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# Test report of the smoke emission of Thornhill Turbo Small of Thornhill Eco Design Ltd.

| SGS registration | |
|---|---|
| Our reference | EZ/09/2890-2 |
| Revision | 0 |
| Date report | December 7th, 2010 |
| Author report | J. Dekker |

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|---|---|---|
| **Rev.** | **Date** | **Changes** |
| 0 | December 7th, 2010 | |
| 1 | | |
| 2 | | |
| 3 | | |

At revision the prior editions of this report are to be discarded.

## Project managment data

### General

| | |
|---|---|
| Company name | Thornhill Eco Design Ltd. |
| Address | Charing Cottage, Garlinge Green, Canterburry, Kent. CT45RS UK |
| Contact person | Attn. Mr G. Thornhill |
| Email address | - |
| Reference number customer | Thornhill Turbo Small |
| Reference number SGS | EZ/09/2890-2 |

### Appliance

| | |
|---|---|
| Name | Thornhill Turbo Small |
| Category | Space heating appliance fired by solid fuel |
| Material | Steel body, combustion chamber and baffle made of vermiculite |

### Measurement information

| | |
|---|---|
| Test category | Determining smoke emission |
| Method | NEN EN 13240: 2001- 2004 / BS 3841-2 : 1994 |
| Period | November 2010 (three test runs in June 2009) |
| Measurement technician | R. van den Berg / J. Dekker |

### Authentication

| Consultant | Manager Environmental Services |
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## Disclaimer

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# 1 Introduction

This is a test report of a freestanding appliance fired by wood in accordance with BS 3841-2: 1994. Test procedures are based on the European Standard EN13240.

The aim of the tests is to verify if it is likely that the appliance meets the requirements of guideline PD 6434:1969 when installed and operated as prescribed by the manufacturer.

This report describes the results of the dust emission measurements at different heat outputs and control settings of the appliance Thornhill Turbo Small of Thornhill Eco Design Ltd when burning wood.

| | |
|---|---|
| **Laboratory**<br>Name, address | SGS Nederland BV<br>Leemansweg 51<br>6827BX Arnhem |
| **Notified under EC number** | 0608 |
| **Manufacturer**<br>Name, address | Thornhill Eco Design Ltd<br>Carling Cottage,<br>Garlinge Green, Canterburry Kent. CT45RS UK |
| **Appliance** | Thornhill Turbo Small |
| **Nominal heat output** | 4.9 kW |
| **Recommended fuel** | Wood logs. |
| **Test category** | Determining the smoke emission:<br>At different burning rates and settings when burning wood. |

## 2 Description of the room heater

Room heater Thornhill Turbo Small is a steel plate stove. The combustion chamber of the stove is equipped with a double glazed front window door and is insulated with vermiculite. The air supply is adjustable with one regulator at the low end of the door. The appliance is equipped with two baffle plates. The flue gas connection is located at the top of the appliance.

Note: the tested appliance has an air intake which provides sufficient combustion air (with a draught of 12 Pa) even when the controller is at its minimum position.

*Picture of the room heater*

# 3 Test procedure

## 3.1 General

The tests are carried out according to European standard EN13240. Tests are executed at different heat outputs and control settings. For most tests approximately the same weight of test fuel (beech) is used. More fuel is added to obtain higher heat outputs.

During each test period emitted particles are sampled by using the dilution tunnel method. The emission of dust is quantified by using the gravimetric method. The optical density of the smoke is measured by using the scattered light method.

By UK customary practice the permitted average smoke emission is related to the heat output of the appliance. Test work to EN 13240 showed that the stove, operating at an output of 5.8 kW has an efficiency of 89%. As most appliances are designed to have the best performance at nominal heat output the efficiency and thus the output, differs at lower and higher settings. Therefore the test laboratory chooses to monitor and report all parameters of EN13240 of each separate test.

## 3.2 Dust measurement

The emission of dust was determined by using the two following methods.

*Gravimetric method*
The flue gas from the top of the test chimney is mixed with ambient air in a dilution tunnel. The diluted flue gas is sampled by using a sampling train in which the particulate matter is collected on a glass fibre filter. The diluted flue gas was iso-kinetic sampled. The filters are conditioned and weighed before and after the tests. The dilution rate was determined by monitoring the $CO_2$ concentration in both the test chimney and the dilution tunnel. More information about the procedure can be found in annex D. A drawing of the test rig can be found in annex E.

*Optical method*
The flue gas is continuously monitored by an optical device using the scattered light method. The relation between the output of this device (SI, no dimension) and the obscuration of the emitted smoke (Ringelmann) is defined by SGS and the results are placed in annex A.

## 3.3 Settings

After positioning the appliance on the test rig, pre-tests were carried out to determine the behaviour of the appliance at different settings.

The combustion air enters the fire chamber through multiple holes drilled at various positions (Annex B) and can be regulated by means of one air slide. When the air slide is at its minimum position there is still air entering the combustion chamber.

The reported tests are carried out over three different settings. These settings were maintained during the whole burning period, except directly after refuel when the amount of combustion air was increased for a short period to light the fire. Information about the used settings is placed in the table below.

*Table 3.3: Used settings*

| Setting of air slide | Burning rate | | |
|---|---|---|---|
| | Low | Nominal | High |
| Primary air | 0 % | 20 % | 100 % |

# 4 Measurements

The following paragraphs contain the results of the measurements. The specification of the fuel used during the tests is followed by the results of the smoke emission tests at the different burning rates. Results of the optical measurements (graphs) are given in annex A.

## 4.1 Test fuel specification

Analytical information of the test fuel in accordance to EN13240 (as fired)

| Test fuel | moisture % | ash % | Volatile matter % dry, ash free | H % | C % | S % | Hu kJ/kg | Size, length cm |
|---|---|---|---|---|---|---|---|---|
| Beech | 12.8 | 1.17 | 84.2 | 4.8 | 43.9 | 0.03 | 16,199 | 20 |

## 4.2 Nominal heat output (1)

| | | Test 1 | Test 2 | Test 3 | **Mean of 3 tests** |
|---|---|---|---|---|---|
| Date (dd-mm-yy) | | 05-11-10 | 05-11-10 | 05-11-10 | |
| Test fuel | | beech | beech | beech | |
| Total mass | kg | 0.91 | 0.90 | 0.92 | **0.91** |
| <u>Setting of:</u><br>- air slide | | 20 % | 20 % | 20 % | **20 %** |
| Mean flue draught | Pa | 12.5 | 11.9 | 11.7 | **12.0** |
| Mean flue gas temperature | K | 157 | 120 | 137 | **137** |
| Mean $CO_2$ concentration | vol% | 10.71 | 10.93 | 10.14 | **10.59** |
| Mean CO concentration at 13% $O_2$ | vol% | 0.07 | 0.29 | 0.18 | **0.18** |
| Efficiency | % | 88.0 | 89.2 | 88.1 | **88.5** |
| Mean nominal heat to space | kW | 6.2 | 5.3 | 5.3 | **5.6** |
| | | | | | |
| Stack gas volume DT | $Nm^3/h$ | 149 | 150 | 129 | **143** |
| Diameter DT | m | 0.15 | 0.15 | 0.15 | **0.15** |
| Speed DT | m/s | 2.34 | 2.36 | 2.03 | **2.25** |
| Nozzle diameter | mm | 11 | 11 | 11 | **11** |
| Surface Nozzle | $m^2$ | 9.50E-05 | 9.50E-05 | 9.50E-05 | **9.50E-05** |
| Speed nozzle | m/s | 2.68 | 2.61 | 2.43 | **2.57** |
| Iso-Kinetics | % | 1.15 | 1.11 | 1.20 | **1.15** |
| | | | | | |
| Duration | h | 0.58 | 0.68 | 0.69 | **0.65** |
| Sampled volume | $Nm^3$ | 0.578 | 0.659 | 0.621 | **0.619** |
| Sampling flow rate | $Nm^3/h$ | 0.92 | 0.89 | 0.83 | **0.88** |
| | | | | | |
| Dust mass | mg | 0.5 | 1.6 | 1.2 | **1.1** |
| Dust concentration | $mg/Nm^3$ | 0.9 | 2.6 | 2.1 | **1.9** |
| Dilution ratio | - | 12.6 | 15.8 | 12.3 | **13.6** |
| Dust concentration | $mg/Nm^3$ | 12 | 41 | 26 | **27** |
| Dust concentration at 13% $O_2$ | $mg/Nm^3$ | 9 | 29 | 20 | **20** |
| Stack gas volume at 13% $O_2$ | $Nm^3/h$ | 16.2 | 13.7 | 13.8 | **14.6** |
| Dust emission | g/h | 0.1 | 0.4 | 0.3 | **0.3** |
| PD6434 permitted | g/h | 7.1 | 6.8 | 6.8 | **6.9** |
| % of time above Ringelmann 2 | % | 0 | 1 | 2 | |

## 4.3 Nominal heat output (2)

| | | Test 4 | Test 5 | Test 6 | **Mean of 3 tests** |
|---|---|---|---|---|---|
| Date (dd-mm-yy) | | 24-06-09 | 24-06-09 | 24-06-09 | |
| Test fuel | | beech | beech | beech | |
| Total mass | kg | 1.10 | 1.20 | 1.00 | **1.10** |
| Setting of:<br>- air slide | | 20 % | 20 % | 20% | **20 %** |
| Mean flue draught | Pa | 11.9 | 12.0 | 11.7 | **11.9** |
| Mean flue gas temperature | K | 115 | 130 | 122 | **122** |
| Mean $CO_2$ concentration | vol% | 9.53 | 10.14 | 10.29 | **9.98** |
| Mean CO concentration at 13% $O_2$ | vol% | 0.15 | 0.17 | 0.21 | **0.18** |
| Efficiency | % | 89.5 | 88.8 | 89.1 | **89.1** |
| Mean nominal heat to space | kW | 5.6 | 6.3 | 5.4 | **5.8** |
| | | | | | |
| Stack gas volume DT | $Nm^3/h$ | 283 | 288 | 244 | **272** |
| Diameter DT | m | 0.15 | 0.15 | 0.15 | **0.15** |
| Speed DT | m/s | 4.45 | 4.52 | 3.84 | **4.27** |
| Nozzle diameter | mm | 9 | 9 | 9 | **9** |
| Surface Nozzle | $m^2$ | 6.36E-05 | 6.36E-05 | 6.36E-05 | **6.36E-05** |
| Speed nozzle | m/s | 5.14 | 5.07 | 5.09 | **5.10** |
| Iso-Kinetics | % | 1.15 | 1.12 | 1.33 | **1.20** |
| | | | | | |
| Duration | h | 0.50* | 0.50* | 0.50* | **0.50*** |
| Sampled volume | $Nm^3$ | 0.634 | 0.625 | 0.629 | **0.629** |
| Sampling flow rate | $Nm^3/h$ | 1.18 | 1.16 | 1.17 | **1.17** |
| | | | | | |
| Dust mass | mg | < 1 | < 1 | < 1 | **< 1** |
| Dust concentration | $mg/Nm^3$ | 1.7 | 1.7 | 1.7 | **1.7** |
| Dilution ratio | - | 24.0 | 23.0 | 23.5 | **23.5** |
| Dust concentration | $mg/Nm^3$ | 41 | 40 | 40 | **40** |
| Dust concentration at 13% $O_2$ | $mg/Nm^3$ | 31 | 27 | 27 | **28** |
| Stack gas volume at 13% $O_2$ | $Nm^3/h$ | 14.6 | 16.5 | 14.0 | **15.0** |
| Dust emission | g/h | 0.5 | 0.4 | 0.4 | **0.4** |
| PD6434 permitted | g/h | 6.9 | 7.1 | 6.8 | **6.9** |
| % of time above Ringelmann 2 | % | **Not available*** | | | |

**Note: These results are obtained during the 'CE- tests' (June 2009). Duration of the sampling of dust is therefore 0.5 hours and no optical measurements are done during the tests. Because of the overall performance of the stove and the similarity with the results of the other test runs the laboratory chooses to report these three test runs instead of doing two additional test runs at nominal heat output.*

## 4.4 Reduced heat output (1)

| | | Test 1 | Test 2 | Test 3 | **Mean of 3 tests** |
|---|---|---|---|---|---|
| Date (dd-mm-yy) | | 03-11-10 | 03-11-10 | 03-11-10 | |
| Test fuel | | beech | beech | beech | |
| Total mass | kg | 0.90 | 1.04 | 1.04 | **0.99** |
| Setting of:<br>- air slide | | 0 % | 0 % | 0 % | **0 %** |
| Mean flue draught | Pa | 11.8 | 11.6 | 12.2 | **11.9** |
| Mean flue gas temperature | K | 123 | 129 | 128 | **127** |
| Mean $CO_2$ concentration | vol% | 10.29 | 10.70 | 10.42 | **10.47** |
| Mean CO concentration at 13% $O_2$ | vol% | 0.34 | 0.20 | 0.24 | **0.26** |
| Efficiency | % | 88.2 | 89.0 | 88.6 | **88.6** |
| Mean nominal heat to space | kW | 4.7 | 5.5 | 5.2 | **5.2** |
| | | | | | |
| Stack gas volume DT | $Nm^3/h$ | 147 | 152 | 138 | **146** |
| Diameter DT | m | 0.15 | 0.15 | 0.15 | **0.15** |
| Speed DT | m/s | 2.31 | 2.39 | 2.18 | **2.30** |
| Nozzle diameter | mm | 12 | 12 | 12 | **12** |
| Surface Nozzle | $m^2$ | 1.13E-04 | 1.13E-04 | 1.13E-04 | **1.13E-04** |
| Speed nozzle | m/s | 2.01 | 2.17 | 2.18 | **2.12** |
| Iso-Kinetics | % | 0.87 | 0.91 | 1.00 | **0.93** |
| | | | | | |
| Duration | h | 0.76 | 0.76 | 0.79 | **0.77** |
| Sampled volume | $Nm^3$ | 0.666 | 0.719 | 0.759 | **0.715** |
| Sampling flow rate | $Nm^3/h$ | 0.82 | 0.88 | 0.89 | **0.86** |
| | | | | | |
| Dust mass | mg | 4.1 | 2.1 | 5 | **3.7** |
| Dust concentration | $mg/Nm^3$ | 6.6 | 3.2 | 7.1 | **5.6** |
| Dilution ratio | - | 16.1 | 14.9 | 13.9 | **14.9** |
| Dust concentration | $mg/Nm^3$ | 107 | 47 | 98 | **84** |
| Dust concentration at 13% $O_2$ | $mg/Nm^3$ | 79 | 34 | 72 | **62** |
| Stack gas volume at 13% $O_2$ | $Nm^3/h$ | 12.4 | 14.3 | 13.7 | **13.5** |
| Dust emission | g/h | 1.0 | 0.5 | 1.0 | **0.8** |
| PD6434 permitted | g/h | 6.6 | 6.8 | 6.7 | **6.7** |
| % of time above Ringelmann 2 | % | 3 | 0 | 2 | **-** |

## 4.5 Reduced heat output (2)

| | | Test 4 | Test 5 | | **Mean of 2 tests** |
|---|---|---|---|---|---|
| Date (dd-mm-yy) | | 03-11-10 | 03-11-10 | | |
| Test fuel | | beech | beech | | |
| Total mass | kg | 0.99 | 1.03 | | **1.01** |
| Setting of:<br>- air slide | | 0% | 0% | | **0%** |
| Mean flue draught | Pa | 11.0 | 11.1 | | **11.1** |
| Mean flue gas temperature | K | 118 | 113 | | **115** |
| Mean $CO_2$ concentration | vol% | 11.51 | 10.56 | | **11.00** |
| Mean CO concentration at 13% $O_2$ | vol% | 0.25 | 0.39 | | **0.32** |
| Efficiency | % | 90.0 | 88.7 | | **89.3** |
| Mean nominal heat to space | kW | 5.3 | 4.7 | | **5.0** |
| | | | | | |
| Stack gas volume DT | $Nm^3/h$ | 144 | 140 | | **142** |
| Diameter DT | m | 0.15 | 0.15 | | **0.15** |
| Speed DT | m/s | 2.26 | 2.20 | | **2.23** |
| Nozzle diameter | mm | 12 | 12 | | **12** |
| Surface Nozzle | $m^2$ | 1.13E-04 | 1.13E-04 | | **1.13E-04** |
| Speed nozzle | m/s | 2.37 | 2.39 | | **2.38** |
| Iso-Kinetics | % | 1.05 | 1.09 | | **1.07** |
| | | | | | |
| Duration | h | 0.75 | 0.87 | | **0.81** |
| Sampled volume | $Nm^3$ | 0.788 | 0.914 | | **0.821** |
| Sampling flow rate | $Nm^3/h$ | 0.97 | 0.97 | | **0.97** |
| | | | | | |
| Dust mass | mg | 2.1 | 7.7 | | **4.9** |
| Dust concentration | $mg/Nm^3$ | 2.9 | 9.1 | | **6.4** |
| Dilution ratio | - | 16.0 | 16.1 | | **16.0** |
| Dust concentration | $mg/Nm^3$ | 46 | 146 | | **100** |
| Dust concentration at 13% $O_2$ | $mg/Nm^3$ | 31 | 104 | | **70** |
| Stack gas volume at 13% $O_2$ | $Nm^3/h$ | 13.7 | 12.3 | | **13.0** |
| Dust emission | g/h | 0.4 | 1.3 | | **0.9** |
| PD6434 permitted | g/h | 6.8 | 6.6 | | **6.7** |
| % of time above Ringelmann 2 | % | 2 | 4 | | **-** |

## 4.6 High heat output (1)

| | | Test 1 | Test 2 | Test 3 | **Mean of 3 tests** |
|---|---|---|---|---|---|
| Date (dd-mm-yy) | | 05-11-10 | 05-11-10 | 05-11-10 | |
| Test fuel | | beech | beech | beech | |
| Total mass | kg | 1.04 | 1.01 | 0.98 | **1.01** |
| Setting of: | | | | | |
| - Primary air | | 100 % | 100 % | 100 % | **100 %** |
| Mean flue draught | Pa | 12.2 | 11.8 | 12.1 | **12.0** |
| Mean flue gas temperature | K | 180 | 182 | 180 | **181** |
| Mean $CO_2$ concentration | vol% | 9.42 | 9.47 | 9.33 | **9.41** |
| Mean CO concentration at 13% $O_2$ | vol% | 0.08 | 0.08 | 0.07 | **0.08** |
| Efficiency | % | 84.8 | 84.7 | 84.7 | **84.7** |
| Mean nominal heat to space | kW | 6.6 | 6.0 | 6.6 | **6.4** |
| | | | | | |
| Stack gas volume DT | $Nm^3/h$ | 143 | 129 | 144 | **139** |
| Diameter DT | m | 0.15 | 0.15 | 0.15 | **0.15** |
| Speed DT | m/s | 2.25 | 2.03 | 2.27 | **2.18** |
| Nozzle diameter | mm | 11 | 11 | 11 | **11** |
| Surface Nozzle | $m^2$ | 9.50E-05 | 9.50E-05 | 9.50E-05 | **9.50E-05** |
| Speed nozzle | m/s | 2.57 | 2.74 | 2.61 | **2.64** |
| Iso-Kinetics | % | 1.14 | 1.35 | 1.15 | **1.21** |
| | | | | | |
| Duration | h | 0.60 | 0.64 | 0.57 | **0.61** |
| Sampled volume | $Nm^3$ | 0.571 | 0.648 | 0.551 | **0.590** |
| Sampling flow rate | $Nm^3/h$ | 0.88 | 0.94 | 0.89 | **0.90** |
| | | | | | |
| Dust mass | mg | 1.6 | 1.2 | 0.7 | **1.2** |
| Dust concentration | $mg/Nm^3$ | 3.0 | 2.0 | 1.4 | **2.1** |
| Dilution ratio | - | 9.6 | 9.6 | 9.7 | **9.6** |
| Dust concentration | $mg/Nm^3$ | 29 | 19 | 13 | **21** |
| Dust concentration at 13% $O_2$ | $mg/Nm^3$ | 24 | 16 | 11 | **17** |
| Stack gas volume at 13% $O_2$ | $Nm^3/h$ | 18.0 | 16.4 | 17.9 | **17.4** |
| Dust emission | g/h | 0.4 | 0.3 | 0.2 | **0.3** |
| PD6434 permitted | g/h | 7.2 | 7.0 | 7.2 | **7.1** |
| % of time above Ringelmann 2 | % | 0 | 0 | 1 | **-** |

## 4.7 High heat output (2)

| | | Test 4 | Test 5 | Test 6 | **Mean of 3 tests** |
|---|---|---|---|---|---|
| Date (dd-mm-yy) | | 05-11-10 | 05-11-10 | 05-11-10 | |
| Test fuel | | beech | beech | beech | |
| Total mass | kg | 1.01 | 0.93 | 0.95 | **0.96** |
| Setting of: | | | | | |
| - air slide | | 100 % | 100 % | 100 % | **100 %** |
| Mean flue draught | Pa | 12.0 | 12.2 | 11.7 | **12.0** |
| Mean flue gas temperature | K | 185 | 189 | 193 | **188** |
| Mean $CO_2$ concentration | vol% | 9.87 | 10.74 | 11.33 | **10.57** |
| Mean CO concentration at 13% $O_2$ | vol% | 0.06 | 0.04 | 0.04 | **0.05** |
| Efficiency | % | 85.1 | 85.9 | 86.3 | **85.7** |
| Mean nominal heat to space | kW | 5.9 | 7.1 | 7.6 | **6.8** |
| | | | | | |
| Stack gas volume DT | $Nm^3/h$ | 122 | 137 | 138 | **132** |
| Diameter DT | m | 0.15 | 0.15 | 0.15 | **0.15** |
| Speed DT | m/s | 1.92 | 2.15 | 2.17 | **2.07** |
| Nozzle diameter | mm | 11 | 11 | 11 | **11** |
| Surface Nozzle | $m^2$ | 9.50E-05 | 9.50E-05 | 9.50E-05 | **9.50E-05** |
| Speed nozzle | m/s | 2.62 | 2.78 | 2.74 | **2.71** |
| Iso-Kinetics | % | 1.36 | 1.29 | 1.26 | **1.31** |
| | | | | | |
| Duration | h | 0.66 | 0.50 | 0.48 | **0.55** |
| Sampled volume | $Nm^3$ | 0.634 | 0.516 | 0.490 | **0.547** |
| Sampling flow rate | $Nm^3/h$ | 0.90 | 0.95 | 0.94 | **0.93** |
| | | | | | |
| Dust mass | mg | 1.0 | 0.9 | 1.0 | **1.0** |
| Dust concentration | $mg/Nm^3$ | 1.7 | 1.9 | 2.2 | **1.9** |
| Dilution ratio | - | 9.6 | 9.8 | 9.8 | **9.7** |
| Dust concentration | $mg/Nm^3$ | 16 | 18 | 22 | **19** |
| Dust concentration at 13% $O_2$ | $mg/Nm^3$ | 13 | 13 | 15 | **14** |
| Stack gas volume at 13% $O_2$ | $Nm^3/h$ | 16.1 | 19.2 | 20.4 | **18.6** |
| Dust emission | g/h | 0.2 | 0.3 | 0.3 | **0.3** |
| PD6434 permitted | g/h | 7.0 | 7.4 | 7.5 | **7.3** |
| % of time above Ringelmann 2 | % | 0 | 0 | 0 | **-** |

# 5 Evaluation of the results

## 5.1 Conclusion

The average dust emission at different heat outputs and settings of appliance Thornhill Turbo Small of Thornhill Eco Design Ltd was determined by using the dilution tunnel method based on British Standard BS 3841-2:1994. By comparing the test results of the gravimetric dust measurements with the maximum acceptable dust emission described in PD 6434:1969 it can be concluded that, when the appliance is operated as described by the manufacturer the maximum permitted dust emission is not exceeded. No individual gravimetric smoke measurement was greater than the permitted mean result of the tests.

During the tests the optical density of the smoke was determined by the use of an optical device. Occasionally the smoke emission reached an objectionably high level. Because of the short periods this occurred, which is less than 10% of the whole burning period, this is interpret as acceptable.

| Test | Mean heat output to space | Dust emission | | Optical density | | Approved |
|---|---|---|---|---|---|---|
| | | Measured | PD6434 permitted* | Time above Ringelmann 2 | Permitted | |
| - | kW | g/h | g/h | % | % | - |
| Nominal 1 | 6.2 | 0.1 | 7.1 | 0 | 10 | **yes** |
| Nominal 2 | 5.3 | 0.4 | 6.8 | 1 | 10 | **yes** |
| Nominal 3 | 5.3 | 0.3 | 6.8 | 2 | 10 | **yes** |
| Nominal 4 | 5.6 | 0.5 | 6.9 | - | - | **-** |
| Nominal 5 | 6.3 | 0.4 | 7.1 | - | - | **-** |
| Nominal 6 | 5.4 | 0.4 | 6.8 | - | - | **-** |
| Reduced 1 | 4.7 | 1.0 | 6.6 | 3 | 10 | **yes** |
| Reduced 2 | 5.5 | 0.5 | 6.8 | 0 | 10 | **yes** |
| Reduced 3 | 5.2 | 1.0 | 6.7 | 2 | 10 | **yes** |
| Reduced 4 | 5.3 | 0.4 | 6.8 | 2 | 10 | **yes** |
| Reduced 5 | 4.7 | 1.3 | 6.6 | 4 | 10 | **yes** |
| High 1 | 6.6 | 0.4 | 7.2 | 0 | 10 | **yes** |
| High 2 | 6.0 | 0.3 | 7.0 | 0 | 10 | **yes** |
| High 3 | 6.6 | 0.2 | 7.2 | 1 | 10 | **yes** |
| High 4 | 5.9 | 0.2 | 7.0 | 0 | 10 | **yes** |
| High 5 | 7.1 | 0.3 | 7.4 | 0 | 10 | **yes** |
| High 6 | 7.6 | 0.3 | 7.5 | 0 | 10 | **yes** |

*** Calculation of permitted smoke emission: 5.0 g/h + 0.1 g/h per 0.3 kW**

## 5.2 Recommendations

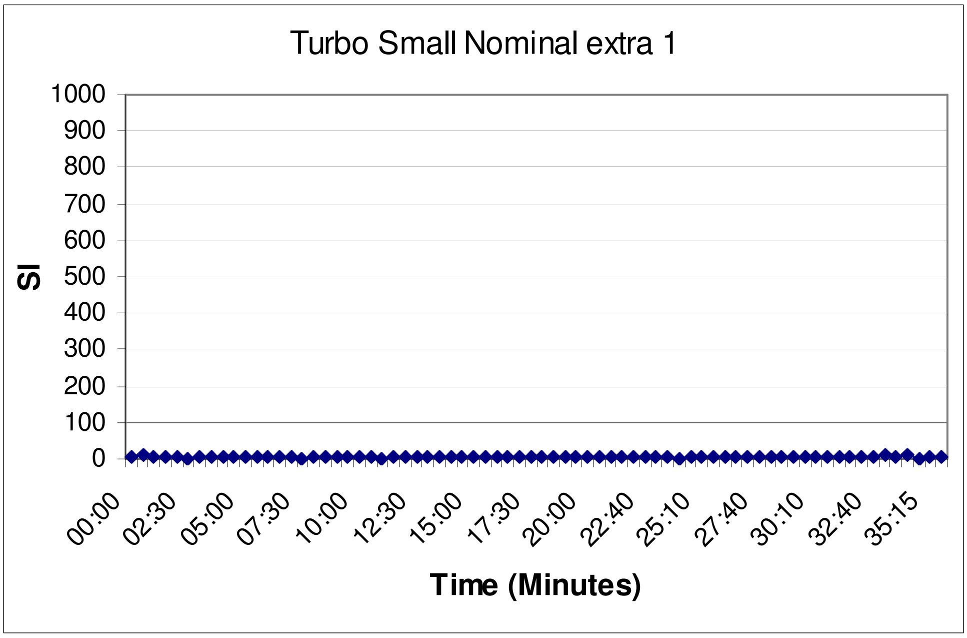
As the customary practice in the UK requires that an exempted fireplace has to be constructed or adapted in such manner that it is impractical to operate it in a way whereby significant smoke will be emitted, we recommend maintaining the characteristics of the air control system as it was present at the tested appliance.

# Annex A

## Graphs

## Graph A-01

| Condition | Nominal heat output |
|---|---|
| Test number | 1 of 3 |
| Setting of:<br>- Air slide | 20% |



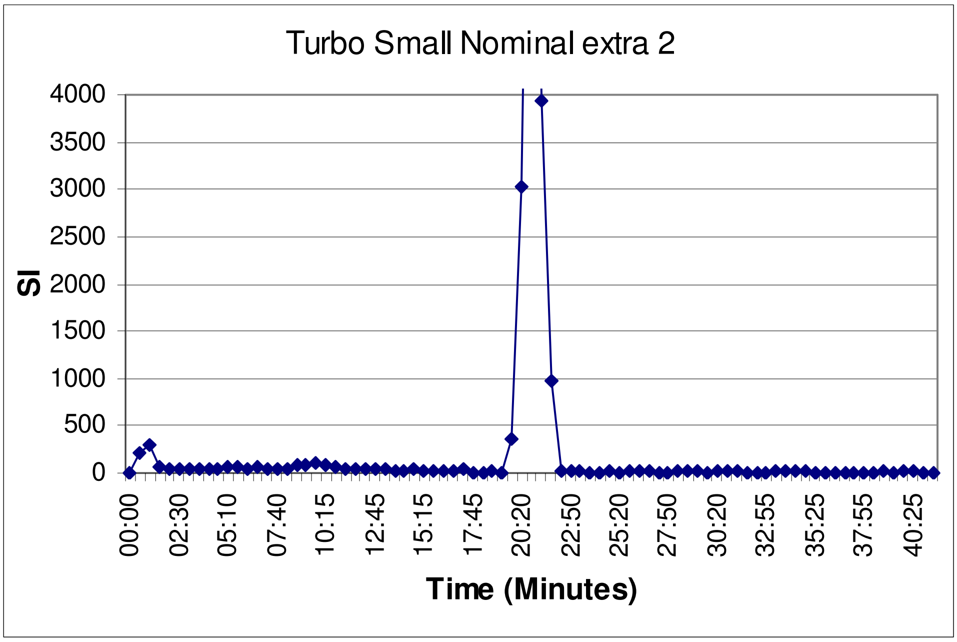

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 0% (maximum permitted; 10%)

## Graph A-02

| Condition | Nominal heat output |
|---|---|
| Test number | 2 of 3 |
| Setting of:<br>- Air slide | 20% |



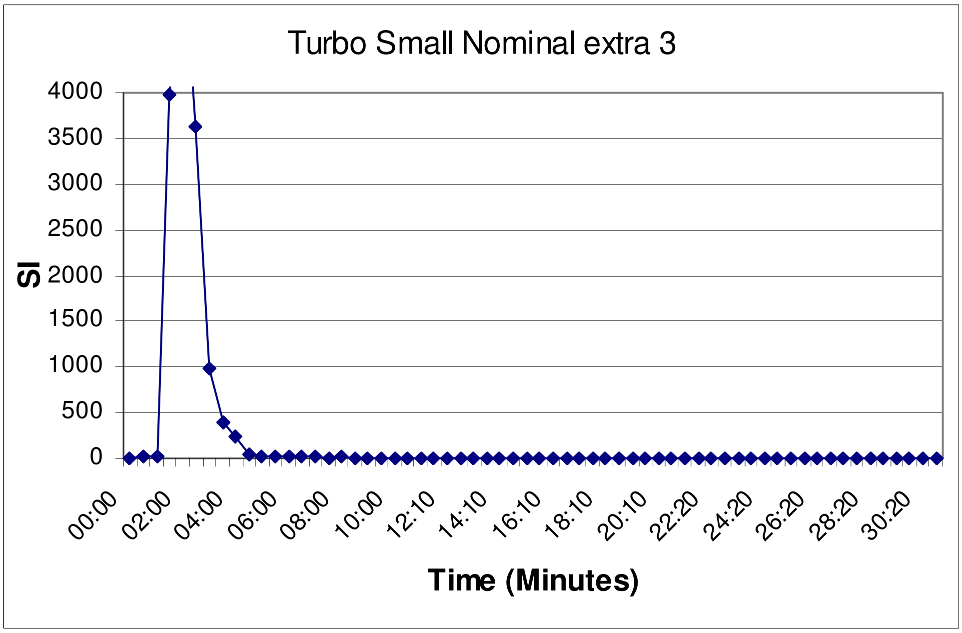

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 1% (maximum permitted; 10%)

# Graph A-03

| Condition | Nominal heat output |
|---|---|
| Test number | 3 of 3 |
| Setting of:<br>- Air slide | 20% |



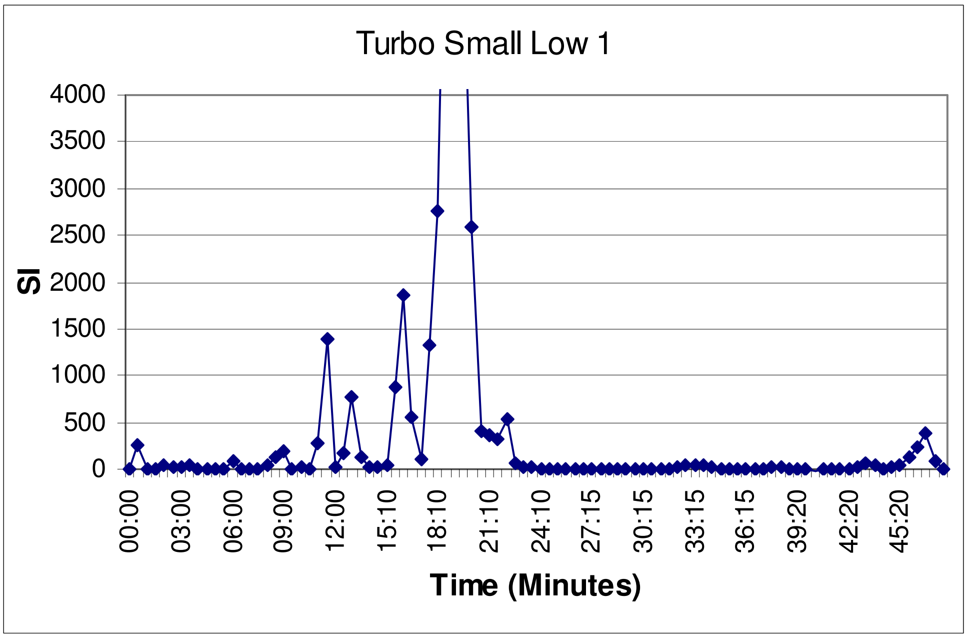

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 2% (maximum permitted; 10%)

## Graph A-04

| Condition | Reduced heat output |
|---|---|
| Test number | 1 of 5 |
| Setting of:<br>- Air slide | 0% |



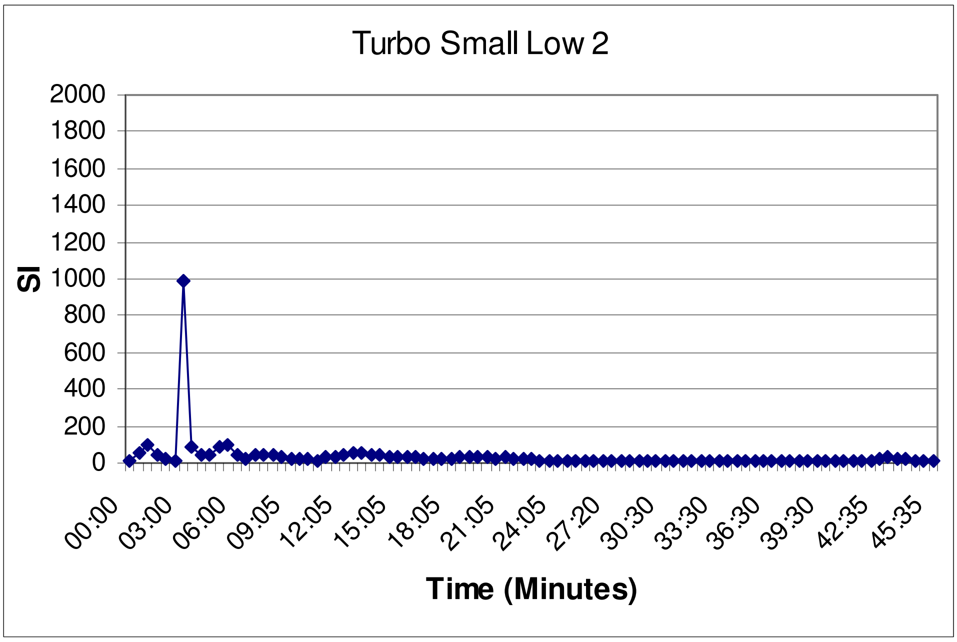

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 3% (maximum permitted; 10%)

## Graph A-05

| Condition | Reduced heat output |
|---|---|
| Test number | 2 of 5 |
| Setting of:<br>- Air slide | 0% |



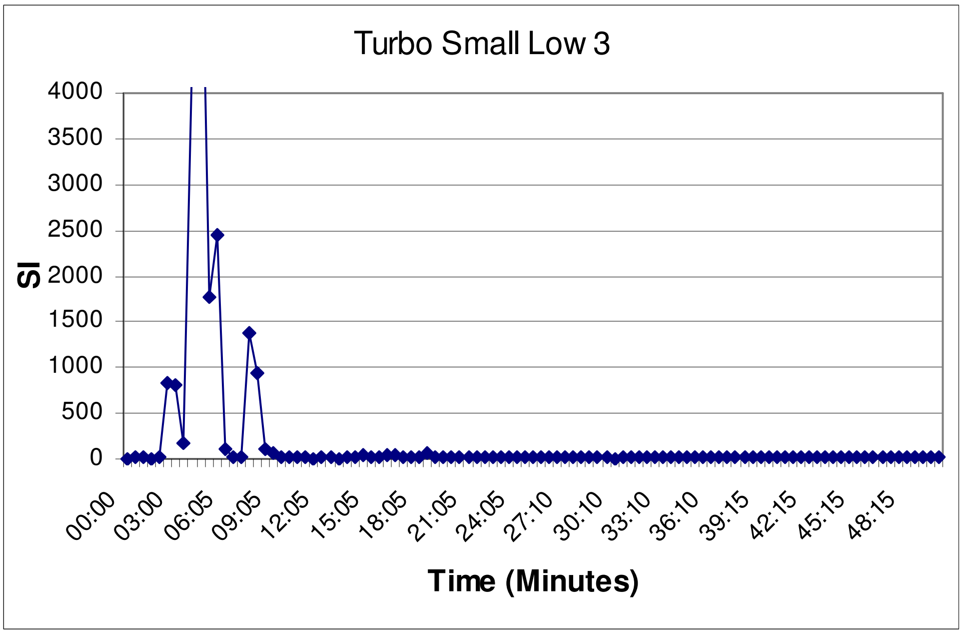

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 0% (maximum permitted; 10%)

## Graph A-08

| Condition | Reduced heat output |
|---|---|
| Test number | 3 of 5 |
| Setting of:<br>- Air slide | 0% |



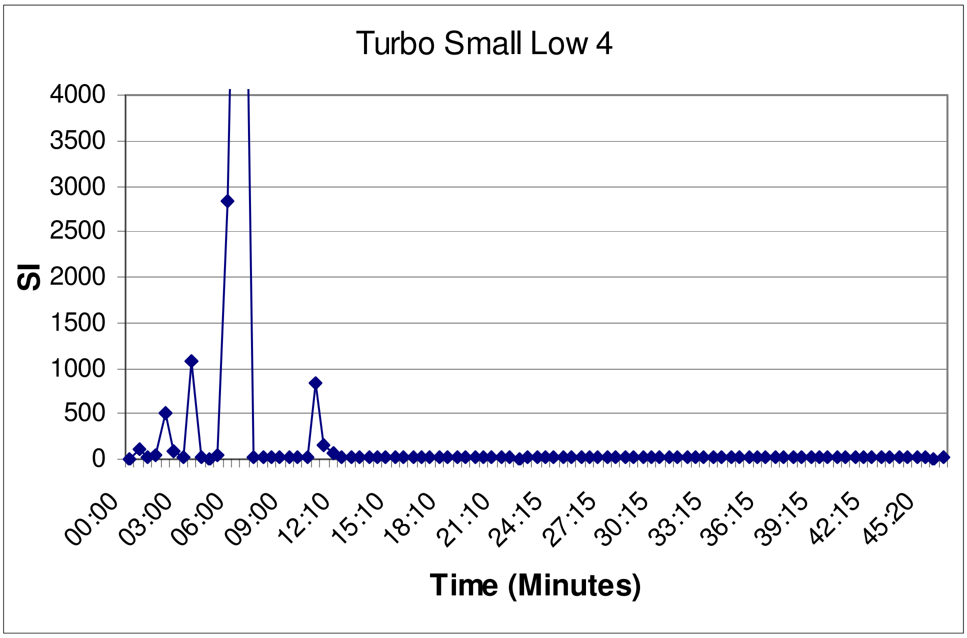

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 2% (maximum permitted; 10%)

## Graph A-09

| Condition | Reduced heat output |
|---|---|
| Test number | 4 of 5 |
| Setting of:<br>- Air slide | 0% |



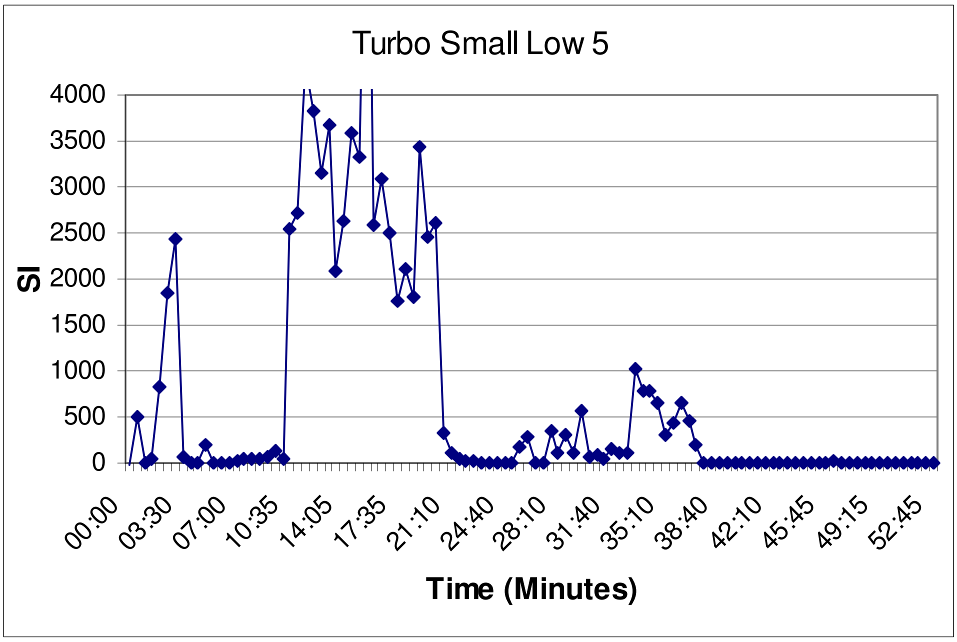

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 2% (maximum permitted; 10%)

# Graph A-10

| Condition | Reduced heat output |
|---|---|
| Test number | 5 of 5 |
| Setting of:<br>- Air slide | 0% |



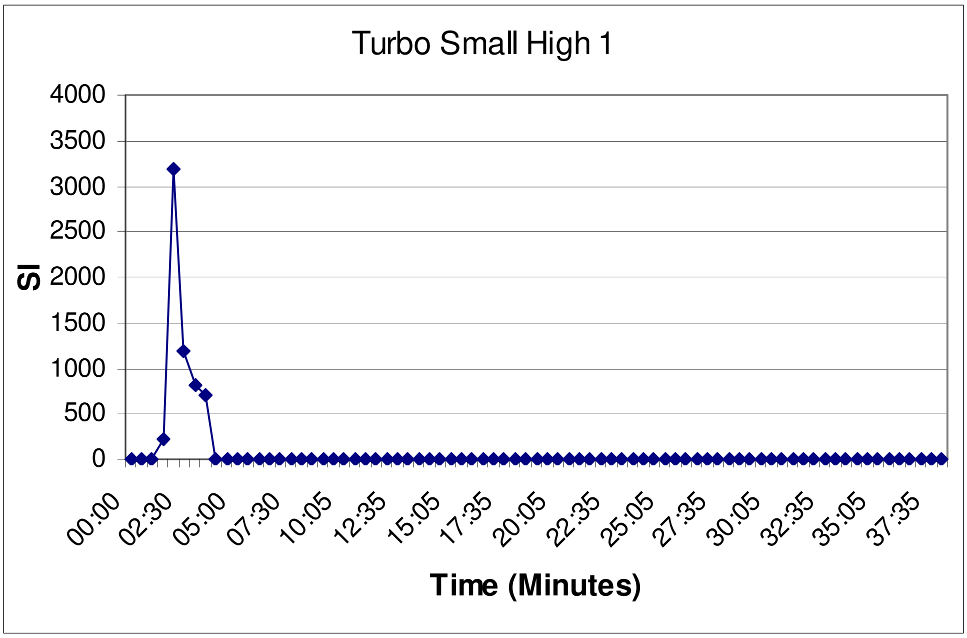

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 4% (maximum permitted; 10%)

## Graph A-11

| Condition | High heat output |
|---|---|
| Test number | 1 of 6 |
| Setting of:<br>- Air slide | 100% |



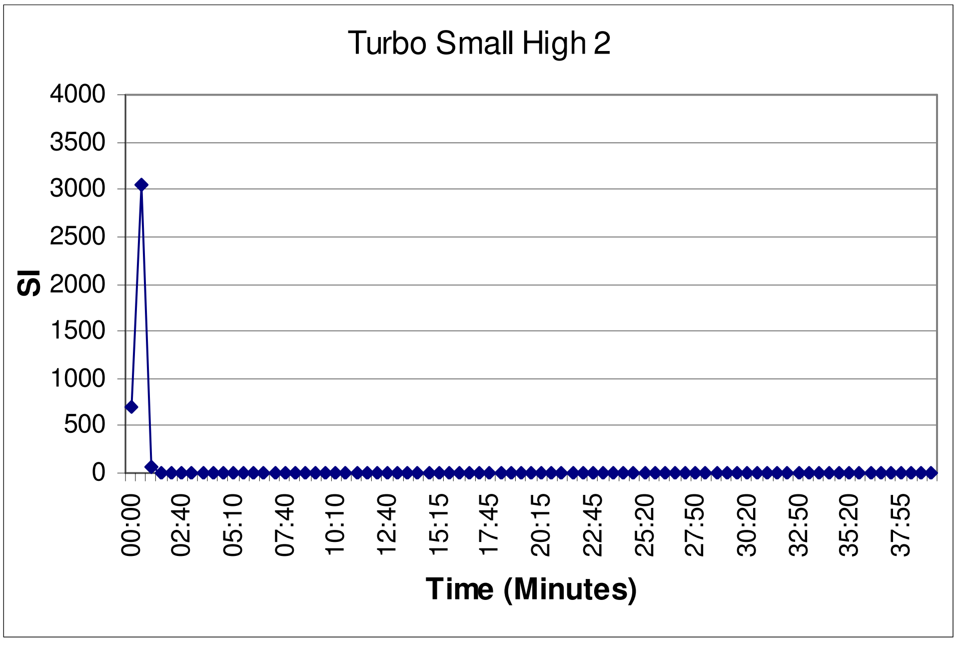

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 0% (maximum permitted; 10%)

## Graph A-12

| Condition | High heat output |
|---|---|
| Test number | 2 of 6 |
| Setting of:<br>- Air slide | 100% |



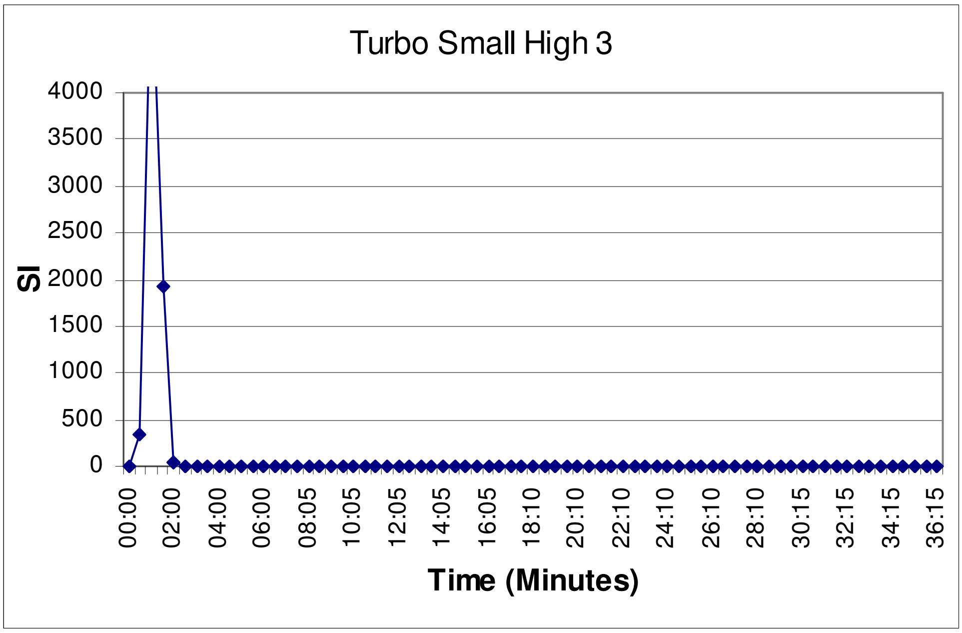

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 0% (maximum permitted; 10%)

# Graph A-13

| Condition | High heat output |
| --- | --- |
| Test number | 3 of 6 |
| Setting of:<br>- Air slide | 100% |



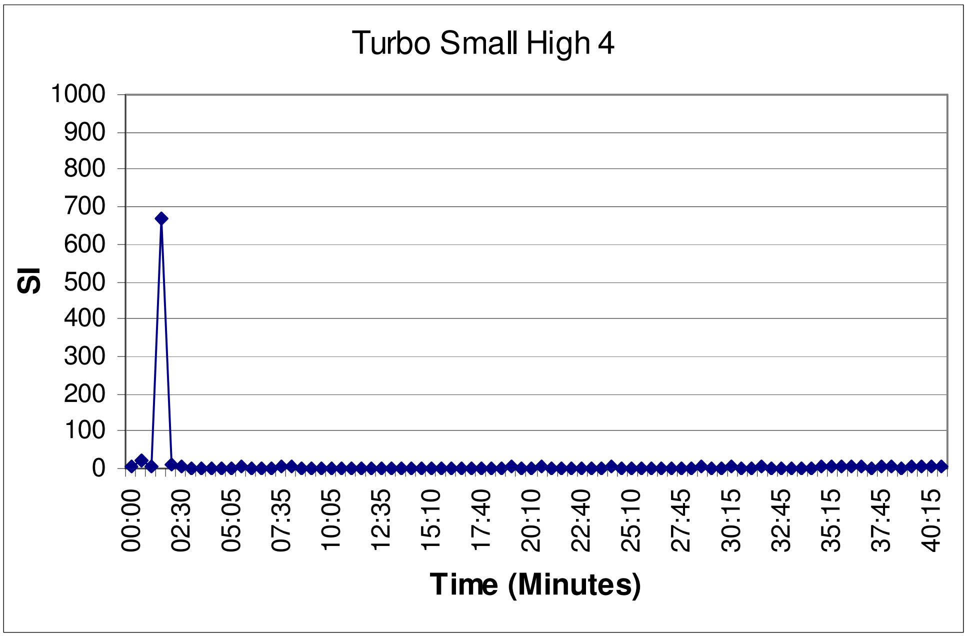

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
| --- | --- | --- |
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 1% (maximum permitted; 10%)

## Graph A-14

| Condition | High heat output |
|---|---|
| Test number | 4 of 6 |
| Setting of:<br>- Air slide | 100% |



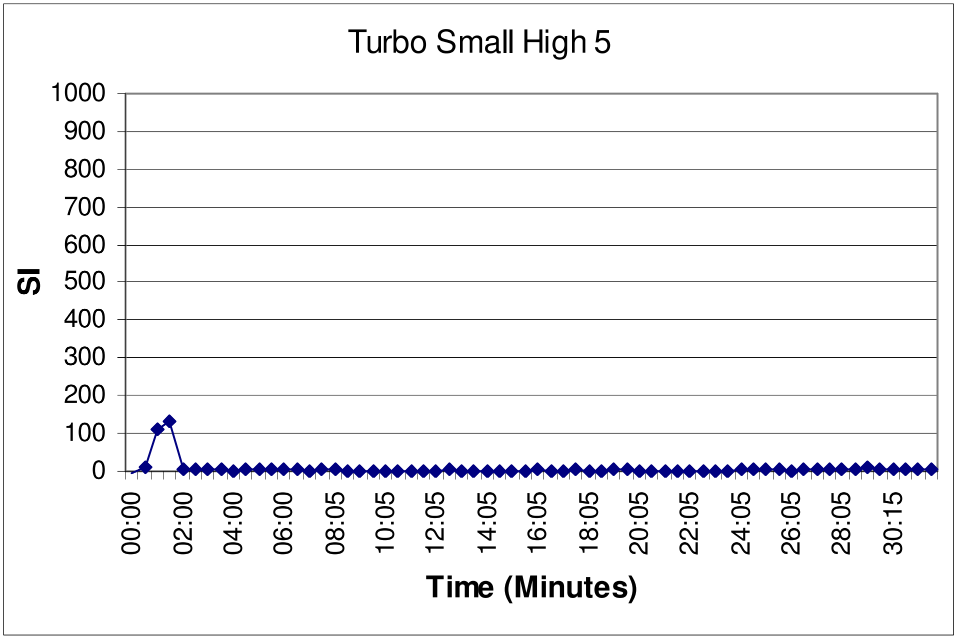

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 0% (maximum permitted; 10%)

# Graph A-15

| Condition | High heat output |
|---|---|
| Test number | 5 of 6 |
| Setting of:<br>- Air slide | 100% |



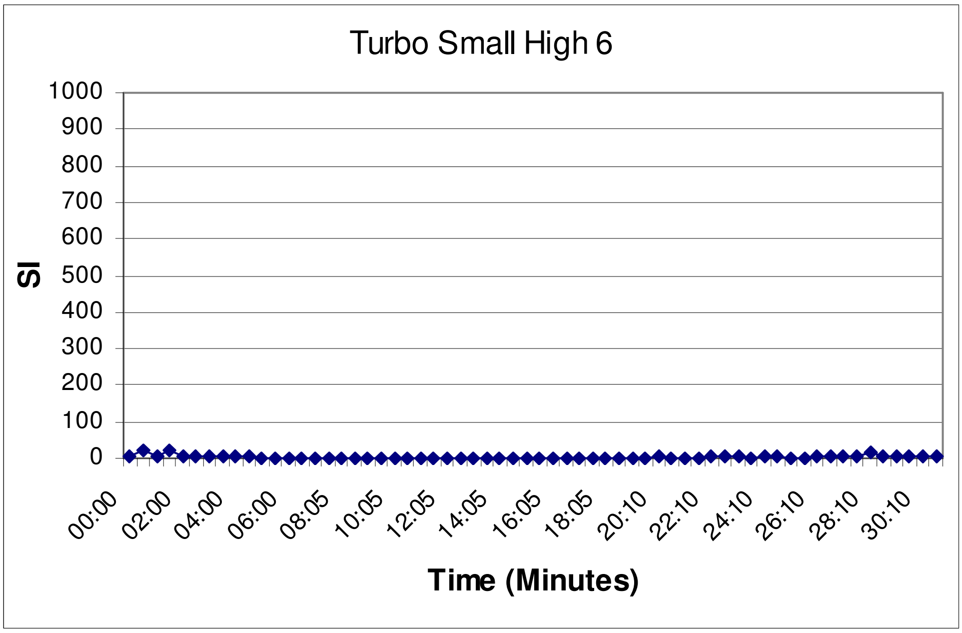

The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 0% (maximum permitted; 10%)

## Graph A-16

| Condition | High heat output |
|---|---|
| Test number | 6 of 6 |
| Setting of:<br>- Air slide | 100% |




The output of optical instrument type Dust Hunter of Sick Maihak (SI, no dimension) is related to the optical density as described in the table below.

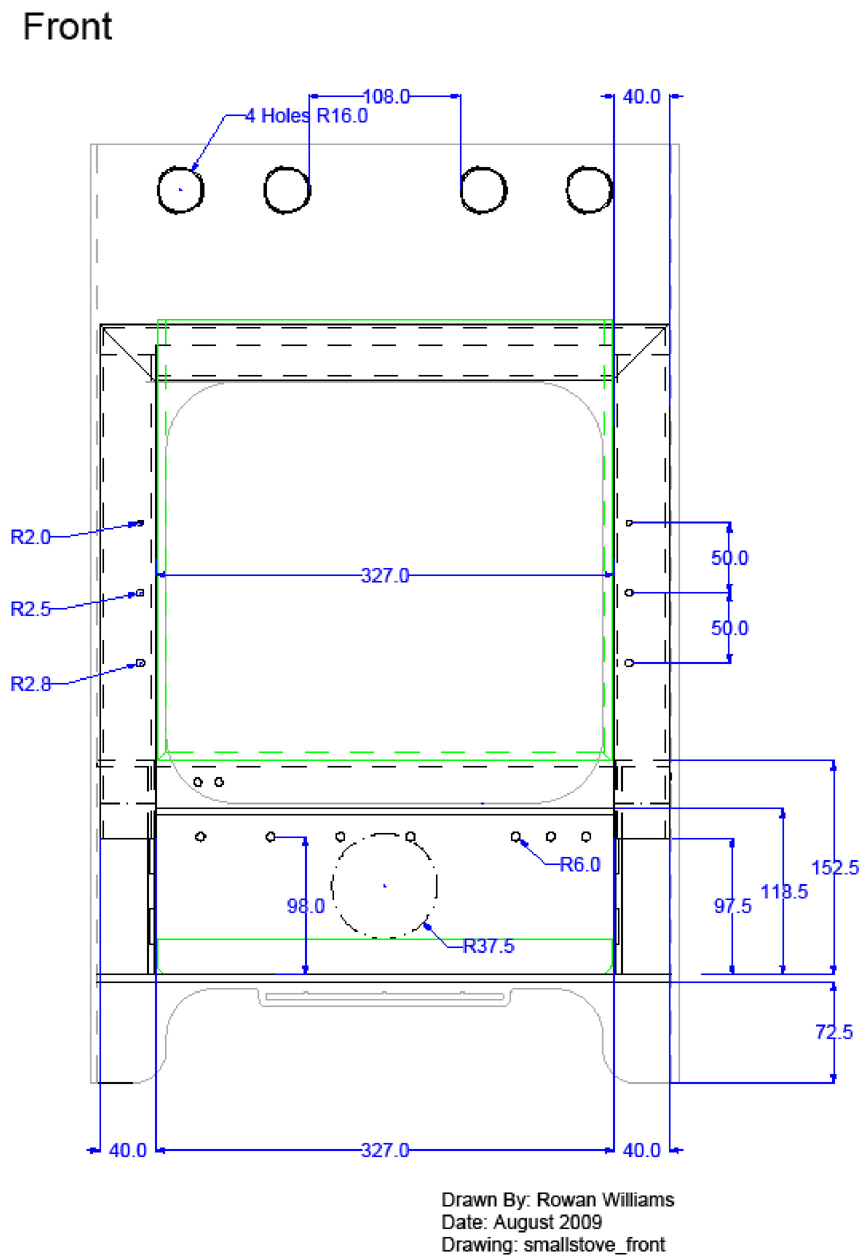
| SI | Observation | Ringelmann (-) |
|---|---|---|
| <400 | Not clearly visible | 0 |
| 1.000 | 20% obscuration | 1 |
| 4.000 | 40% obscuration | 2 |

% of time above Ringelmann 2 = 0% (maximum permitted; 10%)

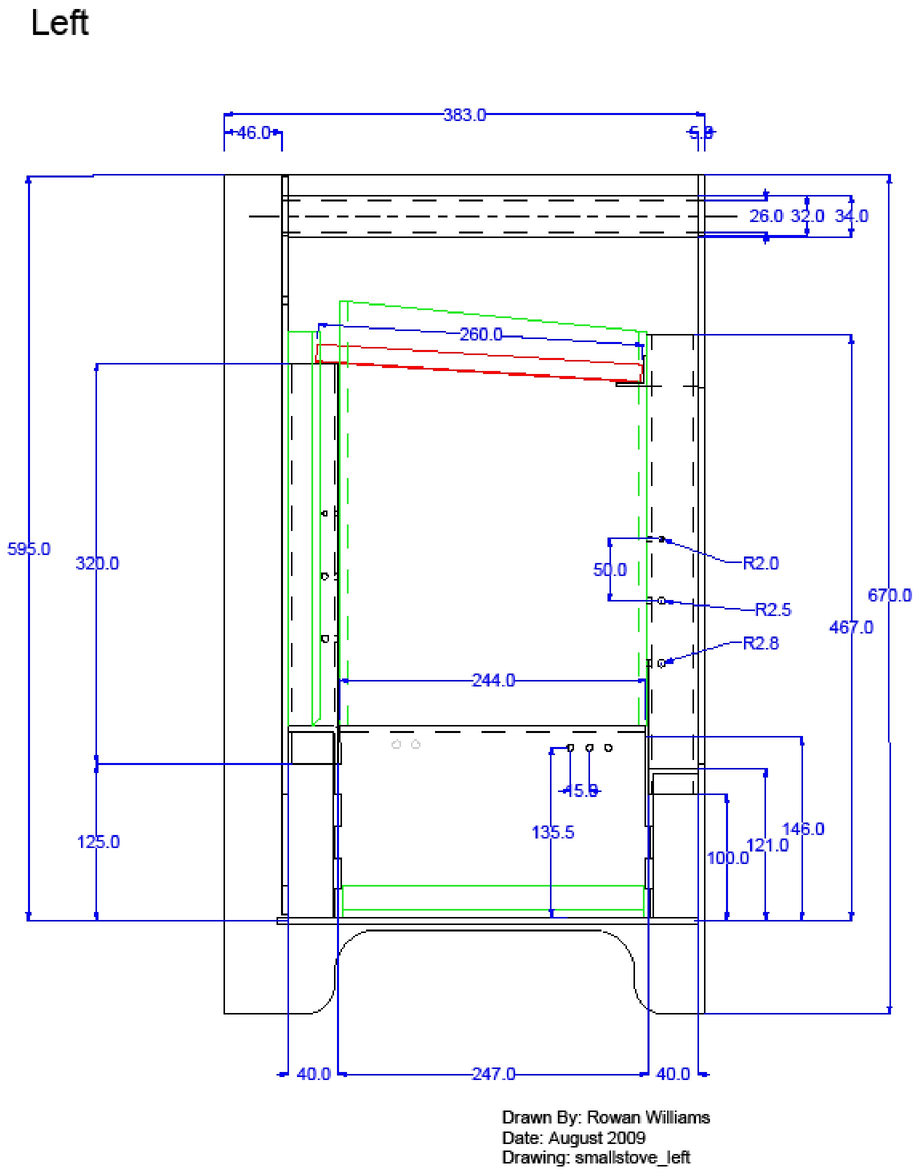
# Annex B

## Drawings of the appliance

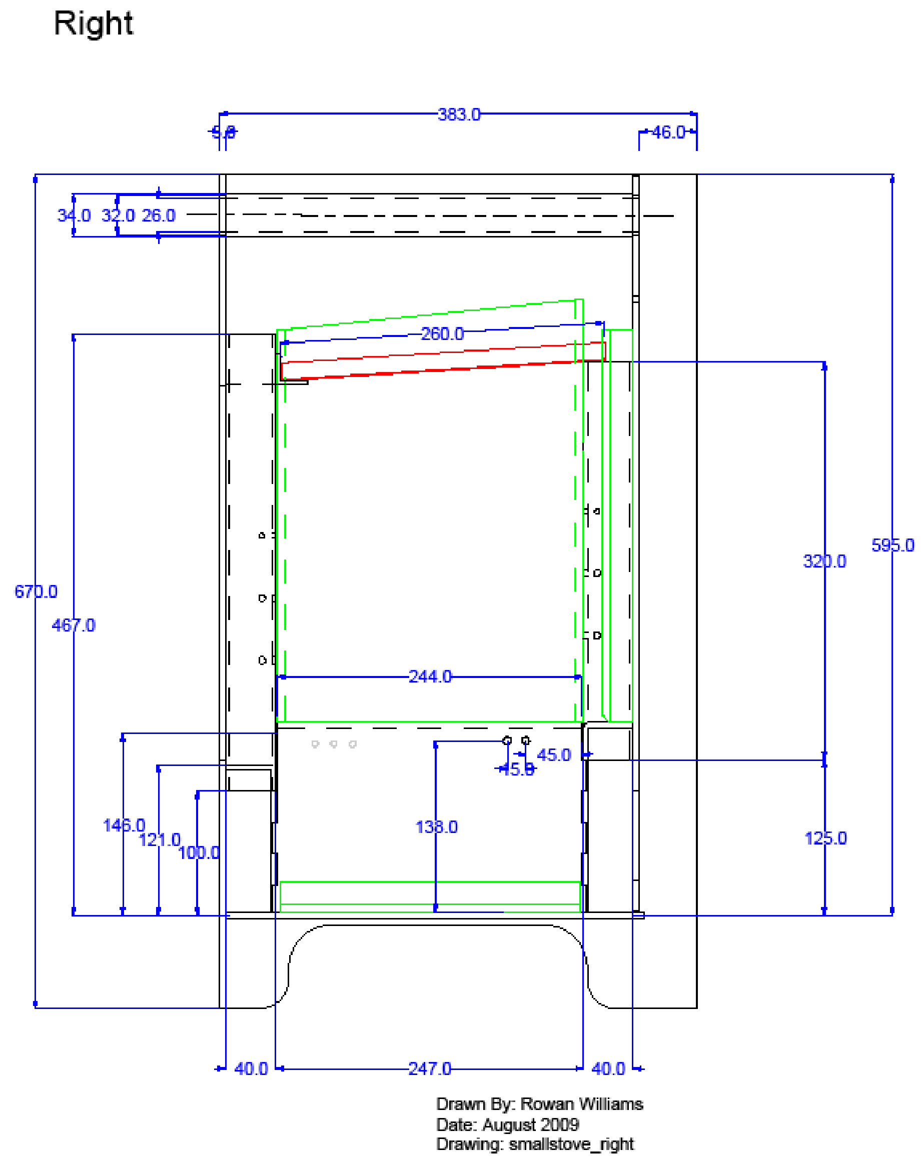
Drawing B1: Front view



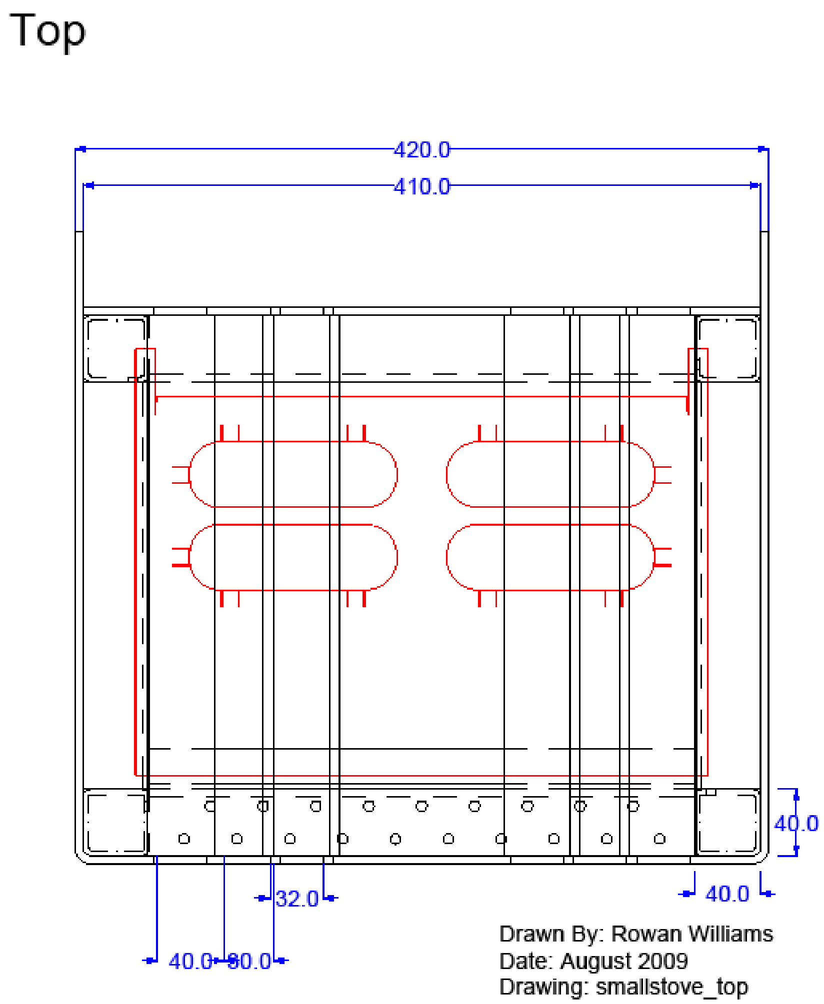
Drawing B2: Left view



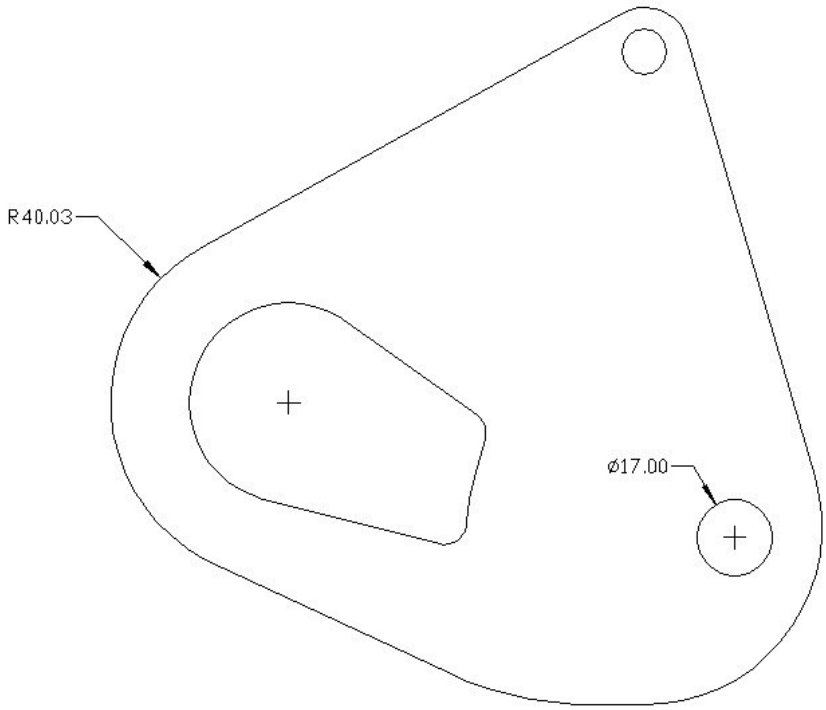
Drawing B3: Right view



Drawing B4: Top view



Drawing B5: Air plate




Air Plate for DEFRA approved small stove

**Annex C**

**Manual**

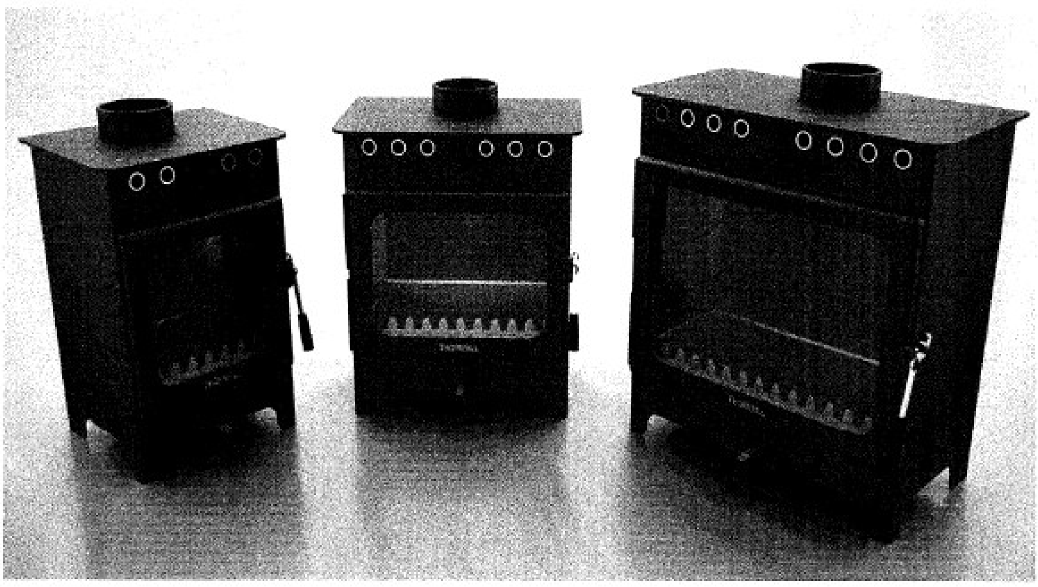
*(Note: Thornhill Turbo Small = Burley Turbo Small)*

# Installation Instructions & User Manual

**for the super-efficient**

# Burley T□

# Wood burning stoves



Please retain these instructions for future reference.

## WARNING

The Burley Turbo series of stoves are wood burning only (this includes logs, sawdust briquettes and pellets); no attempt should be made to burn any other fuel, including all types of coal, smokeless fuels and petroleum coke. Under no circumstances should liquid fuels be added. It is not an incinerator and rubbish included painted, tanalised wood and MDF should not be burnt in this appliance.

Any attempt is dangerous and will invalidate any guarantees immediately.

### Technical data

| All built to EN13240 | Small & Small DEFRA approved | Medium | Large |
|---|---|---|---|
| Efficiency | 89.1% | 85.5% | 84.9% |
| CO concentration<br>@13% Oxygen | 0.1% | 0.1% | 0.1% |
| Fuel | Dry Logs < 25% $H^2O$<br>225 – 300mm long | Dry Logs < 25% $H^2O$<br>225 – 350mm long | Dry Logs < 25% $H^2O$<br>225 – 450mm long |
| Weight in kg | 95 kg | 105 kg | 130 kg |
| kW output intermittent | 5kW | 8kW | 12 kW |
| Air vent requirement | Not required unless house is less that 4 years old then: use manifold or 550mm sq. mm,30mm diameter | 1650mm sq. mm<br>50mm diameter<br>Unless connected using manifold | 4,950mm sq. min<br>100mm diameter<br>Unless connected using manifold |
| Minimum flue draught mm $H^2O$ | 0.5mm | 0.5mm | 0.5mm |
| Flue gas temperature<br>Spigot Temp. | 122 °C<br>241 °C | 183 °C<br>274 °C | 237 °C<br>316 °C |
| Flue size<br>Min. chimney diameter<br>Best chimney diameter | 150mm (6")<br>150mm (6")<br>150mm (6") | 150mm (6")<br>150mm (6")<br>150mm (6") | 150mm (6")<br>150mm (6")<br>175mm (7") |
| Minimum distance to combustible materials | 20cm behind (8").<br>35cm at side (14") | 10cm behind (4").<br>40cm at side (16") | 20cm behind (8")<br>45cm at side (18") |
| Max. Hearth temp. | <100 °C | <100 °C | <100 °C |

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| | | | |
|---|---|---|---|
| Min. Hearth thickness | 12mm | 12mm | 12mm |

## Installation Instructions

When installing these appliances, all local regulations, including those referring to national & European Standards need to be complied with.

This manual covers the appliances: Burley Turbo models small, medium & large.

The nominal space heating output is:

Small: 5Kw, Medium: 8Kw & Large: 12Kw.

Any of the above appliances must be installed by a HETAS registered installer and the installation registered with the local council.

Failure to comply with the above renders all guarantees and liabilities of the manufacturer null and void.

The manufacturer will not guarantee or accept liability for any problem that arises unless, a HETAS installation commissioning certificate has been completed and a valid receipt or proof of purchase is presented from the approved supplier.

The appliances should not be fitted closer than shown in the chart, from combustible materials, e.g. wooden fire surround or stud wall.

When fitted against a wall made of combustible material e.g. a wooden stud wall with plasterboard, extra non-combustible material should be fitted behind the stove if the distance from the wall is less than shown unless a 75mm thick non combustible material is used as a barrier. When fitted inside a masonry or similar non-flammable material recess, e.g., fireplace opening, there is no minimum distance, the gaps are only an aesthetic consideration.

## Hearths

The stove should stand on a non-combustible heath of minimum thickness 12mm (1/2"). This should extend a minimum 225mm (9") in front of the stove. When a stove is free-standing, the hearth should also extend a minimum of 150mm (6") either side of the stove. The hearth must be capable of taking the load of the appliance. Suitable measures, (e.g. a load distribution plate) should be taken if to ensure stability.

## Air supply

All hydrocarbon burning appliances require an oxygen/air supply.

If the chimney/stove is to be fitted on an external wall the air supply can be taken straight from the outside. A 3" (100mm) diameter hole needs to be drilled in the correct place, 138mm above the hearth and the stove 'manifold/extension air pipe' kit purchased and fitted. A proprietary grille is supplied with the kit, if not used an air brick or non-closing vent should be fitted to ensure the air supply is not blocked in any way.

This method of supplying air is always to be preferred as there will be no draught in the room especially when the stove is not in use.

If the stove is not on an outside wall or the direct air supply method cannot be used, an air vent must be supplied in the room in which the stove is fitted.
The sizes of the vents required are:

Small, 0- 550mm sq.(25mm diameter) Medium,1650mm sq.(50mm diam.) Large,4950mm Sq.(100mm diam.)

Only permanently open vents can be used and consideration should be given to draught when the stove is not in use. Site these vent carefully. The vent covers should comply with Building Regulations Part J and should be sited where they cannot be blocked.

## Chimneys

All 3 models require a chimney of minimum 6" diameter (150mm) and a minimum length of 4 metres and they must comply with Building Regulations J. Never share the flue with another appliance.

Without a chimney to these specifications there could be insufficient draw on the chimney to pull sufficient oxygen through the appliance to make it burn properly.

If you live in a valley or are surrounded by tall trees or buildings you might experience downdraught problems where the wind tries to stop the fumes rising up the chimney. An anti-downdraught cowl might help, but anti-downdraught cowls reduce draw, so will not work on single storey chimneys and those with insufficient draw.

We recommend you seek the advice of a HETAS or NACE registered supplier and installer before purchasing any stove or heating appliance.

### Assembly & installation of the stove fire bricks and baffle plates.

Having positioned your Burley Turbo stove & connected it to a chimney with flue pipe, (we recommend 1mm stainless steel pipe sprayed matt black) you need to assemble the inside parts.

There are 5 inside components, top and lower baffles, 2 side cheeks & a rear brick.

Place the top baffle loosely in position resting on the back square steel columns.

Place the left hand side brick in place, followed by the right hand. The top baffle can then be placed correctly and the rear brick inserted.

Finally when these parts are snugly in position with the top baffle as far to the back as it will go, the lower stainless steel baffle can be positioned resting on the front ledge.

When sweeping the chimney or carrying out regular maintenance on the stove, reverse the above procedure, clean the chimney and the top surface of the top baffle and the stainless steel mesh, then reposition all the components.

## Commissioning of the Thornhill Turbo Appliance

On completion of the installation, when any fire cement or paint used has dried, the stove can be lit, a smoke 'bomb' should be burnt and all joints checked for smoke leakage and the chimney draw checked with all doors and windows closed.

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Please leave the instructions with the customer and inform them;-

1/ When they first light the fire, smoke will appear around the stove and flue pipe with a strong acrid smell. This is normal and is the paint curing. If the stove is fired properly for at least 2 hours this should not happen again.

2/ That they should fire it quite hard for at least half an hour every time the stove is lit, to warm the stove, flue pipe & chimney. It can then be turned down, but it will tar up and become less efficient if kept running at a low temperature.

3/ You cannot have wood fuel too dry, wood should be at about 20% maximum moisture content. Mixing wood that is 25% with manufactured logs @ 2-10% helps to keep the average moisture down and the stove working efficiently.

4/ Never empty all the ash, it is required to help keep the combustion chamber temperature up and an efficient clean burn.

## USER INSTRUCTIONS

### To light the Stove.

It is important to keep an approximate minimum depth of ¾" (20mm) of wood ash in the fire box at any time. You will achieve this after the first few firings.

Place 1 or 2 firelighters in the bottom, then some kindling wood criss-crossed diagonally, and finally 2 larger logs on top. Light the firelighters, open the air vent to maximum (to the right) and close the door to the first latch so there is an air gap around it.

Leave it like this for at least five minutes and then add a further 2 logs. After about a further 5 minutes or so, the fire should be well alight, and the door can now be closed to become air tight. Leave the air control lever near the maximum (to the right) for a further 10 to 20 minutes to get the stove completely up to running temperature.

The best running position to achieve maximum efficiency will depend on the chimney draw, but will be normally be near the centre. Every chimney is different, and you will find your stove's optimum position. This is when the flames are swirling in a lazy manner around the stove, not roaring. If the lever is pushed too far to the left, you starve the fire of oxygen, causing the glass to darken. Move the lever a small amount to the right until the glass just stays clean. Once your stove is up to temperature, and you have found your optimum running position, it is best not to move it.

The best way to run any wood stove is 'little and often', if you are around it is best to keep adding a small log (approximately 1kg) every 45 minutes rather than adding 4 large ones every 2 hours.

THE STOVE IS NOT DESIGNED TO BE USED WITH THE DOOR OPEN

To reload, open the air vent to the right, and then open the door slowly. Push some of the burning charcoal to the back of the combustion chamber and, using the gloves provided; place the fresh log towards the front of the appliance.

Close the door and after 1 minute return the air slide to the central position.

After being used 10 -20 times some ash might need to be removed.

Never empty all the ash, leave at least ¾" (20mm) in the bottom.

Ensure the fire is out before trying to remove any ash.

Using the ash scoop provided, scrape back the top layer to one side and scoop out some of the lower ash. Place this on your compost heap or directly round fruit trees or rose bushes.

Spread the remaining ash back evenly over the base of the stove and you are ready to relight the stove.

## Glass

Simple glass cleaner will keep the stove glass fresh most of the time, with a proprietary stove glass cleaner being needed one a month or so to deep clean any stains.

The stove is double glazed; check the rope seals and screws regularly to ensure a long life.

In the event of a glass breakage, lift the door off and place on a flat surface. Undo the 4 screws holding the glass fixing brackets and place to one side.

Remove the sheet of glass and clean the un-broken one. Check the door seal and replace if required. The seal/rope is ready glued, peel back the cover strip and push into place, cut to length using a sharp craft knife.

Glue the second seal on the first pane of glass and place the second sheet over this.

Replace and tighten the screws and brackets. Take care not to over tighten the screws. The glass has to expand and contract with each lighting.

## Chimney sweeping & Maintenance

Your chimney should be swept at least once a year by a registered sweep, twice a year with heavy use. The sweep should also replace the fire cement at the base of the flue if necessary.
The baffles should be removed in the reverse order described above.
The chimney can be swept through the stove.
The baffle should be cleaned at least twice a year with heavy use, checked, renewed as required and replaced.
Under no circumstances should the stove be used with any baffle missing.
All rope and glass seals should be checked annually and replaced as necessary.
If the stove has not been used for a prolonged period, in excess of 6 months, the chimney should be swept prior to use to check for blockages and rubble and debris blocking the flue ways.

NOTE; All solid fuel appliances produce considerably more Carbon Monoxide in normal use than oil or gas appliances. But the general 'smell' of the smoke or exhaust is much stronger (with perhaps the exception of smokeless fuel) and more easily detected by a healthy person. Always use your appliance with the doors shut and look for tell tale signs of excessive leakage. Smoke stains above the fireplace, smoke emitting around the door when running, strong smell of soot upstairs etc etc. There is no such thing as a gas tight chimney, but there has to be a negative pressure inside a chimney for it to draw oxygen through the fire box. Check the seals at the joints annually and re-fire cement as required, check especially the joint of the flue pipe to the chimney register plate, hairline cracks are OK, but lumps of cement missing are a bad joint. A proper proprietary joint should be used here, as they are far superior to cement and rope seals.

Never block air vents internally and externally

The surface of the appliance is hot in normal use; guards should be used when young children or infirm people are around. Avoid all flammable materials within 300mm of the appliance.

In the event of a chimney fire, shut the air vent right down. If possible throw table or dishwasher salt onto the fire.

Never modify or fit parts not recommended by the manufacturer to the appliance.

Never use this appliance in the same flue as another appliance.

'Thornhill Turbo Technology' is the patented clean burning 'engine', used under licence in these stoves.

Burley Appliances Ltd

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Oakham

Rutland LE15 6RB

United Kingdom

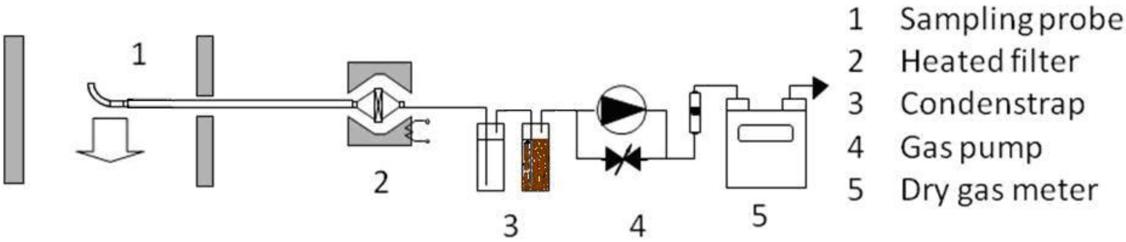
Email: sales@burley.co.uk

## Annex D

### Brief description of dust measurement method

*Before sampling:*
Sampling is being done on a quartz fiber plane filter with a pore size of 0.2 µm and a diameter of 47 mm. The quartz filter is dried at 180 °C for approx. 1 h, weighed on a micro scale with an accuracy of ± 0.05 mg and stored in an identical numbered container. Just before sampling starts the filter is placed in the stainless steel filter holder using a pair of tweezers.
The flue gas static and dynamic pressure is measured by a pitot tube and a micro manometer. The retrieved data is used to calculate the iso kinetic sampling velocity.

The sampling point is situated at the centre point of the flue gas channel. The filter holder is heated to 70 ℃. This temperature is maintained during the sampling. The probe is positioned in the flue gas channel in such a way that the nozzle is at the centre point of the flue gas channel. The nozzle is pointed in the opposite direction of the flue gas stream. See figure.




The setup is tested for any leakage by blocking the nozzle and measuring the sample flow at – 0.8 bar suction pressure. The setup is considered leak tight when the flow rate is less than 0.03 l/min.

*Sampling:*
The volume reading on the gas meter and the start time is noted. The sampling is started directly after loading of the woodstove. The gas pump suction speed is set according to the calculated isokinetic flue gas velocity by means of a flow regulator. During the sampling the gas meter temperature is noted.
Sampling ends when the basic fire bed has been reached. Volume reading on the gas meter is noted.

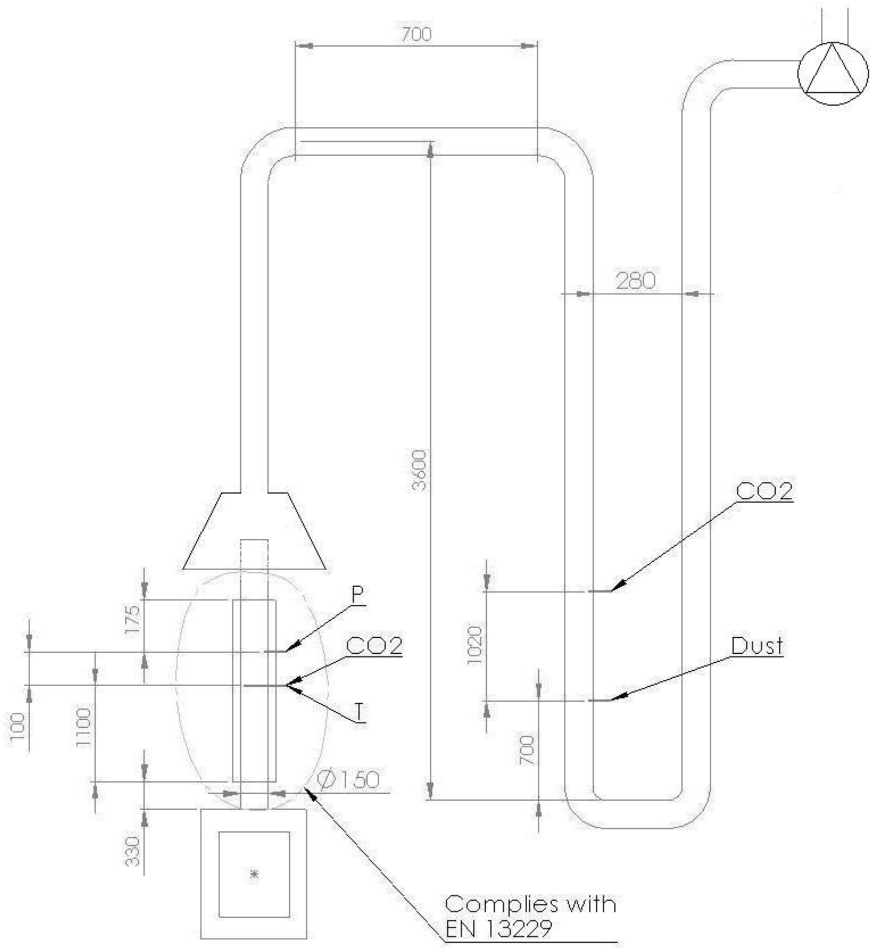
*After sampling:*
The filter is removed from its holder and temporarily kept in a glass container. In an analytical laboratory the filter is dried again at 160 ℃ for approx. 1 h and weighed on a micro scale. The sampled dry volume is calculated by taking the start and end volume readings and corrected to standard conditions (273.15 K, 1013 hPa). The sampled volume is also corrected with a calibration factor, which is determined every year with a calibrated precision gas flow meter.
The amount of sampled dust is calculated by extracting the start weight of the filter from the end weight of the filter.

*Determination of the dilution factor:*
The dilution factor is measured using 2 infrared continuous $CO_2$ analyzers with range 0 – 25 vol% and 0 – 5 % respectively. Prior to, and after, the measurements both analyzers are calibrated and adjusted using certified gas mixtures. The flue gas from the diluted and non-diluted flue gas stream is simultaneously sampled, dried by a cool trap and led through the analyzer.

The $CO_2$ concentration is continuously monitored and the data is automatically stored on a computer every 20 seconds. Afterwards the dilution factor is calculated by dividing the average concentrations upon each other.

# Annex E

**Drawing of the test rig including dilution tunnel**



# Annex F

## Measurements uncertainties

Sampling/analysis methods used, measuring standards and uncertainties. All measurements mentioned in this table are covered by EN-ISO 17025 certification. Measurements marked with an asterisk are also accredited by RvA Testing under no. L-092.

| No. | Component | SGS Procedure/Standard | Uncertainties [1)] |
|---|---|---|---|
| | Determination of the particulate concentration (gravimetric) | ENVI/L/05, dilution tunnel | < ± 14% of measured value higher than 5 mg/m$^3$, when fluctuations in gas flow > 10% may occur < ± 30%. |
| * | Determination of the $CO_2$ concentration (nondispersive infrared) | EMM-006, 007, 030 conform NEN-ISO 12039 | < ± 8%. |
| * | Determination of the CO concentration (nondispersive infrared) | EMM-006, 008, 009, 013, 030 conform NEN-EN 15058 | < ± 8%. |
| * | Determination of the gas temperature (thermocouple) | ENVI/L/03 conform ISO 8756, VDI/VDE 3511, VDI/VDE 3512 Blatt 2 | < ± 0.75% of the measured value or ± 1.5 °C (largest value) |

*1) The stated uncertainties refer to the 95% confidence interval (2 sigma). The stated percentages are related to the actual measurement results, unless indicated otherwise.*