Comparison of the Norwegian standard NS3058/59 and EN16510 with EN-PME

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Technology for a better society

Focusing both on PM measurement method and test procedure and resulting suggestions for improved test procedure in EN16510.

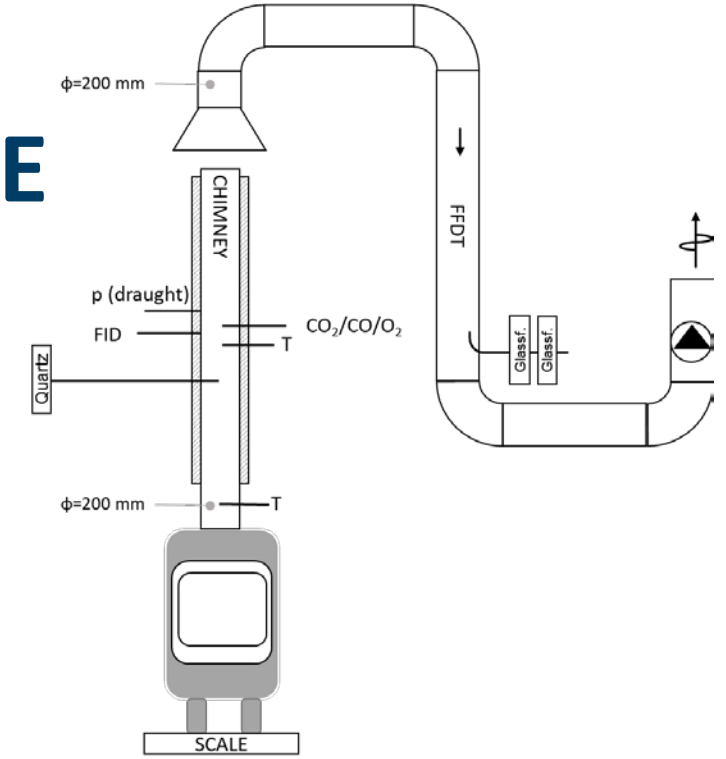
- Overview
  - Background
  - 1. comparison EN-PME with dilution tunnel method
  - 2. EN16510 with dilution tunnel method and adaption of NS 3058 test procedure
  - Suggestion for an amendment in EN16510 CEN TC 295

Background

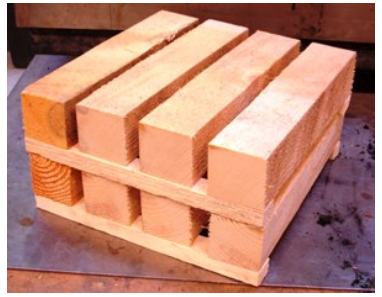
- Norway was one of the few countries in Europe with a national standard on PM emissions since 1998 with the Norwegian standard NS3058/59
- CEN TC 295 ongoing work with a harmonized standard EN16510 including one PM measurement method EN-PME
- In 2022 Ecodesign directive set stricter requirements on local space heaters fired with solid fuels with 3 thresholds for PM in accordance to the 3 measurement methods, Heated Filter, FFDT (NS3058), British Electrostatic precipitator

- Does the EN-PME measurement method satisfies the Norwegian environmental protection level?

NS 3058/59 vs EN 16510 EN-PME



	TEST METHOD	
	EN 16510-1 EN-PME	NS 3058-1/2:1994 and NS3059:1994
Measured PM	Chimney	Isokinetic with a FFDT
Particles	Solid	Solid + condensable
Draft	12 Pa forced	Natural draft
Moisture	16 ± 4 %	16-20 %
Fuel	Beech wood log	Spruce boards
Fuel load	Acc. to manufacture	112 ± 11 kg/m^3 of the firebox volume
Filter temp.	180°C	Max. 35 °C
Tested heat output	Nominal heat output (specified by manufacturer)	4 burn rate categories, low -> max



Testing at 4 burn rates (heat outputs) reflect real life use

	< 1,25 kg/h	1,25 - 1,90 kg/h	1,91 - 2,80 kg/h	> 2,80 kg/h
kW	< 5	5 – 7,6	7,6 – 11,2	> 11,2

Results from 5 stoves

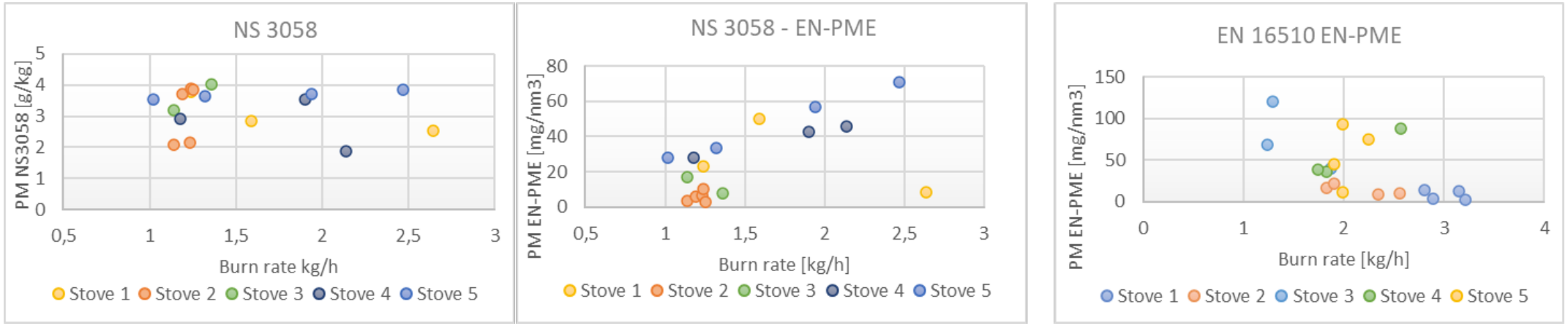


Figure 1: PM emission measured with NS3058 parallell with EN-PME and EN16510 with EN-PME (right)

- All measurements for NS 3058 were below 5 g/kg
- All 5 stoves meet the requirements for the EN-PME method for at least one heat output

→ stoves developed and designed to meet certain test requirements will meet them under type approval

Comparison of test method EN 16510-1:2018 with EN-PME test method vs NS 3058-1/2:1994 and NS 3059:1994; Kausch, F.; Seljeskog, M.; Østnor, A.; 2021

OGC and PM FFDT

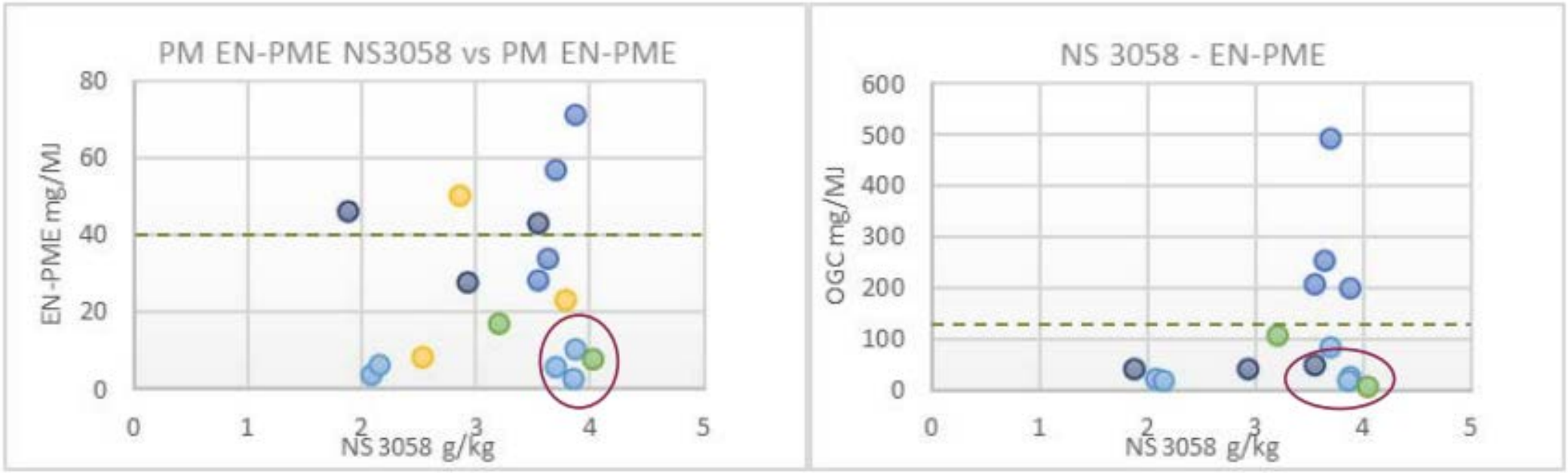


Figure 2: PM NS3058 vs PM EN-PME (left) and PM NS3058 vs OGC (right)

- Low OGC can still result in increased PM when measured with FFDT

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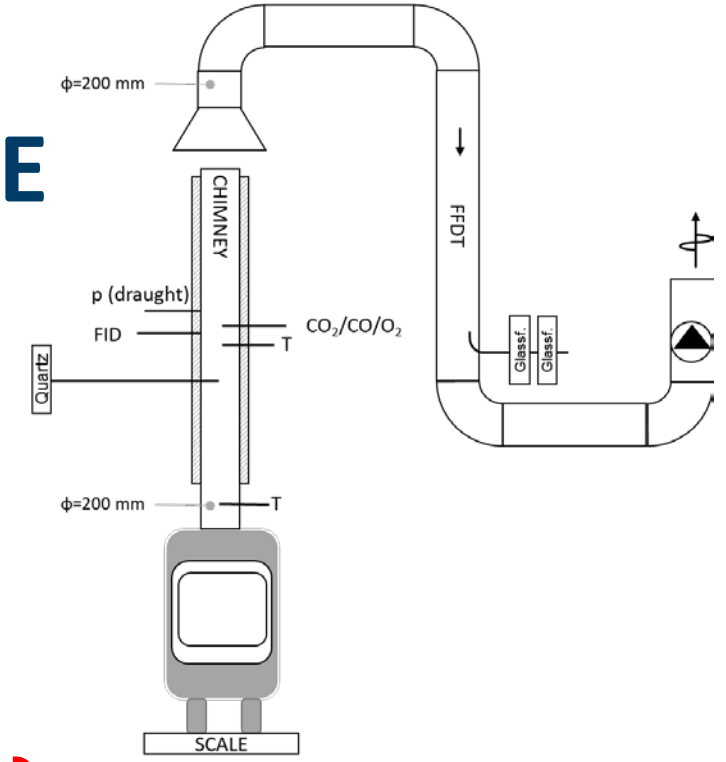
NS 3058/59 vs EN 16510 EN-PME



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Comparison of the test procedure of both methods with different fuel and heat outputs

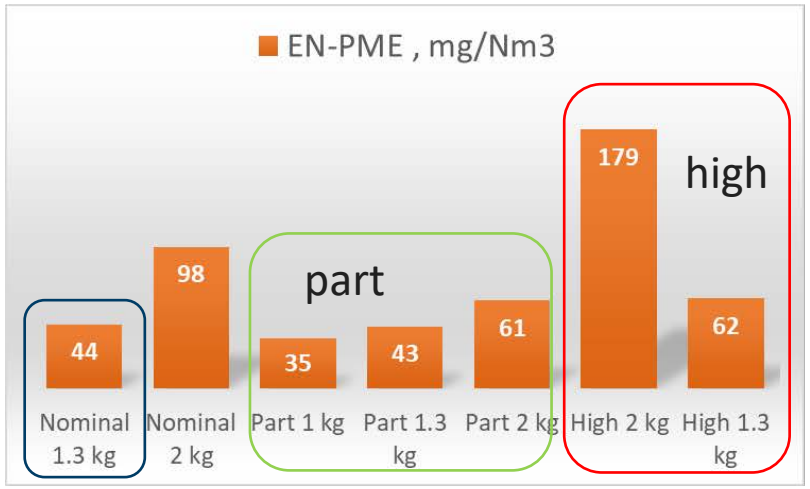
- 2 wood stoves with different design
- 3 heat outputs part, nom, high
- 3 test fuels load
- Each condition tested 3 times

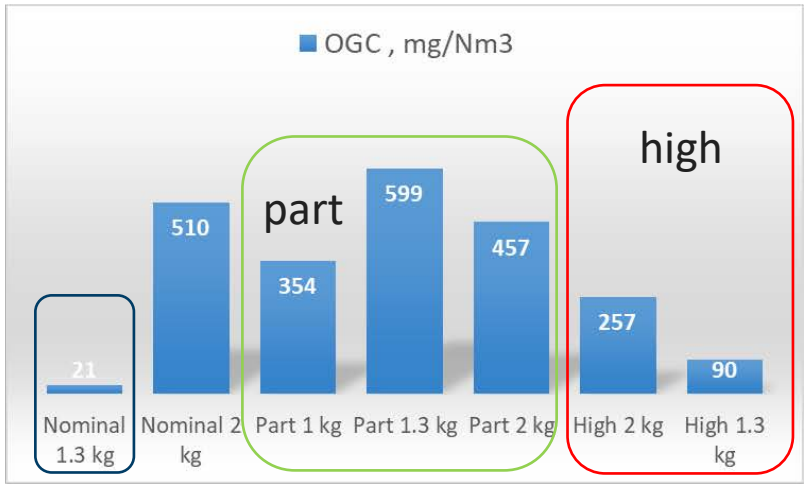
fuel load [kg]	EN16510	NS3058	Assumed part load EN16510
Stove 1	1,3	2	1
Stove 2	1,3	1,5	1

Performances declared by the manufacturer after type test

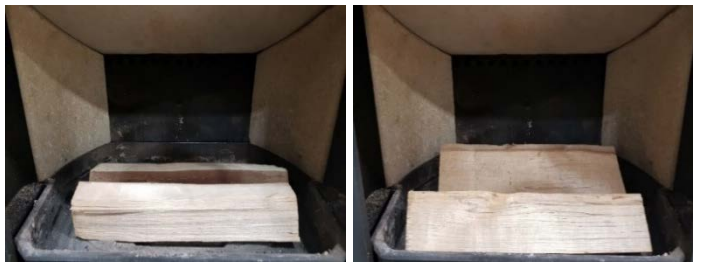
	Combustion chamber volume [dm³]	Fuel declared by manufacturer [kg]	PM [mg/m3]	OGC [mg/m3]	Heat output [kW]
			Type test EN13240		
Stove 1	19,8	1,3	17	68	5,9
Stove 2	14,8	1,3	21	29	6,2

Results Stove 1



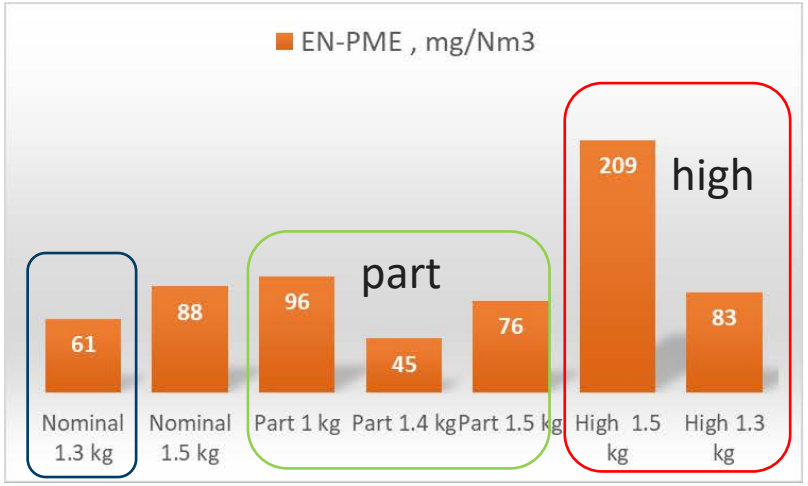


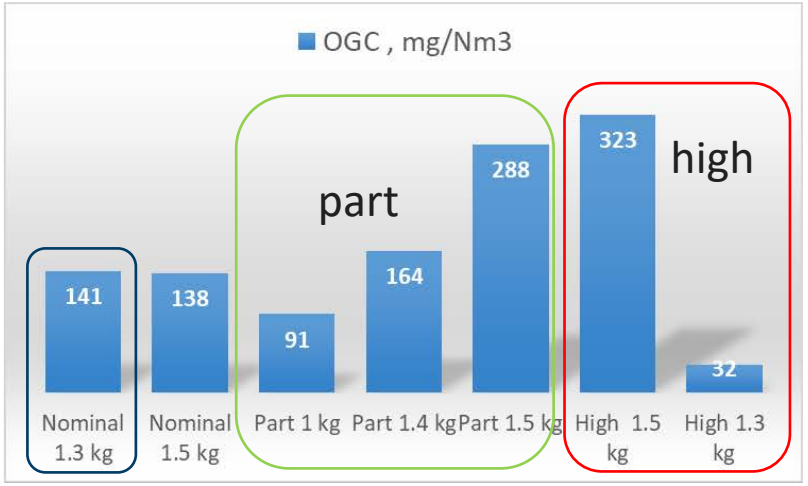
→ Larger fuel amount and different heat outputs resulted in higher emissions

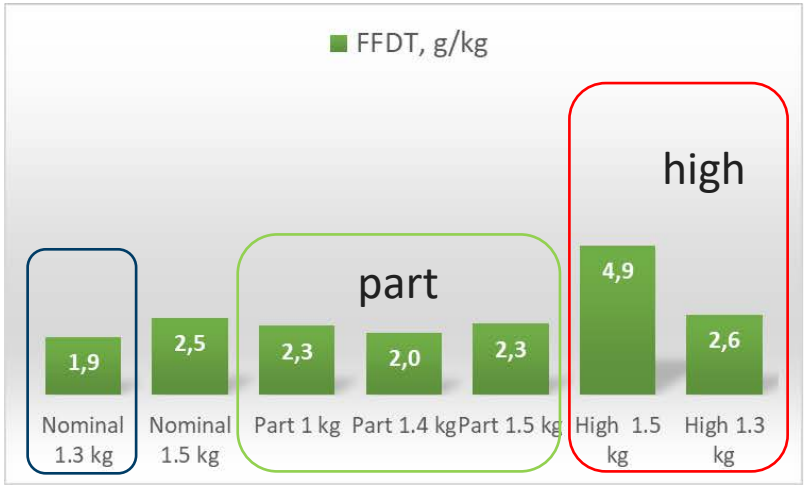


Comparison of test method EN 16510-1:2018 with EN-PME test method vs NS 3058-1/2:1994 and NS 3059:1994; Kausch, F.; Seljeskog, M.; Østnor, A.; 2021

Results Stove 2







→ Small combustion chamber ensure overall better performance with lower OGC values and lower PM when measured with FFDT

Comparison of test method EN 16510-1:2018 with EN-PME test method vs NS 3058-1/2:1994 and NS 3059:1994; Kausch, F.; Seljeskog, M.; Østnor, A.; 2021

Conclusion

- Does the EN-PME measurement method satisfies the Norwegian environmental protection level? – NO!
- Stoves in Norway are developed to perform fairly well at several heat outputs
- Important that stoves a designed to emit little emissions under a range of operation condition not just one optimized condition
- A standard needs to test several heat outputs

Ongoing work in TC 295 on an amendment for an overload test (high heat output test)

CEN/TC 295 - RESIDENTIAL SOLID FUEL BURNING APPLIANCES

Working groups:

- **WG1: Appliances fired by solid fuels**
- **WG2: Appliances fired by pellets**
- **WG3: Heat storage stoves (SHRA) and sauna stoves**
- **WG4: Tiled Stoves**
- **WG5: Measurement methods**
- **WG6: CPR and mandates (CPR: Construction product regulation)**

- In 2021 WG1 group agreed to work on a overload test
- A subgroup was formed to work on several task including to identify the expected use of a wood stove and to define a overload test and propose a text for an amendment
- Subgroup with experts from Italy, France, Germany, Finland
  - Overload: assumed intended use (not worst case scenario)
- The draft was presented to WG1 in September this year

Background of the suggestion

- EN13240/16510: manufacture defines the wood load
- EN test with relatively little fuel load

- 0,7 m wide
- Nominal fuel amount 2 kg

9 kW appliances

- 1 m wide
- Nominal fuel amount 2 kg

→ It can be expected that both stoves will be used with more wood than 2 kg during colder period because of the large combustion chambers.

Expected heat outputs and fuel load

- Overload test
  - 150 % of the nominal fuel load and 14 Pa (at least 2 Pa over nom)

kW		5	6	7	8	9
fuel load nom kg		1.1	1.3	1.5	1.7	1.9
150 % high load kg		1.6	1.9	2.2	2.5	2.8
Part load kW		4	4.4	4.8	5.2	5.6

Proposed amendment for an Overload test in EN16510

A.4.9 Overload test

This test is required for all appliances, where an overload heat output is specified. If appropriate, consider the relevant Part 2 for the specific type of appliance.

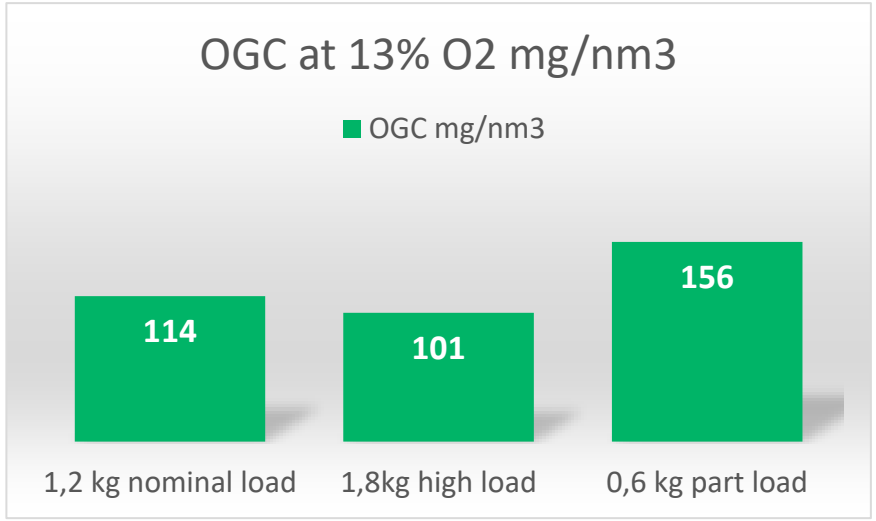
The overload test is carried out the same way as the nominal heat output test (A.4.7) with the following modifications:

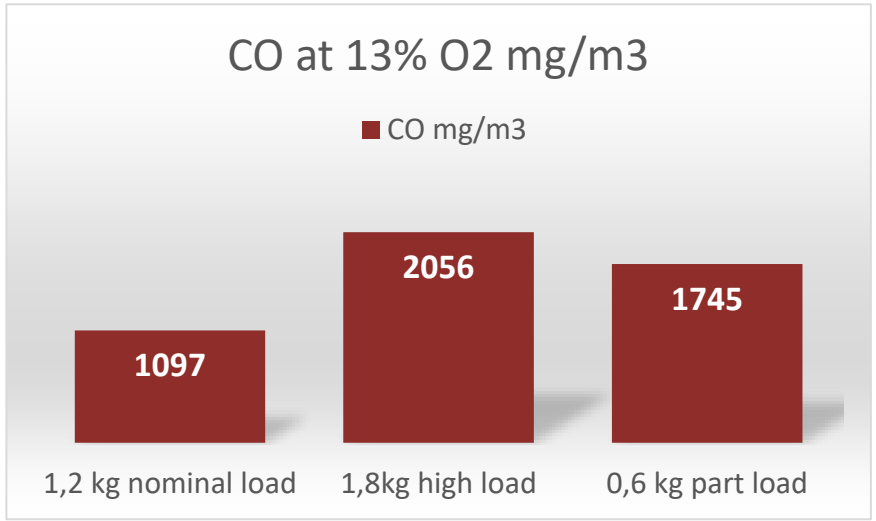
- One batch following either the nominal heat output test or the part load test
- The flue draught is set to p_{over} or the value for the overload test as specified with a minimum of 14 Pa (or at least 2 Pa over the draft in the nominal test)
- The fuel mass for overload test is used as specified with a minimum of 150% of the nominal test fuel load.
- All adjustments and air controls are set to overload test setting as specified, with settings as specified during nominal heat output test settings or more.

Recent results for overload and part load heat output for a 6 kW stove

- Average of 3 test

6 kW stove	CO mg/m3 at 13% O2	OGC mg/nm3 at 13% O2	kW	T EN °C	%
1,2 kg nominal load	1097	114	6,4	262	78
1,8kg high load	2056	101	8,5	291	80
0,6 kg part load	1745	156	4,2	186	84





Next steps

- CEN TC 295 awaits harmonization of EN16510
- WG1 ask for more data
- Next WG1 meeting 2023-02-02

Suggestion to CEN TC 295 WG1 Quick user guide

- Require to include a quick user guide in the manual
- Self-explaining picture/drawings for ignition, amount of fuel, air settings!
- Suggestion:
  - 1-2 side without text
  - 1-2 side with additional written description

1. Preparation & Ignition

- Clean and open the grate and empty the ash box
- Crosswise placement of four firewood pieces (2 layers) on top of shavings(3 layers) on the grate (**Bottom-up ignition**) (Fig. 1 & Fig. 2)
  - Length of firewood: **25 cm**
- Use only dry and natural firewood – at least 1 year stored
  - 3 layers shavings, crosswise placed - total: **0.6 kg**
  - 1. layer 2 firewood pieces, each **0.35 kg**
  - 2. layer 2 firewood pieces, each **0.35 kg**
  - Whole mass of the ignition batch has to be **2.0 kg** (Fig. 1)
- **Air inlet flap settings for ignition:**
  - Bypass foamed ceramic: fully open "**A**" (Fig. 3)
  - Primary air supply: fully open "**Max**" (Fig. 4)
  - Secondary air: fully open "**Max**"(Fig 5)
- Lighting of starting aid (placed on the grate) (Fig. 2)
- Closing of combustion chamber door


Figure 1 Figure 2


Figure 3


Figure 4 Figure 5

2. Recharging

- Recharge when flames are extinguishing or when no flames visible, but enough firebed is available
- After the 1st batch: (Fig. 5)
  - Firewood: **2 pieces**, each **1.0 kg**, Total mass **2.0 kg**
- After the 5th batch: (Fig. 6)
  - Firewood: **1 piece**, Total mass **1.0 kg**
- Placement according to Fig. 6 – only parallel to the window
- **Air inlet flap settings:**
  - Bypass foamed ceramic: closed "**Z**" (Fig. 7)
  - Primary air supply: reduced to **Min** (Fig. 8)
  - Secondary air: reduced to **50 %** (Fig 9)


Figure 5 Figure 6


Figure 7 Figure 8 Figure 9

3. Finishing heating operation

- When flames are extinguished **and** when the firebed is not glowing any more (Fig. 7)
  - **Close air inlet flaps (Fig. 8) for avoidance of heat losses**
  - Primary air supply: closed "**Min**" (Fig. 8)
  - Secondary air: closed "**Min**" (Fig 9)


Figure 7 Figure 8 Figure 9

Example: BeReal project

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