Notified Body 1880 – Regulation (EU) no305/2011

TEST REPORT n.1880-CPR-009-001-17

Compliance of dust load to European Regulations (Austrian 15a B-VG,German BIMSchv, French Flamme Verte and Swiss LRV)

Residential space heating appliances fired by wood pellets
UNI EN 14785:2006

Manufacturer: KLOVER SRL
Via A. Volta, 8
37047 SAN BONIFACIO (VR)
Italy

Type designation: PFP 22 - prototype

Type of appliance: Residential space heating appliances fired by wood pellets with indirect water system.

Receipt date: March 06, 2017

Start test date: March 07, 2017

End test date: March 13, 2017

Testing laboratory: ACTECO SRL
via Amman, 41
33084 Cordenons (PN)
Italy

Issue date: April 28, 2017

Head of Test Laboratory
Dr. Claudia Marcuzzi

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Task

ACTECO SRL was instructed to execute initial type testing to establish compliance according to the:

- European standard UNI EN 14785:2006 Residential space heating appliances fired by wood pellets
- UNI CEN/TS 15883:2009 Residential solid fuel burning appliances. Emission test methods
- Client's documents

The practical tests were performed in the laboratory in Cordenons (PN), via Amman, 41.

Sampling of the appliance

The sampling of the appliance was performed by the manufacturer and was received by the testing laboratory on March 06, 2017.

Description of the appliance

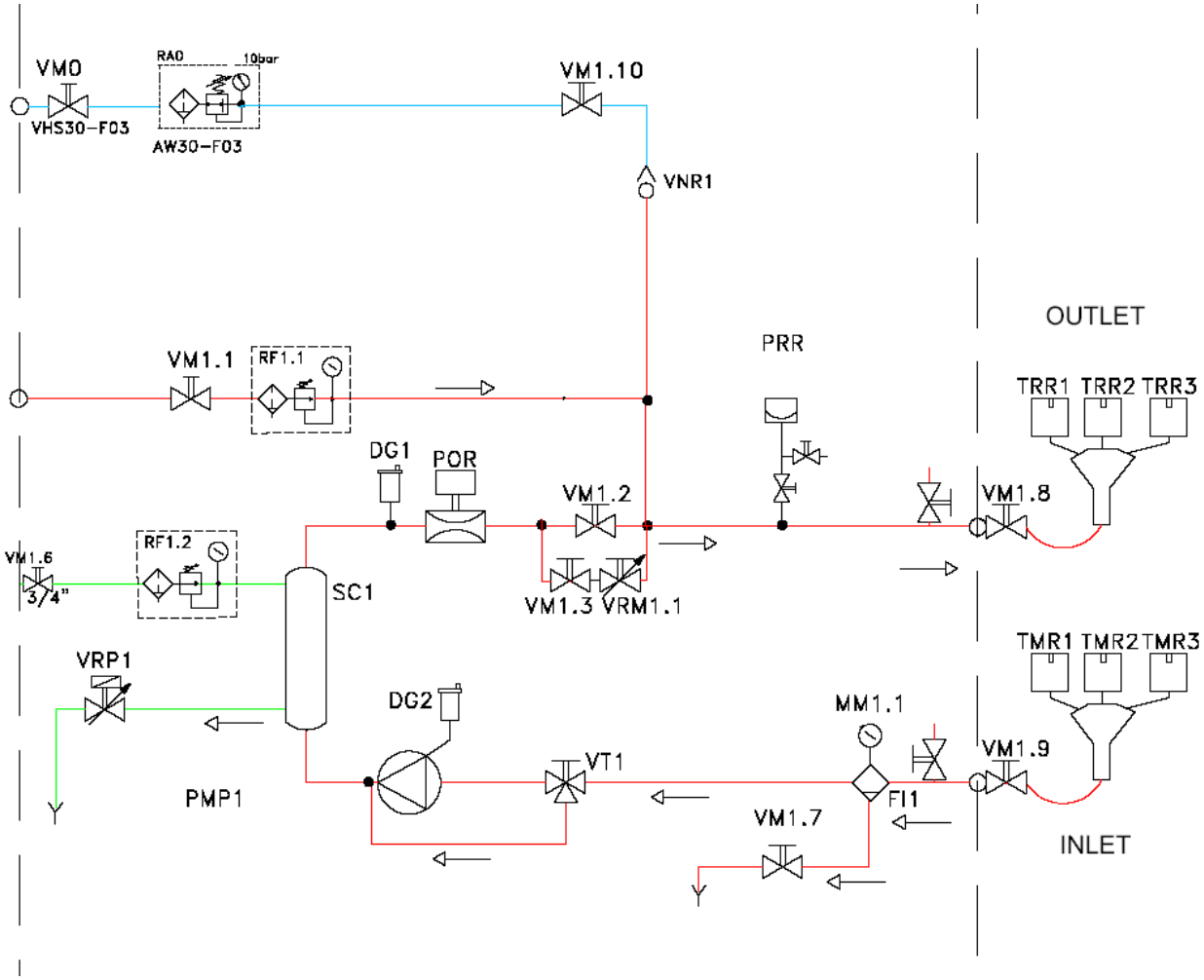
Residential space heating appliances fired by wood pellets with indirect water system.
The combustion air is taken from the test room.

Key data of appliance

Appliance	PFP 22		
Fuel		Wood pellet	
Fuel throughput	kg/h	5,12	
Total heating output	kW	24,0	
Space heating output	kW	5,4	
Water heating output	kW	18,6	
CO emission based on 13% O_2	mg/m³	138	
Efficiency	%	94,4	
Flue gas temperature	°C	123,8	
Necessary flue draught	Pa	9,6	
Flue gas mass flow	g/s	11,2	
Permissible maximum operating pressure	bar	1,5	
Minimum clearance distances from exposed / combustible materials	from rear wall from side walls		250 mm 150 mm

Description of the water circuit used for the water heating output test

The water circuit used for the water heating output test was a closed circuit as shown in the figure below.
The outlet temperature was set to 80°C ±5°C and the water flow was set to a constant flow according to the expected boiler heat output.
During the test period, inlet and outlet temperatures and the water flow were measured at 10 second intervals. At the end of the test period, the mean rise in water temperature between boiler inlet and outlet and the mean water flow were calculated.

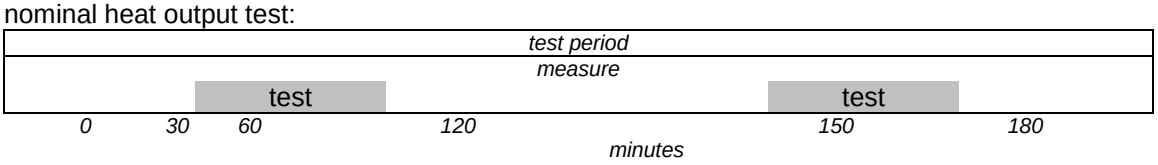


Description of the dust emission test

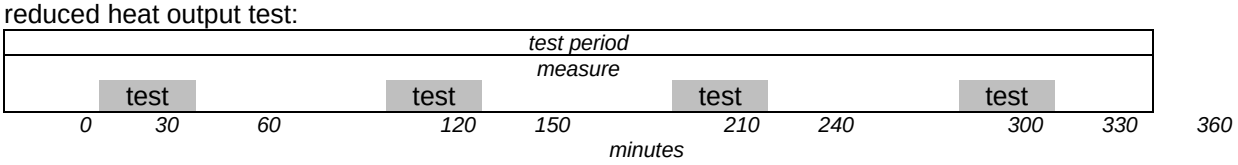
Measurement of particulate emissions is performed with UNI CEN/TS 15883:2009 (equivalent to VDI 2066:2006 part 1) parallel to CO-measurement during the initial type testing according to the nominal heat output test described in UNI EN 14785:2006 A.4.7.
A sample flow of the gas is extracted from the main gas flow at a representative sampling point for the sampling period with a controlled flow rate and the withdrawn volume is measured. The dust entrained in the gas sample is separated by a pre-weighted plain quartz fibre filter, which is dried an re-weighted. The increase of mass of the filter is attributed to the dust collected from the sampled gas.

The measurement position for particle measurement is arranged downstream of measurement positions of CO, CO_2, NOx and OGC (Organic Gaseous Compounds). Measurement of particulate emissions and duration of measurements are described in the following scheme.

nominal heat output test:



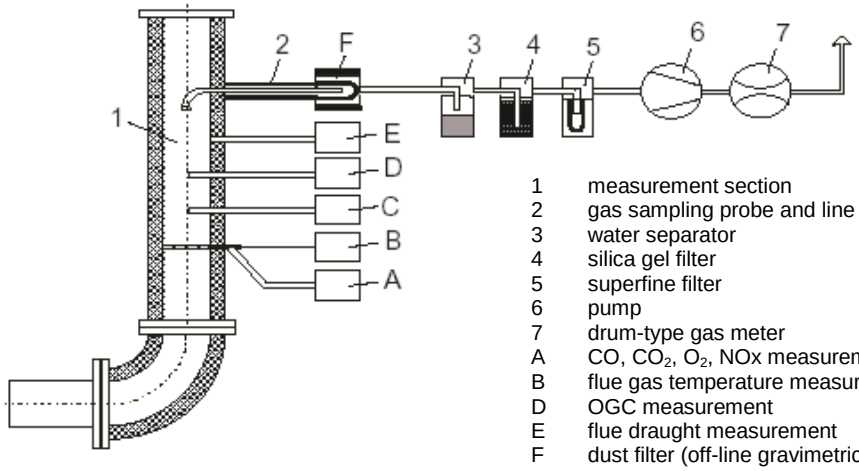
reduced heat output test:



The measuring arrangement is illustrated in the following figure. The sampling tube widens out to 9,74 mm at the specimen inlet. In a sampling period of 30 minutes a waste gas volume of 270 ± 13,5 l relative to normal conditions (273 K, 1013 hPa) is sampled, corresponding to a flow rate of 10,0 ± 0.45 l/min.

Note: In the interests of simplifying the measuring method, individual measurement of the flow velocity and subsequent matching of the inlet cross-section are dispensed with. In order to carry out the measurement, the sampling probe is centred in the exhaust-gas cross-section..

The measuring filter is inserted in a filter holder at the end of the sampling probe and a controlled probe heating system is adopted to exclude the possibility of the sampled flue gas falling below the dew point in front of or in the filter sleeve.



1	measurement section
2	gas sampling probe and line for dust measurement (heat insulated)
3	water separator
4	silica gel filter
5	superfine filter
6	pump
7	drum-type gas meter
A	CO, CO_2, O_2, NOx measurement
B	flue gas temperature measurement
D	OGC measurement
E	flue draught measurement
F	dust filter (off-line gravimetric measurement)

PERFORMANCE AT THE NOMINAL HEAT OUTPUT TEST

test n°			1	2	average
Combustion:					
fuel load		*kg*	15,3	15,4	15,4
test period		*min*	180	180	180
fuel load	*B*	*kg/h*	5,09	5,15	5,12
average flue draught		*Pa*	9,2	10,0	9,6
Ventilation circuit:					
average ambient room temperature	*tr*	*°C*	20,9	22,5	21,7
Flue gas:					
carbon dioxide	CO_2	*%*	14,3	14,7	14,5
oxygen	O_2	*%*	7,2	6,8	7,0
carbon monoxide	*CO*	*%*	0,017	0,021	0,019
average flue gas temperature	*ta*	*°C*	123,2	124,5	123,8
maximum flue gas temperature		*°C*	124,5	126,3	125,4
flue gas mass flow	*m*	*g/s*	11,3	11,1	11,2
Maximum surface temperatures:					
charging door handle (metal)		*°C*	78,0	79,8	78,9
internal fuel hopper		*°C*	54,6	56,2	55,4
pellet loading motor		*°C*	53,5	54,9	54,2
conveyor system where there is pellet		*°C*	43,6	43,2	43,4
Maximum trihedron surface temperatures:					
hearth		*°C*	25,8	27,6	26,7
side wall		*°C*	34,3	35,3	34,8
back wall		*°C*	31,3	32,4	31,9

test n°			1	2	average
Results:					
thermal losses in flue gas	q_a	%	5,4	5,2	5,3
thermal losses in flue gas	Q_a	kJ/kg	956	931	944
chemical losses in flue gas	q_b	%	0,1	0,1	0,1
chemical losses in flue gas	Q_b	kJ/kg	13,3	16,0	14,7
heat losses due to combustible through the grate	q_r	%	0,2	0,2	0,2
efficiency	η	%	94,4	94,5	94,4
carbon monoxide [at 13% O_2]		%	0,010	0,012	0,011
carbon monoxide [at 13% O_2]		mg/m^3	125	150	138
average boiler water output temperature		°C	76,3	76,7	76,5
average boiler water input temperature		°C	60,0	60,0	60,0
average boiler water temperature rise	N	°C	16,3	16,7	16,5
water flow rate	M_w	kg/h	948,6	948,5	948,6
water heat output	P_w	kW	18,3	18,8	18,6
space heat output	P_{SH}	kW	5,5	5,3	5,4
total heat output	P	kW	23,8	24,1	24,0

Dust emission: test A		mg/MJ	10,0	9,8	9,9
test B		mg/MJ	9,3	9,3	9,3
average		mg/MJ	9,7	9,6	9,6
Dust emission (at 13% O_2): test A		mg/m^3	15,0	14,8	14,9
test B		mg/m^3	14,0	14,0	14,0
average		mg/m^3	14,5	14,4	14,4
NOx		ppm	105	106	106
NOx (as NO_2)		mg/MJ	83	81	82
NOx (as NO_2 at 13% O_2)		mg/m^3	124	122	123
THC (as propane)		ppm	1,0	0,9	1,0
OGC (as C)		mg/MJ	0,7	0,6	0,7
OGC (as C at 13% O_2)		mg/m^3	1,0	0,9	1,0

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PERFORMANCE AT REDUCED HEAT OUTPUT TEST

test n°			1	2	average
Combustion:					
fuel load		*kg*	8,5	8,6	8,6
test period		*min*	360	360	360
fuel load	*B*	*kg/h*	1,41	1,43	1,42
average flue draught		*Pa*	9,9	9,6	9,8
Ventilation circuit:					
average ambient room temperature	*tr*	*°C*	21,6	21,2	21,4
Flue gas:					
carbon dioxide	CO_2	*%*	7,6	7,6	7,6
oxygen	O_2	*%*	13,5	13,6	13,5
carbon monoxide	*CO*	*%*	0,040	0,040	0,040
average flue gas temperature	*ta*	*°C*	65,3	66,6	65,9
maximum flue gas temperature		*°C*	66,5	69,4	68,0
flue gas mass flow	*m*	*g/s*	6,0	6,1	6,0
Maximum surface temperatures:					
charging door handle (metal)		*°C*	67,3	63,4	65,4
internal fuel hopper		*°C*	58,1	61,3	59,7
Pellet loading motor		*°C*	38,4	38,9	38,7
conveyor system where there is pellet		*°C*	42,0	42,5	42,3
Maximum trihedron surface temperatures:					
hearth		*°C*	24,2	24,7	24,5
side wall		*°C*	32,8	34,1	33,5
back wall		*°C*	27,4	28,2	27,8

test n°			1	2	average
Results:					
thermal losses in flue gas	q_a	%	4,0	4,1	4,1
thermal losses in flue gas	Q_a	kJ/kg	709	739	724
chemical losses in flue gas	q_b	%	0,3	0,3	0,03
chemical losses in flue gas	Q_b	kJ/kg	58	58	58
heat losses due to combustible through the grate	q_r	%	0,2	0,2	0,2
efficiency	η	%	95,5	95,3	95,4
carbon monoxide [at 13% O_2]		%	0,043	0,043	0,043
carbon monoxide [at 13% O_2]		mg/m^3	534	533	534
average boiler water output temperature		°C	81,5	83,3	82,4
average boiler water input temperature		°C	68,0	70,4	69,2
average boiler water temperature rise	N	°C	13,5	12,9	13,2
water flow rate	M_w	kg/h	305,5	312,6	309,1
water heat output	P_w	kW	4,8	4,7	4,7
space heat output	P_{SH}	kW	1,9	2,1	2,0
total heat output	P	kW	6,7	6,8	6,7

Dust emission: test A	mg/MJ	12,6	13,0	12,8
test B	mg/MJ	12,1	12,5	12,3
test C	mg/MJ	12,4	11,4	11,9
test D	mg/MJ	12,5	12,2	12,4
average	mg/MJ	12,4	12,3	12,4
Dust emission (at 13% O_2): test A	mg/m^3	18,9	19,5	19,2
test B	mg/m^3	18,2	18,8	18,5
test C	mg/m^3	18,7	17,1	18,9
test D	mg/m^3	18,8	18,3	18,6
average	mg/m^3	18,6	18,4	18,5
NOx	ppm	54	53	54
NOx (as NO_2)	mg/MJ	78	78	78
NOx (as NO_2 at 13% O_2)	mg/m^3	118	117	117
THC (as propane)	ppm	2,5	3,0	2,8
OGC (as C)	mg/MJ	3,1	3,8	3,4
OGC (as C at 13% O_2)	mg/m^3	4,6	5,7	5,1

STATEMENTS OF THE TEST RESULTS

The requirements for CO, NOx, OGC and dust emissions and for efficiency of Austrian 15a B-VG, German BIMSchv, French Flamme Verte and Swiss LRV for appliances hand fired by wood are the following.

Austrian 15a B-VG

Nominal heat power	
	[mg/MJ]
CO	500
NOx	100
OGC	30
dust	25
efficiency	80

Reduced heat power	
	[mg/MJ]
CO	750
OGC	30
efficiency	80

German BIMSchv limits (at 13% O_2)

CO [mg/m^3]	dust [mg/m^3]	efficiency [%]
200	20	90

Swiss LRV limits (at 13% O_2)

CO [mg/m^3]	dust [mg/m^3]
500	40

French Flamme Verte limits (at 13% O_2)

stars	CO [mg/m^3]	dust [mg/m^3]	efficiency [%]
5	500	90	85
6	375	40	87
7	250	30	90

The appliance **PFP 22 of Klover** fulfils the requirements of

- Austrian 15a BV-G
- German BIMSchv
- Swiss LRV limits
- Flamme Verte.

MEASURING DEVICES

The requirements of the measuring instruments are fulfilled.
Before each qualified measuring analysers were calibrated with zero gas and calibration gas.

Parameter measured	principle	Company	range	uncertainty	Calibration gas
O_2	paramagnetic	MRU	0 – 21%	±0.1%	0 – 2,5 – 9,0- - 21%
CO_2	infra-red	MRU	0 – 20 %	±1%	0 – 9 – 18 %
CO	infra-red	MRU	0 – 32000 ppm	±2%	0 – 450 – 2500 - 4500 ppm
NOx	infra-red	MRU	0 – 500 ppm	±2%	0 – 50 – 250 – 450 ppm
OGC	FID	Ratfisch	0 -100 ppm	±2%	0 – 82 ppm propane
static pressure	--	MRU	0 – 25 Pa	±0,25 Pa	0 – 20 Pa
temperature: ambient room flue gas surface touchable areas	 K thermocouple K thermocouple T thermocouple K thermocouple	National Instruments	 10 – 50°C 20 – 1000°C 20 – 250°C 20 – 250 °C	 ±0.5°C ±2°C ±1°C ±1°C	 -- -- -- --
cross-draught	heated thermistor	Schmidt Feintechnik	0 – 20 m/s	±0.1 m/s	--
mass: fuel consumption fuel load	 balance balance	 SBP SBP	 0 – 1500 kg 0 – 10 kg	 ±20 g ±0,5 g	 -- --

All data were continuously recorded with data logger at intervals of 5 seconds. All raw data is stored for 10 years.

FUEL DATA

Specifications of the test fuel used:

	nominal heat output test
Fuel	wood pellet
Moisture content [%]	6,02
Lower calorific value [KJ/Kg]	17860
Carbon content [% on dry basis]	46,9
Sulphur content [% on dry basis]	0,005
Hydrogen [% on dry basis]	5,7
Size: length [mm] diameter [mm]	 12 – 30 (at the origin) 6,0