on the "Open" button

Starting the Flash update

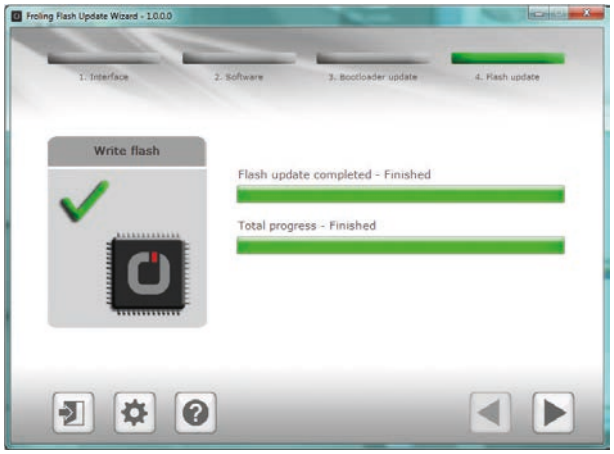
After selected the desired Flash file, it will be displayed next to the "Update to:" field:



❒ Click on the "Next" button

➥ The update process will now start and a progress bar displays the current status

When the flash update is successfully transferred to the boiler controller, the following window appears:



NOTICE! Do not close the update at this time and do not disconnect the boiler controller!

5.7.2 Carrying out a software update on the touch control

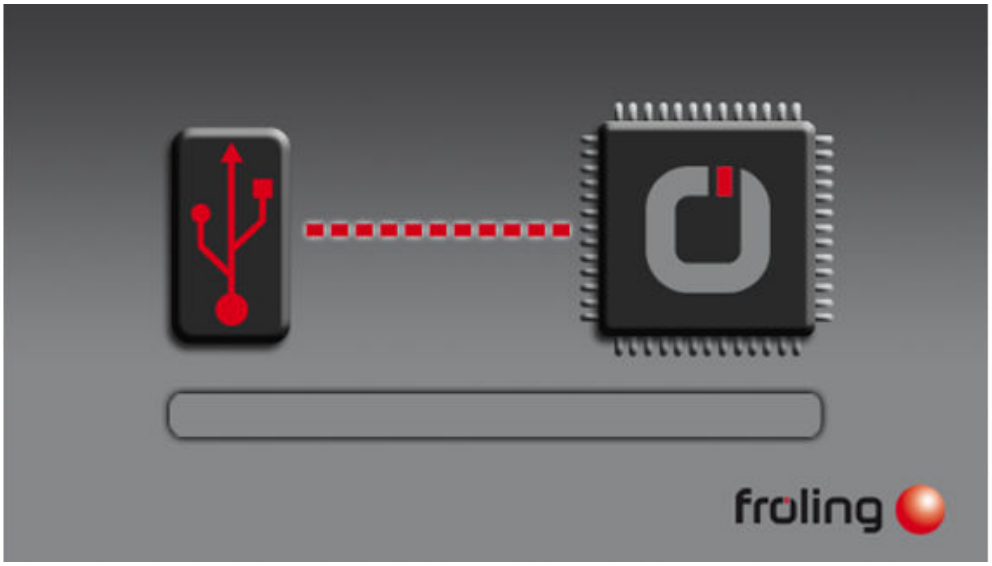
NOTICE! If several touch controls are installed, we recommend the use of several USB sticks and to perform the updates in parallel!

❒ Insert the USB stick with the necessary data (linux.bin; rootfs.img; update; froresetdemo.inc or frorestart.inc) into the USB port

➥ System message for restart is displayed

❒ Tap “OK” to carry out a restart of the touch control

➥ After the restart, the update process will begin automatically



Once the update is complete, a message will appear that you can remove the stick

❒ Remove the USB stick and close the cover flap (only with boiler console)

❒ Tap the touch screen

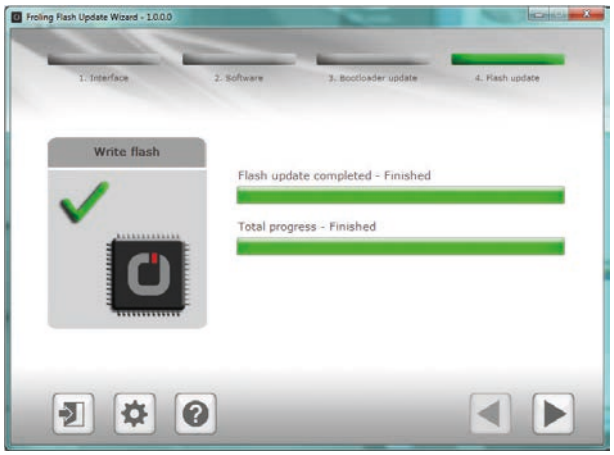
After restarting the display will start calibrating. Once the calibration is complete, it will restart again to finish. The touch control software is now up to date.

❒ Perform software updates to any other touch controls installed

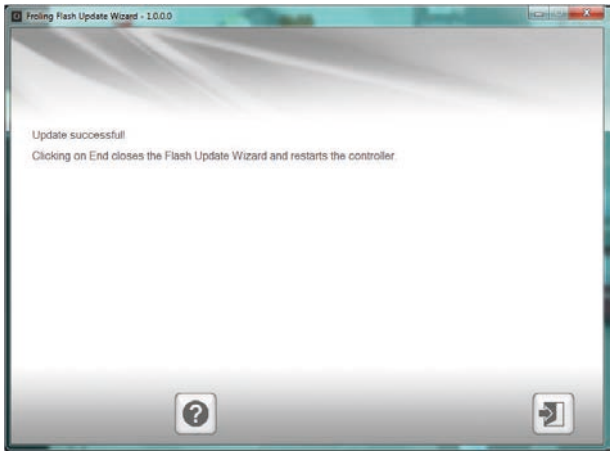
5.7.3 Finishing a software update

When the software update has been performed on all touch controls, the Flash Update Wizard must be ended correctly.

End flash update



❒ Click on the "Next" button
➥ The completion window appears



❒ Clicking on "Close" closes the Flash Update Wizard and restarts the boiler controller
➥ After restarting the boiler controller, check whether all touch controls have started up correctly

NOTICE! If not all touch controls connect to the boiler control, a restart of the entire system (main switch OFF/ ON) is necessary!

6 Notes

7 Appendix

7.1 Addresses

7.1.1 Address of manufacturer

FRÖLING
Heizkessel- und Behälterbau GesmbH

Industriestraße 12
A-4710 Grieskirchen
AUSTRIA

TEL 0043 (0)7248 606 0
FAX 0043 (0)7248 606 600
EMAIL info@froeling.com
INTERNET www.froeling.com

Customer service

Austria	0043 (0)7248 606 7000
Germany	0049 (0)89 927 926 400
Worldwide	0043 (0)7248 606 0

7.1.2 Address of the installer

Stamp

Conditioning of Fröling P4-60 boiler

Herewith we confirm that the boiler had been aged sufficiently (as per of the U.S. EPA 40 CFR Part 60, art.11 Conditioning) before starting the test at SZU lab. In fact the boiler had already been used in 2019 for testing preparations, please see an extract of the time table.

P4 Pellet 60

				Boiler	Flue gas
Datum	**Hr.**	**CAT.**	**P/kW**	**t_K/°C**	**t_{AG}/°C**
05.09.2019	05:30	IV	59.2	73.9	124.2
06.09.2019	04:00	IV	57.9	75.2	121.0
10.09.2019	06:30	IV	58.5	74.8	121.9
11.09.2019	05:45	IV	58.6	74.2	122.8
17.09.2019	04:45	II	12.2	78.7	75.3
18.09.2019	06:00	III	25.1	86.2	91.7
19.09.2019	05:15	III	24.9	85.6	90.3
23.09.2019	06:30	IV	58.6	75.1	122.1
03.10.2019	05:00	I	8.7	73.1	68.4
07.10.2019	05:30	I	8.1	72.7	67.8
	∑ 54,75				

Annex B

No.	Version	Pages
1.	Calibration sheets	1 - 55

Note: Annex B is an integral part of test report 32-10198/4-4/T

Český metrologický institut

Okružní 31, 638 00 Brno

tel. +420 545 555 111, fax +420 545 222 728, www.cmi.cz

Pracoviště: Oblastní inspektorát Pardubice, Průmyslová 455, Pardubice 530 03
Oddělení objemu a průtoku plynů, tel.: +420 466 670 728, fax.: +420 466 670 931

KALIBRAČNÍ LIST

5012-KL-RS091-09

Datum vystavení: 1. prosince 2009

Zákazník: **Strojírenský zkušební ústav, s.p.**
Hudcova 56b
621 00 Brno

Uživatel: **Strojírenský zkušební ústav, s.p., Hudcova 56b, 621 00 Brno**

Měřidlo: Prandtlova sonda typu L
Rozměr: 5 x 500 mm
Výrobní číslo: 1107 inv.č.:ME 485
Výrobce: AHLBORN

Výsledky kalibrace byly získány za podmínek a s použitím postupu uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Použité etalony: prandtlova trubice Ks = 0,9897
aerodynamický tunel EIFFEL
kapalinový mikromanometr Schilknecht 612, v.č.8009

Kalibrační postup: Zkoušky byly provedeny porovnávací metodou podle interní metodiky zkoušení anemometrů - Směrnice VVUÚč.4/91. Vyhodnocení dle ČSN ISO 9096

Místo kalibrace: VVUÚ, a.s., Pikartská 7, 716 07 Ostrava-Radvanice

Datum kalibrace: 24. listopadu 2009

Kalibraci provedl: **Vedoucí oddělení:**

Český metrologický institut
-50-

Radek Novotný
Jaromír Matějů - VVUÚ a.s., Ostrava-Radvanice

Ing. Tomáš Valenta

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Podmínky prostředí: teplota vzduchu (20,6 ± 1,0)°C
vlhkost vzduchu (63 ±10) %
barometrický tlak (98,2 ± 0,5) kPa

Výsledky kalibrace:

referenční hodnota (tlak na etalonové sondě)	údaj měřidla (tlak na zkoušené sondě)	kalibrační konstanta zkoušené Prandtlovy sondy podle vztahu $K = K_{ref} \cdot \sqrt{\frac{\Delta p_{ref}}{\Delta p}}$, kterou lze pak dosadit do vztahu $v = K \cdot \sqrt{\frac{2 \cdot \Delta p}{\rho}}$
(Pa)	(Pa)	(-)
4,8	4,9	0,9795
19,4	19,5	0,9871
38,8	39,3	0,9834
63,1	64,2	0,9812
97,1	99,1	0,9796
135,9	138,6	0,9800
174,8	178,2	0,9802
233,1	237,0	0,9815

Rozšířená nejistota U stanovení diferenčního tlaku nepřesáhla hodnotu 2,5 Pa. Uvedená nejistota U představuje standartní kombinovanou nejistotu násobenou koeficientem pokrytí k=2, což normální rozdělení odpovídá spolehlivosti 95.5%. Standartní kombinovaná nejistota byla stanovena podle dokumentu EA4/02

Konec kalibračního listu

Český metrologický institut
Oblastní inspektorát Pardubice
Průmyslová 455
530 03 Pardubice
-3-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

K 2202

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2005

Pracoviště: Oblastní inspektorát Brno, Okružní 31, 638 00 Brno
Oddělení primární etalonáže průtoku kapalin, rychlosti proudění a tepla
tel. +420 545 555 111, fax. +420 545 555 183

KALIBRAČNÍ LIST

6015-KL-P0241-17

Datum vystavení: 12. dubna 2017

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 424/56b
621 00 Brno

Uživatel: -

Měřidlo: Anemometr termický
Výrobce: Airflow
Typ: TA430
Výrobní číslo: TA4301320002
Ostatní údaje:

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 10. dubna 2017

Kalibraci provedl:

Ing. Jan Sluše

Český metrologický institut -60-

Vedoucí oddělení:

Mgr. Jindřich Bílek

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony: laserový dopplerovský anemometr ILA fp50f-us, ser. č. 738, kalibrováno PTB, kalibrační certifikát PTB-1.41-4082978 ; aerodynamický tunel Westenberg Engineering typ WK 845050-G

Použité etalony mají metrologickou návaznost na státní etalony ČR a PTB (Německo).

Kalibrační postup: Metoda dle pracovního postupu č. 615-MP-C147.

Místo kalibrace: ČMI OI Brno

Podmínky prostředí: Teplota vzduchu (20,0 ± 0,5) °C; RV vzduchu (45 ± 1) %; tlak vzduchu (985 ± 1) hPa

Podmínky kalibrace: Teplota vzduchu v tunelu (20,0 ± 0,5) °C; RV vzduchu v tunelu (45 ± 1) %

Výsledky kalibrace:

v_E	v_M	E	U(E)
m/s	m/s	m/s	m/s
0,313	0,320	0,007	0,011
6,052	5,745	-0,307	0,030
12,098	11,422	-0,676	0,060
18,129	17,210	-0,919	0,091
24,15	22,93	-1,22	0,12
30,14	28,83	-1,31	0,15

v_E … rychlost měřená etalonem
v_M … rychlost měřená měřidlem
E … chyba měřidla
U(E) … kombinovaná rozšířená nejistota chyby měřidla

Standardní nejistota měření byla určena v souladu s dokumentem EA–4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Konec kalibračního listu.

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-11-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

TECHNICKÉ LABORATOŘE OPAVA, akciová společnost
Kalibrační laboratoř geometrických veličin
č. 2277
akreditovaná Českým institutem pro akreditaci, o.p.s.
dle ČSN EN ISO/IEC 17025

K 2277

Telefon 553759860 ÷ 67
E-mail technici@tlo.cz

Těšínská 2962/79b
746 01 OPAVA

KALIBRAČNÍ LIST
č. 8800/2017

Datum vystavení : 27.10.2017

Žadatel : Strojírenský zkušební ústav, s. p., Hudcova 56b
621 00 Brno

Měřidlo :
- **Název:** Svinovací metr ocelový - 4 kusy
- **Výrobce :** Assist
- **Jmenovitý rozměr:** 0 ÷ 5 m / dílek st. 1 mm
- **Identifikační číslo:** viz tabulka

Datum přijetí : 6.10.2017 **Datum kalibrace:** 25.10.2017

Použité etalony :
- **Název :** Měřící dráha
- **Výrobce :** Richter + Preisser
- **Typ / rozsah :** (0 - 20000 mm)
- **Identifikační číslo :** 1
- **Kalibrační list č. :** 5022/14
- **Platnost kalibrace :** 23.7.2018

Etalon je metrologicky navázán na státní (mezinárodní) etalonáž

Kalibrační metoda: Kalibrační postup č. 6.2 – KLGV

Podmínky měření : Teplota vzduchu v laboratoři (20 ±0,8) °C
Změna teploty během měření max. 0,5° C/hod

Výsledek kalibrace a vyhodnocení : Svinovací metry **VYHOVUJÍ** ČSN 251105

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu stran. Naměřené údaje a hodnoty se vztahují ke dni a místu, ve kterém byla kalibrace provedena.

Výsledek měření:

Ev. číslo: ME474		rozsah: 0 ÷ 5 m / dílek st. 1 mm
Přesnost měřidla byla hodnocena v těchto bodech stupnice (mm)	**Dovolená úchylka dle ČSN 251105 (mm)**	**Naměřená úchylka (mm)**
0	0	0
30	± 0,6	0
100	± 0,6	-0,2
220	± 0,6	-0,1
330	± 0,6	-0,1
440	± 0,6	-0,1
500	± 0,6	-0,1
750	± 0,6	0
1000	± 0,6	0
1250	± 1,0	-0,3
1500	± 1,0	-0,4
1750	± 1,0	-0,5
2000	± 1,0	-0,4
2250	± 1,0	-0,3
2500	± 1,0	-0,2
2750	± 1,0	-0,2
3000	± 1,0	-0,1
3500	± 1,5	-0,3
4000	± 1,5	-0,5
4500	± 1,5	-0,1
5000	± 1,5	0
Rozšířená nejistota měření:	U = (0,2 + 0,04.L)mm pro „L“ v (m)	
Výsledek kalibrace:	**VYHOVUJE ČSN 251105**	

Ev. číslo: ME476	**rozsah: 0 ÷ 5 m / dílek st. 1 mm**	
Přesnost měřidla byla hodnocena v těchto bodech stupnice (mm)	**Dovolená úchylka dle ČSN 251105 (mm)**	**Naměřená úchylka (mm)**
0	0	0
30	± 0,6	0
100	± 0,6	-0,1
220	± 0,6	-0,1
330	± 0,6	-0,3
440	± 0,6	-0,5
500	± 0,6	-0,3
750	± 0,6	-0,3
1000	± 0,6	-0,2
1250	± 1,0	-0,1
1500	± 1,0	-0,2
1750	± 1,0	-0,3
2000	± 1,0	-0,3
2250	± 1,0	-0,3
2500	± 1,0	-0,5
2750	± 1,0	-0,5
3000	± 1,0	-0,6
3500	± 1,5	-0,7
4000	± 1,5	-1,0
4500	± 1,5	-1,0
5000	± 1,5	-0,9
Rozšířená nejistota měření:	U = (0,2 + 0,04.L)mm pro „L“ v (m)	
Výsledek kalibrace:	**VYHOVUJE ČSN 251105**	

Ev. číslo: ME477		**rozsah: 0 ÷ 5 m / dílek st. 1 mm**
Přesnost měřidla byla hodnocena v těchto bodech stupnice (mm)	**Dovolená úchylka dle ČSN 251105 (mm)**	**Naměřená úchylka (mm)**
0	0	0
30	± 0,6	0
100	± 0,6	0
220	± 0,6	0
330	± 0,6	0
440	± 0,6	0
500	± 0,6	0
750	± 0,6	0
1000	± 0,6	-0,1
1250	± 1,0	-0,1
1500	± 1,0	-0,1
1750	± 1,0	-0,1
2000	± 1,0	-0,1
2250	± 1,0	0
2500	± 1,0	0
2750	± 1,0	+0,1
3000	± 1,0	+0,1
3500	± 1,5	+0,1
4000	± 1,5	-0,2
4500	± 1,5	-0,3
5000	± 1,5	-0,4
Rozšířená nejistota měření:	$U = (0,2 + 0,04.L)$mm pro „L“ v (m)	
Výsledek kalibrace:	**VYHOVUJE ČSN 251105**	

Ev. číslo: ME478	**rozsah: 0 ÷ 5 m / dílek st. 1 mm**	
Přesnost měřidla byla hodnocena v těchto bodech stupnice (mm)	**Dovolená úchylka dle ČSN 251105 (mm)**	**Naměřená úchylka (mm)**
0	0	0
30	± 0,6	0
100	± 0,6	+0,1
220	± 0,6	+0,2
330	± 0,6	+0,2
440	± 0,6	+0,1
500	± 0,6	0
750	± 0,6	+0,1
1000	± 0,6	+0,2
1250	± 1,0	+0,3
1500	± 1,0	+0,4
1750	± 1,0	+0,4
2000	± 1,0	+0,2
2250	± 1,0	+0,3
2500	± 1,0	+0,1
2750	± 1,0	-0,1
3000	± 1,0	0
3500	± 1,5	-0,3
4000	± 1,5	-0,3
4500	± 1,5	-0,2
5000	± 1,5	-0,1
Rozšířená nejistota měření:	U = (0,2 + 0,04.L)mm pro „L“ v (m)	
Výsledek kalibrace:	**VYHOVUJE ČSN 251105**	

- Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu rozšíření $k = 2$, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí asi 95%. Standardní nejistota měření byla určena v souladu s dokumentem EA 4/02.

Kalibraci provedl : Ondřej Kubalák .....
(podpis)

Schválil: Petr Kubalák .....
zástupce vedoucího akreditované (podpis, razítko)
Kalibrační laboratoře geometrických veličin č. 2277

MEROS
Kalibrační laboratoř č. 2249

Starozuberská 1453, 756 54 Zubří
MEROS, spol. s r.o., tel. +420 774 747 701, e-mail: meros@meros.cz, www.meros.cz

K 2249

KALIBRAČNÍ LIST č. 3434E-17

Žadatel: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Měřidlo:

druh:	digitální stopky
výrobce:	SPEEDO
typ:	neuveden
výrobní číslo:	neuvedeno
inventární (evid.) číslo:	990760

Specifikace: neuvedena

Kalibrační metoda: přímé porovnání dle MKF - t1

Podmínky prostředí: teplota 23°C ± 2°C, relativní vlhkost max. 80 %

Použité etalony:

	typ	výrobní číslo	platnost do	číslo kal. listu
Kalibrátor stopek	NI PCI-6602	ič. 553	25.10.2018	3337E-16

Návaznost: Všechny použité etalony mají metrologickou návaznost na (mezi)národní etalony.

Datum přijetí 25.10.2017

Datum kalibrace: 2.11.2017

Libor Červenka
vedoucí laboratoře

podpis vedoucího oddělení

Kalibraci provedl: Karel Bok

Vyhodnocení: Dle požadavku žadatele uvedeny naměřené hodnoty, které se vztahují pouze k době a místu provedení kalibrace.

Naměřené hodnoty:

rozlišovací schopnost [s]	měřený interval [s]	odchylka [s]	nejistota měření [±s]
0,01	60	0,00	0,02
0,01	900	-0,03	0,02
0,01	1800	-0,07	0,01
1	3600	-0,3	1

Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu rozšíření k=2, které pro normální rozdělení odpovídá pravděpodobnosti pokrytí asi 95%. Standardní nejistota měření byla určena v souladu s dokumentem EA-4/02.

MEROS, spol. s r.o. kalibrační laboratoř č. 2249 akreditovaná Českým institutem pro akreditaci, o.p.s. dle ČSN EN ISO/IEC 17025 prohlašuje, že bez jejího písemného souhlasu se nesmí tento kalibrační list reprodukovat jinak než celý. Výsledky kalibrace se týkají pouze kalibrovaného měřidla a nenahrazují jiné dokumenty.

Bc. Andrea Volejníková
vedoucí KL

Datum vydání: 2.11.2017 Konec kalibračního listu. schválil za KL

MEROS, spol. s r.o.
Kalibrační laboratoř č. 2249

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

CIPM MRA ilac-MRA K 2202

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2005

Pracoviště: Oblastní inspektorát Brno, Okružní 31, 638 00 Brno
Oddělení primární etalonáže průtoku kapalin, rychlosti proudění a tepla
tel. +420 545 555 111, fax. +420 545 555 183

KALIBRAČNÍ LIST

6015-KL-P0696-17

Tento kalibrační list je v souladu s kalibračními schopnostmi měření (CMCs), které jsou uvedeny v příloze C Ujednání o vzájemném uznávání (MRA) vydaného Mezinárodním výborem pro míry a váhy (CIPM). Podle tohoto Ujednání všechny zúčastněné instituty vzájemně uznávají platnost svých kalibračních listů pro veličiny, rozsahy a nejistoty měření uvedené v příloze C (podrobnosti viz www.bipm.org).

Datum vystavení: 16. října 2017 List 1 ze 2 listů

Zákazník Strojírenský zkušební ústav, s.p.
Hudcova 424/56b
621 00 Brno

Měřidlo: Indukční průtokoměr

Výrobce: Krohne

Typ: Optiflux 5300

Výrobní číslo: A13021150

Ostatní údaje: DN15; ev.č.: PrutokomerV1; GK: 1,8671; GKL: 3,7052; (4 – 20) mA = (0 – 6,0) m^3/h

Výsledky kalibrace byly získány za podmínek a s použitím postupu uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Použité etalony: Zkušební stanice SENSUS PREMATEST 32Z/E-95-SP, v.č. 025/2009, váha Mettler Toledo, typ WM3002-L22, v.č. 4230440891, kal.: ČMI OI Brno, kalibrační list č. 6051-KL-H0417-17; váha Mettler Toledo, typ WMHCC300-22, v. č. 3113910, kal.: ČMI OI Brno, kalibrační list č. 6012-KL-V0001-17; váha Mettler Toledo, typ WMHA32-S-22, v.č. 3113909, kal.: ČMI OI Brno, kalibrační list č. 6051-KL-H0418-17.

Použité etalony mají metrologickou návaznost na státní etalon ČR.

Datum kalibrace: 10. - 14. října 2017

Kalibraci provedl:

Ing. Jaroslav Foltýnek

Český metrologický institut -60-

Vedoucí oddělení:

Mgr. Jindřich Bílek

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Kalibrační postup: Hmotnostní metoda s letmým startem dle pracovního postupu č. 615-MP-C142.
Pro zkoušku použit proudový výstup měřidla (20 mA = 7,0 m^3/h).

Místo kalibrace: ČMI OI Brno

Podmínky prostředí: Teplota vzduchu (24 ± 1) °C; RV vzduchu (40 ± 10) %

Podmínky kalibrace: Kalibrační kapalina voda, teplota (20 ± 2) °C

Výsledky kalibrace:

Před justáží, po čištění (GK: 1,8447; GKL: 3,6607)**:**

Průtok	Proud	Chyba	Kombinovaná rozšířená nejistota
[m^3/hod]	[mA]	[%]	[%]
0,09	4,19	-1,22	0,24
6,97	19,93	-1,24	0,10

Po justáži (GK: 1,8671; GKL: 3,7052)**:**

Průtok	Proud	Chyba	Kombinovaná rozšířená nejistota
[m^3/hod]	[mA]	[%]	[%]
0,08	4,19	-0,17	0,18
0,20	4,47	-0,02	0,10
0,59	5,36	0,04	0.10
1,00	6,29	-0,04	0,10
2,49	9,70	0,06	0,10
4,99	15,41	0,05	0,10
6,97	19,93	0,04	0,16

Standardní nejistota měření byla určena v souladu s dokumentem EA–4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Konec kalibračního listu.

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-18-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

FLOMAG®
Measurement & Control Equipment
FLOMAG s.r.o.
V Aleji 180/20a, CZ 620 00 Brno
Kalibrační laboratoř Křižkova 70, 612 00 Brno

K 2367

Kalibrační list č. Q 0191/2018

Měřidlo:	Indukční průtokoměr
Výrobce:	FLOMAG s.r.o.
Typ	Flomag-ICM
Výr. č.:	2000/1516
Rozsah [m³/h]:	0.324 ÷ 6.48
DN:	15
Konstanta zesilovače GK:	K1: -12.6019 K2: -0.00898 Buzení: 3.125 Hz
Impulzní výstup:	
Zákazník:	Strojírenský zkušební ústav s. p. Hudcova 56b Brno

Podmínky měření:

Měřidlo bylo měřeno dle kalibračního postupu KP 01 na etalonážním zařízení EZ/K/ 92-001a FLOMAG s.r.o. porovnáním hlavními etalony - indukčními průtokoměry Krohne DN4, DN15.
Hlavní etalony jsou kalibrovány ČMI-OI Brno, protokoly č.6015-KL-P0585-17, 6015-KL-P0583-17.
Měření má návaznost na (mezi)národní etalony.

Poloha měřidla:	vodorovná
Zkušební médium:	vodárenská voda
Teplota okolí:	(24.6 ± 2,0) °C
Teplota vody při zkoušce:	(24.2 ± 0,5) °C

Výsledek měření:

Naměřené hodnoty byly zpracovány výpočtem do tabulky:

Qe [m³/h]	Relativní chyba [%]	U [%]
0.06	-0.26	0.50
0.33	-0.10	0.30
0.61	-0.10	0.30
1.64	-0.10	0.30
3.30	-0.12	0.25

Uvedené rozšířené nejistoty U měření jsou součinem standardní nejistoty měření a koeficientu rozšíření k=2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí 95 %. Standardní nejistota byla určena v souladu s dokumentem EA 4/02.

FLOMAG® K2367
FLOMAG s.r.o. V Aleji 180/20a, CZ 620 00 Brno
AKREDITOVANÁ KALIBRAČNÍ LABORATOŘ
pracoviště Křižíkova 70, 612 00 Brno

Datum kalibrace: 13.4.2018

Datum vystavení KL: 13.4.2018

Měření provedl: Jaroslav Furthner

Ing. Tomáš Kokojan
Vedoucí KL

Výsledky se týkají pouze uvedeného měřidla a vztahují se k místu provedených měření.
Kalibrační list nemůže být rozmnožován bez písemného souhlasu kalibrační laboratoře, která jej vystavila, jinak než celý.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

K 2202

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2005

Pracoviště: Oblastní inspektorát Pardubice, Průmyslová 455, Pardubice, 530 03
Oddělení primární etalonáže objemu a průtoku plynÚ, tel. 466 670 728, fax 466 670 931

KALIBRAČNÍ LIST

5012-KL-P1484-18

Datum vystavení: 17.7.2018 List 1 ze 2 listů

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b, 621 00 Brno

Měřidlo:	Membránový plynoměr	**Velikost:**	G4	
Výrobce:	Honeywell	**Q_{max}:**	6	m^3/h
Typ:	BK	**Q_{min}:**	0,016	m^3/h
Výrobní číslo:	11400767	**P_{max}:**	0,5	bar
Rok výroby:	2018	**Cyklický objem:**	1,2	dm^3

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 17.7.2018

Kalibraci provedl: **Vedoucí oddělení:**

Český metrologický institut -50/1-

Ing. Stanislav Březina

Ing. Tomáš Valenta

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony:

Při kalibraci byla použita stanice s kritickými dýzami SONICAL SN-1000 v.č. 330, která slouží ke zkouškám plynoměrů a průtokoměrů pro plyn. Kritické dýzy mají návaznost přes sekundární etalony I. řádu na PTB Braunschweig, SRN. Dýza s nominálním průtokem 660 m3/h byla kalibrována dne 11.6.2015 (kalibrační list č. 5012-KL-P0061-15). Dýzy s nominálními průtoky od 16 m3/h do 260 m3/h byly kalibrovány ve dnech 23.9.-25.9.2008 (kalibrační list č. 5012-KL-P188-08). Dýzy s nominálními průtoky od 0,7 m3/h do 8 m3/h byly kalibrovány ve dnech 6.1.-7.1.2009 (kalibrační list č. 5012-KL-P005-09). Dýzy s nominálními průtoky od 0,06 m3/h do 0,50 m3/h byly kalibrovány dne 6.1.2014 (kalibrační list č. 5012-KL-P0008-14).

Kalibrační postup: 512-MP-C103

Místo kalibrace: ČMI OI Pardubice, zkušebna plynoměrů
Průmyslová 455, 530 03 Pardubice (tel. 466 670 728 141; 607 628 951)

Podmínky prostředí:

teplota :	(22,6	± 1,0)	°C
barometrický tlak :	(98,3	± 0,1)	kPa
relativní vlhkost vzduchu :	(48	± 10)	%

Výsledky kalibrace:

průtok (m^3/h)	chyba plynoměru (%)	nejistota stanovení chyby plynoměru U(k=2) (%)
1,22	1,26	0,63
0,71	0,94	0,59
0,41	0,66	0,56
0,25	0,46	0,34
0,16	0,54	0,36

chyba plynoměru = 100 . (Vp - Ve)/Ve (%)

Vp ..... proteklý objem vzduchu zaznamenaný zkoušeným plynoměrem, korigovaný na stavové podmínky vzduchu v etalonu
Ve ..... proteklý objem vzduchu zaznamenaný etalonem

Standardní nejistota měření byla určena v souladu s dokumentem EA-4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Konec kalibračního listu

Český metrologický institut
Oblastní inspektorát Pardubice
Průmyslová 455
530 03 Pardubice
-2-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

K 2202

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2005

Pracoviště: Oblastní inspektorát Pardubice, Průmyslová 455, Pardubice, 530 03
Oddělení primární etalonáže objemu a průtoku plynÚ, tel. 466 670 728, fax 466 670 931

KALIBRAČNÍ LIST

5012-KL-P1483-18

Datum vystavení: 16.7.2018 List 1 ze 2 listů

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b, 621 00 Brno

Měřidlo:	Membránový plynoměr	**Velikost:**	G4	
Výrobce:	Honeywell	**Q_{max}:**	6	m^3/h
Typ:	BK	**Q_{min}:**	0,016	m^3/h
Výrobní číslo:	11400872	**P_{max}:**	0,5	bar
Rok výroby:	2018	**Cyklický objem:**	1,2	dm^3

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 16.7.2018

Kalibraci provedl: **Vedoucí oddělení:**

Český metrologický institut -50/1-

Ing. Stanislav Březina

Ing. Tomáš Valenta

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony:

Při kalibraci byla použita stanice s kritickými dýzami SONICAL SN-1000 v.č. 330, která slouží ke zkouškám plynoměrů a průtokoměrů pro plyn. Kritické dýzy mají návaznost přes sekundární etalony I. řádu na PTB Braunschweig, SRN. Dýza s nominálním průtokem 660 m3/h byla kalibrována dne 11.6.2015 (kalibrační list č. 5012-KL-P0061-15). Dýzy s nominálními průtoky od 16 m3/h do 260 m3/h byly kalibrovány ve dnech 23.9.-25.9.2008 (kalibrační list č. 5012-KL-P188-08). Dýzy s nominálními průtoky od 0,7 m3/h do 8 m3/h byly kalibrovány ve dnech 6.1.-7.1.2009 (kalibrační list č. 5012-KL-P005-09). Dýzy s nominálními průtoky od 0,06 m3/h do 0,50 m3/h byly kalibrovány dne 6.1.2014 (kalibrační list č. 5012-KL-P0008-14).

Kalibrační postup: 512-MP-C103

Místo kalibrace: ČMI OI Pardubice, zkušebna plynoměrů
Průmyslová 455, 530 03 Pardubice (tel. 466 670 728 141; 607 628 951)

Podmínky prostředí:

teplota :	(22,7	± 1,0)	°C
barometrický tlak :	(98,5	± 0,1)	kPa
relativní vlhkost vzduchu :	(48	± 10)	%

Výsledky kalibrace:

průtok (m^3/h)	chyba plynoměru (%)	nejistota stanovení chyby plynoměru U(k=2) (%)
1,22	-0,38	0,42
0,71	-0,58	0,50
0,41	-0,56	0,40
0,25	-0,89	0,56
0,16	-1,12	0,58

chyba plynoměru = 100 . (Vp - Ve)/Ve (%)

Vp ..... proteklý objem vzduchu zaznamenaný zkoušeným plynoměrem, korigovaný na stavové podmínky vzduchu v etalonu

Ve ..... proteklý objem vzduchu zaznamenaný etalonem

Standardní nejistota měření byla určena v souladu s dokumentem EA-4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Konec kalibračního listu

Český metrologický institut
Oblastní inspektorát Pardubice
Průmyslová 455
530 03 Pardubice
-2-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

K 2202

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2005

Pracoviště: Oblastní inspektorát Pardubice, Průmyslová 455, Pardubice, 530 03
Oddělení primární etalonáže objemu a průtoku plynÚ, tel. 466 670 728, fax 466 670 931

KALIBRAČNÍ LIST

5012-KL-P1485-18

Datum vystavení: 17.7.2018

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b, 621 00 Brno

Měřidlo:	Membránový plynoměr	**Velikost:**	G4	
Výrobce:	Honeywell	**Q_{max}:**	6	m^3/h
Typ:	BK	**Q_{min}:**	0,016	m^3/h
Výrobní číslo:	11400875	**P_{max}:**	0,5	bar
Rok výroby:	2018	**Cyklický objem:**	1,2	dm^3

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 17.7.2018

Kalibraci provedl:

Ing. Stanislav Březina

Vedoucí oddělení:

Český metrologický institut -50/1-

Ing. Tomáš Valenta

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony:

Při kalibraci byla použita stanice s kritickými dýzami SONICAL SN-1000 v.č. 330, která slouží ke zkouškám plynoměrů a průtokoměrů pro plyn. Kritické dýzy mají návaznost přes sekundární etalony I. řádu na PTB Braunschweig, SRN. Dýza s nominálním průtokem 660 m3/h byla kalibrována dne 11.6.2015 (kalibrační list č. 5012-KL-P0061-15). Dýzy s nominálními průtoky od 16 m3/h do 260 m3/h byly kalibrovány ve dnech 23.9.-25.9.2008 (kalibrační list č. 5012-KL-P188-08). Dýzy s nominálními průtoky od 0,7 m3/h do 8 m3/h byly kalibrovány ve dnech 6.1.-7.1.2009 (kalibrační list č. 5012-KL-P005-09). Dýzy s nominálními průtoky od 0,06 m3/h do 0,50 m3/h byly kalibrovány dne 6.1.2014 (kalibrační list č. 5012-KL-P0008-14).

Kalibrační postup: 512-MP-C103

Místo kalibrace: ČMI OI Pardubice, zkušebna plynoměrů
Průmyslová 455, 530 03 Pardubice (tel. 466 670 728 141; 607 628 951)

Podmínky prostředí:

teplota :	(22,8	± 1,0)	°C
barometrický tlak :	(98,3	± 0,1)	kPa
relativní vlhkost vzduchu :	(47	± 10)	%

Výsledky kalibrace:

průtok (m^3/h)	chyba plynoměru (%)	nejistota stanovení chyby plynoměru U(k=2) (%)
1,22	0,71	0,33
0,71	0,53	0,48
0,41	0,46	0,77
0,25	0,32	0,69
0,16	0,0	1,6

chyba plynoměru = 100 . (Vp - Ve)/Ve (%)

Vp ..... proteklý objem vzduchu zaznamenaný zkoušeným plynoměrem, korigovaný na stavové podmínky vzduchu v etalonu
Ve ..... proteklý objem vzduchu zaznamenaný etalonem

Standardní nejistota měření byla určena v souladu s dokumentem EA-4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Konec kalibračního listu

Český metrologický institut
Oblastní inspektorát Pardubice
Průmyslová 455
530 03 Pardubice
-2-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Strojírenský zkušební ústav, s.p.
Odštěpný závod 2 SZÚ s.p. kalibrační laboratoř č. 2280
akreditovaná ČIA, dle ČSN EN ISO/IEC 17025:2005
Pracovniště Brno, Hudcova 424/56b, 621 00 Brno

K 2280

KALIBRAČNÍ LIST č.: KL - T - 0116 - 18

Datum vydání: 2018-09-24 Datum kalibrace: 2018-09-20

Kalibrovaný teploměr

Druh teploměru:	Sada pro měření teploty
Invent. č. / v.č.:	MaR11 / -
Snímač:	2 x Pt100
Rozsah kalibrace:	(0 ÷ 140)°C
Dělení stupnice:	0,01°C
Hloubka ponoru:	120 mm
Vnější prohlídka:	Měřidlo bez zjevného poškození

Okolní podmínky

Teplota okolí:	(23 ± 2) °C
Relativní vlhkost:	(45 ± 20) %

Objednatel:
Strojírenský zkušební ústav s.p.
Hudcova 424/56b
621 00 Brno

Kalibrační zařízení

Etalonový teploměr 1:	odporový PT 100 - ZPA, v.č. 850160, KL č. 6036-KL-O0101-16
Termostat 1:	lázeň ATC - 140B, náplň - líh
Termostat 1:	lázeň ATC - 140B, náplň - olej
DMM:	Keithley 2001, v.č. 0909793, KL č. 1195/2017

Výsledky kalibrace

Kontrola funkce: Vyhovuje

Naměřené hodnoty: Jsou uvedeny na straně 2 kalibračního listu

Nejistoty kalibrace: Rozšířené nejistoty měření, uvedené v příloze kalibračního listu, jsou součinem kombinované standardní nejistoty a koeficientu rozšíření k = 2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí cca 95 %. Standardní nejistota byla určena v souladu s dokumentem EA - 4/02. Měření má návaznost na národní etalony.

AKREDITOVANÁ KALIBRAČNÍ LABORATOŘ č. 2280 STROJÍRENSKÝ ZKUŠEBNÍ ÚSTAV, s.p. 2

Seznam použitých předpisů a metodik

Metodika 030 C 001

Kalibroval: Ing. Milan Šmarda

Schválil: technický vedoucí kalibrační laboratoře
Ing. Milan Šmarda

Kalibrační laboratoř prohlašuje, že výsledky kalibrace se týkají pouze uvedeného měřidla a nenahrazují jiné dokumenty.
Kalibrační list se nesmí bez písemného souhlasu kalibrační laboratoře reprodukovat jinak než celý.

Kalibrační list číslo: **KL - T - 0116 - 18**

Výsledky kalibrace

termostat	Etalon teplota	TW21		TW22		Nejistota k = 2
		údaj	chyba	údaj	chyba	
lázeň/etalon	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)
1 / 1	0,01	-0,07	-0,08	-0,03	-0,04	0,06
1 / 1	9,99	9,93	-0,06	9,98	-0,01	0,06
1 / 1	19,99	19,95	-0,04	20,00	0,01	0,06
1 / 1	30,00	29,98	-0,02	30,03	0,03	0,06
1 / 1	40,01	40,00	-0,01	40,05	0,04	0,06
1 / 1	50,00	50,00	0,00	50,05	0,05	0,06
2 / 1	60,00	60,00	0,00	60,05	0,05	0,06
2 / 1	70,00	69,99	-0,01	70,05	0,05	0,06
2 / 1	80,01	80,00	-0,01	80,06	0,05	0,06
2 / 1	90,00	89,99	-0,01	90,05	0,05	0,06
2 / 1	100,01	99,99	-0,02	100,06	0,05	0,06
2 / 1	110,01	109,98	-0,03	110,05	0,04	0,06
2 / 1	120,01	119,99	-0,02	120,04	0,03	0,06
2 / 1	130,00	129,96	-0,04	130,02	0,02	0,06
2 / 1	139,04	138,98	-0,06	139,05	0,01	0,06

Kalibroval: Ing. Milan Šmarda

*** Konec kalibračného listu ***

Strojírenský zkušební ústav, s.p.
Odštěpný závod 2 SZÚ s.p. kalibrační laboratoř č. 2280
akreditovaná ČIA, dle ČSN EN ISO/IEC 17025:2005
Pracovniště Brno, Hudcova 424/56b, 621 00 Brno

K 2280

KALIBRAČNÍ LIST č.: KL - T - 0115 - 18

Datum vydání:	2018-09-24	Datum kalibrace:	2018-09-17

Kalibrovaný teploměr

Druh teploměru:	Sada pro měření teploty
Invent. č. / v.č.:	MaR04 / -
Snímač:	3 x Pt100
Rozsah kalibrace:	(0 ÷ 130)°C
Dělení stupnice:	0,01°C
Hloubka ponoru:	100 mm
Vnější prohlídka:	Měřidlo bez zjevného poškození

Okolní podmínky

Teplota okolí:	(23 ± 2) °C
Relativní vlhkost:	(45 ± 20) %

Objednatel:
Strojírenský zkušební ústav s.p.
Hudcova 424/56b
621 00 Brno

Kalibrační zařízení

Etalonový teploměr 1:	odporový PT 100 - ZPA, v.č. 850160, KL č. 6036-KL-O0101-16
Termostat 1:	lázeň ATC - 140B, náplň - líh
Termostat 1:	lázeň ATC - 140B, náplň - olej
DMM:	Keithley 2001, v.č. 0909793, KL č. 1195/2017

Výsledky kalibrace

Kontrola funkce: Vyhovuje

Naměřené hodnoty: Jsou uvedeny na straně 2 kalibračního listu

Nejistoty kalibrace: Rozšířené nejistoty měření, uvedené v příloze kalibračního listu, jsou součinem kombinované standardní nejistoty a koeficientu rozšíření k = 2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí cca 95 %.
Standardní nejistota byla určena v souladu s dokumentem EA - 4/02.
Měření má návaznost na národní etalony.

AKREDITOVANÁ KALIBRAČNÍ LABORATOŘ č. 2280 • STROJÍRENSKÝ ZKUŠEBNÍ ÚSTAV, s.p. • 2

Seznam použitých předpisů a metodik

Metodika 030 C 001

Kalibroval: Ing. Milan Šmarda

Schválil: technický vedoucí kalibrační laboratoře
Ing. Milan Šmarda

Kalibrační laboratoř prohlašuje, že výsledky kalibrace se týkají pouze uvedeného měřidla a nenahrazují jiné dokumenty.
Kalibrační list se nesmí bez písemného souhlasu kalibrační laboratoře reprodukovat jinak než celý.

Kalibrační list číslo: **KL - T - 0115 - 18**

Výsledky kalibrace

termostat	Etalon teplota	tq		tsp2		Nejistota k = 2
		údaj	chyba	údaj	chyba	
lázeň/etalon	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)
1 / 1	0,01	0,03	0,02	0,09	0,08	0,06
1 / 1	10,00	10,11	0,11	10,22	0,22	0,06
1 / 1	15,01	15,16	0,15	15,26	0,25	0,06
1 / 1	20,01	20,21	0,20	20,31	0,30	0,06
1 / 1	24,99	25,18	0,19	25,35	0,36	0,06
1 / 1	30,00	30,19	0,19	30,38	0,38	0,06
1 / 1	40,00	40,21	0,21	40,50	0,50	0,06

termostat	Etalon teplota	tsp1		tsp2		Nejistota k = 2
		údaj	chyba	údaj	chyba	
lázeň/etalon	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)
2 / 1	49,99	50,50	0,51	50,39	0,40	0,06
2 / 1	59,99	60,62	0,63	60,37	0,38	0,06
2 / 1	80,01	80,71	0,70	80,43	0,42	0,06
2 / 1	100,02	100,83	0,81	100,47	0,45	0,06
2 / 1	120,02	120,99	0,97	120,53	0,51	0,06
2 / 1	130,03	130,96	0,93	130,50	0,47	0,06

Kalibroval: Ing. Milan Šmarda

*** Konec kalibračného listu ***

Strojírenský zkušební ústav, s.p.
Odštěpný závod 2 SZÚ s.p. kalibrační laboratoř č. 2280
akreditovaná ČIA, dle ČSN EN ISO/IEC 17025:2005
Pracovniště Brno, Hudcova 424/56b, 621 00 Brno

K 2280

KALIBRAČNÍ LIST č.: KL - T - 0108 - 18

Datum vydání: 2018-08-10 Datum kalibrace: 2018-08-10

Kalibrovaný teploměr

Druh teploměru:	Sada pro měření teploty
Invent. č. / v.č.:	ME 557 / -
Snímač:	2x PT100
Rozsah kalibrace:	(0 ÷ 60)°C
Dělení stupnice:	0,01°C
Hloubka ponoru:	20 mm
Vnější prohlídka:	Měřidlo bez zjevného poškození

Okolní podmínky

Teplota okolí:	(23 ± 2) °C
Relativní vlhkost:	(45 ± 20) %

Objednatel:
Strojírenský zkušební ústav, s.p.
Hudcova 424/56b
621 00, Brno

Kalibrační zařízení

Etalonový teploměr 1:	odporový PT 100 - ZPA, v.č. 850160, KL č. 6036-KL-O0101-16
Termostat 1:	lázeň ATC - 140B, náplň - líh
Termostat 2:	lázeň ATC - 140B, náplň - olej
DMM:	Keithley 2001, v.č. 0909793, KL č. 3800/2018

Výsledky kalibrace

Kontrola funkce: Vyhovuje

Naměřené hodnoty: Jsou uvedeny na straně 2 kalibračního listu

Nejistoty kalibrace: Rozšířené nejistoty měření, uvedené v příloze kalibračního listu, jsou součinem kombinované standardní nejistoty a koeficientu rozšíření k = 2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí cca 95 %. Standardní nejistota byla určena v souladu s dokumentem EA - 4/02. Měření má návaznost na národní etalony.

AKREDITOVANÁ KALIBRAČNÍ LABORATOŘ č. 2280 STROJÍRENSKÝ ZKUŠEBNÍ ÚSTAV, s.p. 2

Seznam použitých předpisů a metodik

Metodika 030 C 001

Kalibroval: Ing. Milan Šmarda

Schválil: technický vedoucí kalibrační laboratoře
Ing. Milan Šmarda

Kalibrační laboratoř prohlašuje, že výsledky kalibrace se týkají pouze uvedeného měřidla a nenahrazují jiné dokumenty.
Kalibrační list se nesmí bez písemného souhlasu kalibrační laboratoře reprodukovat jinak než celý.

Kalibrační list číslo: **KL - T - 0108 - 18**

Výsledky kalibrace

termostat	Etalon teplota	Teploměr 1		Teploměr 2		Nejistota k = 2
		údaj	chyba	údaj	chyba	
lázeň/etalon	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)
1 / 1	10,00	10,01	0,01	10,05	0,05	0,06
1 / 1	20,01	20,04	0,03	20,08	0,07	0,06
1 / 1	30,01	30,05	0,04	30,10	0,09	0,06
1 / 1	40,00	40,06	0,06	40,11	0,11	0,06
2 / 1	50,01	50,07	0,06	50,13	0,12	0,06
2 / 1	60,00	60,06	0,06	60,12	0,12	0,06

Kalibroval: Ing. Milan Šmarda

*** Konec kalibračního listu ***

Strojírenský zkušební ústav, s.p.
Odštěpný závod 2 SZÚ s.p. kalibrační laboratoř č. 2280
akreditovaná ČIA, dle ČSN EN ISO/IEC 17025:2005
Pracovniště Brno, Hudcova 424/56b, 621 00 Brno

K 2280

KALIBRAČNÍ LIST č.: KL - T - 0106 - 18

Datum vydání:	2018-08-10	Datum kalibrace:	2018-08-10

Kalibrovaný teploměr

Druh teploměru:	Sada pro měření teploty
Invent. č. / v.č.:	ME 555 / -
Snímač:	4x PT100
Rozsah kalibrace:	(0 ÷ 60)°C
Dělení stupnice:	0,01°C
Hloubka ponoru:	30 mm
Vnější prohlídka:	Měřidlo bez zjevného poškození

Okolní podmínky

Teplota okolí:	(23 ± 2) °C
Relativní vlhkost:	(45 ± 20) %

Objednatel:
Strojírenský zkušební ústav, s.p.
Hudcova 424/56b
621 00, Brno

Kalibrační zařízení

Etalonový teploměr 1:	odporový PT 100 - ZPA, v.č. 850160, KL č. 6036-KL-O0101-16
Termostat 1:	lázeň ATC - 140B, náplň - líh
Termostat 2:	lázeň ATC - 140B, náplň - olej
DMM:	Keithley 2001, v.č. 0909793, KL č. 3800/2018

Výsledky kalibrace

Kontrola funkce: Vyhovuje

Naměřené hodnoty: Jsou uvedeny na straně 2 kalibračního listu

Nejistoty kalibrace: Rozšířené nejistoty měření, uvedené v příloze kalibračního listu, jsou součinem kombinované standardní nejistoty a koeficientu rozšíření k = 2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí cca 95 %. Standardní nejistota byla určena v souladu s dokumentem EA - 4/02. Měření má návaznost na národní etalony.

AKREDITOVANÁ KALIBRAČNÍ LABORATOŘ č. 2280 STROJÍRENSKÝ ZKUŠEBNÍ ÚSTAV, s.p. 2

Seznam použitých předpisů a metodik

Metodika 030 C 001

Kalibroval: Ing. Milan Šmarda

Schválil: technický vedoucí kalibrační laboratoře
Ing. Milan Šmarda

Kalibrační laboratoř prohlašuje, že výsledky kalibrace se týkají pouze uvedeného měřidla a nenahrazují jiné dokumenty.
Kalibrační list se nesmí bez písemného souhlasu kalibrační laboratoře reprodukovat jinak než celý.

Kalibrační list číslo: **KL - T - 0106 - 18**

Výsledky kalibrace

termostat	Etalon teplota	Teploměr 1		Teploměr 2		Teploměr 3		Teploměr 4		Nejistota k = 2
		údaj	chyba	údaj	chyba	údaj	chyba	údaj	chyba	
lázeň/etalon	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)
1 / 1	10,00	10,01	0,01	10,04	0,04	10,02	0,02	10,05	0,05	0,06
1 / 1	20,01	20,03	0,02	20,06	0,05	20,03	0,02	20,08	0,07	0,06
1 / 1	30,01	30,04	0,03	30,70	0,69	30,05	0,04	30,10	0,09	0,06
1 / 1	40,00	40,05	0,05	40,10	0,10	40,06	0,06	40,11	0,11	0,06
2 / 1	50,01	50,07	0,06	50,10	0,09	50,07	0,06	50,13	0,12	0,06
2 / 1	60,00	60,06	0,06	60,11	0,11	60,06	0,06	60,12	0,12	0,06

Kalibroval: Ing. Milan Šmarda

*** Konec kalibračního listu ***

Strojírenský zkušební ústav, s.p.
Odštěpný závod 2 SZÚ s.p. kalibrační laboratoř č. 2280
akreditovaná ČIA, dle ČSN EN ISO/IEC 17025:2005
Pracovniště Brno, Hudcova 424/56b, 621 00 Brno

K 2280

KALIBRAČNÍ LIST č.: KL - T - 0107 - 18

Datum vydání:	2018-08-10	Datum kalibrace:	2018-08-10

Kalibrovaný teploměr

Druh teploměru:	Sada pro měření teploty
Invent. č. / v.č.:	ME 556 / -
Snímač:	4x PT100
Rozsah kalibrace:	(0 ÷ 60)°C
Dělení stupnice:	0,01°C
Hloubka ponoru:	30 mm
Vnější prohlídka:	Měřidlo bez zjevného poškození

Okolní podmínky

Teplota okolí:	(23 ± 2) °C
Relativní vlhkost:	(45 ± 20) %

Objednatel:
Strojírenský zkušební ústav, s.p.
Hudcova 424/56b
621 00, Brno

Kalibrační zařízení

Etalonový teploměr 1:	odporový PT 100 - ZPA, v.č. 850160, KL č. 6036-KL-O0101-16
Termostat 1:	lázeň ATC - 140B, náplň - líh
Termostat 2:	lázeň ATC - 140B, náplň - olej
DMM:	Keithley 2001, v.č. 0909793, KL č. 3800/2018

Výsledky kalibrace

Kontrola funkce: Vyhovuje

Naměřené hodnoty: Jsou uvedeny na straně 2 kalibračního listu

Nejistoty kalibrace: Rozšířené nejistoty měření, uvedené v příloze kalibračního listu, jsou součinem kombinované standardní nejistoty a koeficientu rozšíření k = 2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí cca 95 %. Standardní nejistota byla určena v souladu s dokumentem EA - 4/02. Měření má návaznost na národní etalony.

AKREDITOVANÁ KALIBRAČNÍ LABORATOŘ č. 2280 * STROJÍRENSKÝ ZKUŠEBNÍ ÚSTAV, S.P. * 2

Seznam použitých předpisů a metodik

Metodika 030 C 001

Kalibroval: Ing. Milan Šmarda

Schválil: technický vedoucí kalibrační laboratoře
Ing. Milan Šmarda

Kalibrační laboratoř prohlašuje, že výsledky kalibrace se týkají pouze uvedeného měřidla a nenahrazují jiné dokumenty.
Kalibrační list se nesmí bez písemného souhlasu kalibrační laboratoře reprodukovat jinak než celý.

Kalibrační list číslo: **KL - T - 0107 - 18**

Výsledky kalibrace

termostat	Etalon teplota	Teploměr 1		Teploměr 2		Teploměr 3		Teploměr 4		Nejistota k = 2
		údaj	chyba	údaj	chyba	údaj	chyba	údaj	chyba	
lázeň/etalon	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)
1 / 1	10,00	10,01	0,01	10,01	0,05	10,00	0,01	10,05	0,05	0,06
1 / 1	20,01	20,04	0,03	20,03	0,07	20,01	0,03	20,05	0,07	0,06
1 / 1	30,01	30,05	0,04	30,06	0,09	30,02	0,04	30,06	0,09	0,06
1 / 1	40,00	40,06	0,06	40,08	0,11	40,03	0,06	40,05	0,11	0,06
2 / 1	50,01	50,07	0,06	50,08	0,12	50,07	0,06	50,05	0,12	0,06
2 / 1	60,00	60,06	0,06	60,07	0,12	60,06	0,06	60,04	0,12	0,06

Kalibroval: Ing. Milan Šmarda

*** Konec kalibračního listu ***

HES, s.r.o. Kalibrační laboratoř

U dráhy 11, 664 49 Ostopovice, tel.: 547426411, fax.: 547426417

K 2273

KALIBRAČNÍ LIST

č: **10595 / 2018**

Datum vystavení kalibračního listu : 26. 11. 2018

Zdeněk Hubáček
VEDOUCÍ KALIBRAČNÍ LABORATOŘE

Zadavatel :	**Strojírenský zkušební ústav, s.p.** **Hudcova 56B, 621 00 Brno**
Název kalibrovaného přístroje :	Přímo ukazující teploměr a vlhkoměr
Typ :	**THZ 1 ext**
Výrobní číslo :	996062 Inv. č. : 11-6258
Výrobce :	Comet
Měřicí rozsah :	(-10 ÷ 80) °C ; (0 ÷ 100) % RV
Specifikovaná přesnost :	-
Provedením kalibrace byl pověřen :	Ing. Bannert Josef
Kalibrace byla provedena dne :	26. 11. 2018
Výsledek kalibrace :	Naměřené výsledky jsou uvedeny na listu 2. Naměřené hodnoty se týkají pouze kalibrovaného přístroje.

Podmínky měření :	Teplota a vlhkost vzduchu při kalibraci: (20 ± 5) °C a (45 ± 20) %.
Metoda kalibrace :	Kalibrace byla provedena podle interní metodiky TP44.1, TP45 a požadavku zadavatele.
Použité etalony :	Měřicí ústředna **Almemo 2490-2**, v.č. H10110506 Odporový teploměr **02150**, v.č. 140055 Multimetr **HP 34401A**, v.č. US 36097353 Vlhkostní sonda **HMP155,** v.č. J1130025
Další použité měřicí přístroje a zařízení :	Teplotní a vlhkostní komora **BT-120** v.č. 5494
Návaznost etalonu :	Použité etalony mají metrologickou návaznost na národní etalony.

Bez písemného souhlasu kalibrační laboratoře nesmí být kalibrační list kopírován a rozšiřován jinak, než v celkovém počtu stran.

1. **Funkční kontrola :** **vyhovuje**

2. **Kalibrace teploty:**

Teplota naměřená na etalonu	Údaj na kalibrovaném měřidle	Naměřená odchylka	Nejistota
[°C]	[°C]	[°C]	[°C]
15,00	15,0	0,0	0,3
20,00	20,0	0,0	0,3
25,00	25,1	0,1	0,3

3. **Kalibrace vlhkosti:**

Měřeno při teplotě	Vlhkost naměřená na etalonu	Údaj na kalibrovaném měřidle	Naměřená odchylka	Nejistota
[°C]	[% RH]	[% RH]	[% RH]	[% RH]
23,0	**30,0**	35,6	5,6	2,3
23,0	**50,0**	55,4	5,4	2,4
23,0	**80,0**	83,1	3,1	2,6

Nejistota měření teploty 0,3 °C.

měření provedl: _____
Ing. Bannert Josef

Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu rozšíření k=2, což pro normální rozdělení odpovídá pravděpodobnosti pokrytí cca 95%. Standardní nejistota měření byla určena v souladu s dokumentem EA-4/02

KONEC KALIBRAČNÍHO LISTU

Břetislav Toman, Kalibrační laboratoř
Na Spálence 326/7, 400 01 Ústí nad Labem - Klíše, www.akl2368.cz
Kalibrační laboratoř č. 2368 akreditovaná ČIA podle ČSN EN ISO/IEC 17025:2005

K 2368

Kalibrační list č. 14/KA-19

Zákazník **Strojírenský zkušební ústav**
621 00 Brno, Hudcova 56b

Váha **Typ: A120S** **Výrobní číslo: 39060010**
Max = 120 g **d = 0,0001 g**
Výrobce: SARTORIUS **Evidenční číslo: 02-1682**

Kalibrace provedena podle Kalibračního postupu KP 01 vytvořeného podle dokumentu EURAMET cg-18, verze 3.0
Justáž váhy provedena pomocí vestavěného justážního závaží
Místo kalibrace Místnost 39
Parametry prostředí - vzduch: teplota začátek (23 ± 1) °C teplota konec (23 ± 1) °C
vlhkost (26 ± 5) % tlak (990 ± 10) hPa
Použité etalony s kalibrací od Českého metrologického institutu: etalon č., kalibrační list
03-01-E2, 6101-KL-H0403-18;

Opakovatelnost váhy pro zátěž 100 g z deseti měření je 0,00007 g

Excentricita v g

pozice	hodnota	odchylka
1	50,0000	- - - -
2	50,0002	0,0002
3	50,0000	0,0000
4	50,0000	0,0000
5	50,0002	0,0002

Pozice vzhledem k displeji
1. měření uprostřed
2. měření vlevo vpředu
3. měření vlevo vzadu
4. měření vpravo vzadu
5. měření vpravo vpředu

Excentricita váhy pro jmenovitou zátěž 50 g je 0,0002 g

Linearita (chyba vážení)

zátěž	údaj váhy	chyba váhy	nejistota
g	g	g	g
0,01	0,0100	0,00000	0,00013
1	1,0000	-0,00001	0,00013
10	10,0001	0,00009	0,00015
50	50,0001	0,00012	0,00018
100	100,0001	0,00007	0,00023
120	120,0002	0,00015	0,00032

Chyba váhy je vyjádřena jako rozdíl mezi údajem váhy a hodnotou konvenční hmotnosti závaží, které tvoří zátěž, se zaokrouhlením na desetinu dílku váhy.
Rozšířená nejistota uvedená v tabulce naměřených hodnot je součinem standardní nejistoty měření a koeficientu rozšíření k = 2. Pro normální rozdělení odpovídá pokrytí přibližně 95% pravděpodobnosti.
Standardní nejistota měření byla určena v souladu s dokumentem EA 4/02.
Naměřené hodnoty se vztahují k uvedené váze a ke dni a místu, ve kterých byla kalibrace provedena.

Kalibrace provedena dne 16.4.2019
Kalibrační list vystaven 29.4.2019
Kalibrační list schválil Ing. Vladimír Kasan, technik, tel.: 602753193

Akreditovaná kalibrační laboratoř Břetislav TOMAN č. 2368

Tento dokument nesmí být bez písemného schválení laboratoře rozmnožován jinak, než celý a beze změn.

- - - konec kalibračního listu - - -

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

CIPM MRA

Pracoviště: Oblastní inspektorát Brno, Okružní 31, 638 00 Brno, tel. (+420) 545 555 111, fax. 545 555 183
Oddělení primární metrologie tlaku, vakua a malého hmotnostního průtoku

KALIBRAČNÍ LIST

6013-KL-C0464-19

Tento kalibrační list je v souladu s kalibračními schopnostmi měření (CMCs), které jsou uvedeny v příloze C Ujednání o vzájemném uznávání (MRA) vydaného Mezinárodním výborem pro míry a váhy (CIPM). Podle tohoto Ujednání všechny zúčastněné instituty vzájemně uznávají platnost svých kalibračních listů pro veličiny, rozsahy a nejistoty měření uvedené v příloze C (podrobnosti viz www.bipm.org).

Datum vystavení: 10. 6. 2019

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Měřidlo: Číslicový tlakoměr

Výrobce: Dwyer Instruments Inc.

Typ: MS-121-LCD

Výrobní číslo: 000BTN

Rozsah: (0 ÷ 50) Pa

Specifikace: 1 % FS

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 10. 6. 2019

Kalibraci provedl: Bc. Václav Páviš

Vedoucí oddělení: Ing. Zdeněk Krajíček, PhD.

Český metrologický institut -60-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony: Pístový tlakoměr, typ Pressurements V1600/4, v. č. 12215-99, rozsah (20 ÷ 16 000) Pa, kalibrováno ČMI OI Brno, kalibrační list č. 6013-KL-P0001-19, rozšířená nejistota měření pro k = 2 je 0,08 Pa + 0,007 % MH.

Digitální pístový tlakoměr, typ Furness 4 HR, v. č. 961 02 80, rozsah (1 ÷ 3 200) Pa, primární etalon, rozšířená nejistota měření pro k = 2 je 0,015 Pa + 0,0075 % MH.

Kalibrační postup: Měřidlo bylo zkoušeno podle interní metodiky 601-MP-C046.

Podmínky prostředí:

teplota vzduchu:	relativní vlhkost:	barometrický tlak:
(20 ±1) °C	(55 ±10) %	(980 ±30) hPa abs.

Podmínky kalibrace: Použité tlakové médium: suchý čistý plyn

Výsledky kalibrace:

p_e konvenční hodnota tlaku;
p_z střední hodnota tlaku indikovaného kalibrovaným měřidlem;
Δ $\Delta = p_z - p_e$ odchylka kalibrovaného měřidla;
U_Δ rozšířená nejistota stanovení odchylky;
pj střední hodnota tlaku indikovaná kalibrovaným měřidlem před justáží;

Rozlišení displeje: 0,1 Pa

	zatěžování			odlehčování			
p_e	p_z	Δ	U_Δ	p_z	Δ	U_Δ	pj
Pa	Pa	Pa	Pa	Pa	Pa	Pa	Pa
0,00	0,00	0,00	0,06	0,00	0,00	0,06	0,00
5,00	3,80	-1,20	0,16	4,17	-0,83	0,16	-
10,00	8,50	-1,50	0,16	8,47	-1,53	0,06	-
20,00	16,74	-3,26	0,10	17,31	-2,69	0,17	-
25,00	21,10	-3,90	0,06	21,33	-3,67	0,06	-
30,00	26,47	-3,53	0,18	26,67	-3,33	0,18	-
40,00	37,70	-2,30	0,18	38,03	-1,97	0,10	-
50,00	49,05	-0,95	0,18	49,05	-0,95	0,18	45,60

Standardní nejistota měření byla určena v souladu s dokumentem EA–4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření k = 2.

Konec kalibračního listu.

Použité zkratky: MH - měřená hodnota
FS - celkový rozsah měřidla

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-8-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

CIPM MRA

Pracoviště: Oblastní inspektorát Brno, Okružní 31, 638 00 Brno, tel. (+420) 545 555 111, fax. 545 555 183
Oddělení primární metrologie tlaku, vakua a malého hmotnostního průtoku

KALIBRAČNÍ LIST

6013-KL-C0465-19

Tento kalibrační list je v souladu s kalibračními schopnostmi měření (CMCs), které jsou uvedeny v příloze C Ujednání o vzájemném uznávání (MRA) vydaného Mezinárodním výborem pro míry a váhy (CIPM). Podle tohoto Ujednání všechny zúčastněné instituty vzájemně uznávají platnost svých kalibračních listů pro veličiny, rozsahy a nejistoty měření uvedené v příloze C (podrobnosti viz www.bipm.org).

Datum vystavení: 10. 6. 2019

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Měřidlo: Číslicový tlakoměr

Výrobce: Dwyer Instruments Inc.

Typ: MS-121-LCD

Výrobní číslo: 000BTK

Rozsah: (0 ÷ 50) Pa

Specifikace: 1 % FS

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 10. 6. 2019

Kalibraci provedl: Bc. Václav Páviš

Vedoucí oddělení: Ing. Zdeněk Krajíček, PhD.

Český metrologický institut -60-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony: Pístový tlakoměr, typ Pressurements V1600/4, v. č. 12215-99, rozsah (20 ÷ 16 000) Pa, kalibrováno ČMI OI Brno, kalibrační list č. 6013-KL-P0001-19, rozšířená nejistota měření pro k = 2 je 0,08 Pa + 0,007 % MH.

Digitální pístový tlakoměr, typ Furness 4 HR, v. č. 961 02 80, rozsah (1 ÷ 3 200) Pa, primární etalon, rozšířená nejistota měření pro k = 2 je 0,015 Pa + 0,0075 % MH.

Kalibrační postup: Měřidlo bylo zkoušeno podle interní metodiky 601-MP-C046.

Podmínky prostředí:

teplota vzduchu:	relativní vlhkost:	barometrický tlak:
(20 ±1) °C	(55 ±10) %	(980 ±30) hPa abs.

Podmínky kalibrace: Použité tlakové médium: suchý čistý plyn

Výsledky kalibrace:

p_e konvenční hodnota tlaku;
p_z střední hodnota tlaku indikovaného kalibrovaným měřidlem;
Δ $\Delta = p_z - p_e$ odchylka kalibrovaného měřidla;
U_Δ rozšířená nejistota stanovení odchylky;

Rozlišení displeje: 0,1 Pa

	zatěžování			odlehčování		
p_e	p_z	Δ	U_Δ	p_z	Δ	U_Δ
Pa	Pa	Pa	Pa	Pa	Pa	Pa
0,00	0,00	0,00	0,06	0,00	0,00	0,06
5,00	4,70	-0,30	0,16	4,80	-0,20	0,16
10,00	9,80	-0,20	0,16	9,90	-0,10	0,06
20,00	19,81	-0,19	0,30	19,91	-0,09	0,30
25,00	24,60	-0,40	0,06	24,77	-0,23	0,06
30,00	29,50	-0,50	0,30	29,70	-0,30	0,30
40,00	39,07	-0,93	0,18	39,27	-0,73	0,18
50,00	48,95	-1,05	0,18	48,95	-1,05	0,18

Standardní nejistota měření byla určena v souladu s dokumentem EA–4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření k = 2.

Konec kalibračního listu.

Použité zkratky: MH - měřená hodnota
FS - celkový rozsah měřidla

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

CIPM MRA

Pracoviště: Oblastní inspektorát Brno, Okružní 31, 638 00 Brno, tel. (+420) 545 555 111, fax. 545 555 183
Oddělení primární metrologie tlaku, vakua a malého hmotnostního průtoku

KALIBRAČNÍ LIST

6013-KL-C0466-19

Tento kalibrační list je v souladu s kalibračními schopnostmi měření (CMCs), které jsou uvedeny v příloze C Ujednání o vzájemném uznávání (MRA) vydaného Mezinárodním výborem pro míry a váhy (CIPM). Podle tohoto Ujednání všechny zúčastněné instituty vzájemně uznávají platnost svých kalibračních listů pro veličiny, rozsahy a nejistoty měření uvedené v příloze C (podrobnosti viz www.bipm.org).

Datum vystavení: 11. 6. 2019

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Měřidlo: Číslicový tlakoměr

Výrobce: Dwyer Instruments Inc.

Typ: MS-121-LCD

Výrobní číslo: 000BTL

Rozsah: (0 ÷ 50) Pa

Specifikace: 1 % FS

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 11. 6. 2019

Kalibraci provedl: Bc. Václav Páviš

Vedoucí oddělení: Ing. Zdeněk Krajíček, PhD.

Český metrologický institut -60-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony: Pístový tlakoměr, typ Pressurements V1600/4, v. č. 12215-99, rozsah (20 ÷ 16 000) Pa, kalibrováno ČMI OI Brno, kalibrační list č. 6013-KL-P0001-19, rozšířená nejistota měření pro k = 2 je 0,08 Pa + 0,007 % MH.

Digitální pístový tlakoměr, typ Furness 4 HR, v. č. 961 02 80, rozsah (1 ÷ 3 200) Pa, primární etalon, rozšířená nejistota měření pro k = 2 je 0,015 Pa + 0,0075 % MH.

Kalibrační postup: Měřidlo bylo zkoušeno podle interní metodiky 601-MP-C046.

Podmínky prostředí:

teplota vzduchu:	relativní vlhkost:	barometrický tlak:
(20 ±1) °C	(55 ±10) %	(980 ±30) hPa abs.

Podmínky kalibrace: Použité tlakové médium: suchý čistý plyn

Výsledky kalibrace:

p_e konvenční hodnota tlaku;
p_z střední hodnota tlaku indikovaného kalibrovaným měřidlem;
Δ $\Delta = p_z - p_e$ odchylka kalibrovaného měřidla;
U_Δ rozšířená nejistota stanovení odchylky;

Rozlišení displeje: 0,1 Pa

	zatěžování			odlehčování		
p_e	p_z	Δ	U_Δ	p_z	Δ	U_Δ
Pa	Pa	Pa	Pa	Pa	Pa	Pa
0,00	0,00	0,00	0,06	0,00	0,00	0,06
5,00	4,77	-0,23	0,16	5,00	0,00	0,16
10,00	9,57	-0,43	0,16	9,77	-0,23	0,06
20,00	18,44	-1,56	0,10	18,57	-1,43	0,17
25,00	23,00	-2,00	0,06	23,20	-1,80	0,06
30,00	27,53	-2,47	0,10	27,63	-2,37	0,10
40,00	36,73	-3,27	0,10	36,87	-3,13	0,18
50,00	45,92	-4,08	0,10	45,92	-4,08	0,10

Standardní nejistota měření byla určena v souladu s dokumentem EA–4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření k = 2.

Konec kalibračního listu.

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-8-

Použité zkratky: MH - měřená hodnota
FS - celkový rozsah měřidla

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

CIPM MRA

Pracoviště: Oblastní inspektorát Brno, Okružní 31, 638 00 Brno, tel. (+420) 545 555 111, fax. 545 555 183
Oddělení primární metrologie tlaku, vakua a malého hmotnostního průtoku

KALIBRAČNÍ LIST

6013-KL-C0467-19

Tento kalibrační list je v souladu s kalibračními schopnostmi měření (CMCs), které jsou uvedeny v příloze C Ujednání o vzájemném uznávání (MRA) vydaného Mezinárodním výborem pro míry a váhy (CIPM). Podle tohoto Ujednání všechny zúčastněné instituty vzájemně uznávají platnost svých kalibračních listů pro veličiny, rozsahy a nejistoty měření uvedené v příloze C (podrobnosti viz www.bipm.org).

Datum vystavení: 11. 6. 2019

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Měřidlo: Číslicový tlakoměr

Výrobce: Dwyer Instruments Inc.

Typ: MS-121-LCD

Výrobní číslo: 000ACP

Rozsah: (0 ÷ 50) Pa

Specifikace: 1 % FS

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 11. 6. 2019

Kalibraci provedl: Bc. Václav Páviš

Vedoucí oddělení: Ing. Zdeněk Krajíček, PhD.

Český metrologický institut -60-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony: Pístový tlakoměr, typ Pressurements V1600/4, v. č. 12215-99, rozsah (20 ÷ 16 000) Pa, kalibrováno ČMI OI Brno, kalibrační list č. 6013-KL-P0001-19, rozšířená nejistota měření pro k = 2 je 0,08 Pa + 0,007 % MH.

Digitální pístový tlakoměr, typ Furness 4 HR, v. č. 961 02 80, rozsah (1 ÷ 3 200) Pa, primární etalon, rozšířená nejistota měření pro k = 2 je 0,015 Pa + 0,0075 % MH.

Kalibrační postup: Měřidlo bylo zkoušeno podle interní metodiky 601-MP-C046.

Podmínky prostředí:

teplota vzduchu:	relativní vlhkost:	barometrický tlak:
(20 ±1) °C	(55 ±10) %	(980 ±30) hPa abs.

Podmínky kalibrace: Použité tlakové médium: suchý čistý plyn

Výsledky kalibrace:

p_e konvenční hodnota tlaku;
p_z střední hodnota tlaku indikovaného kalibrovaným měřidlem;
Δ $\Delta = p_z - p_e$ odchylka kalibrovaného měřidla;
U_Δ rozšířená nejistota stanovení odchylky;

Rozlišení displeje: 0,1 Pa

	zatěžování			odlehčování		
p_e	p_z	Δ	U_Δ	p_z	Δ	U_Δ
Pa	Pa	Pa	Pa	Pa	Pa	Pa
0,00	0,00	0,00	0,06	0,00	0,00	0,06
5,00	5,00	0,00	0,16	5,17	0,17	0,16
10,00	10,10	0,10	0,16	10,23	0,23	0,06
20,00	20,01	0,01	0,17	20,21	0,21	0,17
25,00	25,17	0,17	0,06	25,27	0,27	0,06
30,00	30,03	0,03	0,10	30,30	0,30	0,18
40,00	40,20	0,20	0,18	40,23	0,23	0,10
50,00	50,22	0,22	0,10	50,22	0,22	0,10

Standardní nejistota měření byla určena v souladu s dokumentem EA–4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření k = 2.

Konec kalibračního listu.

Použité zkratky: MH - měřená hodnota
FS - celkový rozsah měřidla

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
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Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
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www.cmi.cz

CIPM MRA

Pracoviště: Oblastní inspektorát Brno, Okružní 31, 638 00 Brno, tel. +420 545 555 111, fax. +420 545 555 183
Laboratory: Oddělení primární metrologie tlaku, vakua a malého hmotnostního průtoku.

KALIBRAČNÍ LIST
CERTIFICATE OF CALIBRATION

6013-KL-K0005-19

Tento kalibrační list je v souladu s kalibračními schopnostmi měření (CMCs), které jsou uvedeny v příloze C Ujednání o vzájemném uznávání (MRA) vydaného Mezinárodním výborem pro míry a váhy (CIPM). Podle tohoto Ujednání všechny zúčastněné instituty vzájemně uznávají platnost svých kalibračních listů pro veličiny, rozsahy a nejistoty měření uvedené v příloze C (podrobnosti viz www.bipm.org).

This certificate is consistent with the capabilities that are included in Appendix C of the MRA drawn up by the International Committee for Weights and Measures (CIPM). Under the MRA, all participating institutes recognize the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (for details see www.bipm.org).

Datum vystavení: 13. května 2019
Date of issue: *13th May 2019*

Zákazník: Strojírenský zkušební ústav, s. p.
Customer: Hudcova 424/56b, 621 00 Brno
Měřidlo: rtuťový barometr
Measuring instrument: *mercurial barometer*
Výrobce: Chirana
Manufacturer:
Typ: staniční barometr s noniem
Type: *station barometer with nonius*
Výrobní číslo: 3168; ev. č. 11-1985
Serial number:

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

V tomto dokumentu je pro oddělení celé a desetinné části čísel používán znak čárka (,).

The results of the calibration have been obtained following the procedures reported in this Certificate and are related only to the date, place and conditions of the calibration.

The comma (,) is used to separate the integral and the decimal parts of the numbers in this document.

Datum kalibrace: 13. května 2019
Date of calibration: *13th May 2019*

Kalibraci provedl:
Calibrated by:

Bc. Václav Páviš, Mgr. Martin Vičar, PhD.

Český metrologický institut -60-

Vedoucí oddělení:
Head of the Department:

Ing. Zdeněk Krajíček, PhD.

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.
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Použité etalony: *Measurement standards used:*
Digitální tlakoměr, typ DHI RPM4 A200Ks, v. č. 298, rozsah (0 ÷ 200) kPa abs., rozšířená nejistota pro k = 2: do 60 kPa 6 Pa, nad 60 kPa 0,01 % měřené hodnoty.
Digital manometer, type DHI RPM4 A200Ks, s/n 298, range (0 ÷ 200) kPa abs., expanded uncertainty (k = 2): below 60 kPa 6 Pa, above 60 kPa 0,01 % meas. value.

Kalibrační postup: *Calibration procedure:*
Měřidlo bylo zkoušeno podle PNÚ 1704.1, PNÚ 1704.2 a interní metodiky oddělení primární metrologie tlaku.
The device under calibration was tested in the accordance with documents PNÚ 1704.1, PNÚ 1704.2 and the internal procedure of the primary pressure department.

Podmínky prostředí: *Ambient conditions:*
- teplota vzduchu *(air temperature)*: (20,8 ± 0,5) °C
- relativní vlhkost vzduchu *(relative humidity)*: (50 ± 15) %
- atmosferický tlak *(barometric pressure)*: (978,5 ± 0,5) mbar

Podmínky kalibrace: *Calibration conditions:*
Použité tlakové médium: suchý čistý vzduch
Pressure medium used: dry pure air

Výsledky kalibrace *(Results of calibration):*

Konvenční hodnota tlaku / *Conventional value of the pressure* Použitý přepočet: *The conversion used:* 1 mm Hg = 1,333 22 hPa		Indikace kalibrovaného měřidla *Indication of the device under calibration*		Indikace kalibrovaného měřidla přepočtená na hustotu rtuti při 0 °C a normální tíhové zrychlení g_N = 9,80665 m·s^{-2} a nejistota jejího stanovení *Indication of the device under calibration reduced to the mercury density at 0 °C and to the standard gravity g_N = 9,80665 m·s^{-2} and the uncertainty of its estimation*			
		zatěžování *up*	odlehčování *down*	zatěžování *up*		odlehčování *down*	
hPa	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg
799,93	600,00	601,85	601,87	599,97	± 0,18	599,98	± 0,29
853,26	640,00	641,68	641,73	639,68	± 0,29	639,73	± 0,32
899,92	675,00	676,57	676,67	674,45	± 0,34	674,55	± 0,23
919,92	690,00	691,57	691,82	689,40	± 0,29	689,65	± 0,34
939,92	705,00	706,37	706,53	704,16	± 0,65	704,32	± 0,34
959,92	720,00	721,32	721,48	719,06	± 0,32	719,23	± 0,29
979,92	735,00	736,17	736,20	733,86	± 0,29	733,90	± 0,28
999,92	750,00	750,83	751,07	748,48	± 0,38	748,72	± 0,46
1 019,91	765,00	765,48	765,58	763,09	± 0,70	763,19	± 0,64
1 053,24	790,00	789,65	789,73	787,18	± 0,52	787,26	± 0,49

Standardní nejistota měření byla určena v souladu s dokumentem EA–4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu *k*, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření *k* = 2.

The standard uncertainty of measurement has been determined in accordance with EA–4/02 document. The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k corresponding to a coverage probability of approximately 95 %, which for normal distribution corresponds to a coverage factor k = 2.

Český metrologický institut
Oblastní inspektorát Brno
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Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.
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Tabulka vypočtených korekcí údaje kalibrovaného barometru

Teplota barometru	Tlak čtený na stupnici [mm Hg]															
	690	700	710	715	720	725	730	735	740	745	750	755	760	765	785	775
16,0 °C	-1,1	-1,0	-0,9	-0,8	-0,7	-0,6	-0,6	-0,5	-0,4	-0,3	-0,2	-0,1	0,0	0,1	0,2	0,4
16,5 °C	-1,1	-1,0	-0,9	-0,8	-0,8	-0,7	-0,6	-0,5	-0,4	-0,4	-0,3	-0,2	-0,1	0,1	0,2	0,3
17,0 °C	-1,2	-1,1	-1,0	-0,9	-0,8	-0,8	-0,7	-0,6	-0,5	-0,4	-0,3	-0,2	-0,1	0,0	0,1	0,2
17,5 °C	-1,3	-1,2	-1,0	-1,0	-0,9	-0,8	-0,7	-0,7	-0,6	-0,5	-0,4	-0,3	-0,2	-0,1	0,0	0,2
18,0 °C	-1,3	-1,2	-1,1	-1,0	-1,0	-0,9	-0,8	-0,7	-0,6	-0,5	-0,4	-0,3	-0,2	-0,1	0,0	0,1
18,5 °C	-1,4	-1,3	-1,1	-1,1	-1,0	-0,9	-0,9	-0,8	-0,7	-0,6	-0,5	-0,4	-0,3	-0,2	-0,1	0,0
19,0 °C	-1,4	-1,3	-1,2	-1,1	-1,1	-1,0	-0,9	-0,8	-0,8	-0,7	-0,6	-0,5	-0,4	-0,3	-0,1	0,0
19,5 °C	-1,5	-1,4	-1,3	-1,2	-1,1	-1,1	-1,0	-0,9	-0,8	-0,7	-0,6	-0,5	-0,4	-0,3	-0,2	-0,1
20,0 °C	-1,5	-1,4	-1,3	-1,3	-1,2	-1,1	-1,0	-1,0	-0,9	-0,8	-0,7	-0,6	-0,5	-0,4	-0,3	-0,2
20,5 °C	-1,6	-1,5	-1,4	-1,3	-1,2	-1,2	-1,1	-1,0	-0,9	-0,8	-0,7	-0,7	-0,6	-0,4	-0,3	-0,2
21,0 °C	-1,7	-1,6	-1,4	-1,4	-1,3	-1,2	-1,2	-1,1	-1,0	-0,9	-0,8	-0,7	-0,6	-0,5	-0,4	-0,3
21,5 °C	-1,7	-1,6	-1,5	-1,4	-1,4	-1,3	-1,2	-1,1	-1,1	-1,0	-0,9	-0,8	-0,7	-0,6	-0,5	-0,3
22,0 °C	-1,8	-1,7	-1,6	-1,5	-1,4	-1,4	-1,3	-1,2	-1,1	-1,0	-0,9	-0,8	-0,7	-0,6	-0,5	-0,4
22,5 °C	-1,8	-1,7	-1,6	-1,6	-1,5	-1,4	-1,3	-1,3	-1,2	-1,1	-1,0	-0,9	-0,8	-0,7	-0,6	-0,5
23,0 °C	-1,9	-1,8	-1,7	-1,6	-1,5	-1,5	-1,4	-1,3	-1,2	-1,1	-1,1	-1,0	-0,9	-0,8	-0,7	-0,5
23,5 °C	-1,9	-1,8	-1,7	-1,7	-1,6	-1,5	-1,5	-1,4	-1,3	-1,2	-1,1	-1,0	-0,9	-0,8	-0,7	-0,6
24,0 °C	-2,0	-1,9	-1,8	-1,7	-1,7	-1,6	-1,5	-1,4	-1,4	-1,3	-1,2	-1,1	-1,0	-0,9	-0,8	-0,7
24,5 °C	-2,0	-2,0	-1,8	-1,8	-1,7	-1,7	-1,6	-1,5	-1,4	-1,3	-1,2	-1,1	-1,0	-0,9	-0,8	-0,7
25,0 °C	-2,1	-2,0	-1,9	-1,8	-1,8	-1,7	-1,6	-1,6	-1,5	-1,4	-1,3	-1,2	-1,1	-1,0	-0,9	-0,8
25,5 °C	-2,2	-2,1	-2,0	-1,9	-1,8	-1,8	-1,7	-1,6	-1,5	-1,5	-1,4	-1,3	-1,2	-1,1	-1,0	-0,9
26,0 °C	-2,2	-2,1	-2,0	-2,0	-1,9	-1,8	-1,8	-1,7	-1,6	-1,5	-1,4	-1,3	-1,2	-1,1	-1,0	-0,9
26,5 °C	-2,3	-2,2	-2,1	-2,0	-2,0	-1,9	-1,8	-1,7	-1,7	-1,6	-1,5	-1,4	-1,3	-1,2	-1,1	-1,0
27,0 °C	-2,3	-2,2	-2,1	-2,1	-2,0	-1,9	-1,9	-1,8	-1,7	-1,6	-1,5	-1,5	-1,4	-1,3	-1,2	-1,0
27,5 °C	-2,4	-2,3	-2,2	-2,1	-2,1	-2,0	-1,9	-1,9	-1,8	-1,7	-1,6	-1,5	-1,4	-1,3	-1,2	-1,1
28,0 °C	-2,4	-2,4	-2,3	-2,2	-2,1	-2,1	-2,0	-1,9	-1,8	-1,8	-1,7	-1,6	-1,5	-1,4	-1,3	-1,2
28,5 °C	-2,5	-2,4	-2,3	-2,3	-2,2	-2,1	-2,1	-2,0	-1,9	-1,8	-1,7	-1,6	-1,5	-1,4	-1,3	-1,2
29,0 °C	-2,6	-2,5	-2,4	-2,3	-2,3	-2,2	-2,1	-2,0	-2,0	-1,9	-1,8	-1,7	-1,6	-1,5	-1,4	-1,3
29,5 °C	-2,6	-2,5	-2,4	-2,4	-2,3	-2,2	-2,2	-2,1	-2,0	-1,9	-1,9	-1,8	-1,7	-1,6	-1,5	-1,4
30,0 °C	-2,7	-2,6	-2,5	-2,4	-2,4	-2,3	-2,2	-2,2	-2,1	-2,0	-1,9	-1,8	-1,7	-1,6	-1,5	-1,4
30,5 °C	-2,7	-2,6	-2,5	-2,5	-2,4	-2,4	-2,3	-2,2	-2,1	-2,1	-2,0	-1,9	-1,8	-1,7	-1,6	-1,5
31,0 °C	-2,8	-2,7	-2,6	-2,5	-2,5	-2,4	-2,4	-2,3	-2,2	-2,1	-2,0	-2,0	-1,9	-1,8	-1,7	-1,6
31,5 °C	-2,8	-2,8	-2,7	-2,6	-2,5	-2,5	-2,4	-2,3	-2,3	-2,2	-2,1	-2,0	-1,9	-1,8	-1,7	-1,6
32,0 °C	-2,9	-2,8	-2,7	-2,7	-2,6	-2,5	-2,5	-2,4	-2,3	-2,2	-2,2	-2,1	-2,0	-1,9	-1,8	-1,7
32,5 °C	-3,0	-2,9	-2,8	-2,7	-2,7	-2,6	-2,5	-2,5	-2,4	-2,3	-2,2	-2,1	-2,0	-2,0	-1,9	-1,7
33,0 °C	-3,0	-2,9	-2,8	-2,8	-2,7	-2,7	-2,6	-2,5	-2,5	-2,4	-2,3	-2,2	-2,1	-2,0	-1,9	-1,8
33,5 °C	-3,1	-3,0	-2,9	-2,8	-2,8	-2,7	-2,7	-2,6	-2,5	-2,4	-2,4	-2,3	-2,2	-2,1	-2,0	-1,9
34,0 °C	-3,1	-3,0	-3,0	-2,9	-2,8	-2,8	-2,7	-2,6	-2,6	-2,5	-2,4	-2,3	-2,2	-2,1	-2,0	-1,9
34,5 °C	-3,2	-3,1	-3,0	-3,0	-2,9	-2,8	-2,8	-2,7	-2,6	-2,6	-2,5	-2,4	-2,3	-2,2	-2,1	-2,0
35,0 °C	-3,2	-3,2	-3,1	-3,0	-3,0	-2,9	-2,8	-2,8	-2,7	-2,6	-2,5	-2,5	-2,4	-2,3	-2,2	-2,1
35,5 °C	-3,3	-3,2	-3,1	-3,1	-3,0	-3,0	-2,9	-2,8	-2,8	-2,7	-2,6	-2,5	-2,4	-2,3	-2,2	-2,1
36,0 °C	-3,4	-3,3	-3,2	-3,1	-3,1	-3,0	-3,0	-2,9	-2,8	-2,7	-2,7	-2,6	-2,5	-2,4	-2,3	-2,2

Korekce jsou uvedeny v jednotkách mm Hg. Korekce zahrnují redukci výšky sloupce na 0 °C, přepočet na místní tíhové zrychlení $g_{SZÚBrno} = 9{,}80944\ m \cdot s^{-2}$ a přístrojovou funkci (nevykompenzovanou systematickou odchylku). Aplikováním uvedené korekce na údaj odečtený na noniu barometru získáme velikost tlaku v jednotkách torr.

Konec kalibračního listu.
End of calibration certificate.

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-20-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.
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Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

K 2202

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2005

Pracoviště: Oblastní inspektorát Brno, Okružní 31, Brno, 638 00
Oddělení měr a vah, tel. 545 555 229, fax 545 555 183

KALIBRAČNÍ LIST

6051-KL-H0187-19

Datum vystavení: 8. března 2019 List 1 ze 2 listů

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Uživatel: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Měřidlo: váhy s neautomatickou činností
Max = 30000 g d = 0,1 g

Výrobce: AND

Typ: HP-30K

Výrobní číslo: 13005024

Evidenční číslo: 02 2151

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 28. února 2019

Kalibraci provedl: Petr Čefelín

Český metrologický institut -60-

Vedoucí oddělení měr a vah: Jiří Teplý

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony:

Závaží třídy F2, 1g - 5 kg, kalibrační list č. 6051-KL-H0516-18, ČMI OI Brno.

Závaží třídy F2, 10 kg, kalibrační list č. 6051-KL-H0517-18, ČMI OI Brno.

Kalibrační postup: 612-MP-C132

Místo kalibrace: Strojírenský zkušební ústav, s.p.

Podmínky prostředí: teplota: (21,5 ± 0,8) °C

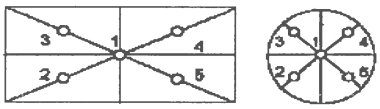
vlhkost: (32,5 ± 3,5) %

Výsledky kalibrace:

Opakovatelnost:

Směrodatná odchylka byla stanovena při: jmenovitém zatížení 30000 g a má hodnotu 0,26 g.

Excentricita:



Jmenovité zatížení (g)	Sektor	Indikace I (g)
10000	1	10 000,3
	2	9 996,2
	3	10 000,3
	4	10 000,7
	5	10 000,8

Správnost:

Tára (g)	Jmenovité zatížení (g)	Chyba (g)	Nejistota U (g)
0	0	0,00	0,06
0	100	0,00	0,68
0	500	0,00	0,69
0	1000	0,00	0,72
0	2000	0,00	0,83
0	5000	0,2	1,4
0	10000	0,3	2,5
0	20000	-0,4	4,8
0	25000	-1,0	6,0
0	30000	1,6	7,2

Standardní nejistota měření byla určena v souladu s dokumentem EA-4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Vyjádření o plnění specifikace: ----------

Poznámka: ----------

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-6-

Konec kalibračního listu

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

K 2202

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2005

Pracoviště: Oblastní inspektorát Brno, Okružní 31, Brno, 638 00
Oddělení měr a vah, tel. 545 555 229, fax 545 555 183

KALIBRAČNÍ LIST

6051-KL-H0190-19

Datum vystavení: 8. března 2019 List 1 ze 2 listů

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Uživatel: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Měřidlo: váhy s neautomatickou činností
Max = 300 kg d = 0,1 kg

Výrobce: Mettler Toledo

Typ: Spider 1-300L/A

Výrobní číslo: 2236396

Evidenční číslo: 02 2211

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 28. února 2019

Kalibraci provedl: Petr Čefelín

Český metrologický institut -60-

Vedoucí oddělení měr a vah: Jiří Teplý

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony:

Závaží třídy F2, 1g - 5 kg, kalibrační list č. 6051-KL-H0516-18, ČMI OI Brno.

Závaží třídy M1, 20 kg, kalibrační list č. 6051-KL-H0348-18, ČMI OI Brno.

Kalibrační postup: 612-MP-C132

Místo kalibrace: Strojírenský zkušební ústav, s.p.

Podmínky prostředí: teplota: (21,5 ± 0,8) °C

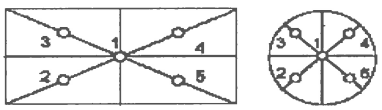
vlhkost: (32,5 ± 3,5) %

Výsledky kalibrace:

Opakovatelnost:

Směrodatná odchylka byla stanovena při: jmenovitém zatížení 300 kg a má hodnotu 0,052 kg.

Excentricita:



Jmenovité zatížení (kg)	Sektor	Indikace I (kg)
100	1	100,0
	2	100,0
	3	100,0
	4	100,0
	5	100,0

Správnost:

Tára (kg)	Jmenovité zatížení (kg)	Chyba (kg)	Nejistota U (kg)
0	0	0,00	0,06
0	10	0,00	0,16
0	20	0,00	0,16
0	60	0,00	0,16
0	100	0,00	0,16
0	140	0,00	0,16
0	180	-0,10	0,16
0	220	-0,10	0,16
0	260	-0,10	0,16
0	300	-0,10	0,16

Standardní nejistota měření byla určena v souladu s dokumentem EA-4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Vyjádření o plnění specifikace: ----------

Poznámka: ----------

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-6-

Konec kalibračního listu

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

K 2202

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2005

Pracoviště: Oblastní inspektorát Brno, Okružní 31, Brno, 638 00
Oddělení měr a vah, tel. 545 555 229, fax 545 555 183

KALIBRAČNÍ LIST

6051-KL-H0243-19

Datum vystavení: 8. března 2019 List 1 ze 2 listů

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Uživatel: Strojírenský zkušební ústav, s.p.
Hudcova 56b
621 00 Brno

Měřidlo: váhy s neautomatickou činností
Max = 1500 kg d = 0,05 kg

Výrobce: Mettler Toledo

Typ: IND560/PUA574

Výrobní číslo: 2997831

Evidenční číslo: 02 2331

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 8. března 2019

Kalibraci provedl: Petr Čefelín

Český metrologický institut -80-

Vedoucí oddělení měr a vah: Jiří Teplý

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony:

Závaží třídy F2, 1g - 5 kg, kalibrační list č. 6051-KL-H0516-18, ČMI OI Brno.

Závaží třídy M1, 20 kg, kalibrační list č. 6051-KL-H0348-18, ČMI OI Brno.

Kalibrační postup: 612-MP-C132

Místo kalibrace: Strojírenský zkušební ústav, s.p.

Podmínky prostředí: teplota: (20,5 ± 0,8) °C

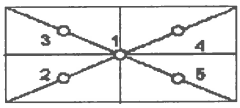
vlhkost: (33,5 ± 3,5) %

Výsledky kalibrace:

Opakovatelnost:

Směrodatná odchylka byla stanovena při: jmenovitém zatížení 1000 kg a má hodnotu 0,15 kg.

Excentricita:



Jmenovité zatížení (kg)	Sektor	Indikace I (kg)
500	1	500,00
	2	500,00
	3	499,85
	4	500,00
	5	500,00

Správnost:

Tára (kg)	Jmenovité zatížení (kg)	Chyba (kg)	Nejistota U (kg)
0	0	0,000	0,030
0	100	0,00	0,70
0	200	-0,05	0,70
0	300	-0,05	0,71
0	400	-0,05	0,71
0	500	0,00	0,71
0	600	0,00	0,71
0	800	0,05	0,72
0	1000	0,05	0,73
0	1500	0,15	0,75

Standardní nejistota měření byla určena v souladu s dokumentem EA-4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Vyjádření o plnění specifikace: ----------

Poznámka: ----------

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-6-

Konec kalibračního listu

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Kalibrační list

E.ON Servisní, s.r.o.
Čsl. armády 2114
390 03 Tábor

Kalibrační laboratotoř
č. 2313
Akreditována ČIA
ČSN EN ISO/IEC 17025:2005

K 2313

T +420-381 78-52 32
F +420-381 23-51 25
petr.svechota@eon.cz

039/15/E
Číslo

1) Základní údaje

Strojírenský zkušební ústav, s.p., Hudcova 56b, 621 00 Brno
Zákazník

27.5.2015
Datum přijetí ke kalibraci

28.5.2015
Datum provedení kalibrace

Rostislav Gálik
Kalibraci provedl

2) Údaje o měřidle

Elektroměr
Kalibrované měřidlo

ZE310.DU.11E301-10
Typ

3x230/400 V
Jmenovité napětí

ZPA
Výrobce

0,2-5(100) A
Jmenovitý proud

05236515
Výrobní číslo

2015
Rok výroby

A
Třída přesnosti

3) Údaje o použitém zařízení

Zkušební stanice Applied Precision, typ ELMA 8310B, výrobní číslo 2047100197, etalonový elektroměr AP, typ RS2310E, výrobní číslo 1097080272, kalibroval ČMI OI Brno, kalibrační list č. 6011-KL-L0896-14. Použitý etalon má metrologickou návaznost na (mezi) národní etalony.

4) Údaje o podmínkách měření

23,8°C
Teplota okolí

36,2%
Relativní vlhkost

5) Údaje o kalibračním postupu

Kalibrace byla provedena podle kalibračního postupu KPM 1.

6) Údaje o výsledcích kalibrace

+
Vnější prohlídka

Zkouška VN

+
Chod naprázdno

+
Náběh

Zkouška přesnosti

30460001-0205-002-4

Napětí [%]	Proud [%]	Označ. fáze	Cos φ [-]	Chyba [%]	Nejistota Měření [%]	Hodnocení dle KPM 1
100	Imin	L_1,L_2,L_3	1	0,07	0,062	+
100	Itr	L_2	1	0,16	0,062	+
100	Itr	L_3	0,5i	0,20	0,064	+
100	50% Iref	L_1	1	0,12	0,062	+
100	50% Iref	L_2	1	0,15	0,062	+
100	50% Iref	L_3	1	0,10	0,062	+
100	Iref	L_1,L_2,L_3	1	0,09	0,062	+
100	Iref	L_1,L_2,L_3	-1	0,10	0,062	+
100	Iref	L_1,L_2,L_3	1	0,10	0,062	+ S0
100	Iref	L_1,L_2,L_3	0,5i	0,21	0,064	+
100	Iref	L_1,L_2,L_3	0,8k	0,06	0,064	+
100	Imax	L_1,L_2,L_3	1	0,13	0,062	+

Zkouška číselníku

Tarif	Napětí [%]	Proud [%]	Cos φ [-]	Poč. stav	Kon. stav	Chyba [%]	Nejistota Měření [%]	Hodnocení dle KPM 1
1	100	50%Imax	1	12,1097	15,1094	-0,01	0,20	+
1	100	50%Imax	-1	3,9898	6,9919	0,07	0,20	+

7) Údaje o nejistotě měření

Standardní nejistota měření byla určena v souladu s dokumentem EA 4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu k, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření k = 2.

8) Datum vystavení kalibračního listu

28.5.2015

Datum vystavení kalibračního listu

Akreditovaná kalibrační laboratoř č. 2313 Čsl. armády 2114, Tábor

9) Podpisy

Kalibroval

Jan Tošl, zástupce vedoucího AKL

Kalibrační list č. 039/15/E obsahuje 2 stránky na 2 listech.
Jeden výtisk tohoto kalibračního listu a 1 stránka na 1 listu Záznamu o měření jsou uloženy v Kalibrační laboratoři E.ON Servisní, s.r.o. Záznam o provedeném měření je uložen pod č. 2199/15.
Výsledky kalibrace se týkají pouze přístroje uvedeného na tomto kalibračním listu.
Kalibrační list může být rozšiřován pouze v celkovém počtu stran beze změny.
Změny a doplňky v tomto kalibračním listu mohou být provedeny pouze Kalibrační laboratoří E.ON Servisní, s.r.o.

Konec kalibračního listu.

Český metrologický institut
Okružní 31, 638 00 Brno
tel. +420 545 555 111
www.cmi.cz

L 1341

Kalibrační laboratoř č. 2202 akreditovaná Českým institutem pro akreditaci, o.p.s. podle ČSN EN ISO/IEC 17025:2018

Pracoviště: Oblastní inspektorát Brno, Okružní 31, 638 00 Brno
Oddělení primární etalonáže průtoku kapalin, rychlosti proudění a tepla
tel. +420 545 555 111, fax. +420 545 555 183

KALIBRAČNÍ LIST

6015-KL-P0404-20

Datum vystavení: 1. července 2020

Zákazník: Strojírenský zkušební ústav, s.p.
Hudcova 424/56b
621 00 Brno

Uživatel: -

Měřidlo: Anemometr termický
Výrobce: Airflow
Typ: TA430
Výrobní číslo: TA4301320002
Ostatní údaje:

Výsledky kalibrace byly získány za podmínek a s použitím postupů uvedených v tomto kalibračním listě a vztahují se pouze k době a místu provedení kalibrace.

Datum kalibrace: 1. července 2020

Kalibraci provedl:

Ing. Jan Sluše

Český metrologický institut
-60-

Vedoucí oddělení:

Mgr. Jindřich Bílek

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Použité etalony: laserový dopplerovský anemometr ILA fp50f-us, ser. č. 738, kalibrováno PTB, kalibrační certifikát PTB-1.41-4087981

Použité etalony mají metrologickou návaznost na státní etalony ČR a PTB (Německo).

Kalibrační postup: Metoda dle pracovního postupu č. 615-MP-C147 za použití aerodynamického tunelu Westenberg Engineering typ WK 845050-G.

Místo kalibrace: ČMI OI Brno, Okružní 31, 638 00 Brno

Podmínky prostředí: Teplota vzduchu (24,0 ± 0,5) °C; RV vzduchu (55,5 ± 0,5) %; tlak vzduchu (973 ± 2) hPa

Podmínky kalibrace: Teplota vzduchu v tunelu (24,0 ± 0,5) °C; RV vzduchu v tunelu (55,5 ± 0,5) %

Výsledky kalibrace:

v_E	v_M	E	U(E)
m/s	m/s	m/s	m/s
0,792	0,900	0,108	0,058
5,054	5,100	0,046	0,060
10,104	9,870	-0,234	0,069
15,116	14,956	-0,160	0,082
20,16	19,94	-0,22	0,10
25,19	24,88	-0,31	0,13

v_E … rychlost měřená etalonem

v_M … rychlost měřená měřidlem

E … chyba měřidla

U(E) … kombinovaná rozšířená nejistota chyby měřidla

Standardní nejistota měření byla určena v souladu s dokumentem EA–4/02. Uvedená rozšířená nejistota měření je součinem standardní nejistoty měření a koeficientu *k*, který odpovídá pravděpodobnosti pokrytí přibližně 95 %, což pro normální rozdělení odpovídá koeficientu rozšíření $k = 2$.

Konec kalibračního listu.

Český metrologický institut
Oblastní inspektorát Brno
Okružní 31
638 00 Brno
-11-

Tento dokument nesmí být bez písemného souhlasu provádějící laboratoře rozmnožován jinak než v celkovém počtu listů.

Annex C

No.	Email from	Date	Pages
1.	Sanchez Rafael	2020-05-08	1 - 2
2.	Emhofer Werner	2020-11-02	3 - 4
3.	Emhofer Werner	2021-01-15	5 - 6
4.	Sanchez Rafael	2021-03-12	7 - 8
5.	Sanchez Rafael	2022-06-30	9 - 12

Note: Annex C is an integral part of test report 32-10198/4-4/T

Od: "Sanchez, Rafael" <Sanchez.Rafael@epa.gov>
Datum: 8. května 2020 20:36:37 SELČ
Komu: Emhofer Werner <W.Emhofer@froeling.com>, Havlů Michal <michal.havlu@szutest.cz>
Kopie: Holomek Milan <milan.holomek@szutest.cz>, "Scinta, Robert" <scinta.robert@epa.gov>, "Yellin, Patrick" <Yellin.Patrick@epa.gov>, "Aldridge, Amanda" <Aldridge.Amanda@epa.gov>, "Toney, Mike" <Toney.Mike@epa.gov>, "Johnson, Steffan" <johnson.steffan@epa.gov>
Předmět: RE: Froling's P4 Pellet 60 pellets boiler, P4 Pellet 60 pellets boiler, and S3 Turbo 30 Boilers Test Reports Deficiencies and 60-day Test Result Submission

Mr. Werner and Mr. Michal,

This email is a follow up to my email from yesterday regarding the above-referenced models. We are reviewing your certification requests and found the below deficiencies on the test reports.

1. **All reports - No first hour data.** Per § 60.5476(c)(6) For all tests conducted using ASTM 2515–11 (IBR, see § 60.17) pursuant to this section, the manufacturer and approved test laboratory must also measure the first hour of particulate matter emissions for each test run using a separate filter in one of the two parallel trains. The manufacturer and approved test laboratory must report the test results for the first hour separately and also include them in the total particulate matter emissions per run.
2. S3 Turbo 30 only- **Cord wood species not listed.** The test report must identify the species of fuel used. This is specified in the General Provisions to EPA 40, Part 60.8 (f)(2), which governs content that must be included in the test report. Paragraph (iii) of this section reads: "(iii) Description of the emission unit tested including fuel burned, control devices, and vent characteristics; the appropriate source classification code (SCC); the permitted maximum process rate (where applicable); and the sampling location."
3. All reports – **Performance data such as emissions rate, CO, and efficiency are provided on a test run basis NOT TOTAL or AVERAGE**. Per Appendix A–8 to Part 60, Calculated results for delivered efficiency at each heat output rate and the weighted average emissions reported as total emissions in grams, pounds per mm Btu of delivered heat, grams per MJ of delivered heat, grams per kilogram of dry fuel and grams per hour. Results shall be reported for each heat output category and the weighted average. CO must be given in grams/min.
   While the below table optional, it helps tabulate the information in one place:

Table 1C: Additional (Hangtag) Information

MANUFACTURER:			
MODEL NUMBER:			
MAXIMUM OUTPUT RATING:	Qmax		BTU/HR
ANNUAL EFFICIENCY RATING:	η_{avg}		(Using higher heating value)
PARTICLE EMISSIONS:	E_{avg}		GRAMS/HR (average)
			LBS/MILLION BTU OUTPUT
CARBON MONOXIDE:	COg/MIN		GRAMS/MINUTE

4. S3 Turbo 30 Only- **No firebox volume calculations**. We need it for compliance evaluation.
5. S3 Turbo 30 Only- **No manufacturer's instructions**. The requirement to submit this information is to comply with the General Provisions of 60.8(b) and (c).
6. P4 60 and P4 100 Only – **no side and front view photographs of the stove**.

Finally, all reports - In addition to the above deficiencies and per my earlier email, please explain the reason the performance test data was not submitted to the Agency within 60 days after completion of each certification test. Please submit a revised test report for each model by **May 15, 2020,** for EPA to continue with the reviews. If you have any questions, please let me know.

Rafael Sanchez, Ph.D.
Wood Heater Program Lead
Air Branch
Monitoring, Assistance, and Media Programs Division

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U.S. Environmental Protection Agency (EPA)
Room 7149-D
1200 Pennsylvania Ave., NW
MS:2227A
Washington, DC 20460
202-564-7028
202-564-0050 fax
Teleworking on Mondays and Fridays (571-236-1927)

Are you looking for a wood heater? Please try our new fully searchable EPA Certified Wood Heater Database (https://www.epa.gov/compliance/epa-certified-wood-heater-database).

SZU:

- To new version of test report 32-10198/4/T were added:
  - based on new testing – first hour data
  - correction of data and filled to the table 1C
  - new side and front view photographs

From: Emhofer Werner [mailto:W.Emhofer@froeling.com]
Sent: Monday, November 02, 2020 3:53 PM
To: Havlů Michal; Foit Vladimír
Cc: Pauzenberger Robert
Subject: WG: Froling P4 100 Pellet test report deficiencies.
Importance: High

Dear Mr. Havlu,

unfortunately this email got stock in my inbox last week, not sure whether you got this directly from EPA as well.
Please comment on EPAs findings below.

They are asking for a correction until October 30th, which is already passed now, so I will talk to them. Still you may have a look at this very quickly.

Thank you.

Kind Regards

Werner EMHOFER
Verkaufsleiter Export / Export Sales Manager

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Fröling Heizkessel- und Behälterbau Ges.m.b.H.
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Firmenbuchnummer: 99229a | Firmenbuchgericht: Landesgericht Wels

Von: Sanchez, Rafael <Sanchez.Rafael@epa.gov>
Gesendet: Mittwoch, 21. Oktober 2020 17:51
An: Emhofer Werner <W.Emhofer@froeling.com>
Cc: Scinta, Robert <scinta.robert@epa.gov>; Yellin, Patrick <Yellin.Patrick@epa.gov>; Toney, Mike <Toney.Mike@epa.gov>; Johnson, Steffan <johnson.steffan@epa.gov>; Brashear, Angelina <Brashear.Angelina@epa.gov>
Betreff: RE: Froling P4 100 Pellet test report deficiencies.
Priorität: Hoch

Mr. Werner,

Thank you for your October 20, 2020 email. We are reviewing the submitted test reports. We just finished the review of the P4 100 model and would like to share our findings:

1. All test runs use the wrong molecular weight of 28.78. This can be seen on Emissions Sampling Data (ASTM E2515-11) spread sheet when looking at the square box on the left hand side of the spread sheet. For run 1 this can be seen on page 14, run 2 page 22, run 3 page 32 and run 4 page 42. Also in this square box is the dilution tunnel moisture of 2.0% which is correct. When using ASTM E2515-11 the molecular weight should be **29.00** and the dilution tunnel moisture should be 2.0%. By using the 28.78 for molecular weight does not change the emissions significantly but the lab should be using the correct value for molecular weight.

2. On page 111 Section X (Table A) has several errors. A) Under the heading test duration, hours is shown but 240 minutes are in the table. When using ASTM E2618 automated fuel section all test runs are 4.0 hours (or 240 minutes). If the lab wanted to use hours, 4.0 should be listed for each test run or change the hour in the heading to minutes would make the

column correct. B) Under the test duration heading run 3 has a time of 235, this should be changed to **240** minutes to match the other three test runs. C) Under the heading test fuel weight, run 1 Category IV has a weight of 29.1 lbs. This should be changed to the correct value of **201** lbs as correctly stated for all test fuel weights on page 57, section ASTM E2618-13 heat output results (total test fuel weight wet) run 1 = 201.0 lbs, run 2 = 29.1 lbs, run 3 = 43.8 lbs, run 4 = 88.5 lbs.

3. On page 12, Particulate Emissions Results, measurement results table, burn rates are incorrect. The values presented are run 1 = 16.10, run 2 = 3.345, run 3 = 5.33, run 4 = 9.77. These numbers do not match the correct burn rate values listed on page 108, Section Test Results in accordance with CSA B415.1-09, run 1 = **21.43**, run 2 = **3.10**, run 3 = **4.67**, run 4 = **9.43**. These burn rates should replace the incorrect values on page 12.

4. Page 111 Table B, PM output based on lb/MM BTU heading shows run 1 (category IV) = **0.023**, run 2 (category I) = **0.107**, run 3 (category II) = **0.048**, run 4 (category II) = **0.022**. The low burn, category I, run 2, is a above the rule requirement of 0.10 for each individual test run.

5. Cannot find data showing that the heater was conditioned for the proper 48 hours.

6. Did not find a volume for the fire box, this is usually reported for would heaters but should be reported here also.

We will share feedback on the other models soon. In the meantime, please address the above deficiencies. It is likely that the same or similar deficiencies will be found on the other 2 TRs. To that extend, please make the appropriate corrections on the other TRs. **Please be mindful that once the test report has been corrected it will need to obtain approval from the certifier and a revised or updated CoC issued**. **Finally, please note #4 above, the Cat 1 run 2 emissions limit (0.107) is over allowable limit.** To continue w/ the certification review, please submit a revised TR and CoC by October 30, 2020.

If you have any questions regarding the above deficiencies, please contact Mike Toney, which I have added to the email.

Rafael Sanchez, EPA

SZU:

- To new version of test report 32-10198/4-1/T were added:
  - Conditioning data
  - Correction of molecular weight
  - Correction of time and weight
  - Correction of burn rate
  - Correction of Burn rate
  - Volume of firebox

Von: Emhofer Werner
Gesendet: Freitag, 15. Jänner 2021 12:50
An: 'Foit Vladimír' <vladimir.foit@szutest.cz>; Wenzl Markus <m.wenzl@froeling.com>
Cc: Havlů Michal <michal.havlu@szutest.cz>; Holomek Milan <milan.holomek@szutest.cz>
Betreff: AW: Review of Froling S3 Turbo 30 test report and deficiencies found

Dear Gents,

please wait with the new report and CoC.
We got another remark from Mr. Sanchez yesterday, see attachment.

On the one hand I thought we were done at least with the S3, but not there is another remark:
In addition, for each test report, you need to include a discussion on run appropriateness. Test report didn't have documentation of run appropriateness: Run Validity, Run Anomalies.

We should talk on the phone next week how we can react.

Kind Regards

Werner EMHOFER
Verkaufsleiter Export / Export Sales Manager

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4710 Grieskirchen

Firmenbuchnummer: 99229a | Firmenbuchgericht: Landesgericht Wels

From: Sanchez, Rafael [mailto:Sanchez.Rafael@epa.gov]
To: Emhofer Werner

I wanted to follow up on the appliances you are seeking certification.

1. P4 Pellet 100 – Froling is conducting a retest
2. S3 Turbo – There is no conditioning - missing data
3. P4 Pellet 60 – I found the below deficiencies were not met (deficiencies were noted on an 11/17/20 email from Mike Toney)
    a. The test fuel weights listed on page 108, in section Test results in accordance with CSA B415.1-09, lists test fuel weight (dry) run 1 = 107.98 lb, run 2 = 16.35 lb, run 3 = 25.09 lb, run 4 = 47.08 lb. These test fuel weights do not agree with the test fuel weights listed in Table A page 111, run 1 = 114.9 lb, run 2 = 17.4 lb, run 3 = 26.7 lb, run 4 = 50.1 lb. These test fuel weights listed in table A, also agree with the individual test run data sheets for each test run at the 240 minute mark on the far right hand side, run 1 page 68, run 2 page 81, run 3 page 94, run 4 page 107.
    b. No firebox calculations.
4. In addition,
    a. No technicians note
    b. No manufacturer's instructions

In addition, for each test report, you need to include a discussion on run appropriateness. Test report didn't have documentation of run appropriateness: Run Validity, Run Anomalies. Per the requirement, 40 CFR 60.533(b)(5), "Documentation must include discussion of each test run and its appropriateness and validity, and must include detailed discussion of all anomalies, whether all burn rate categories were achieved, any data not used in the calculations and, for any test runs not

completed, the data collected during the test run and the reason(s) that the test run was not completed and why" and *"All documentation pertaining to a valid certification test, including the complete test report and, for all test runs: Raw data sheets, laboratory technician notes, calculations and test results."*

Regarding the P4 pellet 60 Owner's manual, I was not able to locate:
Tamper warnings
The following statement must be included in the owner's manual for all units: "This wood heater has a manufacturer-set minimum low burn rate that must not be altered. It is against federal regulations to alter this setting or otherwise operate this wood heater in a manner inconsistent with operating instructions in this manual."

Certification Statement: see below example:
"This manual describes the installation and operation of the Brand X, Model 0 catalytic equipped wood heater. This heater meets the 2015 U.S. Environmental Protection Agency's crib wood emission limits for wood heaters sold after May 15, 2015. Under specific test conditions this heater has been shown to deliver heat at rates ranging from 8,000 to 35,000 Btu/hr."

Each revised test report should include a **revision date and summary page** outlining the test report's revisions and updated **conformity certification**. Please submit revised test reports (P4 60 and S3 turbo) by 1/21/21.

If you have any questions, please let me know.

Rafael Sanchez, EPA

SZU:

- To new version of test report 32-10198/4-2/T were added:
  - Discussion on run appropriateness, run validity, run anomalies
  - Sample calculations

From: Sanchez, Rafael [mailto:Sanchez.Rafael@epa.gov]
Sent: Friday, March 12, 2021 6:11 PM
To: Emhofer Werner; Holomek Milan
Cc: Scinta, Robert; Toney, Mike; Johnson, Steffan
Subject: RE: Review of Froling S3 Turbo 30 and P4 Pellet 60 test reports/CoC deficiencies found
Importance: High

Mr. Werner,

Thank you for your revised test report submittals. Upon a preliminary review of the S3 Turbo 30 test report and Certificate of conformity, I noted the following deficiencies.

1. No CBI test report in the last submission.
2. The certification of conformity for the 1/21/21 test report requires revision. The CoC should be revised to include each revision date and description of every revision made to the test report for which the third-party Certifier evaluated the report. Our records show that Froling submitted a CoC on 3/26/20, 11/18/20, and 1/21/21. Those dates must be on the revised CoC, along with a summary of the evaluated revisions. The CoC and the revised test report both must be in concert in terms of revision dates.
3. The 1/21/21 test report only shows a report issue date. The test report must be revised to include the date of each revision. Our records show that the TR was initially prepared on 12/20/19, then modified on 8/26/20 and 1/21/21. Our records show that on May 08, 2020, we emailed Froling indicating the following irregularities:
    - All reports - No first-hour data. Per § 60.5476(c)(6) For all tests conducted using ASTM 2515–11 (IBR, see § 60.17) pursuant to this section, the manufacturer and approved test laboratory must also measure the first hour of particulate matter emissions for each test run using a separate filter in one of the two parallel trains. The manufacturer and approved test laboratory must report the test results for the first hour separately and also include them in the total particulate matter emissions per run.
    - S3 Turbo 30 only- Cord wood species not listed. The test report must identify the species of fuel used. This is specified in the General Provisions to EPA 40, Part 60.8 (f)(2), which governs content that must be included in the test report. Paragraph (iii) of this section reads: "(iii) Description of the emission unit tested including fuel burned, control devices, and vent characteristics; the appropriate source classification code (SCC); the permitted maximum process rate (where applicable); and the sampling location."
    - All reports – Performance data such as emissions rate, CO, and efficiency are provided on a test run basis, NOT TOTAL or AVERAGE. Per Appendix A–8 to Part 60, Calculated results for delivered efficiency at each heat output rate and the weighted average emissions reported as total emissions in grams, pounds per mm Btu of delivered heat, grams per MJ of delivered heat, grams per kilogram of dry fuel and grams per hour. Results shall be reported for each heat output category and the weighted average. CO must be given in grams/min.
    - S3 Turbo 30 Only- No firebox volume calculations. We need it for a compliance evaluation.
    - S3 Turbo 30 Only- No manufacturer's instructions. The requirement to submit this information is to comply with the General Provisions of 60.8(b) and (c).
4. On 11/5/20 and 1/14/21, we emailed Froling, indicating additional observations and irregularities. See the email thread below.
5. The summary page in the test report is deficient. The above-referenced irregularities, including all follow-up emails, must be included as a summary page in the revised report.

We request that Froling submit both a revised CBI test report and a revised non-CBI test report to EPA within ten (10) business days from receipt of this email to continue with the review of the above-referenced model. The revised test reports (both CBI and non-CBI) should clearly identify the report as revised, provide a revision date(s), and include a summary table indicating what revisions have been made and where in the report the revisions are located. Similarly, the CoC should indicate each CoC revision and a summary of the revisions evaluated by the Certifier. **This request should also apply**

to the Froling P4 Pellet 60 test report. Please note, the above-referenced observations do not constitute a full review of the submitted test report. If you have any Qs, please let me know._

Rafael Sanchez, Ph.D.
Wood Heater Program Lead
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Monitoring, Assistance, and Media Programs Division
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Questions about Wood Heaters or Certifications? Send them to WoodHeaterReports@epa.gov

Are you looking for a wood heater or central heater? Please try our fully searchable EPA Certified Wood Heater Database (https://www.epa.gov/compliance/epa-certified-wood-heater-database).

SZU:

- To new version of test report 32-10198/4-3/T were added:
  - Annex C – Email comunaction
  - Information about versions of test reports
  - New version of CBI report

From: WoodHeaterReports <WoodHeaterReports@epa.gov>
Sent: Thursday, June 30, 2022 9:42 PM
To: Dvořáček Michal <michal.dvoracek@szutest.cz>; Johnson, Steffan <johnson.steffan@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>
Cc: Toney, Mike <Toney.Mike@epa.gov>; Holomek Milan <milan.holomek@szutest.cz>; W.Emhofer@froeling.com; Scinta, Robert <scinta.robert@epa.gov>; Brashear, Angelina <Brashear.Angelina@epa.gov>
Subject: RE: Request for EPA´s clarification and support (Certification of Froling Appliances based on testing by SZU)

A revised report with the appropriate column labelling as suggested below would address the identified deficiency. We can proceed with drafting the certification letter once the appropriate revisions have been received per the deficiency letter. Thanks.

WoodHeaterReports on behalf of:
Rafael Sanchez, Ph.D.
Wood Heater Program Manager
Air Branch
Monitoring, Assistance, and Media Programs Division
Office of Compliance, Office of Enforcement and Compliance Assurance
U.S. Environmental Protection Agency

From: Dvořáček Michal <michal.dvoracek@szutest.cz>
Sent: Thursday, June 30, 2022 1:16 AM
To: Johnson, Steffan <johnson.steffan@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>
Cc: Toney, Mike <Toney.Mike@epa.gov>; Holomek Milan <milan.holomek@szutest.cz>; W.Emhofer@froeling.com; Ayres, Sara <Ayres.Sara@epa.gov>; Scinta, Robert <scinta.robert@epa.gov>; Brashear, Angelina <Brashear.Angelina@epa.gov>
Subject: RE: Request for EPA´s clarification and support (Certification of Froling Appliances based on testing by SZU)
Importance: High

Dear Dr. Sanchez, dear Steffan,

Would you be so kind and send us your decision on our pending request?

Thank you in advance for your support.

Kind regards
Michal Dvoracek
SZU

Yours sincerely

Michal Dvořáček
Foreign Cooperation Manager
Strojírenský zkušební ústav, s.p. (SZU)
Engineering Test Institute, Public Enterprise
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From: Johnson, Steffan <johnson.steffan@epa.gov>
Sent: Thursday, June 16, 2022 6:40 PM
To: Sanchez, Rafael <Sanchez.Rafael@epa.gov>
Cc: Toney, Mike <Toney.Mike@epa.gov>; Holomek Milan <milan.holomek@szutest.cz>; W.Emhofer@froeling.com; Dvořáček Michal <michal.dvoracek@szutest.cz>; Ayres, Sara <Ayres.Sara@epa.gov>; Scinta, Robert <scinta.robert@epa.gov>; Brashear, Angelina <Brashear.Angelina@epa.gov>
Subject: RE: Request for EPA´s clarification and support (Certification of Froling Appliances based on testing by SZU)

Hello Rafael,

We had a meeting in the Measurement Technology group this morning and reviewed the issues between fuel weights presented on pages 109 and 112 in the Froling F4-60 appliance test report.

The data presented in the Table A on page 112 were mistakenly thought by us to be Dry weights and, when compared to the weights presented as Dry weights on page 109 there was an obvious discrepancy. However, after review of the statement below where the test lab discusses these as Dry weight on page 109 and Wet weight on page 112, we reviewed the test method and the test report again through this lens.

The ASTM method used for this requires the use presentation of Wet fuel mass, as presented in table A on page 112. When we used their 6.2% moisture value, we arrive at the Dry fuel values presented on page 109.

There is no discrepancy here, these two tables present different weights, however they are equivalent.

Our only comment to the test lab would be to ask that they label such table columns as either W or D to indicate which mass they are representing.

I hope this resolves any lingering questions with regard to the compliance status of this unit.

Please let us know if you have any questions.

Sincerely,

Steffan Johnson

Steffan M Johnson (he/him/his) | Leader – Measurement Technology Group | US EPA Office of Air Quality Planning and Standards | Air Quality Assessment Division | 109 T.W. Alexander Drive, RTP, NC 27710 | Mail Drop: E-143-02 | Phone: (919) 541-4790 | Cell: (919) 698-5096

From: Dvořáček Michal <michal.dvoracek@szutest.cz>
Sent: Thursday, June 16, 2022 4:09 AM
To: Sanchez, Rafael <Sanchez.Rafael@epa.gov>
Cc: Toney, Mike <Toney.Mike@epa.gov>; Holomek Milan <milan.holomek@szutest.cz>; W.Emhofer@froeling.com; Johnson, Steffan <johnson.steffan@epa.gov>
Subject: Request for EPA´s clarification and support (Certification of Froling Appliances based on testing by SZU)
Importance: High

Dear Dr. Sanchez,

Let me address your authority and the person who has the main role in this assessment process with one specific and long time unsuccessfully negotiated matter.
My colleagues from our testing lab here in Brno turned to me with a request for intervention and help.

After getting acquainted with the current communication between you, our customer (Mr. Emhofer from Fröling Heizkessel- und Behälterbau Ges.m.b.H.) and my colleagues from the SZU testing lab (Mr. Holomek), I would like to invite you and ask for support in order to clarify the current situation and indicate further steps that would lead to solution for Fröling company, because that's actually the most important thing.

SZU has become an approved testing lab and certifier under EPA to help customers, especially European ones, with the demanding testing and recognition process required to market products in the US.
This specific and problematic issue is related to the Report for the P4 Pellet 60 boiler.
We have **attached** two essential **emails**.

Let me focus on the essence of the problem:

- On 4th Feb 2021, Mr Mike Toney wrote to us that he had received all the information and that it was in order.
- *Quoted: „I fine with Mr. Holomek response. He answered all my questions. Good to go.“*
- On 26th May 2022 Dr. Sanchez wrote that there was still a inconsistency in the fuel weight.
- *„Although many of the other inconsistencies in the report were addressed by the latest revision, we have confirmed with Mr. Toney that the deficiency noting the inconsistency in test load fuel weights in tables on pg 112 and pg 109 remains.“*

Our questions:

- Does this mean that on 4th Feb 2021 we misunderstood Mr. Mike Toney's statement?
- Or was everything really correct from his point of view (that's how we understood it!)
- If it is true that we misinterpreted his words and his answer meant that there was a continuing problem, ... we would like to ask you hereby which weight you consider incorrect, a dry weight on page 108 or wet weight on page 111?
- Could you please also indicate for at least one value what number you would expect to be acceptable?

Thank you in advance for your kind help and recommendations for further actions ... and for sending us your answers to our questions.

Kind regards

Michal Dvoracek
Foreign Cooperation Manager
SZU

Yours sincerely

Michal Dvořáček
Foreign Cooperation Manager
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SZU:

- To new version of test report 32-10198/4-4/T was added:
  - Index „wet“ and description „wet“ into the table A at page 112 (column Wood weight)