



# TEST REPORT

Date: 28.08.2015

Report no.: 300-ELAB-2179

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Init.: RSL/TNJ/LSHA

Order no: 617624

No. of appendices: 6

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**Requested by:** Contact person: Jannich Hansen

Company: NBE Production A/S

www.nbe.dk

Address: Brinken 6-10

email: jannich@nbe.dk

Town: DK-9750 Øster Vrå

Tel.: +45 8820 9230

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**Subject:** Automatic biofuel boiler

Manufacturer: NBE Production A/S

Type: RTB 50

Nominal output: 46.8 kW

Fuel: C1 (wood pellets)

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**Deadlines:** Date of receipt: 30.09.2014

Date of testing: 03.10.2014 – 14.10.2014 / 24.06.2015

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**Procedure:** Testing of biofuel boiler according to DS/EN 303-5:2012.

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**Result:** Requirements according to DS/EN 303-5:2012 Class 5 were met.

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**Remarks:** See page 2. This is a translation of the Danish report. In case of doubt, the Danish version of the test report prevails.

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**Terms:** Testing has been carried out on the conditions stated overleaf in compliance with the guidelines laid down for the laboratory by DANAK (Danish Accreditation) and in compliance with DTI's General Terms and Conditions Regarding Commissioned Work Accepted by the Danish Technological Institute (DTI), February 2013. The test results apply to the tested samples only. This test report may be reproduced in extracts only if the laboratory has approved the extract in writing.

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**Place:** Danish Technological Institute, Energy Laboratory

**Signature:**   
Torben Nørgaard Jensen  
B.Sc.



## **Appendices:**

- a) Drawings of the biofuel boiler: R5054 A08 (2014-09-18), ASM\_2204 (2014-09-23), skamol – 135x200 (2014-09-22), A1595 (2014-09-23), R5004 (2014-09-23), Auger 190mm (2014-09-23), ASM\_2033 (2014-09-23).
- b) Photos of the biofuel boiler and steering: 30 pcs of boiler and 8 pcs of steering
- c) User's instructions and installation manual: Manual RTB OKT 2014 rev1, approved 02-10-2014
- d) Technical information: approved 2014-09-30
- e) Data plate: approved 2014-09-30
- f) Risk assessment: Dated: 2014-09-25

The appendices are kept separately.

## **1 Remarks**

The report is a revised version of report no.: 300-ELAB-2109 because a new nominal test has been performed.

Control of the welded steel sheet boiler, electrical safety and EMC are not included in this report (see paragraph 4).

Determination of particle emission at in-stack sampling with turbular filter device. Drying was carried out before and after sampling at 105 °C for minimum 4 hours.

## **2 Description of the biofuel boiler**

The Ready To Burn (RTB) boiler is a compact fully automatic stoker boiler for stoking with debris of solid biofuel. The fuel is transported by means of an inclined auger from the storage hopper further on via a drop chute to an internal auger in the burner. Combustion takes place during supply of primary and secondary air.

RTB is performed with electrical ignition and compressor cleaner for the boiler and burner.

The boiler is not suited for firewood burning.

The regulation system is fully modulating. Measurements on smoke- and flow temperature are continuously carried out.

The boiler is a welded steel sheet boiler with a convection part consisting of a pass with two flue gas turbulators.

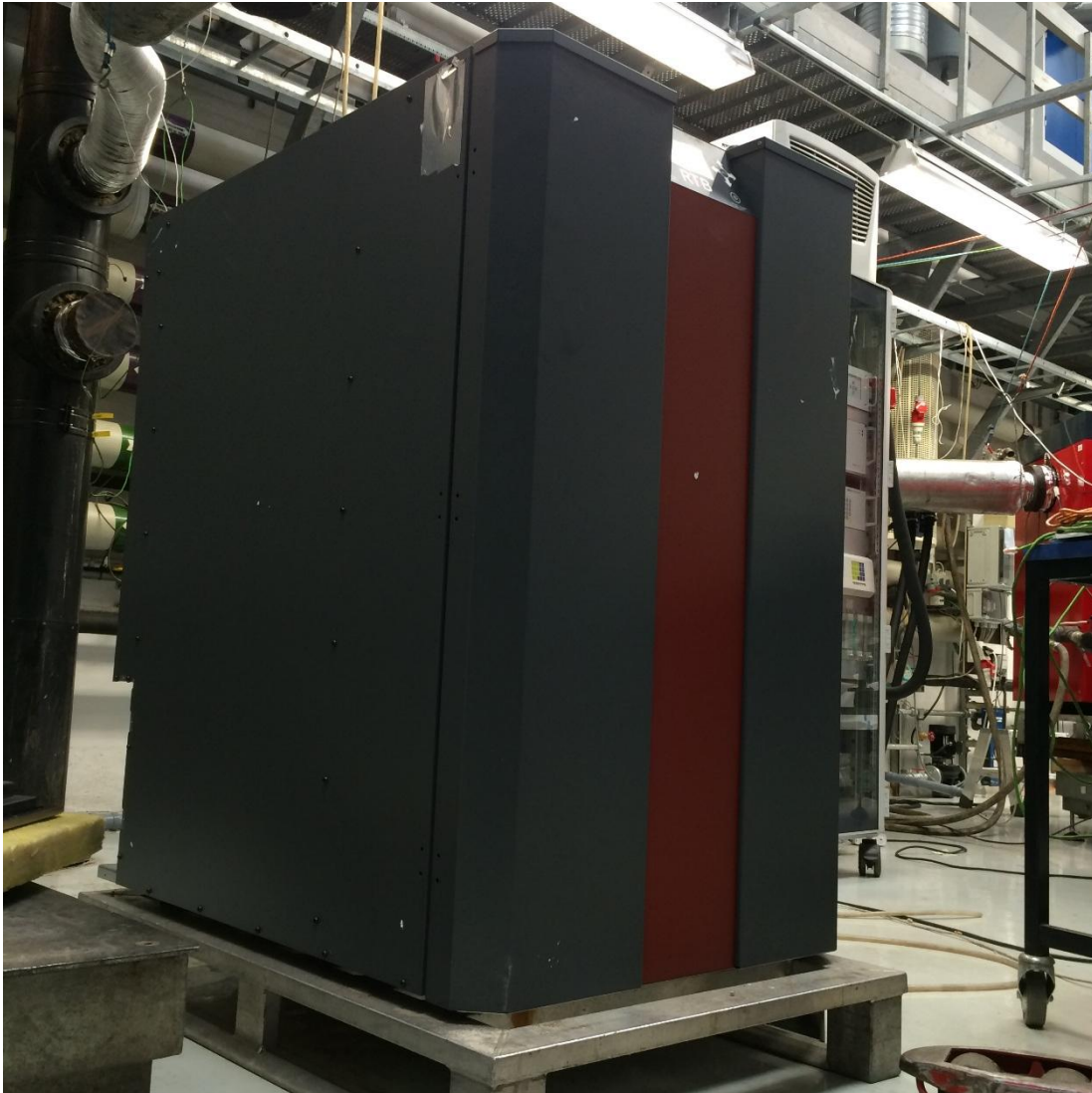
The unit is equipped with ascending auger feeding and a drop chute larger than 250 mm to secure against back burning in the fuel supply.

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**Safety equipment:**

Boiler temperature controller type: ..... Electronic  
Safety temperature limiter: ..... CA-95A, set point 95 °C  
Protection against back burning: ..... Drop chute with set point 75 °C  
Protection against back burning: ..... Drop chute >250 mm

Stand-by power consumption (measured) ..... 20 W

**Settings on boiler during testing:**

Boiler temperature controller (nominal): ..... 85 °C  
Boiler temperature controller (partial load): ..... 72 °C  
(Further information regarding settings of biofuel boiler during testing see appendix)

**Feeding system:**

Type: ..... Feeding by means of inclined auger  
Fuel engine external <sup>1</sup>: ..... Linix YN70-20, 1-100 gear, 20W  
Fuel engine internal: ..... Linix YN70-20, 20W

**Burner:**

Type: ..... Aircooled hearth with fireresistant crossbar  
Width: ..... approx. 180 mm  
Depth: ..... approx. 287 mm  
Fan: ..... SOHON, type FL120034Y-18F, 230V, 75W

**Boiler:**

Type: ..... Welded steel sheet boiler  
Length: ..... 1092 mm  
Height: ..... 1225 mm  
Width: ..... 762 mm  
Weight: ..... 390 kg  
Water content: ..... 78 l  
Flue gas tube: ..... ø133 mm  
Flow connection: ..... 1”  
Return connection: ..... 1”

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<sup>1</sup> During testing



### 3 Test equipment

Testing stand and equipment has been set up according to EN 303-5 and EN 304.

<b>Rack B1</b>			
<b>Instrument</b>	<b>Type</b>	<b>Traceability</b>	<b>No.</b>
Data acquisition unit	HP 34970A	DANAK 200	270-A-2436
CO meter	Sick Maihak Sidor	-	270-A-2430
CO/CO <sub>2</sub> meter	Sick Maihak Sidor	-	270-A-2432
FID meter	Sick Maihak EuroFID		270-A-2434
NO <sub>x</sub> analyzer	ECO Physics CLD	-	270-A-2428
Pressure gauge	Autotran 700	ELAB	270-A-2479
Heated hose/probe	M&C	-	270-A-2482
Heated hose/probe	M&C	-	270-A-2483
Flue gas temperature sensor	Type K	ELAB	270-A-2488
Ambient temperature sensor	Type K	ELAB	270-A-2487

<b>Rack 3</b>			
<b>Instrument</b>	<b>Type</b>	<b>Traceability</b>	<b>No.</b>
Data acquisition unit	HP 34970A	DANAK 200	270-A-1613
CO/CO <sub>2</sub> /O <sub>2</sub> meter	H & B Uras 14	-	270-A-1501
NO <sub>x</sub> analyzer	ECO Physics CLD-60	-	ID: 91348
FID meter	M&A	-	ID: 98350
Pressure gauge	Autotran 700	ELAB	270-A-1578
Heated hose/probe	M&C	-	270-A-2295
Heated hose/probe	M&C	-	270-A-1752
Flue gas temperature sensor	Type K	ELAB	270-A-1528
Ambient temperature sensor	Type K	ELAB	270-A-1527

<b>Test stand 1</b>			
<b>Instrument</b>	<b>Type</b>	<b>Traceability</b>	<b>No.</b>
Water flow meter	0-3,5 m <sup>3</sup> /h	DANAK 200	270-A-1175
Water temperature sensor	Pt100 (flow)	DANAK 200	270-A-1494
Water temperature sensor	Pt100 (return)	DANAK 200	270-A-1493
Gas meter	Elster BK-G4MT	DANAK 9	ID: 101144

<b>Other equipment</b>			
<b>Instrument</b>	<b>Type</b>	<b>Traceability</b>	<b>No.</b>
Spangas, C <sub>3</sub> H <sub>8</sub>	AGA	Swedac	270-A-2294
Spangas, CO/CO <sub>2</sub>	AGA	Swedac	270-A-1727
Spangas, NO/SO <sub>2</sub>	AGA	Swedac	270-A-1725
Zero gas, N <sub>2</sub>	AGA	Swedac	270-A-1731
Data acquisition software	N.I. Labview	-	TI-DOP
Dust measuring equipment	Ströhlein	-	270-A-1330
Surface thermometer	Technoterm 5500	DANAK 200	270-A-976

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Water gauge	ELAB	-	270-A-1759
Scale (dust)	Mettler XS 204	ELAB	ID: 7084
Scale (moisture)	Mettler PC 440	ELAB	270-A-947
Scale (boiler)	Mettler IND 560	ELAB	270-A-0551



## 4 Requirements for construction etc.

	Reference paragraph in EN303-5	Requirement met
<b>4.1 General requirements</b>		
Safety during normal use	4.1	Yes
<b>4.2 Requirements on documentation</b>		
Drawings	4.2.1.1	Yes
Quality manual	4.2.1.2	Yes
Data plate	7.1-7.2	Yes
Technical information	8.2	Yes
User's instructions	8.3	Yes
Risk assessment	4.3.1	Yes
<b>4.3 Requirements on welded steel sheet boiler</b>		
Execution of welding work	4.2.2.1	*
Welding seams and fillers	4.2.2.2	*
Parts of steel subject to pressure	4.2.2.3	*
Least wall thickness and tolerances	4.2.2.4	*
<b>4.4 Requirements on safety and design</b>		
Venting etc.	4.2.4.1	Yes
Cleaning of heating surfaces	4.2.4.2	Yes
Inspection of the flame	4.2.4.3	Yes
Water tightness	4.2.4.4	Yes
Spare parts	4.2.4.5	Yes
Water side connections	4.2.4.6	Yes
Thermostat pockets	4.2.4.7	Yes
Thermal insulation	4.2.4.8	Yes
Water side resistance	4.2.4.9	Yes
Storage hopper	4.2.4.10	Yes
Combustion chamber	4.2.4.11	Yes
Ash chamber	4.2.4.12	Yes
Overfeeding and disturbances in the fuel supply	4.3.4	Yes
Supply of combustion air	4.3.5	Yes
Surface temperatures of accessible parts	4.3.6	Yes
Leakage of combustion products	4.3.7	Yes
<b>4.5 Safety requirements in connection with stoking</b>		
Generally	4.3.3.1	Yes
Manual fuel supply	4.3.2	Not relevant
Automatic fuel supply	4.3.3	Yes
Thermal conduction	4.3.3.2	Yes



Back flow of flammable combustion gasses	4.3.3.3	Yes
Spreading of fire in fuel line	4.3.3.4	Yes
Alternative solutions against back-burning	4.3.3.5	Not relevant
<b>4.6 Safety requirements at automatic stoking</b>		
Temperature control for open vented systems	4.3.8.2	Yes
Temperature control for closed vented systems	4.3.8.3	Yes <sup>2</sup>
Accessories /fittings	4.3.9.1	Yes
Electric safety	4.3.9.2	*
Electromagnetic compatibility, EMC	4.3.9.3	*

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<sup>2</sup> Only applies with automatic stoking

\* Not included in this report. Reference is made to the manufacturer's EU declaration of conformity.





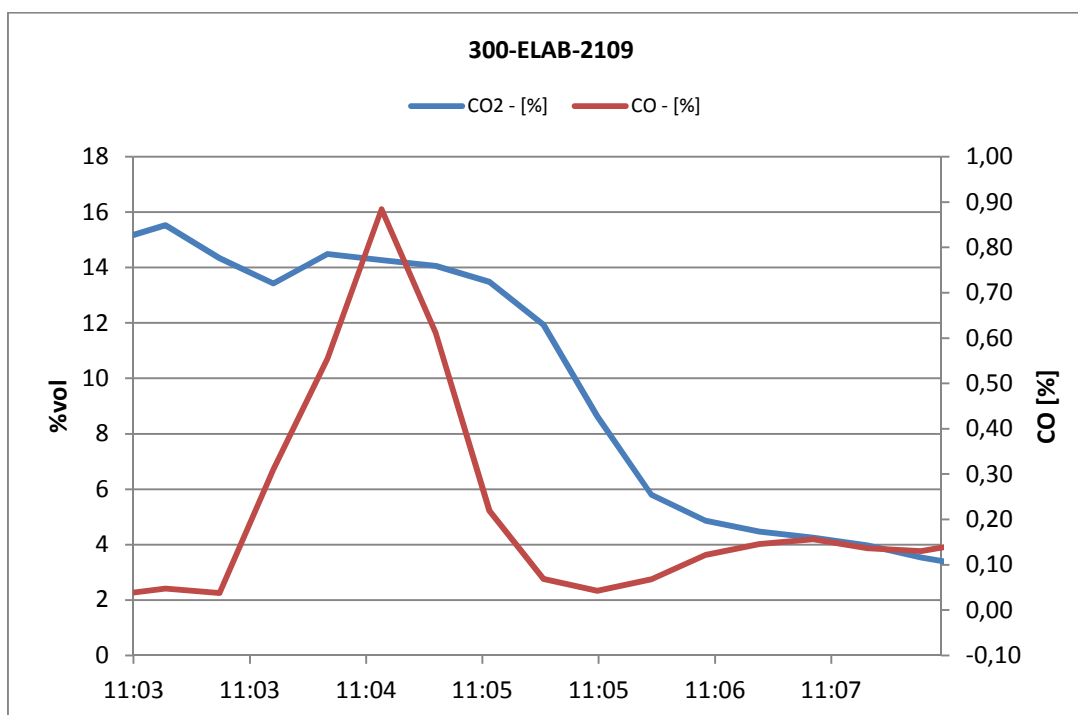
## 5 Test results

### 5.1 Water resistance

Equivalent temperature difference at nominal output	Water flow	Drop of pressure
20 K	2.0 m <sup>3</sup> /h	10 mbar
10 K	4.0 m <sup>3</sup> /h	36 mbar

### 5.2 Disconnection of air fan

	Measured CO	Allowed limit CO
Disconnection of air fan	0.9 % <sub>vol</sub>	5 % <sub>vol</sub>





### 5.3 Surface temperatures

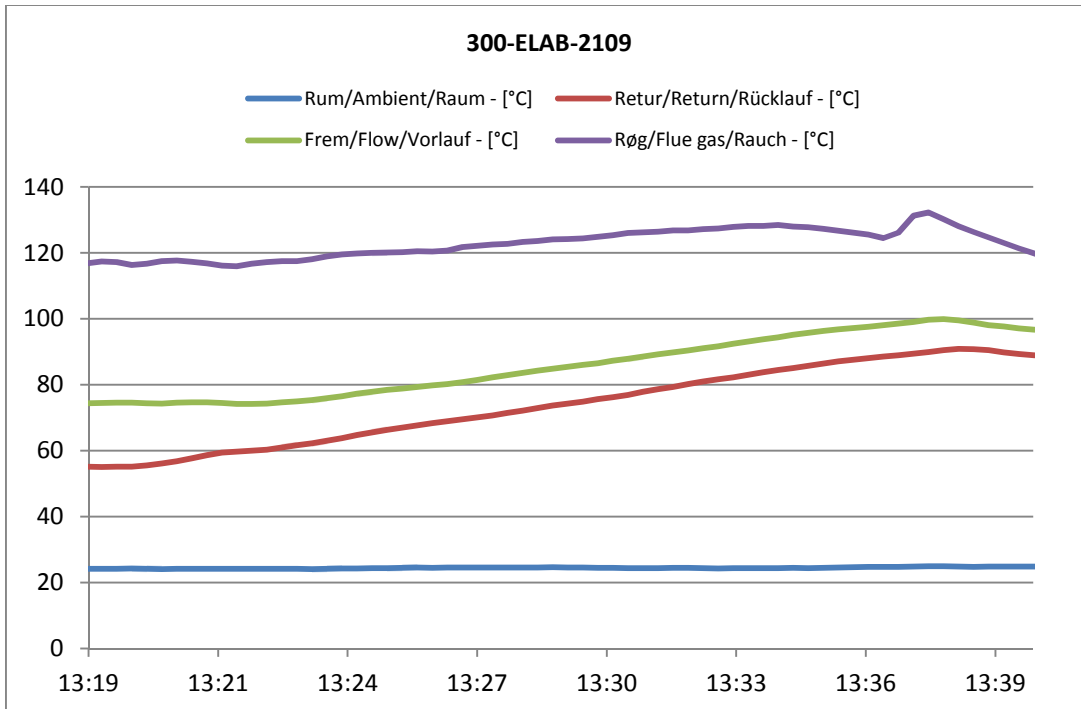
	Measured temperature	Allowed limit
Boiler doors etc., average of 5 measurements	29 °C	+ 100 K
Boiler's underside, average of 5 measurements	30 °C	+ 65 K
Handles being touched during operation		
Metal and similar materials	29 °C	+ 35 K
Porcelain and similar materials	-	+ 45 K
Plastic and similar materials	-	+ 60 K
Boiler's average surface temperature		
Average of 10 spot measurements	33 °C	-
Ambient temperature	25 °C	-

### 5.4 Function control

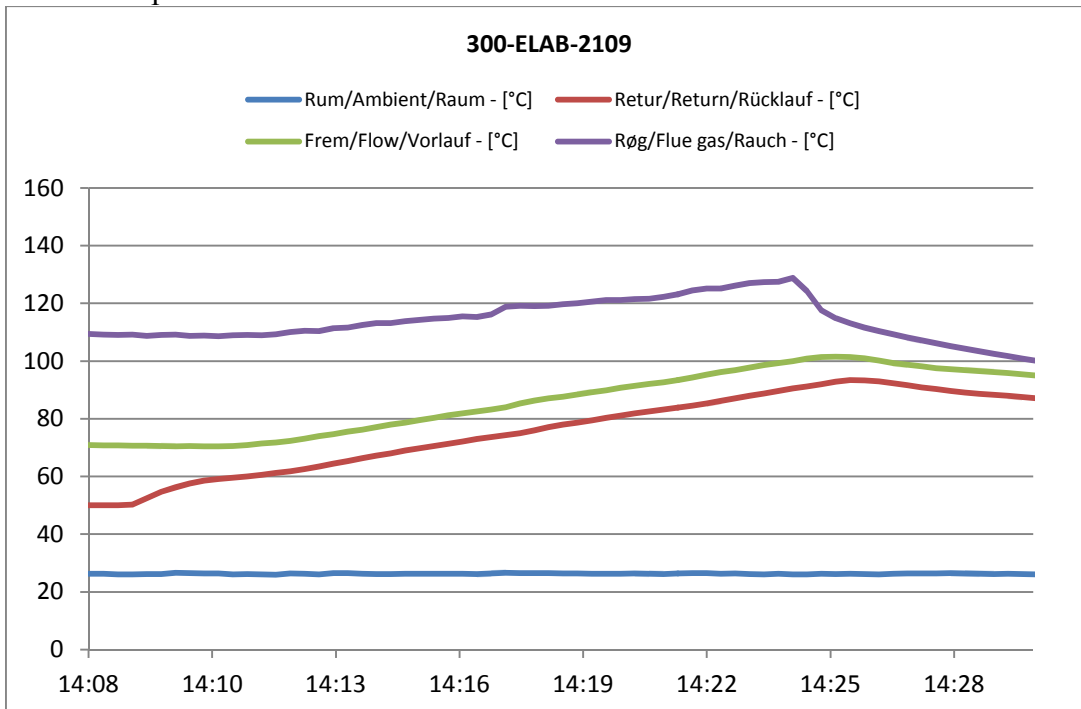
The stoking system is completely disconnectable, DS/EN303-5 paragraph 4.3.8.3 a), and therefore the safety equipment includes a temperature controller and a safety temperature limiter with manual reset device.

The thermostats of the boiler are tested in accordance with DS/EN303-5 paragraph 5.13. Loss of power supply and sudden lack of heat dissipation are controlled in accordance with paragraph 5.14.

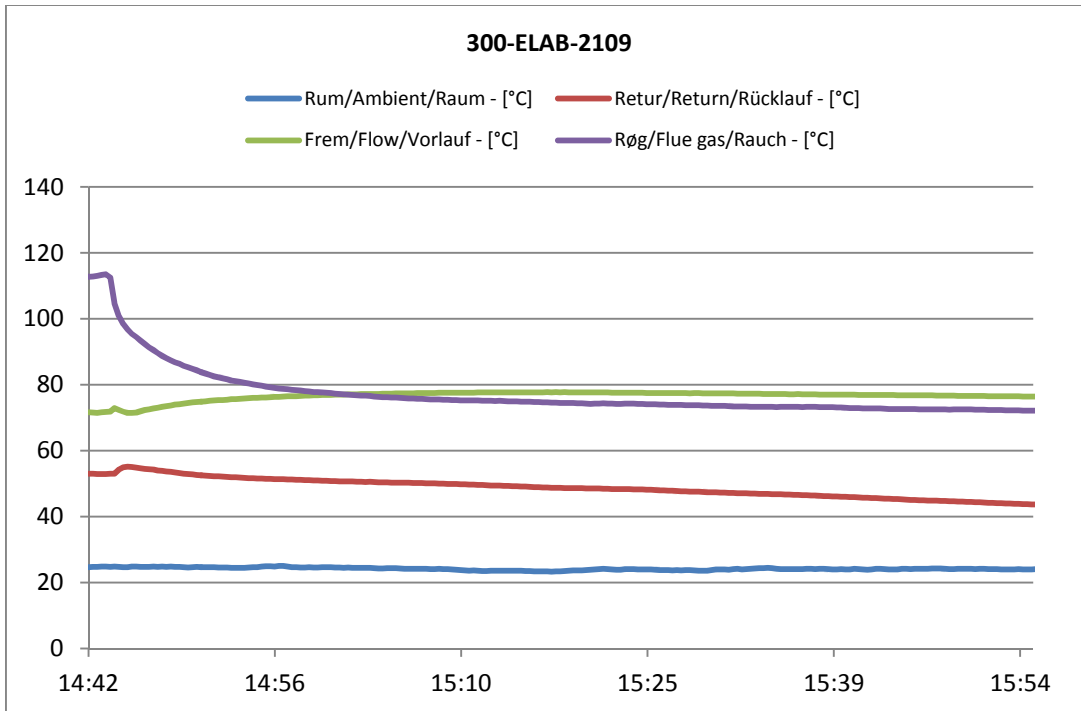
	Measured temperature	Allowed limit
Temperature controller	100 °C	100 °C
Safety temperature limiter	101 °C	110 °C



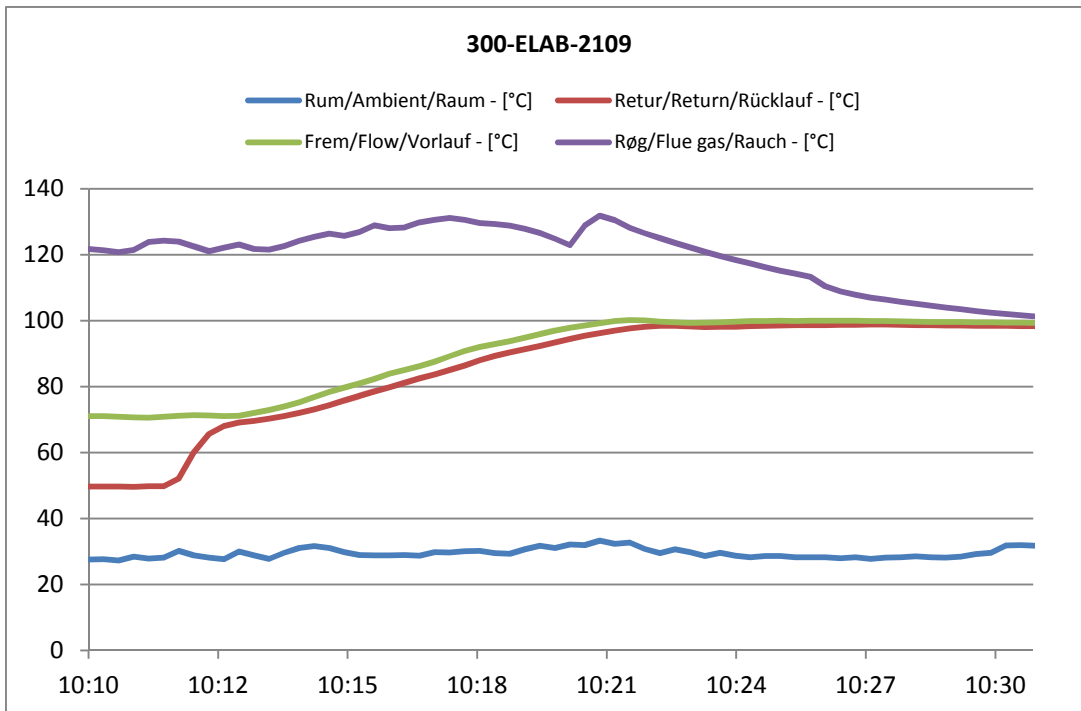
Test of temperature controller



Test of safety temperature limiter



Test of loss of power



Test of loss of output

### 5.5 Pressure test of boiler shell

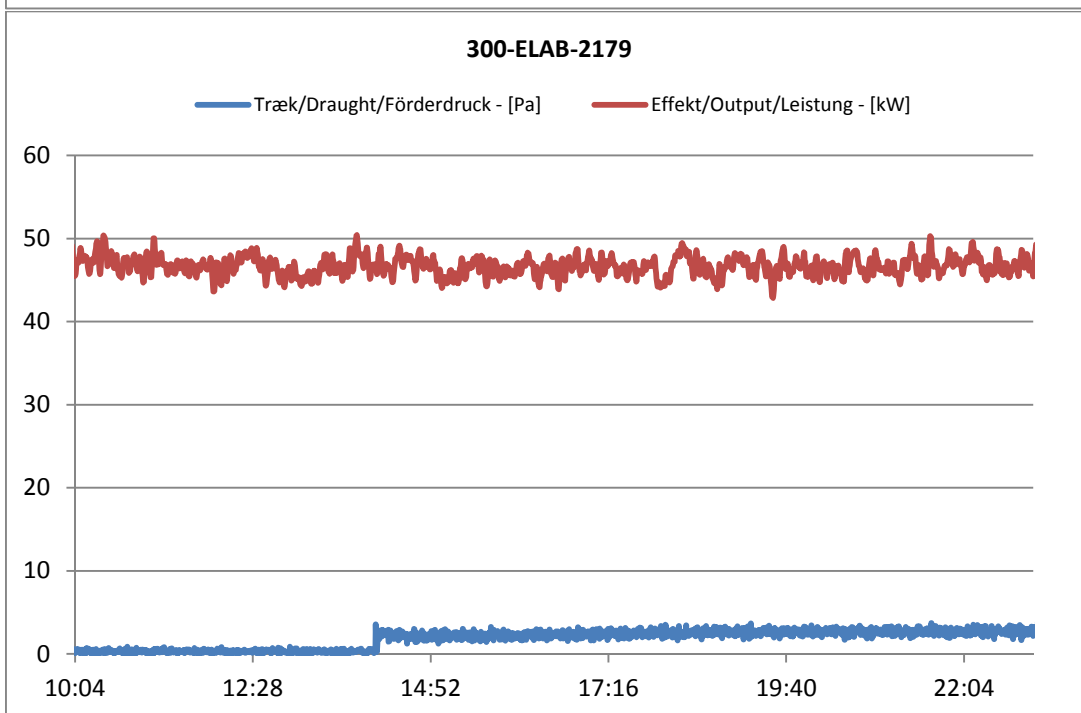
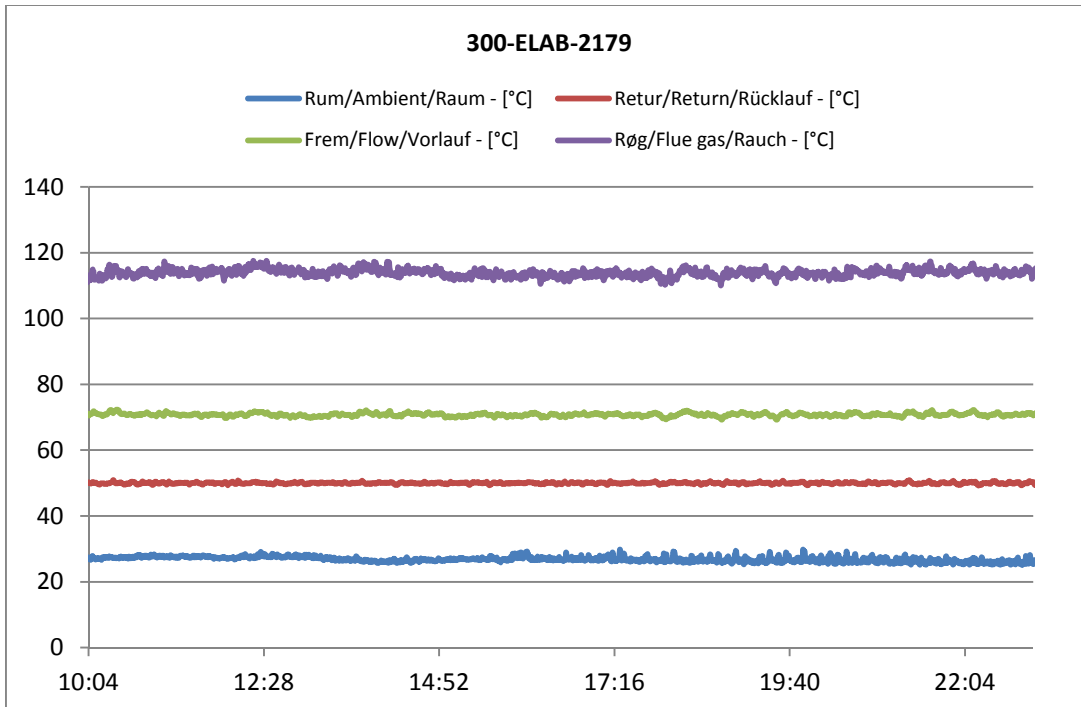
The necessary tests cf. DS/EN303-5 paragraph 5.4 are carried out by the manufacturer.

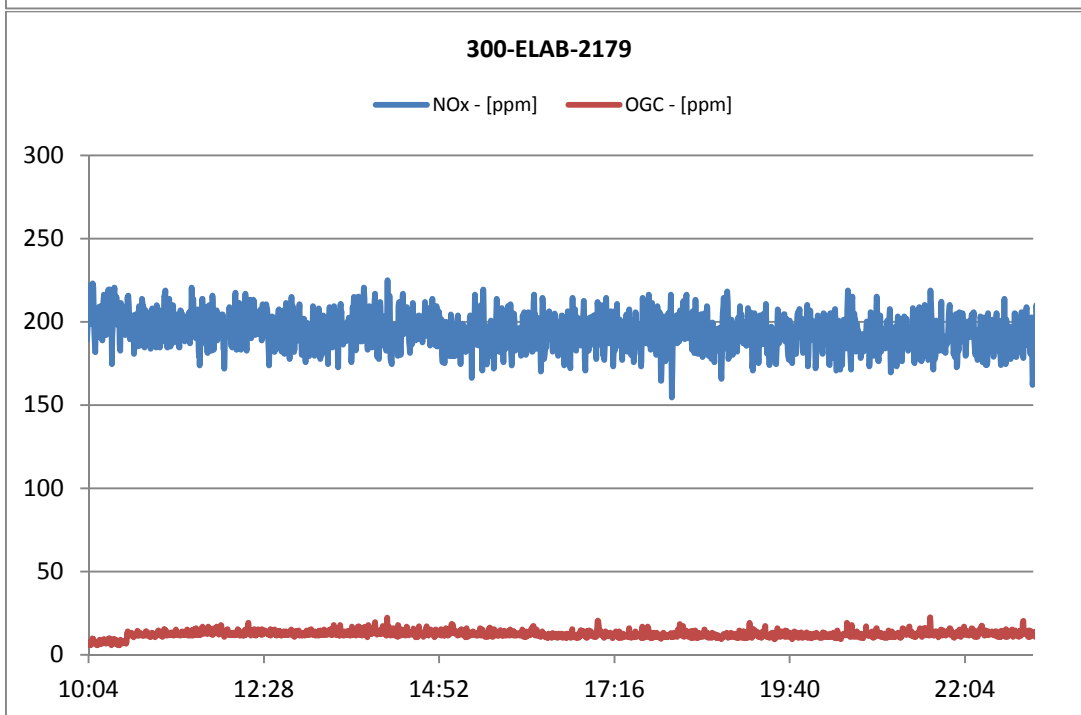
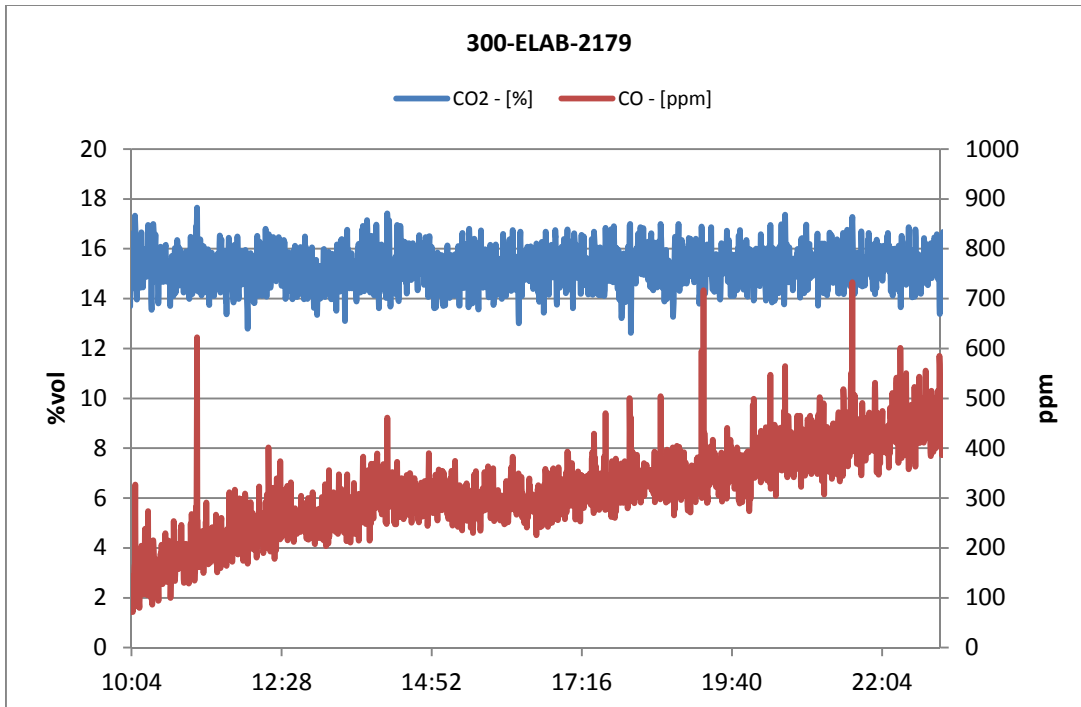


## 5.6 Test results at nominal output

Measurement	Result	Requirement
Return temperature	50.00 °C	
Flow temperature	70.79 °C	
Water flow	1.96 m <sup>3</sup> /h	
Heat output	46.83 kW	
Test duration	12.93 h	
Power consumption	168.24 W	
Fuel consumption	10.11 kg/h	
Water content	7.6 %	
Calorific value	17813 J/g	
Heat input	50.04 kW	
Efficiency	93.6 %	89 (Class 5) 89 (Denmark) 85 (Austria)
Ambient temperature	25 °C	
Flue gas temperature	114 °C	
Chimney draught	2 Pa	
Flue gas volume flow	91.4 m <sup>3</sup> /h	
Flue gas mass flow	84.1 kg/h	
CO <sub>2</sub>	15.3 % <sub>vol</sub>	
Dust measured	24 mg/m <sup>3</sup>	
Dust at 10% O <sub>2</sub>	17 mg/m <sup>3</sup>	40 (Class 5)
Dust at 13% O <sub>2</sub>	0.01 g/m <sup>3</sup>	0.02 (Germany)
Dust emission	8 mg/MJ	20 (Austria)
CO measured	0.0313 % <sub>vol</sub>	
CO at 10% O <sub>2</sub>	0.0216 % <sub>vol</sub>	
CO at 10% O <sub>2</sub>	271 mg/m <sup>3</sup>	500 (Class 5)
CO at 13% O <sub>2</sub>	0.197 g/m <sup>3</sup>	0.4 (Germany)
CO at 13% O <sub>2</sub>	197 mg/m <sup>3</sup>	300 (Switzerland)
CO emission	123 mg/MJ	250 (Austria)
NO <sub>x</sub> (NO <sub>2</sub> ) at 10% O <sub>2</sub>	0.0135 % <sub>vol</sub>	
NO <sub>x</sub> (NO <sub>2</sub> ) at 10% O <sub>2</sub>	276 mg/m <sup>3</sup>	
NO <sub>x</sub> emission (NO <sub>2</sub> )	126 mg/MJ	100 (Austria)
OGC (C <sub>3</sub> H <sub>8</sub> ) at 10% O <sub>2</sub>	0.0010 % <sub>vol</sub>	
OGC (C) at 10% O <sub>2</sub>	16 mg/m <sup>3</sup>	20 (Class 5)
OGC emission (C)	7 mg/MJ	30 (Austria)

All emission values are stated on the basis of dry flue gas.







## 5.7 Test results at lowest output

Measurement	Result	Requirement
Return temperature	50.01 °C	
Flow temperature	72.50 °C	
Water flow	0.52 m <sup>3</sup> /h	
Heat output	13.56 kW	
Test duration	14.82 h	
Power consumption	81.79 W	
Fuel consumption	2.96 kg/h	
Water content	6.8 %	
Calorific value	17405 J/g	
Heat input	14.33 kW	
Efficiency	94.6 %	88 (Class 5) 88 (Denmark) 81 (Austria)
Ambient temperature	22 °C	
Flue gas temperature	71 °C	
Chimney draught	13 Pa	
Flue gas volume flow	40.8 m <sup>3</sup> /h	
Flue gas mass flow	42.0 kg/h	
CO <sub>2</sub>	8.5 % <sub>vol</sub>	
Dust measured	23 mg/m <sup>3</sup>	
Dust at 10% O <sub>2</sub>	29 mg/m <sup>3</sup>	40 (Class 5)
Dust at 13% O <sub>2</sub>	0.021 g/m <sup>3</sup>	0.1/0.02* (Germany)
Dust emission	14 mg/MJ	40/20* (Austria)
CO measured	0.0016 % <sub>vol</sub>	
CO at 10% O <sub>2</sub>	0.0020 % <sub>vol</sub>	
CO at 10% O <sub>2</sub>	25 mg/m <sup>3</sup>	500 (Class 5)
CO at 13% O <sub>2</sub>	0.0181 g/m <sup>3</sup>	0.5/0.4* (Germany)
CO at 13% O <sub>2</sub>	18 mg/m <sup>3</sup>	300 (Switzerland)
CO emission	12 mg/MJ	250 (Austria)
NO <sub>x</sub> (NO <sub>2</sub> ) at 10% O <sub>2</sub>	0.0085 % <sub>vol</sub>	
NO <sub>x</sub> (NO <sub>2</sub> ) at 10% O <sub>2</sub>	174 mg/m <sup>3</sup>	
NO <sub>x</sub> emission (NO <sub>2</sub> )	82 mg/MJ	150/100* (Austria)
OGC (C <sub>3</sub> H <sub>8</sub> ) at 10% O <sub>2</sub>	0.0004 % <sub>vol</sub>	
OGC (C) at 10% O <sub>2</sub>	7 mg/m <sup>3</sup>	20 (Class 5)
OGC emission (C)	3 mg/MJ	30 (Austria)

All emission values are stated on the basis of dry flue gas.

\*: Limit values are valid from 2015.01.01



