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Austria

Testing of a pellet boiler (non CBI report)

(15 appendices)

This is a revised version of the test report dated 23/04/20 and revised 29/06/20, 17/05/21 and 28/10/21. This revised version concerns missing information about difference between particulate matter in sampling train in %, conditioning data and the alternative method Alt-126.

Tables and pages concerned with the revision are:

- *Table 6 appendix 2, including sample precision in percentage.*
- *Appendix 13 including method Alt-126*
- *Appendix 16 conditioning data*

The assignment

Testing the wood pellet hydronic heater, model BioWIN 332 in accordance with the alternative test method IDC dated January 03 2020 (see appendix 13) for compliance with EPA 40 CFR Part 60, March 16, 2015.

Item for testing

The item tested was a hydronic heater– type BioWIN 332 with serie no. 0555901906001866, year of production 2019 and manufactured by Windhager Zentralheizung Technik GmbH, Austria. The hydronic heater arrived at RISE on the 30th January 2020. The hydronic heater had been pre-conditioned and was therefore in used condition when arriving to RISE. Additionally two external thermal storage tanks (119 gallon each) were delivered by Windhager Zentralheizung Technik GmbH.

The performance tests were conducted on the 24th to 26th of February 2020.

This test report relates only to the actual item tested.

Technical description

Boiler:

The BioWIN 332 is fired automatically when the control system signals a heating requirement. Following purging ignition starts and the pellet auger switches on. The burner bowl is automatically filled with pellets. When flame formation has been detected by the thermo control sensor the boiler enters flame stabilisation mode and afterwards control mode which maintains the specified boiler temperature setpoint. The boiler enters burnout mode if the output drops below the minimum nominal thermal output or no heating requirement is signalled by the control system. The boiler pellet hopper is loaded by hand in the models Klassik/Klassik L and Exklusiv-S/Exklusiv-SL. The model Premium/Exklusiv has an

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automatically fed pellet system which uses a suction turbine to fill the pellet hopper. The models Exklusiv-S/Exklusiv-SL and Premium/Exklusiv have a fully automatic ash removal system.

The wood pellet fired hydronic heater BioWIN 332 is intended for indoor installation.

Storage tank:

The storage tank(s) model no. S120, serial no. 021930765 and serial no. 021930764 part no. S120D4B manufactured by Vaughn Thermal Corporation had a water volume of 119 gallon/tank (two tanks 238 gallon).

Informative material supplied

Three manuals were delivered by the manufacturer:

- Operating manual, BIOWIN 2 Touch, for use in Canada/USA. Dated 02/2020 version no. 094897/01 .
- Operating manual, INFOWIN Touch, for use in Canada/USA. Dated 02/2020 version no. 095713/01-v1.4.x
- Installation instructions BIOWIN 2 Touch, for use in Canada/USA. Dated 02/2020 version no. 094896/01

Test arrangement

The hydronic heater was connected to the test rig according to the alternative test method in appendix 13. The boiler was connected to two storage tanks with a volume of 119 gallon each (total 238 gallon). See figure 3a in appendix 10.

The chimney was connected to a dilution tunnel, see figure 3b in appendix 10.

The chimney diameter was 150 mm (5.9 in.), with a height of about 5 m (197 in.) above the upper surface of the scale. The dilution tunnel diameter was 160 mm (6.3 in.).

The manufacturer conducted a pre-test burning of 50 hours to condition the unit before testing. The wood pellet hydronic heater BioWIN 332 is a non-catalytic appliance.

Test procedure

Testing was carried out at/by RISE, Building Environment department for Energy Resources during February 2020 in accordance with EPA regulations 40 CFR Part 60 subpart QQQQ. Testing was performed according to an alternative method (IDC), see appendix 13.

The particulate matter from the probe assembly was handled according to the alternative method 126 dated March 6 2018 (broadly applicable) by rinsing the probe and probe assembly with acetone, drying down the rinse in beakers, desiccation followed by weighing.

Calculation of the stack loss efficiency was done in accordance with Canadian standard CSA B415.1-10, clause 13.7 except for 13.7.2 (e), (f), (g), and (h) where the following average fuel properties for oak were used: C = 50.0 %, H = 6.6 %, O = 43.2 %, Ash = 0.2 %. The higher heating value (HHV) 8600 Btu/lb (19.99 MJ/kg) were used when calculating the efficiencies (see comments and observation on page 4).

CO, CO₂ and O₂ emissions were measured continuously in the chimney during the test period. Emissions of CO in g/min was not possible to calculate according to the Canadian standard CSA B415.1-10 clause 13.9, see comments and observations on page 4 and comment in table 5.

The test fuel used was manufactured by Riegler & Zechmeister and was classified as EN plus pellet and DIN plus. The fuel was delivered in 15 kg plastic bags. See appendix 12 for fuel analysis.

Leakage checks of the particulate sampling trains were carried out before and after the test runs (see appendix 4).

The proportional rate variation were calculated according to ASTM 2515-11 clause 11.6 (see appendix 5)

The appliance was in cold condition before the test run commenced. At least 48 hours of standstill before the first test run commenced and then at least 8 hours of standstill before the second and third test run was performed. Before starting each test run the boiler ash and coal were removed.

Martin Westermayer, (martin.westermayer@windhager.com) from the company Windhager Zentralheizung Technik GmbH, Austria were present as an observer during the tests.

The alternative test method cycle (IDC) had the following sequences (see also appendix 13 alternative method):

Table 1. Test cycle (IDC)

| IDC Test Procedure Summary | |
|----------------------------|--|
| Start-up Phase | Startup per manufacturer’s instructions. Pull off heat as needed when approaching operating temperature limit and ramp up to 100% |
| Phase 1 | 100% heat demand 60 minutes |
| Phase 2 | 13% heat demand (+/-2%) for 120 minutes or after one cycle, whichever comes first. If unit begins to cycle within 0-30 minutes of Phase 2, 6 cycles must be completed in Phase 4. If the unit begins to cycle within 31-60 minutes of Phase 2, 4 cycles must be completed in Phase 4. If the unit cycles within 61-90 minutes of Phase 2, 3 cycles must be completed in Phase 4. If the unit cycles within 91-120 minutes of Phase 2, 2 cycles must be completed in Phase 4. If the unit does not cycle during Phase 2, only 1 cycle must be completed in Phase 4. |
| Phase 3 | No heat demand for 45 minutes |
| Phase 4 | Forced cycling - Must complete 1-6 cycles, as determined by cycling time in Phase 2. <ul style="list-style-type: none"> • During on-cycle - cooling water is stopped, the system heats to maximum temperature limit • Off-cycle - Wait 30 minutes, then set cooling water at 100% heat demand until system reaches minimum operating temperature limit • Phase 4 ends after number of required cycles has been completed, and concludes the second 30 minute off period |
| Phase 5 | 100% heat demand for 60 minutes <ul style="list-style-type: none"> • Stop cooling water if water jacked drops below minimum operating temperature limit and resume cooling water at 100% heat demand when water jacket reaches operating temperature setpoint |

Summary of test results

In table 2 a summary of the test results and a hangtag information are presented for the tested hydronic heater BioWIN 332 installed with thermal storage. For complete results see appendix 2. The results are based on the alternative method and the IDC cycle. No weighting factors have been used in the calculations.

Table 2. Summary of the test results.

| | | | |
|--|--|-----------------------|-------------------------------|
| MANUFACTURER: | Windhager Zentralheizung Technik GmbH Anton-Windhager-Straße 20 AT-5201 Seekirchen am Wallersee Austria | | |
| MODEL NUMBER: | BioWIN 332 installed with 238 gallons thermal storage | | |
| 8-HOUR OUTPUT RATING | $Q_{out-8hr}$ | N.A | Btu/hr |
| 8-HOUR AVERAGE EFFICENCY | $\eta_{avg-8hr}$ | N.A | (Using higher heating value) |
| | | N.A | (Using lower heating value) |
| MAXIMUM OUTPUT RATING | Q_{max} | 110,900 | BTU/HR |
| ANNUAL EFFICIENCY RATING (based on the IDC test cycle): | η_{avg} | 82.7 (70.6) | (Using higher heating value) |
| | | 89.0 (76.0) | (Using lower heating value) |
| PARTICLE EMISSIONS: | E_{avg} | 0.67 0.002 | Grams/hr (Average) (lb/hr) |
| | | 0.040 | lbs/mmBtu Output |
| CO EMISSIONS | CO_{avg} | 0.04 ¹ | Grams/minute |

N.A = Not Applicable because the hydronic heater is an automatic pellet fuelled appliance.

¹See comments and observations below and comment in table 5 appendix 2.

Comments and observations

The wood pellet hydronic heater BioWIN 332 manufactured by Windhager Zentralheizung Technik GmbH, Austria meets the step 2 requirement 2020 for PM emissions in EPA 40 CFR Part 60 of 0.10 lb/mmBtu heat output (average) and at each individual test run when installed with thermal storage of minimum water volume 238 gallon (900 l).

To compare stack loss efficiency with thermal efficiency is not relevant when testing a system which consists of a boiler and external thermal storage. The thermal efficiency is dependent on the system of boiler, thermal storage, piping and the water circulation in the different

circuits whereas stack loss efficiency only consider the boiler. The difference in efficiency between those two calculations can be significant and can be more than 5 %-units. This test cycle also includes phases where the boiler is in a shut off mode and thus produces no combustion gases. Stack loss calculations based on the method CBA B415.1-10 presumes that there are combustion gases in the stack to be able to calculate the output energy and efficiency and therefore this calculation is not relevant when the boiler is in an off mode. However, the calculation sheets in B415.1-10 has been corrected for the periods of boiler standstill and thus been able to present CO emissions and stack loss efficiency.

The following corrections were made to the spreadsheet in CSA B415.1-10:

1. The total fuel weight consumed during the test has been inserted in the first cell of column B (B 20) in the spreadsheet "data".
2. The scale has been corrected thus the weight is continuously decreasing (except standstill periods) and ending at zero from cell B 21.
3. The standstill periods (phase 3 and phase 5) with increasing scale weight due to changed water density has been corrected so that the fuel feed rate is zero in these periods.

To state thermal efficiency in the different phases of this alternative test method can also give "false" figures due to the fact that the input energy to the thermal storage could have been loaded in a different phase than to which the output energy is drawn from. The calculation in the IDC method clause 13.9 is also calculating the total heat output energy of the system (boiler, thermal storage and load side of the heat exchanger) and not only the energy drawn from the load side of the heat exchanger. This is also a reason why some of the efficiency calculation in the different phases shows "strange" figures and are not relevant.

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Quality assurance

RISE Research Institute of Sweden AB is accredited according to ISO/IEC 17025 as well as accredited by EPA as a test lab to perform tests according to EPA 40 CFR Part 60 subpart QQQQ.

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Appendices

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Appendix 2 Results

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Appendix 1

Identification



Figure 1a. Hydronic heater BioWIN 332

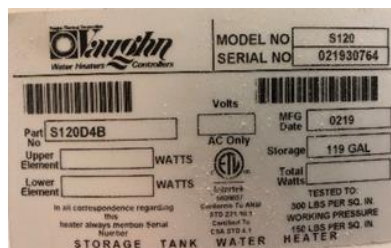


Figure 1b. Thermal storage tank and labels

Appendix 2

Results

In tables 3 to 5 a summary of the test run results are presented for the hydronic heater BioWIN 332 installed with two thermal storage tanks. Additional test results are shown in table 6.

Run 1:

Table 3a. Data Summary Part A - Run 1

| Phase | Target Load | Actual Load | Phase Duration | Wood (pellet) Consumed | Stack Loss Efficiency | Thermal Efficiency ¹ | Min water Return Temp. |
|-----------|-------------|--|------------------------------|-------------------------------|-----------------------|-------------------------------------|------------------------|
| | Btu/hr | Btu/hr | hours | lbs | % | % | °F |
| Start-up | - | 41,128 (115,280) | 1.14 | 15.24 | 85.1 | 108.1² (107.9) | 82 |
| 1 | 110,900 | 105,131 (105,176) (107,501⁴) (107,212 ⁴) | 1.00 (0.50 ⁴) | 15.44 (7.72 ⁴) | 84.8 ³ | 85.4 (87.0 ⁴) | 127 |
| 2 | ≤ 16,635 | 15,393 (15,621) | 2.00 | 27.97 | 86.3 | 56.8 | 122 |
| 3 | 0 | 0 ⁵ | 1.66 ⁶ | - 1.19 (0) ⁶ | N.A | N.A | N.A |
| 4 | - | 775 (57,106) | 2.30 | 20.26 | 92.3 ⁸ | 60.4 (81.3) | 92 |
| 5 | 110,900 | 103,450⁷ (28,747) | 1.00 | -2.00 (0) ⁶ | N.A | N.A ⁷ | 101 |
| Total Run | - | 40,798 (45,685) | 9.1 | 74.29 | 85.1 ⁸ | 85.6 (70.2) | 82 |

N.A = Not applicable because of boiler standstill in this entire phase (see also page 4, comments and observations).

¹ Heat input based on the higher heating value

² The efficiency is over 100 % which is not possible. The heat output calculation in the IDC method clause 13.9 take into account the energy stored in the boiler and storage tanks. But the calculation presumes that the temperature stratification in the tanks are evenly distributed. This is not the case in the start-up phase when the tanks are in the phase of being loaded. This will give a false figure of the energy stored in the storage tanks and thus give an efficiency over 100 %. See also “comments and observations” on page 4.

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³ The stack loss efficiency is lower than the thermal efficiency. The difference is small but can be explained by the fact that the stack loss method is calculating the fuel moisture content by wet base whereas the thermal efficiency energy input is calculated on the dry base moisture content. The wet based moisture content will give a higher heat input and thus a lower efficiency.

⁴ Figures within parenthesis are measured with storage tanks closed for 30 minutes.

⁵ According to the test method in phase 3 a cooling load shall be set after 45 minutes of standstill so that the boiler gets a signal to start in phase 4. The ramp down time in phase 2 was 10 minutes and in phase 3 2,5 minutes.

⁶ When the heat demand is set to zero in phase 3 the boiler temperature decreases and thus changes the water density which gives a negative weight (boiler weight increases) on the scale in phase 3. The same reasoning applies to phase 5 when the boiler is in standstill and the load is drawn from the storage tanks. This is however corrected in this revised version. See comments and observation on page 4 to 5.

⁷ Heat output was drawn from the storage tank and the boiler was in shut down mode for the entire part of this phase. See also technician notes in appendix 7. According to a revised version of the IDC protocol the thermal efficiency can be assumed to be 98 % in this phase if the boiler has satisfied a 100 % heat load without cycling.

⁸ The stack loss efficiency is only considering the boiler and cannot be compared to the thermal efficiency for the boiler system (boiler-piping-storage tanks).

Run 2:

Table 3b. Data Summary Part A - Run 2

| Phase | Target Load | Actual Load | Phase Duration | Wood (pellet) Consumed | Stack Loss Efficiency | Thermal Efficiency ¹ | Min water Return Temp. |
|----------|-------------|---|------------------------------|-------------------------------|-----------------------|---------------------------------|------------------------|
| | Btu/hr | Btu/hr | hours | lbs | % | % | °F |
| Start-up | - | 42,949 (71,401) | 0.91 | 11.94 | 85.6 | 74.5 (75.0) | 91 |
| 1 | 110,900 | 108,802 (108,819) (109.557³) (109,015³) | 1.00 (0.50 ³) | 15.92 (7.92 ³) | 85.1 ² | 85.7 (86.3 ³) | 126 |
| 2 | ≤ 16,635 | 19,018⁴ (19,241 ⁴) | 2.00 | 23.77 | 85.1 | 54.6 (53.1) | 128 |
| 3 | 0 | 0 ⁵ | 1.38 ⁵ | - 1.10 (0) ⁶ | N.A | N.A | N.A |
| 4 | - | 269 (35,579) | 2.73 | 20.54 | 85.7 ⁸ | 58.9 (59.3) | 113 |

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| | | | | | | | |
|-----------|---------|--|------|-------|-------------------|------------------------------------|-----|
| 5 | 110,900 | 70,180⁷ (9,950 ⁷) | 1.38 | 4.19 | 71.7 ⁸ | 104.1⁹ (41.0) | 123 |
| Total Run | - | 35,785 (44,184) | 9.40 | 75.45 | 84.8 ⁸ | 79.5 (69.0) | 91 |

N.A = Not applicable because of boiler standstill of this entire phase (see also page 4, comments and observations).

¹ Heat input based on the higher heating value.

² The stack loss efficiency is lower than the thermal efficiency. The difference is small but can be explained by the fact that the stack loss method is calculating the fuel moisture content by wet base whereas the thermal efficiency energy input is calculated on the dry base moisture content. The wet based moisture content will give a higher heat input and thus a lower efficiency.

³ Figures within parenthesis are measured with storage tanks closed for 30 minutes.

⁴ After the ramp down time the average heat output on the load side was 14652 Btu/hr.

⁵ According to the test method in phase 3 a cooling load shall be set after 45 minutes of standstill so that the boiler gets a signal to start in phase 4. The ramp down time in phase 2 was 9 minutes and in phase 3 it was 1.5 minutes.

⁶ When the heat demand is set to zero in phase 3 the boiler temperature decreases and thus changes the water density which gives a negative weight (boiler weight increases) on the scale in phase 3. This is however corrected in this revised version. See comments and observation on page 4 to 5.

⁷ Heat output was drawn from the storage tank and the boiler was in shut off mode for the main part of this phase. See also technician notes in appendix 7.

⁸ The stack loss efficiency is only considering the boiler and cannot be compared to the thermal efficiency for the boiler system (boiler-piping-storage tanks).

⁹ The efficiency is over 100 % which is not possible. The heat output calculation in the IDC method clause 13.9 take into account the energy stored in the boiler and storage tanks. But the calculation presumes that the temperature stratification in the tanks are evenly distributed. This is not the case in the start-up phase when the tanks are in the phase of being loaded. This will give a false figure of the energy stored in the storage tanks and thus give an efficiency over 100 %. See also “comments and observations” on page 4.

Appendix 2

Run 3:

Table 3c. Data Summary Part A - Run 3

| Phase | Target Load | Actual Load | Phase Duration | Wood (pellet) Consumed | Stack Loss Efficiency | Thermal Efficiency ¹ | Min water Return Temp. |
|-----------|-------------|--|------------------------------|-------------------------------|-----------------------|---|------------------------|
| | Btu/hr | Btu/hr | hours | lbs | % | % | °F |
| Start-up | - | 41,012 (113,293) | 0.72 | 10.61 | 85.7 | 96.9² (96.3) | 92 |
| 1 | 110,900 | 101,568 (101,571) (109,620³) (109,473 ³) | 1.00 (0.50 ³) | 15.43 (7.72 ³) | 85.0 | 82.5 (84.6³) (88.9 ³) | 126 |
| 2 | ≤ 16,635 | 16,506 (16,733 ⁴) | 2.00 | 26.66 | 86.2 | 66.8 (66.4) | 122 |
| 3 | 0 | 0 ⁴ | 2.00 ⁵ | - 1.19 (0) ⁵ | N.A | N.A | N.A |
| 4 | - | 306 (37,702) | 2.73 | 23.36 | 84.5 ⁷ | 54.9 (55.2) | 111 |
| 5 | 110,900 | 96,449⁶ (25,328 ⁷) | 1.00 | -1.10 (0) ^{5,6} | N.A | N.A ⁷ | 124 |
| Total Run | - | 38,563 (44,290) | 9.45 | 72.34 | 85.6 ⁷ | 83.0 (72.5) | 92 |

N.A = Not applicable because of boiler standstill in this entire phase (see also page 4 comments and observations).

¹ Heat input calculated with the higher heating value

² The efficiency is very high. The heat output calculation in the IDC method clause 13.9 take into account the energy stored in the boiler and storage tanks. But the calculation presumes that the temperature stratification in the tanks are evenly distributed. This is not the case in the start-up phase when the tanks are in the phase of being loaded. This will give a false figure of the energy stored in the storage tanks and thus give a very high efficiency. See also “comments and observations” on page 4.

³ Values within parenthesis are measured with storage tanks closed for 30 minutes.

⁴ According to the test method in phase 3 a cooling load shall be set after 45 minutes so that the boiler gets a signal to start in phase 4. The ramp down time in phase 2 was 7 minutes and in phase 3 one minute.

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⁵ When the heat demand is set to zero in phase 3 the boiler temperature decreases and thus changes the water density which gives a negative weight (boiler weight increases) on the scale in phase 3. This is however corrected in this revised version. See comments and observation on page 4 to 5.

⁶ Heat output was drawn from the storage tank and boiler was in shut down mode for the entire period of this phase. See also technician notes in appendix 7.

⁷ The stack loss efficiency is only considering the boiler and cannot be compared to the thermal efficiency for the boiler system (boiler-piping-storage tanks). According to a revised version of the IDC protocol the thermal efficiency can be assumed to be 98 % in this phase if the boiler has satisfied a 100 % heat load without cycling.

In table 4 emission results from the first hour of measurement are presented.

Table 4. Data Summary Part B – 60-minute test results

| Phase | EFco | EIco | ERco | EFpm | EIpm | ERpm | E _j (CO) | E _{tj} (PM) |
|--|--------------------|---------------------|-------|--------------------|-----------|-------|------------------------|-------------------------|
| | Lb/MMBtu Output | g/kg dry fuel | g/hr | Lb/MMBtu output | g/kg fuel | g/hr | g | g |
| Run 1 | 0.27 | 1.99 | 10.69 | 0.010 | 0.100 | 0.534 | 244 | 0.534 |
| Run 2 | 0.11 | 0.75 | 4.23 | 0.014 | 0.095 | 0.533 | 126 | 0.533 |
| Run 3 | 0.10 | 0.74 | 4.64 | 0.020 | 0.162 | 1.010 | 177 | 1.010 |
| | | | | | | | | |
| Average of all runs ¹ | 0.16 | 1.16 | 6.52 | 0.015 | 0.119 | 0.692 | 182 | 0.692 |

¹ Calculated as the arithmetic average.

Appendix 2

In table 5 a summary results for the three test runs are presented. A column of particulate emissions in g/hour has been added to the table (ERpm) and the column ERAco has been changed from lb/hr to grams/minute.

Table 5. Data Summary Part C – Averages

| | EFAco | EIAco | ERAco | EFApm | EIApm | ERpm | ERApm | Thermal Efficiency η_{TA} |
|-------------------------------------|---------------------------------|----------------------------------|--------------------|--------------------|--------------|-------|-------|--------------------------------|
| | Lb/MMBtu Output ¹ | g/kg dry fuel ¹ | g/min ¹ | Lb/MMBtu output | g/kg fuel | g/hr | Lb/hr | % |
| Test 1 | 0.10 | 0.74 | 0.04 | 0.044 | 0.219 | 0.753 | 0.002 | 85.6 (70.2) |
| Test 2 | 0.07 | 0.51 | 0.03 | 0.037 | 0.173 | 0.588 | 0.002 | 79.5 (69.0) |
| Test 3 | 0.09 | 0.67 | 0.04 | 0.040 | 0.211 | 0.682 | 0.002 | 83.0 (72.5) |
| Average of three tests ² | 0.08 | 0.58 | 0.04 | 0.040 | 0.199 | 0.666 | 0.002 | 82.7 (70.6) |

¹ Calculation of CO (and heat output) according to the Canadian standard B415.1-10 is based on emissions in the stack and a fuel feed rate. In this alternative method (IDC) there are phases when the boiler is in an off mode and produces no emissions. Consequently the calculation of CO will not be possible. However, the periods when the boiler is in standstill have been corrected in this revised test report and thus been able to calculate a CO emission.

² Calculated as the arithmetic average.

Table 6 show additional test results for the hydronic heater BioWIN 332 with thermal storage.

Table 6. Additional test results

| | Unit | Run 1 | Run 2 | Run 3 |
|---|-----------------|--------------|--------------|--------------|
| Test date | | 24/02/2020 | 25/02/2020 | 26/02/2020 |
| Atmospheric pressure | mm Hg (mbar) | 740 (987) | 723 (964) | 726 (968) |
| Test duration | minutes | 546.0 | 564.0 | 567.2 |
| Absolute average gas static pressure in dilution tunnel | mm Hg | 741 | 724 | 727 |
| Average velocity in dilution tunnel | m/s | 7.8 | 7.7 | 7.7 |

Appendix 2

| | Unit | Run 1 | Run 2 | Run 3 |
|---|--------------------|--|--|--|
| Average gas tunnel temperature (at Pitot tube) | °F (°C) | 81 (27) | 79 (26) | 79 (26) |
| Relative humidity in dilution tunnel | % | 26.0 | 30.2 | 26.0 |
| Dilution tunnel dew point temperature | °F (°C) | 44 (6.5) | 45 (7.4) | 41 (5.2) |
| Average temperature at PM filter, sampling train 1 | °F (°C) | 82 (28.0) | 83 (28.3) | 82 (28.0) |
| Average temperature at PM filter, sampling train 2 | °F (°C) | 83 (28.5) | 83 (28.4) | 83 (28.5) |
| Flue gas temp (chimney) | °F (°C) | 199 (93) | 203 (95) | 201 (94) |
| | | | | |
| Average temperature of the appliance and water at start of the test | °F (°C) | 84 (29) | 94 (35) | 96 (36) |
| Average temperature of the appliance and water at the end of the test | °F (°C) | 140 (60) | 149 (65) | 154 (68) |
| Average temperature of the storage system at the start of the test | °F (°C) | 86 (30) | 89 (32) | 98 (37) |
| Average temperature of the storage system at the end of the test | °F (°C) | 149 (65) | 155 (68) | 150 (66) |
| Average inlet temperature load side of the heat exchanger | °F (°C) | 109 (43) | 107 (41) | 106(41) |
| Average outlet temperature load side of the heat exchanger | °F (°C) | 124 (51) | 125 (52) | 124 (51) |
| | | | | |
| Test load as fired | lb (kg) | 74.29 (33.69) | 75.45 (34.23) | 72.34 (32.81) |
| Fuel moisture content on dry basis (wet base) | % | 7.8 (7.2) | 7.8 (7.2) | 7.8 (7.2) |
| Diameter of pellet | mm | 6 | 6 | 6 |
| | | | | |
| Water flow rate load side | gal/min (l/min) | 4.13 (15.61) | 3.15 (11.91) | 3.51 (13.29) |
| Heat output (load side including storage tanks) | Btu/hr (kW) | 40,798 (45,685) (12.0) (13.4) | 35,785 (44,184) (10.5) (12.9) | 38,563 (44,290) (11.3) (13.0) |
| Efficiency delivered (HHV) | % | 85.6 (70.2) | 79.5 (69.0) | 83.0 (72.5) |
| Efficiency delivered (LHV) | % | 92.1 (75.5) | 85.6 (74.3) | 89.4 (78.1) |
| | | | | |
| CO (mean value) | ppm | 72 | 74 | 72 |
| CO (mean value) | % | 0.0072 | 0.0074 | 0.0072 |
| CO2 (mean value) | % | 7.0 | 7.7 | 7.0 |

Appendix 2

| | Unit | Run 1 | Run 2 | Run 3 |
|---|----------------------------|----------------|----------------|----------------|
| O ₂ , (mean value) | % | 13.9 | 13.0 | 13.9 |
| Room air blank filter | mg | 0.0 | 0.0 | 0.06 |
| Total amount of particulate matter collected in dilution tunnel, sampling train 1 | g | 6.810 | 5.039 | 6.206 |
| Total amount of particulate matter collected in dilution tunnel, sampling train 2 | g | 6.878 | 5.511 | 6.672 |
| Average gas flow rate in dilution tunnel | dscm/min | 8.83 | 8.48 | 8.56 |
| Absolute average dry gas meter temperature, sampling train 1 | K | 294 | 294 | 293 |
| Absolute average dry gas meter temperature, sampling train 2 | K | 294 | 293 | 293 |
| Volume of gas sample measured corrected to standard conditions, sampling train 1 | dscm | 2.8044 | 2.7918 | 2.8635 |
| Volume of gas sample measured corrected to standard conditions, sampling train 2 | dscm | 3.1383 | 4.9502 | 2.9903 |
| Volume of room air gas sample measured corrected to standard conditions | dscm | 2.7524 | 2.7872 | 2.8168 |
| Difference of PM between the two sampling trains ¹ | g/kg _{dry} (%) | 0.002 (0.5) | 0.030 (8.7) | 0.015 (3.6) |

¹ The requirement in ASTM 2515-11 is the difference between the two sampling trains not to exceed 0.5 g/kg dry fuel or 7.5 % of total emissions from the average total emissions

Appendix 2

Figures 2 a-f show the heat output on the load side of the heat exchanger in Btu/hr and scale weight, CO, CO₂ and O₂ during the test runs.

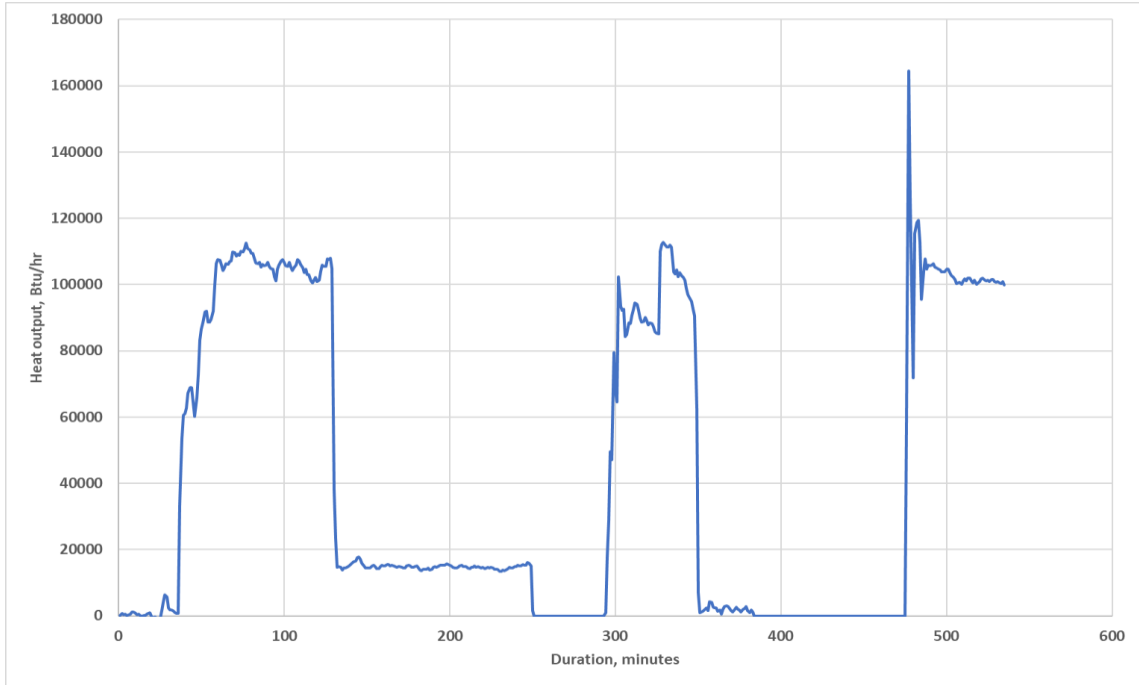


Figure 2 a. Heat output load side, run 1

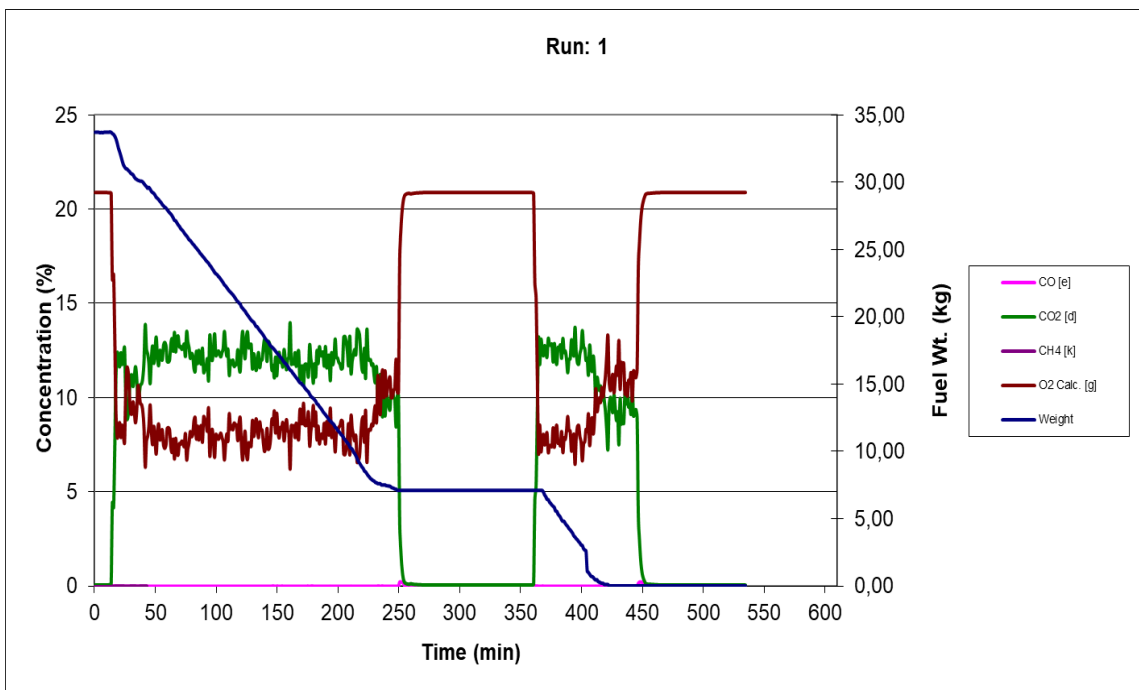


Figure 2 b. Scale weight, CO, CO₂ and O₂ in run 1. The scale weight has been corrected for the standstill periods of the boiler.

Appendix 2

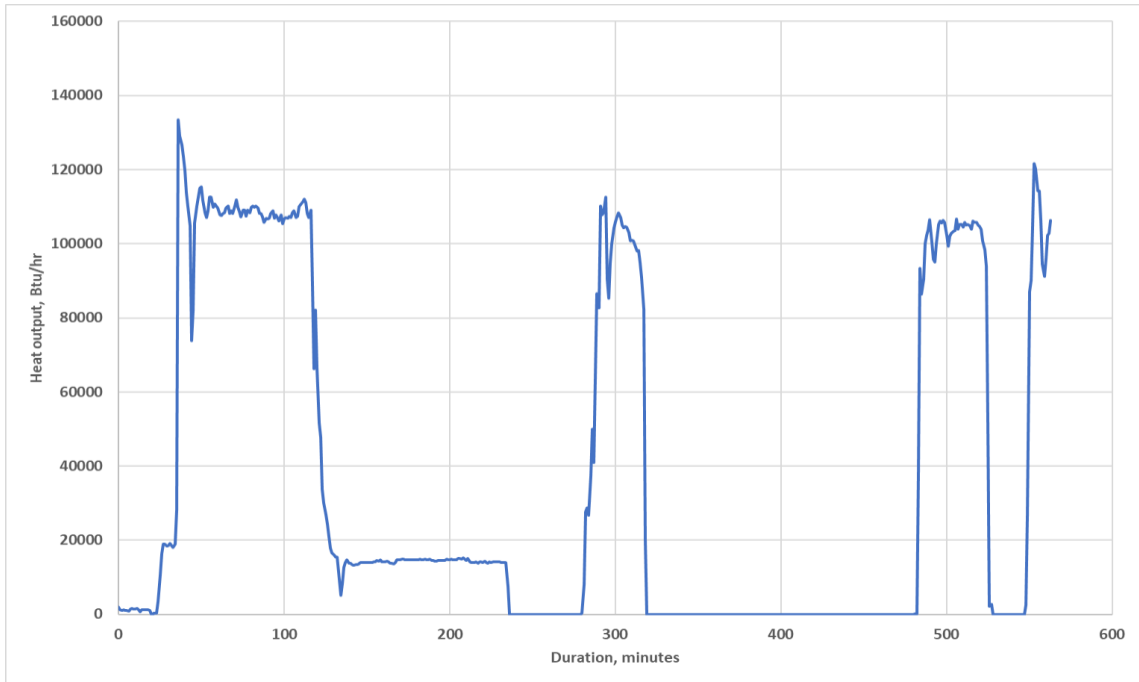


Figure 2 c. Heat output load side, run 2

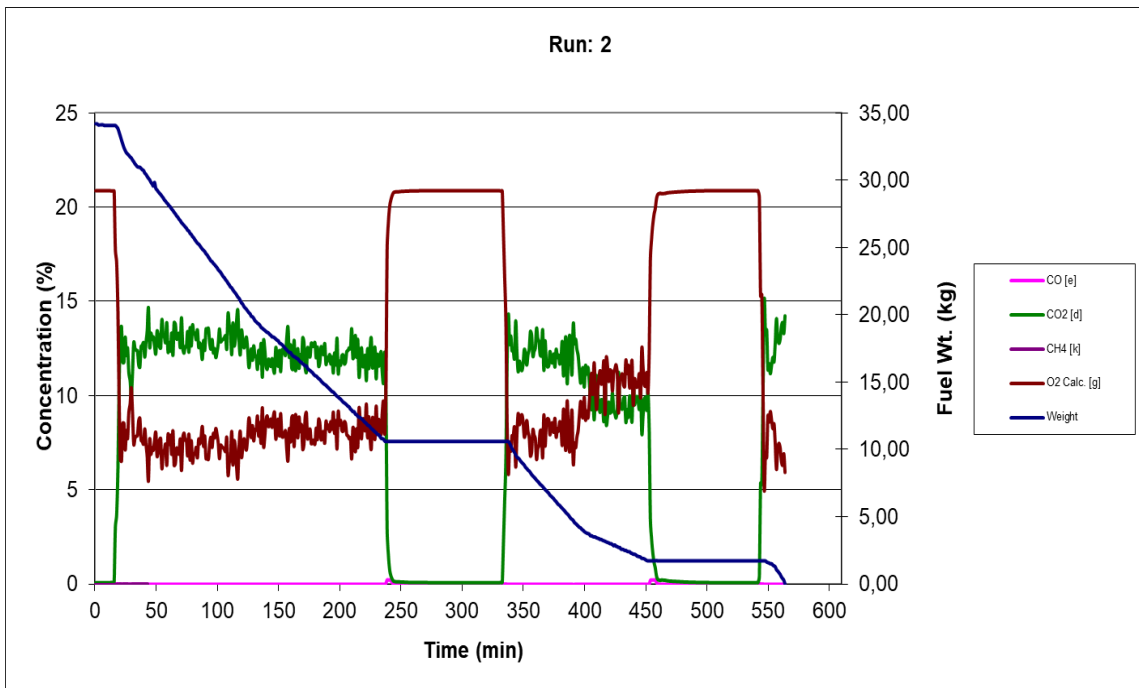


Figure 2 d. Scale weight, CO, CO2 and O2 in run 2. The scale weight has been corrected for the standstill periods of the boiler.

Appendix 2

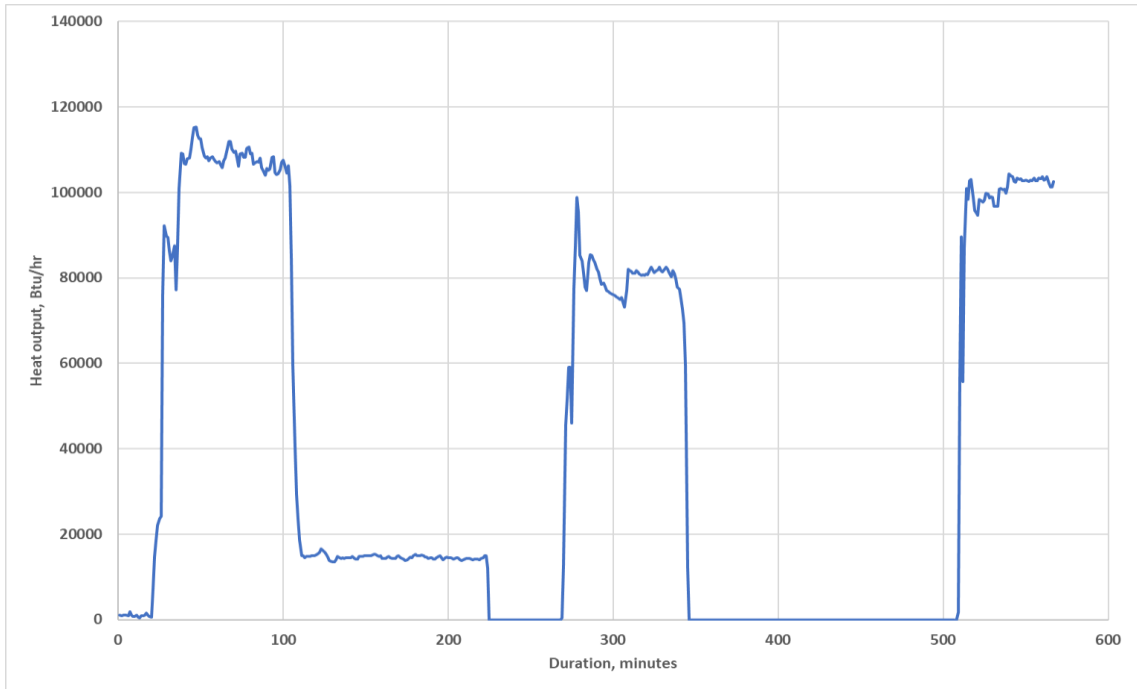


Figure 2 e. Heat output run 3

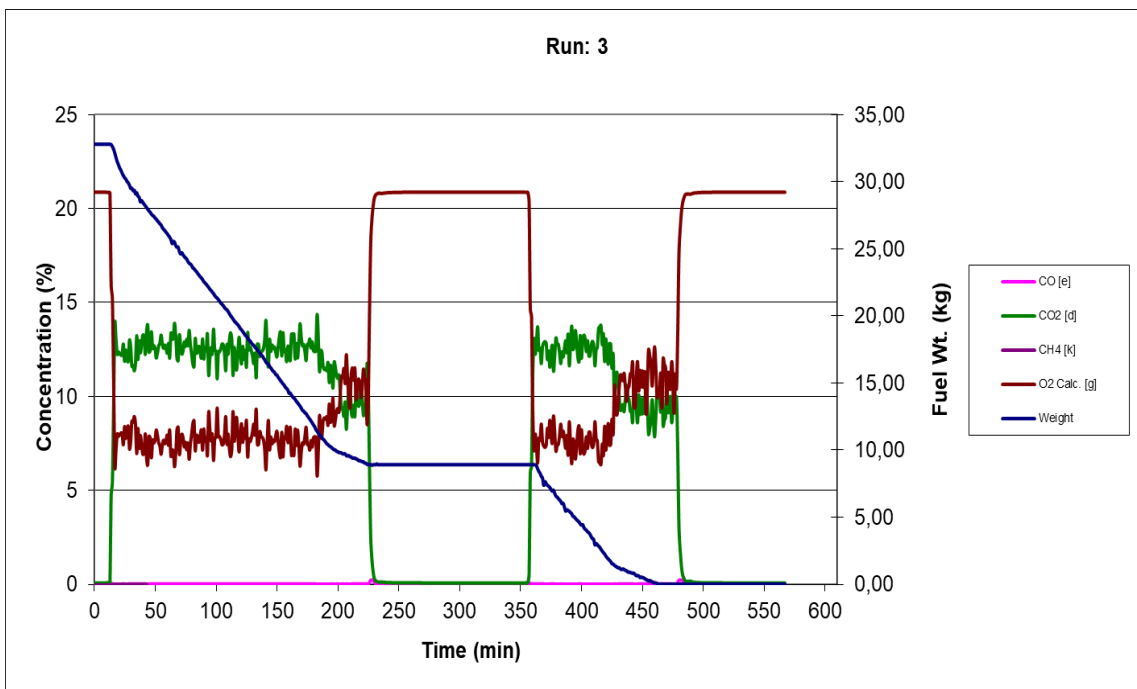

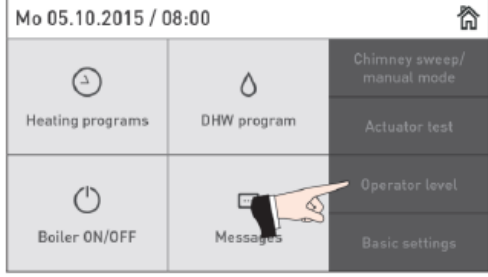
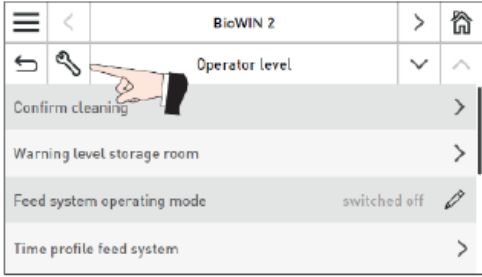

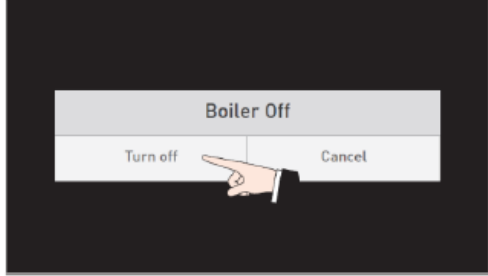


Figure 2 f. Scale weight, CO, CO2 and O2 in run 3. The scale weight has been corrected for the standstill periods of the boiler.

Appendix 3

Manufacturers user guide

| <p>1 Press „Turn on Button“</p>  | <p>2 Settings</p>  | | | | | | | | | | | | | | | | | | |
|--|---|-------------------|----------------------|---------|-----------------------------|---------|------------------------------|---------|---------------------|--------------------|--|----------|--------|--------------|------|----------|--------|--------------|------|
| <p>3 Settings</p>  | <p>4 Settings</p>  | | | | | | | | | | | | | | | | | | |
| <p>5 Settings</p> <p>Choose 'Parameters', then check and adjust the following settings:</p> <table border="1" data-bbox="306 1346 805 1525"> <tr> <td>Maximum value of set temp.</td> <td>185°F</td> </tr> <tr> <td>Hysteresis Burner ON</td> <td>-14 °F</td> </tr> <tr> <td>Minimum boiler power output</td> <td>30%</td> </tr> <tr> <td>Flue gas minimum temperature</td> <td>158°F</td> </tr> <tr> <td>Profile ash removal</td> <td>Stage 1</td> </tr> </table> | Maximum value of set temp. | 185°F | Hysteresis Burner ON | -14 °F | Minimum boiler power output | 30% | Flue gas minimum temperature | 158°F | Profile ash removal | Stage 1 | <p>6 Thermal storage controller settings.</p> <p>Settings for Top sensor or thermostat (heat demand on)</p> <table border="1" data-bbox="833 1317 1337 1384"> <tr> <td>Setpoint</td> <td>166 °F</td> </tr> <tr> <td>differential</td> <td>9 °F</td> </tr> </table> <p>Settings for bottom sensor thermostat (heat demand off)</p> <table border="1" data-bbox="833 1451 1337 1518"> <tr> <td>Setpoint</td> <td>176 °F</td> </tr> <tr> <td>differential</td> <td>7 °F</td> </tr> </table> | Setpoint | 166 °F | differential | 9 °F | Setpoint | 176 °F | differential | 7 °F |
| Maximum value of set temp. | 185°F | | | | | | | | | | | | | | | | | | |
| Hysteresis Burner ON | -14 °F | | | | | | | | | | | | | | | | | | |
| Minimum boiler power output | 30% | | | | | | | | | | | | | | | | | | |
| Flue gas minimum temperature | 158°F | | | | | | | | | | | | | | | | | | |
| Profile ash removal | Stage 1 | | | | | | | | | | | | | | | | | | |
| Setpoint | 166 °F | | | | | | | | | | | | | | | | | | |
| differential | 9 °F | | | | | | | | | | | | | | | | | | |
| Setpoint | 176 °F | | | | | | | | | | | | | | | | | | |
| differential | 7 °F | | | | | | | | | | | | | | | | | | |
| <p>7 Fuel requirements</p> <table border="1" data-bbox="306 1637 805 1951"> <thead> <tr> <th>Fuel Property</th> <th>PFI Super Premium</th> </tr> </thead> <tbody> <tr> <td>Moisture</td> <td>≤ 8.0 %</td> </tr> <tr> <td>Ash Fusion</td> <td>2192 °F</td> </tr> <tr> <td>Diameter</td> <td>0.25 in</td> </tr> <tr> <td>Heating Value</td> <td>7737 - 8511 BTU/lb</td> </tr> </tbody> </table> | Fuel Property | PFI Super Premium | Moisture | ≤ 8.0 % | Ash Fusion | 2192 °F | Diameter | 0.25 in | Heating Value | 7737 - 8511 BTU/lb | <p>8 Turn boiler off before cleaning</p>  | | | | | | | | |
| Fuel Property | PFI Super Premium | | | | | | | | | | | | | | | | | | |
| Moisture | ≤ 8.0 % | | | | | | | | | | | | | | | | | | |
| Ash Fusion | 2192 °F | | | | | | | | | | | | | | | | | | |
| Diameter | 0.25 in | | | | | | | | | | | | | | | | | | |
| Heating Value | 7737 - 8511 BTU/lb | | | | | | | | | | | | | | | | | | |

Appendix 4

Sampling equipment leakage check

The leakage check of the sampling trains were performed at a vacuum of 380 mm Hg (0.5 bar). This vacuum was not exceeded during the test periods.

Table 7a. Run 1

| | Leakage rate m ³ /min | | Requirement, 0.0003 m ³ /min |
|-------------------------|-------------------------------------|-----------|--|
| | Pre-test | Post-test | |
| Sampling train 1 | 0.0002 | 0.0001 | OK |
| Sampling train 2 | 0.00025 | 0.0000 | OK |
| Sampling train 3 | 0.0000 | 0.0000 | OK |
| Ambient train | 0.0003 | 0.0002 | OK |

Table 7b. Run 2

| | Leakage rate m ³ /min | | Requirement, 0.0003 m ³ /min |
|-------------------------|-------------------------------------|-----------|--|
| | Pre-test | Post-test | |
| Sampling train 1 | 0.0003 | 0.00025 | OK |
| Sampling train 2 | 0.0000 | 0.0000 | OK |
| Sampling train 3 | 0.0000 | 0.0000 | OK |
| Ambient train | 0.0002 | 0.0002 | OK |

Table 7c. Run 3

| | Leakage rate m ³ /min | | Requirement, 0.0003 m ³ /min |
|-------------------------|-------------------------------------|-----------|--|
| | Pre-test | Post-test | |
| Sampling train 1 | 0.00025 | 0.0002 | OK |
| Sampling train 2 | 0.0001 | 0.0001 | OK |
| Sampling train 3 | 0.0001 | 0.0001 | OK |
| Ambient train | 0.0002 | 0.00025 | OK |

Appendix 5

Proportional rate variation

Table 8a to 8f shows the proportional rate variation of the sampling trains.

Table 8a. Run 1 sampling train 1

| PROBE 1, run 1, 24-02-2020 | | | | | | | | | | | | | | | | | | | | |
|---|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| | i 1 | i 2 | i 4 | i 5 | i 6 | i 7 | i 8 | i 9 | i 10 | i 11 | i 12 | i 13 | i 14 | i 15 | i 16 | i 17 | i 18 | i 19 | i 20 | i 21 |
| Time total, minute | 0 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 |
| Average gas velocity in tunnel, m/s | V _s | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 | 8,552 |
| Absolute average dry gas meter temperature, K | T _{mi} | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 | 293,707 |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{si} | 293,93 | 295,87 | 299,03 | 298,08 | 300,27 | 303,05 | 304,58 | 305,09 | 305,32 | 305,36 | 305,48 | 305,51 | 305,64 | 305,75 | 305,84 | 305,92 | 305,99 | 305,85 | 305,88 |
| Volume of gas sample total, m ³ | V _{si} | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,64 | 8,63 | 8,57 | 8,57 | 8,54 | 8,52 | 8,50 | 8,49 | 8,49 | 8,50 | 8,49 | 8,50 | 8,49 | 8,48 | 8,49 | 8,48 | 8,48 | 8,48 | 8,47 |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 292,27 | 292,35 | 292,41 | 292,51 | 292,58 | 292,69 | 292,84 | 292,97 | 293,04 | 293,10 | 293,18 | 293,23 | 293,30 | 293,44 | 293,60 | 293,66 | 293,68 | 293,70 | 293,72 |
| Actual time when reading, minute | Θ _i | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Results | | 110 | 110 | 109 | 110 | 109 | 106 | 107 | 108 | 107 | 107 | 107 | 107 | 106 | 106 | 106 | 105 | 105 | 104 | 103 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | i 22 | i 23 | i 24 | i 25 | i 26 | i 27 | i 28 | i 29 | i 30 | i 31 | i 32 | i 33 | i 34 | i 35 | i 36 | i 37 | i 38 | i 39 | i 40 | i 41 |
|---|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Time total, minute | 0 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 |
| Average gas velocity in tunnel, m/s | V _s | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 |
| Absolute average dry gas meter temperature, K | T _{mi} | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{si} | 306,02 | 305,34 | 302,10 | 299,01 | 298,11 | 298,04 | 295,79 | 295,64 | 295,48 | 295,37 | 295,25 | 295,11 | 294,87 | 294,79 | 295,17 | 295,27 | 299,89 | 303,36 | 304,20 |
| Volume of gas sample total, m ³ | V _{si} | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,48 | 8,49 | 8,51 | 8,56 | 8,57 | 8,57 | 8,59 | 8,60 | 8,60 | 8,60 | 8,59 | 8,60 | 8,60 | 8,62 | 8,62 | 8,62 | 8,58 | 8,52 | 8,50 |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 293,84 | 293,87 | 293,91 | 293,98 | 294,02 | 294,10 | 294,11 | 294,16 | 294,18 | 294,19 | 294,22 | 294,25 | 294,19 | 294,14 | 294,09 | 294,09 | 294,05 | 294,08 | 294,07 |
| Actual time when reading, minute | Θ _i | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Results | | 102 | 101 | 101 | 99 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 97 | 97 | 97 | 97 | 97 | 96 | 97 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | i 42 | i 43 | i 44 | i 45 | i 46 | i 47 | i 48 | i 49 | i 50 | i 51 | i 52 | i 53 | i 54 | i 55 | i 56 |
|---|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Time total, minute | 0 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 | 546,00 |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,03 |
| Average gas velocity in tunnel, m/s | V _s | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 |
| Absolute average dry gas meter temperature, K | T _{mi} | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 | 293,71 |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{si} | 303,67 | 302,10 | 299,59 | 297,75 | 297,44 | 297,35 | 296,94 | 295,18 | 294,98 | 294,76 | 294,61 | 294,55 | 294,42 | 294,33 |
| Volume of gas sample total, m ³ | V _{si} | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 | 2,84 |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,51 | 8,51 | 8,54 | 8,56 | 8,59 | 8,58 | 8,57 | 8,60 | 8,61 | 8,61 | 8,61 | 8,61 | 8,61 | 8,60 |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 | 299,86 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 294,01 | 294,06 | 294,07 | 294,13 | 294,17 | 294,16 | 294,15 | 294,07 | 294,09 | 294,04 | 294,02 | 294,01 | 293,96 | 293,93 |
| Actual time when reading, minute | Θ _i | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 6 |
| Results | | 96 | 96 | 95 | 94 | 94 | 93 | 94 | 93 | 92 | 93 | 93 | 93 | 92 | 92 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

Appendix 5

Table 8b. Run 1 sampling train 2 and 3

| PROBE 2+3, run 1, 24-02-2020 | | Probe 2 | | | | | | | Probe 3 | | | | | | | | | | | |
|---|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| | i 1 | i 2 | i 4 | i 5 | i 6 | i 7 | i 8 | i 9 | i 10 | i 11 | i 12 | i 13 | i 14 | i 15 | i 16 | i 17 | i 18 | i 19 | i 20 | i 21 |
| Time total, minute | Ø | 60,00 | 60,00 | 60,00 | 60,00 | 60,00 | 60,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,05 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 |
| Average gas velocity in tunnel, m/s | V _s | 8,580 | 8,580 | 8,580 | 8,580 | 8,580 | 8,580 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 | 8,549 |
| Absolute average dry gas meter temperature, K | T _m | 292,500 | 292,500 | 292,500 | 292,500 | 292,500 | 292,500 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 | 293,804 |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pi} | 293,93 | 295,87 | 299,03 | 298,08 | 300,27 | 303,05 | 304,66 | 305,09 | 305,32 | 305,36 | 305,48 | 305,51 | 305,64 | 305,75 | 305,84 | 305,92 | 305,99 | 305,85 | 305,88 |
| Volume of gas sample total, m ³ | V _m | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,64 | 8,63 | 8,57 | 8,57 | 8,54 | 8,52 | 8,50 | 8,49 | 8,49 | 8,50 | 8,49 | 8,50 | 8,49 | 8,48 | 8,49 | 8,48 | 8,48 | 8,48 | 8,48 |
| Absolute average gas temperature in tunnel (pitot), K | T _{si} | 298,36 | 298,36 | 298,36 | 298,36 | 298,36 | 298,36 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 292,30 | 292,34 | 292,41 | 292,54 | 292,63 | 292,79 | 292,98 | 293,10 | 293,16 | 293,22 | 293,30 | 293,34 | 293,41 | 293,54 | 293,69 | 293,70 | 293,60 | 293,54 | 293,60 |
| Actual time when reading, minute | Ø _i | 10 | 10 | 10 | 10 | 10 | 10 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Results | | 100 | 100 | 101 | 100 | 101 | 97 | 111 | 105 | 105 | 105 | 105 | 105 | 105 | 105 | 105 | 105 | 105 | 105 | 105 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | | i 22 | i 23 | i 24 | i 25 | i 26 | i 27 | i 28 | i 29 | i 30 | i 31 | i 32 | i 33 | i 34 | i 35 | i 36 | i 37 | i 38 | i 39 | i 40 | i 41 |
|---|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Time total, minute | Ø | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 |
| Average gas velocity in tunnel, m/s | V _s | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 |
| Absolute average dry gas meter temperature, K | T _m | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pi} | 306,02 | 305,34 | 302,10 | 299,01 | 298,11 | 298,04 | 295,79 | 295,64 | 295,48 | 295,37 | 295,25 | 295,11 | 294,87 | 294,79 | 295,17 | 295,27 | 299,89 | 303,36 | 304,20 | 304,44 |
| Volume of gas sample total, m ³ | V _m | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,48 | 8,49 | 8,51 | 8,56 | 8,57 | 8,57 | 8,59 | 8,60 | 8,60 | 8,60 | 8,59 | 8,60 | 8,60 | 8,62 | 8,62 | 8,62 | 8,58 | 8,52 | 8,50 | 8,50 |
| Absolute average gas temperature in tunnel (pitot), K | T _{si} | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 293,81 | 293,85 | 293,88 | 293,93 | 293,95 | 294,02 | 294,02 | 294,07 | 294,09 | 294,09 | 294,11 | 294,10 | 293,94 | 293,91 | 293,90 | 293,91 | 293,89 | 293,95 | 293,96 | 293,94 |
| Actual time when reading, minute | Ø _i | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Results | | 103 | 103 | 101 | 100 | 100 | 100 | 98 | 99 | 98 | 99 | 98 | 99 | 98 | 98 | 98 | 98 | 98 | 99 | 100 | 100 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | | i 42 | i 43 | i 44 | i 45 | i 46 | i 47 | i 48 | i 49 | i 50 | i 51 | i 52 | i 53 | i 54 | i 55 | i 56 |
|---|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Time total, minute | Ø | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 | 484,00 |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,03 |
| Average gas velocity in tunnel, m/s | V _s | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 | 8,55 |
| Absolute average dry gas meter temperature, K | T _m | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 | 293,80 |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pi} | 303,67 | 302,10 | 299,59 | 297,75 | 297,44 | 297,35 | 296,94 | 295,18 | 294,98 | 294,76 | 294,61 | 294,55 | 294,42 | 294,33 | 294,31 |
| Volume of gas sample total, m ³ | V _m | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 | 2,88 |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,51 | 8,51 | 8,54 | 8,56 | 8,59 | 8,58 | 8,57 | 8,60 | 8,61 | 8,61 | 8,61 | 8,61 | 8,61 | 8,60 | 8,60 |
| Absolute average gas temperature in tunnel (pitot), K | T _{si} | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 | 300,03 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 293,94 | 294,00 | 294,02 | 294,07 | 294,09 | 294,07 | 294,05 | 293,96 | 293,96 | 293,89 | 293,88 | 293,87 | 293,83 | 293,80 | 293,80 |
| Actual time when reading, minute | Ø _i | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 6 |
| Results | | 99 | 99 | 97 | 97 | 97 | 96 | 96 | 95 | 96 | 96 | 95 | 95 | 95 | 96 | 90 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

Appendix 5

Table 8c. Run 2 sampling train 1

| PROBE 1, run 2, 25-02-2020 | | | | | | | | | | | | | | | | | | | | | | |
|---|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| | | i1 | i2 | i4 | i5 | i6 | i7 | i8 | i9 | i10 | i11 | i12 | i13 | i14 | i15 | i16 | i17 | i18 | i19 | i20 | i21 | |
| Time total, minute | Ø | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | |
| Average gas velocity in tunnel, m/s | V _s | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | 8,308 | |
| Absolute average dry gas meter temperature, K | T _m | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | 293,427 | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pi} | 294,08 | 294,93 | 299,73 | 300,55 | 303,54 | 304,38 | 304,71 | 304,91 | 304,97 | 304,99 | 304,95 | 304,93 | 303,61 | 301,49 | 300,80 | 301,04 | 300,67 | 300,86 | 300,92 | 300,96 | |
| Volume of gas sample total, m ³ | V _m | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,38 | 8,37 | 8,33 | 8,32 | 8,27 | 8,27 | 8,26 | 8,25 | 8,25 | 8,24 | 8,23 | 8,25 | 8,29 | 8,29 | 8,29 | 8,29 | 8,29 | 8,29 | 8,29 | 8,29 | |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 292,54 | 292,56 | 292,62 | 292,67 | 292,78 | 292,67 | 292,91 | 292,99 | 293,08 | 293,10 | 293,13 | 293,18 | 293,24 | 293,24 | 293,26 | 293,30 | 293,30 | 293,30 | 293,32 | 293,26 | |
| Actual time when reading, minute | Ø _i | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | |
| Results | | 98 | 101 | 102 | 103 | 105 | 104 | 104 | 104 | 104 | 104 | 104 | 104 | 104 | 103 | 102 | 102 | 102 | 101 | 101 | 102 | 101 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | | i22 | i23 | i24 | i25 | i26 | i27 | i28 | i29 | i30 | i31 | i32 | i33 | i34 | i35 | i36 | i37 | i38 | i39 | i40 | i41 | |
|---|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Time total, minute | Ø | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | |
| Average gas velocity in tunnel, m/s | V _s | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | |
| Absolute average dry gas meter temperature, K | T _m | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pi} | 301,14 | 300,90 | 301,08 | 300,61 | 297,05 | 294,79 | 294,69 | 294,25 | 293,55 | 293,59 | 293,62 | 294,51 | 294,84 | 298,37 | 302,80 | 302,91 | 303,11 | 303,42 | 302,79 | 301,31 | |
| Volume of gas sample total, m ³ | V _m | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,28 | 8,28 | 8,28 | 8,29 | 8,34 | 8,37 | 8,38 | 8,38 | 8,38 | 8,38 | 8,37 | 8,37 | 8,37 | 8,35 | 8,26 | 8,27 | 8,26 | 8,25 | 8,27 | 8,28 | |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 293,28 | 293,29 | 293,35 | 293,39 | 293,39 | 293,43 | 293,45 | 293,40 | 293,30 | 293,18 | 293,10 | 293,12 | 293,22 | 293,25 | 293,28 | 293,26 | 293,30 | 293,41 | 293,52 | 293,62 | |
| Actual time when reading, minute | Ø _i | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | |
| Results | | 101 | 101 | 101 | 100 | 99 | 98 | 98 | 98 | 99 | 97 | 98 | 99 | 98 | 99 | 100 | 100 | 100 | 100 | 100 | 100 | 99 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | | i42 | i43 | i44 | i45 | i46 | i47 | i48 | i49 | i50 | i51 | i52 | i53 | i54 | i55 | i56 | i57 | i58 |
|---|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Time total, minute | Ø | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 | 564,00 |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _{mi} | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,02 |
| Average gas velocity in tunnel, m/s | V _s | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 |
| Absolute average dry gas meter temperature, K | T _m | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 | 293,43 |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pi} | 298,83 | 297,90 | 297,68 | 297,52 | 297,45 | 298,07 | 296,23 | 295,74 | 295,77 | 295,58 | 295,51 | 295,44 | 296,13 | 296,16 | 298,74 | 302,46 | 304,40 |
| Volume of gas sample total, m ³ | V _m | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 | 2,90 |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,32 | 8,32 | 8,33 | 8,31 | 8,32 | 8,31 | 8,33 | 8,34 | 8,34 | 8,34 | 8,33 | 8,34 | 8,33 | 8,32 | 8,31 | 8,27 | 8,23 |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 | 299,35 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _{mi} | 293,71 | 293,79 | 293,85 | 293,89 | 293,95 | 294,00 | 294,04 | 294,07 | 294,10 | 294,11 | 294,12 | 294,14 | 294,16 | 294,18 | 294,15 | 294,18 | 294,21 |
| Actual time when reading, minute | Ø _i | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 4 |
| Results | | 98 | 99 | 97 | 98 | 97 | 99 | 97 | 97 | 97 | 97 | 98 | 97 | 97 | 98 | 97 | 97 | 100 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

Appendix 5

Table 8d. Run 2 sampling trains 2 and 3

| PROBE 2+3, run 2, 25-02-2020 | | | | | | | | | | | | | | | | | | | | | | | | |
|---|----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|--|--|--|
| | Probe 2 | | | | | | Probe 3 | | | | | | Probe 3 | | | | | | Probe 3 | | | | | |
| | i 1 | i 2 | i 4 | i 5 | i 6 | i 7 | i 8 | i 9 | i 10 | i 11 | i 12 | i 13 | i 14 | i 15 | i 16 | i 17 | i 18 | i 19 | i 20 | i 21 | | | | |
| Time total, minute | Ø | 60,00 | 60,00 | 60,00 | 60,00 | 60,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | | | | |
| Gas meter volume of gas sample during 10 min interval, m³ | V _m | 0,06 | 0,05 | 0,05 | 0,05 | 0,05 | 0,03 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | | | | |
| Average gas velocity in tunnel, m/s | V _s | 8,322 | 8,322 | 8,322 | 8,322 | 8,322 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | 8,306 | | | | |
| Absolute average dry gas meter temperature, K | T _m | 292,651 | 292,651 | 292,651 | 292,651 | 292,651 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | 293,489 | | | | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _p | 294,08 | 294,93 | 299,73 | 300,55 | 303,54 | 304,38 | 304,74 | 304,91 | 304,97 | 304,99 | 304,95 | 304,93 | 303,61 | 301,49 | 300,80 | 301,04 | 300,67 | 300,86 | 300,92 | 300,96 | | | |
| Volume of gas sample total, m³ | V _m | 0,32 | 0,32 | 0,32 | 0,32 | 0,32 | 0,32 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | | | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _s | 8,38 | 8,37 | 8,33 | 8,32 | 8,27 | 8,27 | 8,25 | 8,25 | 8,25 | 8,25 | 8,24 | 8,23 | 8,25 | 8,29 | 8,29 | 8,29 | 8,29 | 8,29 | 8,29 | 8,28 | | | |
| Absolute average gas temperature in tunnel (pitot), K | T _p | 299,53 | 299,53 | 299,53 | 299,53 | 299,53 | 299,53 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | | | |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 292,52 | 292,53 | 292,58 | 292,62 | 292,76 | 292,89 | 292,97 | 293,05 | 293,12 | 293,13 | 293,14 | 293,14 | 293,18 | 293,18 | 293,21 | 293,25 | 293,23 | 293,24 | 293,26 | 293,20 | | | |
| Actual time when reading, minute | Ø | 10 | 10 | 10 | 10 | 10 | 10 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | |
| Results | | 110 | 100 | 96 | 96 | 99 | 98 | 115 | 102 | 103 | 102 | 103 | 102 | 103 | 101 | 101 | 100 | 101 | 100 | 101 | 101 | | | |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | | | |

| PROBE 2+3, run 2, 25-02-2020 | | | | | | | | | | | | | | | | | | | | | | | | |
|---|----------------|--------|--------|--------|--------|--------|---------|--------|--------|--------|--------|--------|---------|--------|--------|--------|--------|--------|---------|--------|--------|--|--|--|
| | Probe 2 | | | | | | Probe 3 | | | | | | Probe 3 | | | | | | Probe 3 | | | | | |
| | i 22 | i 23 | i 24 | i 25 | i 26 | i 27 | i 28 | i 29 | i 30 | i 31 | i 32 | i 33 | i 34 | i 35 | i 36 | i 37 | i 38 | i 39 | i 40 | i 41 | | | | |
| Time total, minute | Ø | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | | | | |
| Gas meter volume of gas sample during 10 min interval, m³ | V _m | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | | | | |
| Average gas velocity in tunnel, m/s | V _s | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | | | | |
| Absolute average dry gas meter temperature, K | T _m | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | | | | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _p | 301,14 | 300,90 | 301,08 | 300,61 | 297,05 | 294,79 | 294,69 | 294,25 | 293,55 | 293,59 | 293,62 | 294,51 | 294,84 | 298,37 | 302,80 | 302,91 | 303,11 | 303,42 | 302,79 | 301,31 | | | |
| Volume of gas sample total, m³ | V _m | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | | | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _s | 8,28 | 8,28 | 8,28 | 8,29 | 8,34 | 8,37 | 8,38 | 8,38 | 8,38 | 8,38 | 8,37 | 8,37 | 8,37 | 8,35 | 8,26 | 8,27 | 8,26 | 8,25 | 8,27 | 8,28 | | | |
| Absolute average gas temperature in tunnel (pitot), K | T _p | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | | | |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 293,22 | 293,23 | 293,29 | 293,33 | 293,34 | 293,39 | 293,39 | 293,25 | 292,95 | 292,76 | 292,77 | 292,91 | 293,10 | 293,19 | 293,24 | 293,26 | 293,33 | 293,46 | 293,59 | 293,71 | | | |
| Actual time when reading, minute | Ø | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | |
| Results | | 101 | 101 | 100 | 101 | 99 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 98 | 99 | 101 | 102 | 101 | 101 | 101 | | | |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | | | |

| PROBE 2+3, run 2, 25-02-2020 | | | | | | | | | | | | | | | | | | | | | | | | |
|---|----------------|--------|--------|--------|--------|--------|---------|--------|--------|--------|--------|--------|---------|--------|--------|--------|--------|--------|---------|--|--|--|--|--|
| | Probe 2 | | | | | | Probe 3 | | | | | | Probe 3 | | | | | | Probe 3 | | | | | |
| | i 42 | i 43 | i 44 | i 45 | i 46 | i 47 | i 48 | i 49 | i 50 | i 51 | i 52 | i 53 | i 54 | i 55 | i 56 | i 57 | i 58 | | | | | | | |
| Time total, minute | Ø | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | 502,00 | | | | | | | |
| Gas meter volume of gas sample during 10 min interval, m³ | V _m | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,04 | 0,02 | | | | | | | |
| Average gas velocity in tunnel, m/s | V _s | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | | | | | | | |
| Absolute average dry gas meter temperature, K | T _m | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | 293,49 | | | | | | | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _p | 298,83 | 297,90 | 297,68 | 297,52 | 297,45 | 298,07 | 296,23 | 295,74 | 295,77 | 295,58 | 295,51 | 295,44 | 296,13 | 296,16 | 298,74 | 302,46 | 304,40 | | | | | | |
| Volume of gas sample total, m³ | V _m | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | 1,90 | | | | | | | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _s | 8,32 | 8,32 | 8,33 | 8,31 | 8,32 | 8,31 | 8,33 | 8,34 | 8,34 | 8,34 | 8,33 | 8,34 | 8,33 | 8,32 | 8,31 | 8,27 | 8,23 | | | | | | |
| Absolute average gas temperature in tunnel (pitot), K | T _p | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | 299,31 | | | | | | | |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 293,81 | 293,90 | 293,96 | 293,99 | 294,05 | 294,09 | 294,11 | 294,11 | 294,11 | 294,11 | 294,13 | 294,15 | 294,16 | 294,18 | 294,12 | 294,13 | 294,14 | | | | | | |
| Actual time when reading, minute | Ø | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 4 | | | | | | | |
| Results | | 99 | 99 | 99 | 99 | 98 | 99 | 98 | 99 | 98 | 99 | 97 | 98 | 98 | 98 | 100 | 101 | 103 | | | | | | |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | | | | | | | |

Appendix 5

Table 8e. Run 3 sampling train 1

| PROBE 1, run 3, 26-02-2020 | | | | | | | | | | | | | | | | | | | | | |
|---|------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| | i1 | i2 | i4 | i5 | i6 | i7 | i8 | i9 | i10 | i11 | i12 | i13 | i14 | i15 | i16 | i17 | i18 | i19 | i20 | i21 | |
| Time total, minute | Ø | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _m | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | |
| Average gas velocity in tunnel, m/s | V _t | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | 8,368 | |
| Absolute average dry gas meter temperature, K | T _m | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | 293,393 | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pit} | 294,17 | 296,93 | 301,57 | 303,34 | 304,50 | 304,96 | 305,15 | 305,20 | 305,24 | 305,35 | 305,33 | 305,37 | 305,46 | 305,48 | 305,81 | 305,89 | 305,92 | 305,99 | 303,58 | 300,72 |
| Volume of gas sample total, m ³ | V _m | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{ti} | 8,42 | 8,41 | 8,36 | 8,34 | 8,32 | 8,32 | 8,30 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,30 | 8,30 | 8,29 | 8,30 | 8,30 | 8,29 | 8,32 | 8,34 |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 292,54 | 292,55 | 292,55 | 292,62 | 292,71 | 292,85 | 292,94 | 293,00 | 293,02 | 293,08 | 293,06 | 293,12 | 293,16 | 293,22 | 293,35 | 293,40 | 293,43 | 293,48 | 293,44 | 293,51 |
| Actual time when reading, minute | Ø | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Results | | 92 | 103 | 104 | 106 | 106 | 106 | 106 | 106 | 105 | 106 | 106 | 105 | 105 | 105 | 105 | 104 | 103 | 103 | 102 | 101 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | i22 | i23 | i24 | i25 | i26 | i27 | i28 | i29 | i30 | i31 | i32 | i33 | i34 | i35 | i36 | i37 | i38 | i39 | i40 | i41 | |
|---|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Time total, minute | Ø | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _m | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | |
| Average gas velocity in tunnel, m/s | V _t | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | |
| Absolute average dry gas meter temperature, K | T _m | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pit} | 298,45 | 297,79 | 297,68 | 296,40 | 295,15 | 294,90 | 294,82 | 294,77 | 294,63 | 294,50 | 294,44 | 294,35 | 294,39 | 294,36 | 294,99 | 295,62 | 301,94 | 302,53 | 302,92 | 303,06 |
| Volume of gas sample total, m ³ | V _m | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{ti} | 8,37 | 8,38 | 8,38 | 8,38 | 8,39 | 8,41 | 8,41 | 8,41 | 8,42 | 8,43 | 8,42 | 8,41 | 8,42 | 8,43 | 8,43 | 8,42 | 8,34 | 8,32 | 8,32 | 8,33 |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 293,49 | 293,53 | 293,53 | 293,56 | 293,58 | 293,55 | 293,60 | 293,60 | 293,60 | 293,59 | 293,59 | 293,57 | 293,56 | 293,60 | 293,61 | 293,59 | 293,59 | 293,56 | 293,57 | 293,63 |
| Actual time when reading, minute | Ø | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Results | | 100 | 100 | 100 | 100 | 99 | 99 | 99 | 99 | 99 | 99 | 98 | 99 | 98 | 99 | 99 | 99 | 99 | 99 | 99 | 99 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | i42 | i43 | i44 | i45 | i46 | i47 | i48 | i49 | i50 | i51 | i52 | i53 | i54 | i55 | i56 | i57 | i58 | |
|---|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Time total, minute | Ø | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | 567,16 | |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _m | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,05 | 0,04 | |
| Average gas velocity in tunnel, m/s | V _t | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | |
| Absolute average dry gas meter temperature, K | T _m | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | 293,39 | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{pit} | 303,60 | 303,04 | 300,70 | 297,83 | 297,30 | 297,07 | 296,85 | 296,84 | 296,93 | 295,03 | 294,82 | 294,72 | 294,62 | 294,57 | 294,53 | 294,47 | 294,43 |
| Volume of gas sample total, m ³ | V _m | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | 2,95 | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{ti} | 8,31 | 8,32 | 8,34 | 8,37 | 8,38 | 8,39 | 8,38 | 8,39 | 8,39 | 8,43 | 8,42 | 8,43 | 8,44 | 8,43 | 8,44 | 8,44 | 8,44 |
| Absolute average gas temperature in tunnel (pitot), K | T _i | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | 299,34 | |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 293,63 | 293,62 | 293,64 | 293,65 | 293,68 | 293,68 | 293,63 | 293,62 | 293,59 | 293,59 | 293,57 | 293,55 | 293,54 | 293,52 | 293,48 | 293,47 | 293,46 |
| Actual time when reading, minute | Ø | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 7,16 | |
| Results | | 99 | 99 | 98 | 97 | 96 | 96 | 96 | 97 | 97 | 96 | 95 | 96 | 96 | 96 | 96 | 95 | 99 |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | |

Appendix 5

Table 8f. Run 3 sampling train 2 and 3

| PROBE 2+3, run 3, 26-02-2020 | | Probe 2 | | | | | | | Probe 3 | | | | | | | | | | | | | | |
|---|-----------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| | | i 1 | i 2 | i 4 | i 5 | i 6 | i 7 | i 8 | i 9 | i 10 | i 11 | i 12 | i 13 | i 14 | i 15 | i 16 | i 17 | i 18 | i 19 | i 20 | i 21 | i 22 | |
| Time total, minute | Ø | 60,00 | 60,00 | 60,00 | 60,00 | 60,00 | 60,00 | 60,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _m | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,04 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 |
| Average gas velocity in tunnel, m/s | V _s | 8,360 | 8,360 | 8,360 | 8,360 | 8,360 | 8,360 | 8,360 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 | 8,369 |
| Absolute average dry gas meter temperature, K | T _m | 292,665 | 292,665 | 292,665 | 292,665 | 292,665 | 292,665 | 292,665 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 | 293,483 |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{si} | 294,17 | 296,93 | 301,57 | 303,34 | 304,50 | 304,96 | 305,17 | 305,20 | 305,24 | 305,35 | 305,33 | 305,37 | 305,46 | 305,48 | 305,81 | 305,89 | 305,92 | 305,99 | 303,58 | 300,72 | | |
| Volume of gas sample total, m ³ | V _m | 0,34 | 0,34 | 0,34 | 0,34 | 0,34 | 0,34 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,42 | 8,41 | 8,36 | 8,34 | 8,32 | 8,32 | 8,30 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,31 | 8,30 | 8,30 | 8,29 | 8,30 | 8,30 | 8,29 | 8,32 | 8,34 | |
| Absolute average gas temperature in tunnel (pitot), K | T _s | 300,91 | 300,91 | 300,91 | 300,91 | 300,91 | 300,91 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 292,47 | 292,48 | 292,56 | 292,68 | 292,82 | 292,98 | 293,08 | 293,12 | 293,13 | 293,16 | 293,15 | 293,20 | 293,23 | 293,28 | 293,40 | 293,45 | 293,48 | 293,51 | 293,47 | 293,50 | | |
| Actual time when reading, minute | Ø | 10 | 10 | 10 | 10 | 10 | 10 | 7,84 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Results | | 97 | 98 | 99 | 100 | 101 | 103 | 103 | 104 | 104 | 103 | 104 | 104 | 103 | 104 | 104 | 104 | 104 | 104 | 104 | 103 | 101 | |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 |

| | | 22 | | 23 | | 24 | | 25 | | 26 | | 27 | | 28 | | 29 | | 30 | | 31 | | 32 | | 33 | | 34 | | 35 | | 36 | | 37 | | 38 | | 39 | | 40 | | 41 | |
|---|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----|--|
| Time total, minute | Ø | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | | |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _m | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | | |
| Average gas velocity in tunnel, m/s | V _s | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | | | |
| Absolute average dry gas meter temperature, K | T _m | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | | | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{si} | 298,45 | 297,79 | 297,68 | 296,40 | 295,15 | 294,90 | 294,82 | 294,77 | 294,63 | 294,50 | 294,44 | 294,35 | 294,39 | 294,36 | 294,99 | 295,62 | 301,94 | 302,53 | 302,92 | 303,06 | | | | | | | | | | | | | | | | | | | | |
| Volume of gas sample total, m ³ | V _m | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | | | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,37 | 8,38 | 8,38 | 8,38 | 8,39 | 8,41 | 8,41 | 8,41 | 8,42 | 8,43 | 8,42 | 8,41 | 8,42 | 8,43 | 8,43 | 8,42 | 8,34 | 8,32 | 8,32 | 8,33 | | | | | | | | | | | | | | | | | | | | |
| Absolute average gas temperature in tunnel (pitot), K | T _s | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | | | | |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 293,48 | 293,52 | 293,52 | 293,54 | 293,56 | 293,53 | 293,55 | 293,54 | 293,54 | 293,53 | 293,54 | 293,52 | 293,52 | 293,52 | 293,57 | 293,58 | 293,56 | 293,53 | 293,53 | 293,60 | | | | | | | | | | | | | | | | | | | | |
| Actual time when reading, minute | Ø | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | | | | |
| Results | | 100 | 100 | 100 | 99 | 99 | 99 | 98 | 99 | 98 | 98 | 98 | 99 | 99 | 98 | 99 | 99 | 99 | 99 | 100 | 101 | 102 | 101 | | | | | | | | | | | | | | | | | | |
| Requirement | | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | 90-110 | | | |

| | | i 42 | | i 43 | | i 44 | | i 45 | | i 46 | | i 47 | | i 48 | | i 49 | | i 50 | | i 51 | | i 52 | | i 53 | | i 54 | | i 55 | | i 56 | | i 57 | | i 58 | | |
|---|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|
| Time total, minute | Ø | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | 505,00 | | | |
| Gas meter volume of gas sample during 10 min interval, m ³ | V _m | 0,06 | 0,05 | 0,06 | 0,06 | 0,06 | 0,06 | 0,05 | 0,05 | 0,06 | 0,05 | 0,06 | 0,05 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,06 | 0,05 | 0,06 | 0,06 | 0,04 | | | | | |
| Average gas velocity in tunnel, m/s | V _s | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | 8,37 | | |
| Absolute average dry gas meter temperature, K | T _m | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | 293,48 | |
| Absolute average gas temperature in tunnel during 10 minute interval, K (pitot) | T _{si} | 303,60 | 303,04 | 300,70 | 297,83 | 297,30 | 297,07 | 296,85 | 296,84 | 296,93 | 295,03 | 294,82 | 294,72 | 294,62 | 294,57 | 294,53 | 294,47 | 294,43 | | | | | | | | | | | | | | | | | | |
| Volume of gas sample total, m ³ | V _m | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | 2,81 | | |
| Average gas velocity in tunnel for 10 min interval, m/s | V _{si} | 8,31 | 8,32 | 8,34 | 8,37 | 8,38 | 8,39 | 8,38 | 8,39 | 8,39 | 8,43 | 8,42 | 8,43 | 8,44 | 8,43 | 8,44 | 8,44 | 8,44 | | | | | | | | | | | | | | | | | | |
| Absolute average gas temperature in tunnel (pitot), K | T _s | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | 299,13 | | |
| Absolute average dry gas meter temperature during 10 minute interval, K (probe i) | T _m | 293,60 | 293,61 | 293,62 | 293,63 | 293,66 | 293,67 | 293,62 | 293,61 | 293,58 | 293,58 | 293,55 | 293,52 | 293,50 | 293,49 | 293,46 | | | | | | | | | | | | | | | | | | | | |

Appendix 6

Weight from filter, gasket and rinse

The tables below show the results from the filter, gasket and rinse weighting. The filters and gasket have been weighted in pairs. The underlined values have been used in the calculation.

Table 9 a: Filter weights.

| Test Run | Filter nr. Probe nr. | Pre-weight 1 g (date, RH %) | Pre-weight 2 g (date, RH %) | Post-weight 1 g (date, RH %) | Post-weight 2 g (date, RH %) |
|----------|-----------------------------|-----------------------------------|-----------------------------------|------------------------------------|---|
| Run 1 | AF1 (filter) | 0.08860 (21/02/20, 25) | <u>0.08857</u> (24/02/20, 21) | 0.08862 (25/02/20, 21) | <u>0.08859</u> (27/02/20, 13) |
| Run 1 | F1, probe 1 (front+back) | 0.17678 (21/02/20, 25) | <u>0.17678</u> (24/02/20, 21) | 0.18060 (25/02/20, 21) | <u>0.18058</u> (27/02/20, 13) |
| Run 1 | F2, probe 2 (front+back) | 0.17460 (21/02/20, 25) | <u>0.17463</u> (24/02/20, 21) | 0.17507 (25/02/20, 21) | <u>0.17505</u> (27/02/20, 13) |
| Run 1 | F3, probe 3 (front+back) | 0.17489 (21/02/20, 25) | <u>0.17487</u> (24/02/20, 21) | 0.17868 (25/02/20, 21) | <u>0.17865</u> (27/02/20, 13) |
| Run 2 | AF2 (filter) | 0.08806 (21/02/20, 25) | <u>0.08806</u> (25/02/20, 22) | 0.08810 (28/02/20, 13) | <u>0.08807</u> (28/02/20 +6h, 18) |
| Run 2 | F4, probe 1 (front/back) | 0.17519 (21/02/20, 25) | <u>0.17519</u> (25/02/20, 22) | 0.17824 (28/02/20, 13) | <u>0.17826</u> (28/02/20 +6h, 18) |
| Run 2 | F5, probe 2 (front/back) | 0.17564 (21/02/20, 25) | <u>0.17564</u> (25/02/20, 22) | 0.17597 (28/02/20, 13) | <u>0.17595</u> (28/02/20 +6h, 18) |
| Run 2 | F6, probe 3 (front/back) | 0.17356 (21/02/20, 25) | <u>0.17354</u> (25/02/20, 22) | 0.17547 (28/02/20, 13) | <u>0.17540</u> (28/02/20 +6h, 18) |
| Run 3 | AF3 (filter) | 0.08700 21/02/20, 25) | <u>0.08699</u> (26/02/20, 18) | 0.08702 (28/02/20, 13) | <u>0.08703</u> (03/03/20, 25) |
| Run 3 | F7, probe 1 (front/back) | 0.17351 (21/02/20, 25) | <u>0.17348</u> (26/02/20, 18) | 0.17714 (03/03/20, 25) | <u>0.17715</u> (03/03/20 +6h, 24) |
| Run 3 | F8, probe 2 (front/back) | 0.17461 (21/02/20, 25) | <u>0.17459</u> (26/02/20, 18) | 0.17515 (03/03/20, 25) | <u>0.17518</u> (03/03/20 +6h, 24) |
| Run 3 | F9, probe 3 (front/back) | 0.17464 (21/02/20, 25) | <u>0.17462</u> (26/02/20, 20) | 0.17778 (03/03/20, 25) | <u>0.17778</u> (03/03/20, 24) |
| | Blank filter | 0.16678 | <u>0.16678</u> | 0.16677 | 0.16678 |

Table 9 b: Gasket weights

| Test Run | Gasket nr. Probe nr. | Pre-weight 1 g (date) | Pre-weight 2 g (date) | Post-weight 1 g (date) | Post-weight 2 g (date) |
|----------|-------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|
| Run 1 | AG1 (gasket) | 2.50071 (21/02/20) | <u>2.50069</u> (24/02/20) | 2.50070 (25/02/20) | <u>2.50067</u> (27/02/20) |

Appendix 6

| | | | | | |
|-------|-----------------------------|-----------------------|------------------------------|-----------------------|------------------------------------|
| Run 1 | G1, probe 1 (front/back) | 4.99759 (21/02/20) | <u>4.99755</u> (24/02/20) | 4.99751 (25/02/20) | <u>4.99749</u> (27/02/20) |
| Run 1 | G2, probe 2 (front/back) | 4.36248 (21/02/20) | <u>4.36241</u> (24/02/20) | 4.36249 (25/02/20) | <u>4.36234</u> (27/02/20) |
| Run 1 | G3, probe 3 (front/back) | 4.89167 (21/02/20) | <u>4.89163</u> (24/02/20) | 4.89179 (25/02/20) | <u>4.89172</u> (27/02/20) |
| Run 2 | AG2 (gasket) | 2.44554 (21/02/20) | <u>2.44551</u> (25/02/20) | 2.44553 (28/02/20) | <u>2.44548</u> (28/01/20, +6hr) |
| Run 2 | G4, probe 1 (front/back) | 5.01196 (21/02/20) | <u>5.01196</u> (25/02/20) | 5.01188 (28/02/20) | <u>5.01183</u> (28/02/20, +6hr) |
| Run 2 | G5, probe 2 (front/back) | 5.02662 (21/02/20) | <u>5.02658</u> (25/02/20) | 5.02654 (28/02/20) | <u>5.02650</u> (28/02/20,+6hr) |
| Run 2 | G6, probe 3 (front/back) | 4.95020 (21/02/20) | <u>4.95018</u> (25/02/20) | 4.95015 (28/02/20) | <u>4.95011</u> (28/02/20,+6hr) |
| Run 3 | AG3 (gasket) | 2.44606 (21/02/20) | <u>2.44606</u> (26/02/20) | 2.44606 (28/02/20) | <u>2.44608</u> (03/03/20) |
| Run 3 | G7, probe 1 (front/back) | 4.31863 (21/02/20) | <u>4.31858</u> (26/02/20) | 4.31856 (03/03/20) | <u>4.31863</u> (03/03/20,6hr) |
| Run 3 | G8, probe 2 (front/back) | 4.91052 (21/02/20) | <u>4.91052</u> (26/02/20) | 4.91052 (03/03/20) | <u>4.91055</u> (03/03/20,+6hr) |
| Run 3 | G9, probe 3 (front/back) | 4.91461 (21/02/20) | <u>4.91461</u> (26/02/20) | 4.91475 (03/03/20) | <u>4.91476</u> (03/03/20,+6hr) |
| | Blank gasket | 5.01180 | <u>5.01178</u> | 5.01178 | <u>5.01178</u> |

Table 9 c: Probe rinse weights.

| Test Run | Rinse nr. container Probe nr. | Pre-weight 1 container, g (date) | Pre-weight 2 container, g (date) | Post-weight 1 (cont.+rinse), g (date) | Post-weight 2 (cont.+rinse), g (date) |
|----------|-------------------------------------|--|--|---|---|
| Run 1 | R1 Probe 1 | 45.07883 (21/02/20) | <u>45.07866</u> (24/02/20) | 45.07904 (26/02/20) | <u>45.07888</u> (27/02/20) |
| Run 1 | R2 Probe 2 | 48.85347 (21/02/20) | <u>48.85365</u> (24/02/20) | 48.85320 (26/02/20) | <u>48.85325</u> (27/02/20) |
| Run 1 | R3 Probe 3 | 41.92220 (21/02/20) | <u>41.92225</u> (24/02/20) | 41.92240 (26/02/20) | <u>41.92252</u> (27/02/20) |
| Run 2 | R4 Probe 1 | 41.59267 (21/02/20) | <u>41.59274</u> (25/02/20) | 41.59254 (28/02/20) | <u>41.59274</u> (03/03/20) |
| Run 2 | R5 Probe 2 | 39.70440 (21/02/20) | <u>39.70454</u> (25/02/20) | 39.70439 (28/02/20) | <u>39.70462</u> (03/03/20) |
| Run 2 | R6 Probe 3 | 46.30966 (21/02/20) | <u>46.30956</u> (25/02/20) | 46.30996 (28/02/20) | <u>46.31008</u> (03/03/20) |
| Run 3 | R7 Probe 1 | 46.84424 (24/02/20) | <u>46.84452</u> (26/02/20) | 46.84455 (03/03/20) | <u>46.84446</u> (03/03/20,+6hr) |
| Run 3 | R8 Probe 2 | 47.94228 (24/02/20) | <u>47.94223</u> (26/02/20) | 47.94226 (03/03/20) | <u>47.94224</u> (03/03/20,+6hr) |
| Run 3 | R9 Probe 3 | 46.94317 (24/02/20) | <u>46.94328</u> (26/02/20) | 46.94350 (03/03/20) | <u>46.94352</u> (03/03/20,+6hr) |
| | Aceton blank | 16.07860 | 16.07862 | 16.07858 | 16.07864 |

Appendix 7

Technician notes

Logg BioWin332, 2020

Preparations:

Scale weight without calibration weight =474.97 - Scale weight with 20 kg calibrated weight =494.97 - Scale weight without calibration weight again = 474.97

- PM Pallflex filter:



- The boiler operating limiter is set on 194 F (90 C) and safety limiter at 201 (94 C)

- Two thermal storage tanks were installed in series with the boiler. Water volume in the tanks 238 gallon (119+119).



- Software version 1.03

- Dilution tunnel induced static pressure at the boiler: 8,5 m/s = 0,8 Pa

- fuel moisture: $(853-369)-(818-369)/(818-369)*100 = 7.80 \% (db) : 7.23 \% (wb)$

Appendix 7

- 6 mm pellets from Riegler & Zechmeister:



Test day 1 Run 1, 200224

- At least 48 hours of standstill before start of test
- Air velocity around the boiler and tanks: 0.05 m/s
- Electrical power: 110 V and 60 Hz
- Static pressure induced by the dilution tunnel = 0,6 Pa (at 8,5 m/s in the dilution tunnel)
- Pstat in tunnel = 83.7



| Test | Time (computer time) | Weight (scale), kg | Probe 2 (gas meter 202743) | Probe 1 (gas meter 901070) | Probe 3 (gas meter 202743) | Ambient | barometer/humidity/temp. | Comments |
|----------|----------------------|--------------------|----------------------------|----------------------------|----------------------------|----------|--------------------------|---|
| Start up | 4:17 | 519.26 | F2+G2 | F1+G1 | F3+G3 | AF1, AG1 | 987mbar/ RH 33 %/20 C | Open to storage tanks. Pump start 39:17. Close the tank at 67:50. Stable for 5 minutes Stop Probe 2 (1 hour) = 64.17 Gas volume= 0.3625 m ³ Start probe 3 at 66:17 |

Appendix 7

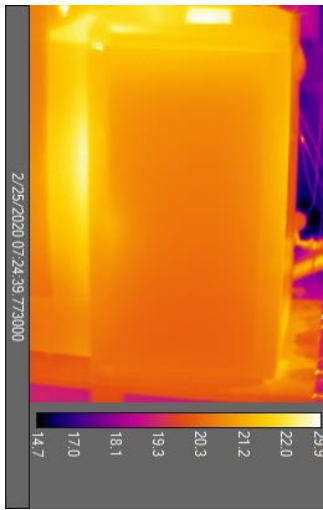
| | | | | | | | | |
|---------|----------------------|--------|--|--|--|--|--------------------------|--|
| Phase 1 | 72:50 102:50 | 512.34 | | | | | | Closed to storage tank 30 minutes. Open tank at 102:50 for 30 minutes. |
| Phase 2 | 132:50 | 505.34 | | | | | | The heat output on load side was reduced slowly down to 13 % within 10 minutes. The boiler did not cycle which means 1 cycle in phase 4. |
| Phase 3 | 252:50 297:50 | 492.65 | | | | | | The heat demand was decreased to 0 % within 5 minutes. The boiler was manually shut off as well. After 45 minutes (297:50 computer time) the heat demand load was set to 100 % (32.5 kW) and the boiler was turned on and waited for signal from the storage tanks. The boiler circulation flow was turned off because there was a flow through the boiler which gave cold water to the load side. |
| Phase 4 | 352:17 460:17 | 493.84 | | | | | | The boiler got a signal to start (purging, storage tank at 71 C, 160 F) and the heat demand was set to 0. The boiler reached its set point (storage tank at 82 C in the bottom 180 F) at time 460:17 and the boiler was switched off manually for 30 minutes. |
| Phase 5 | 490:17 | 484.65 | | | | | 987mbar/ RH 33 %/20 C | Start 100 % heat demand on load side. Because of big differences in temperature in the system the heat output fluctuated in the beginning of this phase. |
| End | 550:17 | 485.56 | | | | | | |

Test day 2, Run 2, 2020-02-25

- At least 10 hours standstill before the test
- Air velocity: 0.05 m/s
- 110 V and 60 Hz
- Static pressure induced by the draught = 1,6 Pa (at 8,5 m/s in the dilution tunnel). The boiler was still warm from run 1 at start of this test run which affects the draught in the chimney

Appendix 7

- Pstat in tunnel = 84.6 Pa



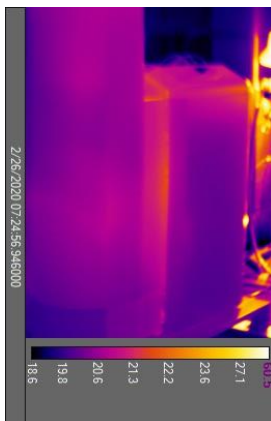
| Test | Time (computer time) | Weight (scale), kg | Probe 2 (gas meter 202743) | Probe 1 (gas meter 901070) | Probe 3 (gas meter 202743) | Ambient | barometer/humidity/temp. | Comments |
|----------|----------------------|--------------------|----------------------------|----------------------------|----------------------------|----------|--------------------------|---|
| Start up | 2:17 | 515.97 | F5+G5 | F4+G4 | F6+G6 | AF1, AG1 | 964mbar/RH 33 %/20 C | Open to storage tanks. Pump start 37:83. Close the tank at 51:83. Stable for 5 minutes Stop Probe 2 (1 hour) = 62.17 Gas volume= 0.2542 m ³ Start probe 3 at 64:17 |
| Phase 1 | 56:83 86:83 | | | | | | | Closed to storage tank 30 minutes. Open tank at 86:83 for 30 minutes. |
| Phase 2 | 116:83 | | | | | | | The heat output on load side was reduced slowly down to 13 % within 10 minutes. The boiler did not cycle which means 1 cycle in phase 4. |
| Phase 3 | 236:83 281:83 | | | | | | | The heat demand was decreased to 0 % within 5 minutes. The boiler was manually shut off as well. After 45 minutes (281:83 computer time) the heat demand load was set to 100 % (32.5 kW) and the boiler was turned on and waited for signal from the storage tanks. Difficult to have a steady state condition because of the varying temperature from the tanks! |

Appendix 7

| | | | | | | | | | |
|---------|------------------------------------|--------|--|--|--|--|--|-------------------------|--|
| Phase 4 | 319:50 453:17 | 493.15 | | | | | | | The boiler get a signal to start (purging, storage tank at 71 C) and the heat demand was set to 0. The boiler reached its set point (storage tank at 82 C in the bottom 180 F) at time 453:17 and the boiler was switched off manually for 30 minutes. |
| Phase 5 | 483:17 526:83 549:83 | | | | | | | | Start 100 % heat demand on load side. Because of the big differences in temperature in the system the heat output fluctuated in the beginning of this phase. The boiler started again within the 60 minutes (at 526:83 computer time) and the cooling water was then stopped. Storage tanks was 71 C. Cooling water started again when the boiler returned to its operating temperature (at 549:83). The boiler was then run from full load at 549:83 for 16 minutes more to complete the 60 minutes in phase 5. |
| End | 566:17 | | | | | | | 960mbar/RH 33 %/20 C | |

Test day 3, Run 3, 2020-02-26

- At least 10 hours standstill before the test
- Air velocity around the boiler and storage tanks: 0 - 0.05 m/s
- 110 V and 60 Hz
- Static pressure induced by the draught = 1.4 Pa (at 8,5 m/s in the dilution tunnel). The boiler was still warm from run 2 at start of this test run which affects the draught in the chimney
- Pstat in tunnel = 84.9 Pa



Appendix 7

| Test | Time (computer time) | Weight (scale), kg | Probe 2 (gas meter 202743) | Probe 1 (gas meter 901070) | Probe 3 (gas meter 202743) | Ambient | barometer/humidity/temp. | Comments |
|----------|----------------------------|--------------------|----------------------------|----------------------------|----------------------------|----------|--------------------------|---|
| Start up | 5:17 | 515.97 | F8+G8 | F7+G7 | F9+G9 | AF1, AG1 | 968mbar/RH 31 %/20 C | Open to storage tanks. Pump started to heat demand at 31:00. Close the tank at 42:33. Stable for 5 minutes. Stop Probe 2 (1 hour) = 65:17 Gas volume= 0.3356 m ³ Start probe 3 at 66:50 |
| Phase 1 | 48:33 | 510.56 | | | | | | Closed to storage tank 30 minutes. Open tank at 78:33 for 30 minutes. |
| Phase 2 | 108:33 | 503.34 | | | | | | The heat output on load side was reduced slowly down to 13 % within 10 minutes. The boiler did not cycle which means 1 cycle in phase 4. |
| Phase 3 | 228:33 273:33 | 492.56 | | | | | | The heat demand was decreased to 0 % within 5 minutes. The boiler was manually shut off as well. After 45 minutes (273:33 computer time) the heat demand load was set to 100 % (32.5 kW) and the boiler was turned on and waited for signal from the storage tanks. |
| Phase 4 | 348:33 482:33 512:33 | 492.97 | | | | | | The boiler got a signal to start (purging, storage tank at 71 C) and the heat demand was set to 0 %. The boiler reached its set point (storage tank at 82 C in the bottom, 180 F) at time 482:33 and the boiler was manually set in off mode for 30 minutes. |
| Phase 5 | 512:33 | 483.65 | | | | | | Start 100 % heat demand on load side. The boiler did not cycle. |
| End | 572:33 | 481.75 | | | | | | |

Appendix 8

Dilution tunnel velocity traverse measurement

The dilution tunnel inside diameter was 160 mm (6.3 inch) and cross sectional area was 0.02 m² (0.22 ft²).

Table 10. Dilution tunnel traverse

| Traverse point | % of diameter (160 mm) | Temperature, °C (F) | Velocity, m/s |
|--------------------------------------|---------------------------|------------------------|------------------|
| Y1 | 6.7 | 20.7 | 7.15 |
| Y2 | 25.0 | 20.7 | 7.80 |
| Centre | 50.0 | 20.7 | 8.33 |
| Y3 | 75.0 | 20.7 | 7.83 |
| Y4 | 93.3 | 20.7 | 7.20 |
| X1 | 6.7 | 20.6 | 7.43 |
| X2 | 25.0 | 20.6 | 8.01 |
| Centre | 50.0 | 20.7 | 8.46 |
| X3 | 75.0 | 20.7 | 8.26 |
| X4 | 93.3 | 20.7 | 7.17 |
| V _{strav} , average (Y + X) | - | - | 7.606 |
| V _{scnt} , average (Centre) | - | - | 8.395 |

$$F_p = \frac{V_{strav}}{V_{scnt}} = \frac{7.61}{8.40} = 0.9060$$

The F_p factor has been included in the calculations of the particulate matter.

Instrumentation and uncertainty

Measuring instruments

The designations listed below refer to RISE quality system

| | |
|--|------------------|
| Resistance thermometer, PT-100 | ETf-QD Db 2 |
| Thermocouple, type K | ETf-QD-Db 3 |
| Water flow meter Valmet 9V-MP150 (load side) | Inv.no. 200 783 |
| Water flow meter Valmet 9V-MP150 (supply side) | Inv.no. 201 655 |
| Data logging system | Inv. no. 202 561 |
| Atmospheric pressure | Inv.no. 701 275 |
| Scale Mettler (filter weighing) | Inv.no. BX7 2435 |
| Particulate sampling equipment (Train 1) | Inv.no. 901 070 |
| Particulate sampling equipment (Train 2, probe 2 and 3) | Inv.no. 202 743 |
| Particulate sampling equipment (ambient) | Inv.no. 200 721 |
| Differential pressure gauge Furness FCO 14 (static pressure) | Inv.no. 200 628 |
| Differential pressure gauge Furness FCO 12 (Dynamic pressure tunnel) | Inv.no. 202 638 |
| CO/CO ₂ - analyser XStream (CO 0-2000 ppm) | Inv.no. 901 073 |
| O ₂ -analyser PMA 10 | Inv.no. 202 589 |
| Humidity gauge Vaisala HMP 125B | Inv.no 201 670 |

Uncertainty of measurement

Table 11. Uncertainty of measurements

| | Uncertainty |
|--------------------------------------|----------------|
| Temperature difference, load side | ± 0.05 °C |
| Flue gas temperature | ± 1 °C |
| Ambient temperature | ± 1 °C |
| Static pressure in chimney | ± 10 % |
| Relative humidity in dilution tunnel | ± 1 % RH |
| Liquide flow, load side | ± 1 %-of flow |
| Fuel quantity | ± 0.01 kg |
| PM filter weight | ± 0.1 mg |
| CO-concentration | ± 49 ppm |
| CO ₂ -concentration | ± 0.4 %-points |
| Boiler efficiency ¹ | ± 2 %-points |

Appendix 9

¹ The efficiency uncertainty of the system (boiler, storage tank and piping) have not been calculated but is most likely significantly higher.

The uncertainty has been calculated according to EA-4/16 with coverage factor k=2

Calibration gases

The calibration gases for calibrating the gas analyser were accredited and delivered by Air Liquide. Oxygen calibration was performed at zero and span (21 %) points.

Table 12. Calibration gases

| | Concentration | Uncertainty | Id. No. |
|-----------------|---------------|-------------|---------|
| CO | 1742 mol-ppm | 1.0 % rel. | NoK9E36 |
| CO ₂ | 15.89 mol-% | 1.0 % rel. | NoK9E36 |

In table 13 the uncertainty of particulate emissions are calculated according to appendix x1 in ASTM 2515-11. The measured value is an average from the two sample probes. The uncertainty is calculated at a 95 % confidence level.

Table 13. Particulate emission uncertainty.

| Test category | Measured value | Uncertainty |
|--------------------------------------|----------------|-------------|
| Particulates (E _T) Run 1 | 6.9 g | ± 0,33 g |
| Particulates (E _T) Run 2 | 5.4 g | ± 0.34 g |
| Particulates (E _T) Run 3 | 6.4 g | ± 0.32 g |

Appendix 10

Test setup

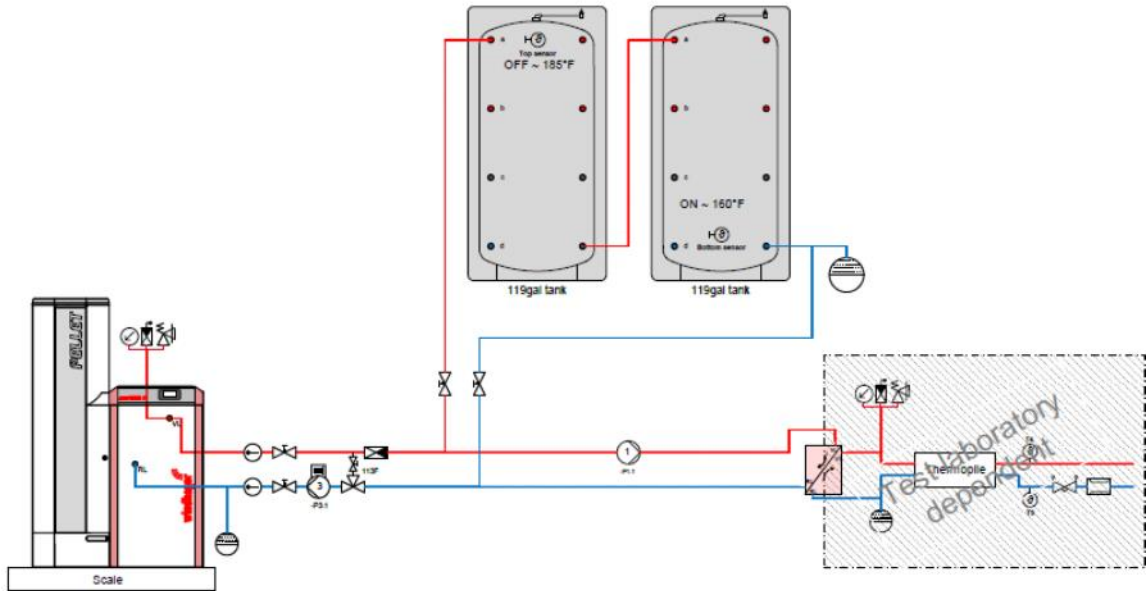


Figure 3a. Test rig

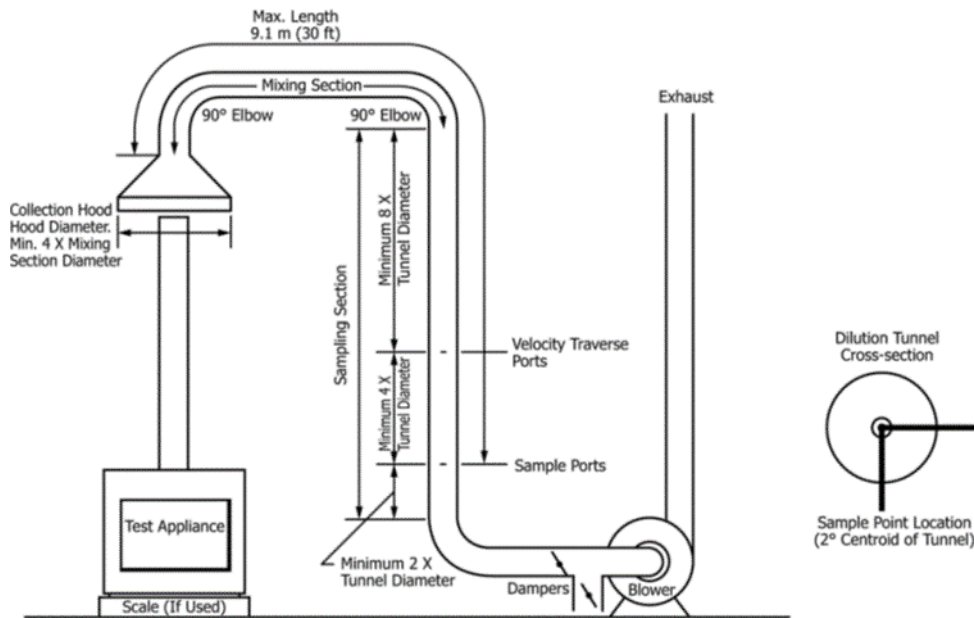


Figure 3b. Dilution tunnel

Appendix 11

Calibrations

Calibration of manometer for dynamic pressure in dilution tunnel



KALIBRERINGSBEVIS

Datum 2019-05-07
Beteckning ETK9P00564-K02

Sida 2 (3)

Tabell 1. Kalibreringsresultat Mätområde 0- 200 Pa.

| Referens Verkligt tryck [Pa] | Objekt | | |
|------------------------------------|----------------------|--------------------|----------------------|
| | Avläst tryck [Pa] | Korrektion [Pa] | Mätosäkerhet [Pa] |
| 0,0 | 0,0 | 0,0 | ±0,31 |
| 2,0 | 2,0 | 0,0 | ±0,31 |
| 6,0 | 6,0 | 0,0 | ±0,31 |
| 10,1 | 10,0 | 0,1 | ±0,31 |
| 20,3 | 20,0 | 0,3 | ±0,31 |
| 30,2 | 30,0 | 0,2 | ±0,31 |
| 40,3 | 40,0 | 0,3 | ±0,31 |
| 50,3 | 50,0 | 0,3 | ±0,31 |
| 100,5 | 100,0 | 0,5 | ±0,31 |
| 150,9 | 150,0 | 0,9 | ±0,31 |
| 200,3 | 199,0 | 1,3 | ±0,41 |
| 0,0 | 0,0 | 0,0 | ±0,31 |
| 200,3 | 199,0 | 1,3 | ±0,41 |
| 0,0 | 0,0 | 0,0 | ±0,31 |
| 200,3 | 199,0 | 1,3 | ±0,41 |
| 0,0 | 0,0 | 0,0 | ±0,31 |

Calibration of manometer for static pressure in chimney



KALIBRERINGSBEVIS

Datum 2019-09-24
Beteckning ETK9P00564-K13

Sida 2 (3)

Tabell 1.
Kalibreringsresultat 0-200 Pa.

| Referens Verkligt tryck [Pa] | Objekt | | |
|------------------------------------|----------------------|--------------------|----------------------|
| | Avläst tryck [Pa] | Korrektion [Pa] | Mätosäkerhet [Pa] |
| 0,0 | 0,0 | 0,0 | ±0,31 |
| 2,0 | 2,0 | 0,0 | ±0,31 |
| 5,9 | 6,0 | -0,1 | ±0,31 |
| 10,0 | 10,0 | 0,0 | ±0,31 |
| 20,0 | 20,0 | 0,0 | ±0,31 |
| 30,1 | 30,0 | 0,1 | ±0,31 |
| 40,1 | 40,0 | 0,1 | ±0,31 |
| 50,1 | 50,0 | 0,1 | ±0,31 |
| 100,3 | 100,0 | 0,3 | ±0,31 |
| 150,7 | 150,0 | 0,7 | ±0,31 |
| 199,9 | 199,0 | 0,9 | ±0,41 |
| 0,0 | 0,1 | -0,1 | ±0,31 |
| 199,9 | 199,0 | 0,9 | ±0,41 |
| 0,0 | 0,1 | -0,1 | ±0,31 |
| 200,0 | 199,0 | 1,0 | ±0,41 |
| 0,0 | 0,1 | -0,1 | ±0,31 |



Calibration of gas meter sampling train 1



KALIBRERINGSBEVIS

Datum 2019-06-18
Beteckning ETk9P00564-K07

Sida 2 (2)

Tabell 1. Kalibreringsresultat.

| Referens | Objekt betingelser | | | Objekt | | | | |
|------------------|--------------------|-------------------|-------------|--------------|------------------|----------------|------------|-------------|
| | Verkligt flöde | Temperatur | Gasdensitet | Avläst volym | Avläst tid | Beräknat flöde | Korrektion | Måttolerans |
| l/m ³ | [°C] | kg/m ³ | l | s | l/m ³ | [%] | [%] | |
| 0.200 | 24.0 | 1.166 | 20.0 | 362.8 | 0.198 | 1.0 | ± 1.1 | |
| 0.490 | 24.0 | 1.166 | 40.0 | 299.4 | 0.481 | 1.8 | ± 0.98 | |
| 0.983 | 24.0 | 1.166 | 80.0 | 297.9 | 0.967 | 1.9 | ± 0.93 | |
| 1.77 | 24.0 | 1.166 | 160.0 | 313.0 | 1.71 | 2.4 | ± 0.92 | |
| 2.85 | 24.0 | 1.166 | 300.0 | 259.9 | 2.77 | 2.8 | ± 0.92 | |

Kalibreringsgas: Luft

Angivna gasflöden avser volymflöden in i objektet vid aktuella kalibreringsbetingelser

$$\dot{V}_{\text{Beräknat}} = \frac{V_{\text{Avläst}}}{t}$$

$$\dot{V}_{\text{Verkligt}} = \dot{V}_{\text{Beräknat}} \cdot \left(1 + \frac{\dot{V}_{\text{Korrektion}}}{100} \right)$$

där

- $V_{\text{Avläst}}$ Avläst gasvolym
- t Avläst mättid
- $\dot{V}_{\text{Beräknat}}$ Beräknat volymflöde
- $\dot{V}_{\text{Korrektion}}$ Korrektion vid beräknat volymflöde
- $\dot{V}_{\text{Verkligt}}$ Verkligt volymflöde

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Harriet Standar

Fredrik Niklasson

Calibration of gas meter sampling trains 2 and 3



KALIBRERINGSBEVIS

Datum 2019-06-18
Beteckning ETk9P00564-K06

Sida 2 (2)

Tabell 1. Kalibreringsresultat.

| Referens | Objekt betingelser | | | Objekt | | | | |
|------------------|--------------------|-------------------|-------------|--------------|------------------|----------------|------------|-------------|
| | Verkligt flöde | Temperatur | Gasdensitet | Avläst volym | Avläst tid | Beräknat flöde | Korrektion | Måttolerans |
| l/m ³ | [°C] | kg/m ³ | l | s | l/m ³ | [%] | [%] | |
| 0.201 | 23.8 | 1.167 | 20.0 | 351.3 | 0.205 | -1.9 | ± 1.1 | |
| 0.494 | 23.8 | 1.167 | 40.0 | 286.8 | 0.502 | -1.6 | ± 0.98 | |
| 0.978 | 23.7 | 1.167 | 80.0 | 290.8 | 0.991 | -1.2 | ± 0.93 | |
| 1.68 | 23.7 | 1.167 | 140.0 | 297.8 | 1.69 | -0.7 | ± 0.92 | |
| 2.85 | 23.7 | 1.167 | 300.0 | 253.5 | 2.84 | 0.2 | ± 0.92 | |

Kalibreringsgas: Luft

Angivna gasflöden avser volymflöden in i objektet vid aktuella kalibreringsbetingelser

$$\dot{V}_{\text{Beräknat}} = \frac{V_{\text{Avläst}}}{t}$$

$$\dot{V}_{\text{Verkligt}} = \dot{V}_{\text{Beräknat}} \cdot \left(1 + \frac{\dot{V}_{\text{Korrektion}}}{100} \right)$$

där

- $V_{\text{Avläst}}$ Avläst gasvolym
- t Avläst mättid
- $\dot{V}_{\text{Beräknat}}$ Beräknat volymflöde
- $\dot{V}_{\text{Korrektion}}$ Korrektion vid beräknat volymflöde
- $\dot{V}_{\text{Verkligt}}$ Verkligt volymflöde

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2019-06-18 13:34:18 -02:00

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Appendix 11

Calibration of gas meter blank probe (ambient)



KALIBRERINGSBEVIS

Datum 2019-09-20
Beskrivning ETk9P00564-K11

Sida 2 (2)

Tabell 1. Kalibreringsresultat.

| Beräknat Verkligt flöde | Objekt betingelser | | | Objekt | | | |
|-------------------------|--------------------|-------------|--------------|------------|----------------|------------|--------------|
| | Temperatur | Gasdensitet | Avläst volym | Avläst tid | Beräknat flöde | Korrektion | Mätosäkerhet |
| [l/min] | [°C] | [kg/m³] | [l] | [s] | [l/min] | [%] | [%] |
| 0,640 | 22,2 | 1,382 | 6,0 | 608,5 | 0,592 | 8,1 | ± 2,2 |
| 1,27 | 22,2 | 1,382 | 8,0 | 392,6 | 1,22 | 4,0 | ± 1,8 |
| 2,60 | 22,2 | 1,381 | 12,0 | 283,4 | 2,54 | 2,3 | ± 1,6 |
| 5,11 | 22,4 | 1,381 | 20,0 | 239,9 | 5,00 | 2,2 | ± 1,1 |
| 7,56 | 22,4 | 1,381 | 40,0 | 326,7 | 7,35 | 2,9 | ± 0,98 |
| 10,1 | 22,4 | 1,381 | 60,0 | 307,7 | 9,79 | 3,3 | ± 0,94 |

Kalibreringsgas: Luft

Angivna gasflöden avser volymflöden in i objektet vid aktuella kalibreringsbetingelser

$$V_{\text{Beräknat}} = \frac{V_{\text{Avläst}}}{t}$$

$$V_{\text{Verkligt}} = V_{\text{Beräknat}} \cdot \left(1 + \frac{V_{\text{Korrektion}}}{100}\right)$$

där

- $V_{\text{Avläst}}$ Avläst gasvolym
- t Avläst mätid
- $V_{\text{Beräknat}}$ Beräknat volymflöde
- $V_{\text{Korrektion}}$ Korrektion vid beräknat volymflöde
- V_{Verkligt} Verkligt volymflöde

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Energi och cirkulär ekonomi - Hållbara energisystem

Utgett av

Omsett av

Hans Stenbo Signed by: Hans Stenbo
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2019-09-20 11:17:40.00

Frank Nilsson Signed by: Frank Nilsson
I have read and approved this document
2019-09-28 15:31:27:40.00

Calibration of scale



KALIBRERINGSBEVIS

Datum 2018-06-12
Beskrivning KVj1718 062

Sida 2 (2)

Resultat

(Resultaten avser endast de föremål som är specificerade i detta dokument)

Före varje belastning har vägen nollställt

Efter intrimning med vägens inbyggda vikt

| Belastning, g | Avläst på väg, g | Mätosäkerhet, %g |
|---------------|------------------|------------------|
| 5 | 5,00001 | 0,00001 |
| 20 | 20,00002 | 0,00003 |
| 40 | 40,00000 | 0,00005 |
| 60 | 60,00001 | 0,00006 |
| 80 | 80,00005 | 0,00007 |
| 150 | 150,0001 | 0,0002 |
| 200 | 200,0001 | 0,0002 |

Samtliga avlästa värden är angivna som medelvärde baserat på tre mätningar.

Excentriskt placerad last

| Belastningspunkt | Belastning, g | Avläst på väg, g |
|------------------|---------------|------------------|
| 1 | 100 | 99,9996 |
| 2 | 100 | 100,0000 |
| 3 | 100 | 99,9995 |
| 4 | 100 | 99,9995 |
| 5 | 100 | 100,0002 |



Mätosäkerhet

Den angivna utvidgade mätosäkerheten är produkten av standardmätosäkerhet och täckningsfaktorn $k = 2$, vilket för en normalfördelning svarar mot en sannolikhet av ungefär 95 %. Standardmätosäkerheten har bestämts i enlighet med EAL:s publikation EA-4/02.

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Kalibrering och Verifiering

Utgett av

Niklas Sund Signed by: Niklas Sund
I have read and approved this document
2018-06-12 07:46:36:40.00

Niklas Sund



Appendix 11

Calibration of flow meter on load side

| FLÖDESMÄTARE: Valmet 9V MP115 | | | | Inv.nr. 200 783 | | | DATUM: 2019-08-15 | | | | SIGN.: MJ | |
|--|--------|-------|--------|-------------------|-----------------|-------------------|------------------------|-------------------|------------|-------------------|---------------|----------------|
| Normal: Flödeskalibrator Inv.nr. 200 083 | | | | | | | | | | | | |
| TEMP. | PULSER | TID | MASSA | DENSITET | VOLYM | VERKL. FLÖDE | NOM. MÄTAR-KONSTANT | UPPMÄTT FLÖDE | KORREKTION | KORREKTION | MÄT-OSÄKERHET | NOTERINGAR |
| °C | st | s | kg | kg/m ³ | dm ³ | m ³ /h | pulser/dm ³ | m ³ /h | % | m ³ /h | % | |
| 51,6 | 290763 | 601,8 | 50,14 | 987,3 | 50,84 | 0,304 | 5760 | 0,302 | 0,71 | 0,0022 | 0,22 | Flygande start |
| 50,5 | 292219 | 608,5 | 50,41 | 987,8 | 51,08 | 0,302 | 5760 | 0,300 | 0,69 | 0,0021 | 0,22 | |
| 50,3 | 291289 | 607,6 | 50,25 | 987,9 | 50,92 | 0,302 | 5760 | 0,300 | 0,68 | 0,0020 | 0,22 | |
| | | | | | | 0,303 | | 0,301 | 0,69 | 0,0021 | | |
| 50,3 | 581910 | 633,9 | 100,51 | 987,9 | 101,85 | 0,578 | 5760 | 0,574 | 0,81 | 0,0047 | 0,22 | Flygande start |
| 50,3 | 582258 | 634,2 | 100,57 | 987,9 | 101,91 | 0,578 | 5760 | 0,574 | 0,82 | 0,0047 | 0,22 | |
| 50,3 | 583168 | 635,4 | 100,72 | 987,9 | 102,06 | 0,578 | 5760 | 0,574 | 0,81 | 0,0046 | 0,22 | |
| | | | | | | 0,578 | | 0,574 | 0,81 | 0,0047 | | |
| 50,1 | 588252 | 360,3 | 101,60 | 988,0 | 102,95 | 1,029 | 5760 | 1,020 | 0,80 | 0,0082 | 0,28 | Flygande start |
| 50,3 | 586293 | 358,9 | 101,21 | 987,9 | 102,56 | 1,029 | 5760 | 1,021 | 0,76 | 0,0077 | 0,22 | |
| 50,4 | 587286 | 359,6 | 101,32 | 987,9 | 102,68 | 1,028 | 5760 | 1,021 | 0,71 | 0,0072 | 0,24 | |
| | | | | | | 1,028 | | 1,021 | 0,76 | 0,0077 | | |
| 50,4 | 591876 | 249,3 | 102,14 | 987,9 | 103,51 | 1,495 | 5760 | 1,484 | 0,73 | 0,0109 | 0,24 | Flygande start |
| 50,5 | 595864 | 250,9 | 102,79 | 987,8 | 104,17 | 1,494 | 5760 | 1,484 | 0,70 | 0,0103 | 0,26 | |
| 50,6 | 591792 | 249,5 | 102,06 | 987,8 | 103,43 | 1,493 | 5760 | 1,483 | 0,67 | 0,0100 | 0,23 | |
| | | | | | | 1,494 | | 1,483 | 0,70 | 0,0104 | | |
| 50,6 | 601561 | 187,7 | 103,80 | 987,8 | 105,20 | 2,017 | 5760 | 2,003 | 0,73 | 0,0145 | 0,25 | Flygande start |
| 50,7 | 597746 | 186,7 | 103,09 | 987,7 | 104,48 | 2,014 | 5760 | 2,001 | 0,68 | 0,0137 | 0,28 | |
| 50,8 | 598177 | 186,9 | 103,23 | 987,7 | 104,64 | 2,016 | 5760 | 2,000 | 0,76 | 0,0151 | 0,23 | |
| | | | | | | 2,016 | | 2,001 | 0,72 | 0,0144 | | |
| 50,8 | 605361 | 133,1 | 104,34 | 987,7 | 105,75 | 2,859 | 5760 | 2,842 | 0,62 | 0,0177 | 0,22 | Flygande start |
| 50,8 | 601273 | 132,8 | 103,66 | 987,7 | 105,07 | 2,848 | 5760 | 2,829 | 0,66 | 0,0185 | 0,22 | |
| 50,9 | 605178 | 133,7 | 104,31 | 987,7 | 105,72 | 2,846 | 5760 | 2,828 | 0,63 | 0,0177 | 0,22 | |
| | | | | | | 2,851 | | 2,833 | 0,64 | 0,0180 | | |

Mätosäkerhet för normalen ±0,3% vid normala tillämpningar. Se ETL-QD annex D B1.

| Flöde | Korrektion | Flöde | Korrektion |
|-------|------------|-------|------------|
| 20 °C | | 20 °C | |
| 0,301 | 0,69 | 0,301 | 0,0021 |
| 0,574 | 0,81 | 0,574 | 0,0047 |
| 1,021 | 0,76 | 1,021 | 0,0077 |
| 1,483 | 0,70 | 1,483 | 0,0104 |
| 2,001 | 0,72 | 2,001 | 0,0144 |
| 2,833 | 0,64 | 2,833 | 0,0180 |

Calibration of temperature sensors on load side (PT-100)

| Tempgivare | | Kalibrering av temperaturgivare/instrument | | | | |
|----------------------------------|------------|--|--------------|------------|------------|--------------|
| 1 = Givare 4T1 Kanal A Sprit | | Instruktion ET vvs 002 | | | | |
| 2 = Givare 4T2 Kanal B Vatten | | Referens: | | | | |
| 401 = Givare 0401 Kanal A Sprit | | Kalibreringsobjekt | | | | |
| 402 = Givare 0402 Kanal B Vatten | | Kalibreringsbad Heto + Systemteknik S1220 | | | | |
| | | K alibrerad 2019-08-16 | | | | |
| | | Inv. nr 200 437+200 076+202 108 | | | | |
| | | PT01-VV1 | | | | |
| | | Datorvagn TIGER kanal 1102 | | | | |
| | | Inv. nr | | | | |
| | Visad temp | Korrektion | Verdlig temp | Visad temp | Korrektion | Mätosäkerhet |
| | °C | °C | °C | °C | °C | °C |
| 2 | 29,900 | 0,092 | 29,992 | 30,16 | -0,17 | ±0,07 |
| 2 | 39,918 | 0,106 | 40,024 | 40,21 | -0,19 | ±0,07 |
| 2 | 49,873 | 0,117 | 49,990 | 50,19 | -0,20 | ±0,07 |
| 2 | 59,858 | 0,128 | 59,986 | 60,20 | -0,22 | ±0,07 |
| 2 | 69,850 | 0,145 | 69,995 | 70,23 | -0,24 | ±0,07 |
| 2 | 79,845 | 0,163 | 80,008 | 80,26 | -0,26 | ±0,07 |

Verdlig temp = Visad temp + Korrektion

Datum: 190909

Signatur: HP



Appendix 11

| Tempgivare | | Kalibrering av temperaturgivare/instrument | | | | |
|---|---------------|--|-----------------|---------------|---------------|-----------------|
| 1 = Givare 4T1 Kanal A Sprit | | Instruktion ET vvs 002 | | | | |
| 2 = Givare 4T2 Kanal B Vatten | | | | | | |
| 401 = Givare 0401 Kanal A Sprit | | | | | | |
| 402 = Givare 0402 Kanal B Vatten | | | | | | |
| Referens | | Kalibreringsobjekt | | | | |
| Kalibreringsbad Heto + Systemteknik S1220 | | PT04-VV3 | | | | |
| K alibrerad 2019-08-16 | | Datorvagn TIGER kanal 1103 | | | | |
| Inv. nr 200 437+200 076+202 108 | | Inv. nr | | | | |
| | Visad temp °C | Korrektion °C | Verdlig temp °C | Visad temp °C | Korrektion °C | Mätosäkerhet °C |
| 2 | 29,900 | 0,092 | 29,992 | 29,83 | 0,16 | ±0,07 |
| 2 | 39,918 | 0,106 | 40,024 | 39,86 | 0,16 | ±0,07 |
| 2 | 49,873 | 0,117 | 49,990 | 49,82 | 0,17 | ±0,07 |
| 2 | 59,858 | 0,128 | 59,986 | 59,82 | 0,17 | ±0,07 |
| 2 | 69,850 | 0,145 | 69,995 | 69,83 | 0,17 | ±0,07 |
| 2 | 79,845 | 0,163 | 80,008 | 79,85 | 0,16 | ±0,07 |
| Verdlig temp = Visad temp + Korrektion | | | | | | |
| Datum: 190909 | | | | | | |
| Signatur: HP | | | | | | |

Calibration of temperature sensors on supply side

| Tempgivare | | Kalibrering av temperaturgivare/instrument | | | | |
|---|---------------|--|-----------------|---------------|---------------|-----------------|
| 1 = Givare 4T1 Kanal A Sprit | | Instruktion ET vvs 002 | | | | |
| 2 = Givare 4T2 Kanal B Vatten | | | | | | |
| 401 = Givare 0401 Kanal A Sprit | | | | | | |
| 402 = Givare 0402 Kanal B Vatten | | | | | | |
| Referens | | Kalibreringsobjekt | | | | |
| Kalibreringsbad Heto + Systemteknik S1220 | | Mätvagn Tiger Kanal 1302 | | | | |
| K alibrerad 2019-08-16 | | | | | | |
| Inv. nr 200 437+200 076+202 108 | | Inv. nr Tal top | | | | |
| | Visad temp °C | Korrektion °C | Verdlig temp °C | Visad temp °C | Korrektion °C | Mätosäkerhet °C |
| 2 | 24,932 | 0,086 | 25,018 | 25,00 | 0,02 | ±0,07 |
| 2 | 29,939 | 0,092 | 30,031 | 30,00 | 0,03 | ±0,07 |
| 2 | 39,903 | 0,106 | 40,009 | 40,00 | 0,01 | ±0,07 |
| 2 | 49,880 | 0,117 | 49,997 | 50,00 | 0,00 | ±0,07 |
| 2 | 59,863 | 0,128 | 59,991 | 59,90 | 0,09 | ±0,07 |
| 2 | 69,883 | 0,145 | 70,028 | 69,90 | 0,13 | ±0,07 |
| 2 | 79,837 | 0,163 | 80,000 | 79,80 | 0,20 | ±0,07 |
| Verdlig temp = Visad temp + Korrektion | | | | | | |
| Datum: 2020-01-03 | | | | | | |
| Signatur: HP | | | | | | |

Appendix 11

| Tempgivare | | Kalibrering av temperaturgivare/instrument | | | | | |
|--|---------------|--|-----------------|---------------|---------------|-----------------|--|
| 1 = Givare 4T1 Kanal A Sprit | | Instruktion: ET vvs 002 | | | | | |
| 2 = Givare 4T2 Kanal B Vatten | | Referens | | | | | |
| 401 = Givare 0401 Kanal A Sprit | | Kalibreringsobjekt | | | | | |
| 402 = Givare 0402 Kanal B Vatten | | Kalibreringsbad Heto + Systemteknik S1220 | | | | | |
| | | Mätvärden Tämär Kanal 1305 | | | | | |
| | | Kalibrerad 2019-08-16 | | | | | |
| | | Inv. nr 200 437+200 076+202 108 | | | | | |
| | | Inv. nr Ta2 bottom | | | | | |
| | Visad temp °C | Korrektion °C | Verdlig temp °C | Visad temp °C | Korrektion °C | Mätosäkerhet °C | |
| 2 | 24,932 | 0,086 | 25,018 | 25,00 | 0,02 | ±0,07 | |
| 2 | 29,939 | 0,092 | 30,031 | 30,00 | 0,03 | ±0,07 | |
| 2 | 39,903 | 0,106 | 40,009 | 40,00 | 0,01 | ±0,07 | |
| 2 | 49,880 | 0,117 | 49,997 | 50,00 | 0,00 | ±0,07 | |
| 2 | 59,863 | 0,128 | 59,991 | 59,90 | 0,09 | ±0,07 | |
| 2 | 69,883 | 0,145 | 70,028 | 70,00 | 0,03 | ±0,07 | |
| 2 | 79,837 | 0,163 | 80,000 | 79,90 | 0,10 | ±0,07 | |
| Verdlig temp = Visad temp + Korrektion | | | | | | | |
| Datum: 2020-01-03 | | | | | | | |
| Signatur: HP | | | | | | | |

Calibration of humidity gauge



KALIBRERINGSBEVIS

Datum 2020-01-20
Bilagsnummer 104104-9P00566-K143

Sida 2 (2)

Resultat

Resultaten vid de av uppdragsgivaren beställda fuktnivåerna presenteras i tabell 1 där även mätosäkerhet för korrektionerna anges för respektive punkt. Avlästa värden i tabell 1 och i diagram, motsvarar spänningsutsignal samt beräkning enligt redovisad ekvation. I bilaga 1 redovisas kalibreringsresultaten i diagramform.

Tabell 1

| Mätning Nr | Laboratoriereferens | | | | Provobjekt | | |
|------------|---------------------|----------------------|-----------------------|------------|----------------|----------|---------------------------|
| | Mätvärden | | | | Avlästa värden | Beräknad | Korrektion |
| | t _{amb} °C | t _{dagg} °C | t _{frost} °C | φ %rh | V | φ %rh | φ _{beräknad} %rh |
| 1 | 20,00 ± 0,15 | -6,95 ± 0,16 | -6,17 ± 0,16 | 15,5 ± 0,3 | 1,701 | 14,34 | 1,19 ± 0,26 |
| 2 | 19,95 ± 0,15 | -12,52 ± 0,16 | -11,16 ± 0,16 | 10,1 ± 0,3 | 1,196 | 9,31 | 0,74 ± 0,26 |
| 3 | 19,96 ± 0,15 | -18,70 ± 0,16 | -16,75 ± 0,16 | 6,0 ± 0,3 | 0,778 | 5,15 | 0,87 ± 0,26 |
| 4 | 29,95 ± 0,15 | 28,22 ± 0,16 | - | 90,5 ± 1,3 | 9,298 | 89,98 | 0,47 ± 1,31 |
| 5 | 30,19 ± 0,15 | 18,46 ± 0,16 | - | 49,5 ± 0,7 | 5,325 | 50,43 | -0,93 ± 0,72 |
| 6 | 29,99 ± 0,15 | -4,82 ± 0,16 | -4,27 ± 0,16 | 10,1 ± 0,3 | 1,226 | 9,62 | 0,45 ± 0,26 |

t_{amb} Omgivningstemperaturen runt givarens mät kropp.
 t_{dagg} Daggpunkten vid givarens mät kropp (kondenserar som vatten).
 t_{frost} Frostpunkten vid givarens mät kropp (kondenserar som frost).
 φ Relativa fukthalten vid givarens mät kropp.

$$\phi_{beräknad} = A \cdot utsignal + B$$

A = 9,956

B = -2,59

$$\phi_{verklig} = \phi_{beräknad} + \phi_{kor}.$$

Verkligt värde = avläst värde + korrektion.

RISE Research Institutes of Sweden AB
 Energi och cirkulär ekonomi - Hållbara energisystem

Utfört av

Granskat av

Gunilla Karlsson
 Gunilla Karlsson

Signed by: Gunilla Karlsson
 Printed: 2020-01-20 12:11:18 AM
 Date & Time: 2020-01-20 12:11:18 AM

Per Jacobsson
 Per Jacobsson

Signed by: Per Jacobsson
 Printed: 2020-01-20 12:11:18 AM
 Date & Time: 2020-01-20 12:11:18 AM



Appendix 12

Fuel analyse



ASG
Analytik-Service
Gesellschaft

ASG Analytik-Service Gesellschaft mbH
Trentiner Ring 30 • 86356 Neusäss • Germany

Windhager Zentralheizung Technik GmbH
Anton-Windhager-Straße 20
5201 Seekirchen am Wallersee
ÖSTERREICH

Ihr Zeichen : Handlechner
Ihr Auftrag : Brief
Ihr Auftrag vom : 19.02.2019
Eingegangen am : 20.02.2019
Probenahme : Kunde
Beginn der Prüfung(en) : 21.02.2019
Ende der Prüfung(en) : 13.03.2019
Prüfbericht vom : 13.03.2019
Seite : 1 von 2

Prüfbericht: 2701433-2

| Prüfmuster | ASG-ID | Prüfparameter | Prüfmethode | Prüfresultat | Einheit | |
|---|-------------|------------------------|---------------------------------|---------------------|-------------|----------|
| RZ-Sackware Lieferung vom 30.01.2019 / Produktion Y1402919 | 2701433_001 | Wassergehalt (Feuchte) | DIN EN ISO 18134-2 :2017 | 7,2 | % (m/m) roh | |
| | | Heizwert (Hu.p) | DIN EN ISO 18125 mod. :2017 (a) | 17360 | J/g roh | |
| | | Aschegehalt (550 °C) | DIN EN ISO 18122 :2016 | 0,4 | % (m/m) wf | |
| | | Kohlenstoffgehalt | DIN EN ISO 16948 :2015 | 51,1 | % (m/m) wf | |
| | | Wasserstoffgehalt | | 6,57 | % (m/m) wf | |
| | | Stickstoffgehalt | | <0,2 | % (m/m) wf | |
| | | Chlorgehalt | DIN EN ISO 16994 :2016 | 0,005 | % (m/m) wf | |
| | | Arsen (As) | DIN EN ISO 16968 :2015 | <0,5 | mg/kg wf | |
| | | Cadmium (Cd) | | <0,5 | mg/kg wf | |
| | | Chrom (Cr) | | <1 | mg/kg wf | |
| | | Kupfer (Cu) | | <1 | mg/kg wf | |
| | | Quecksilber (Hg) | | <0,05 | mg/kg wf | |
| | | Nickel (Ni) | | <1 | mg/kg wf | |
| | | Blei (Pb) | | <10 | mg/kg wf | |
| | | Zink (Zn) | | 8 | mg/kg wf | |
| | | Mangan (Mn) | | 98 | mg/kg wf | |
| | | Eisen (Fe) | | 8 | mg/kg wf | |
| | | Aluminium (Al) | DIN EN ISO 11885 :2009 (a) | 13 | mg/kg wf | |
| | | Magnesium (Mg) | | 82 | mg/kg wf | |
| | | Kalium (K) | | 360 | mg/kg wf | |
| | | Natrium (Na) | | 19 | mg/kg wf | |
| | | Calcium (Ca) | | 810 | mg/kg wf | |
| | | Phosphor (P) | | 39 | mg/kg wf | |
| | | Schwefel (S) | | 56 | mg/kg wf | |
| | | Silicium (Si) | | 200 | mg/kg wf | |
| | | Stickstoffgehalt | | DIN 51444 :2003 (a) | 670 | mg/kg wf |

roh = im Anlieferungszustand
wf = wasserfrei

Karen Kirchhübel

Karen Kirchhübel (stellv. Laborleiterin)

(a) Dieses Prüfverfahren ist nicht Bestandteil der Akkreditierungsurkunde.
Dieser Prüfbericht ersetzt Prüfbericht 2701433-1.
Dieser Prüfbericht bezieht sich ausschließlich auf die untersuchten Prüfmuster und darf nicht ohne Genehmigung des Prüflaboratoriums auszugsweise vervielfältigt werden. Aufbewahrung der Prüfmuster: 4 Wochen ab Datum des Prüfberichts.
Weitere Informationen siehe allg. Geschäftsbedingungen unter www.asg-analytik.de. Akkreditiert nach DIN EN ISO / IEC 17025.



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General Manager:
Dr. Th. Wiharm, J. Bernath
Amtsgericht Augsburg HRB 12297



Appendix 12



ASG
Analytik-Service
Gesellschaft

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Prüfbericht: 2701433-2

| Prüfmuster | ASG-ID | Prüfparameter | Prüfmethode | Prüfergebnis | Einheit |
|---|---------------------|------------------------|---------------------------------|--------------|-------------|
| RZ-Sackware Lieferung vom 30.01.2019 / Produktion Y1502919 | 2701433_002 | Wassergehalt (Feuchte) | DIN EN ISO 18134-2 :2017 | 8,8 | % [m/m] roh |
| | | Heizwert (Hu,p) | DIN EN ISO 18125 mod. :2017 (a) | 17030 | J/g roh |
| | | Aschegehalt (550 °C) | DIN EN ISO 18122 :2016 | 0,4 | % [m/m] wf |
| | | Kohlenstoffgehalt | DIN EN ISO 16948 :2015 | 50,9 | % [m/m] wf |
| | | Wasserstoffgehalt | | 6,45 | % [m/m] wf |
| | | Stickstoffgehalt | | <0,2 | % [m/m] wf |
| | | Chlorgehalt | DIN EN ISO 16994 :2016 | 0,004 | % [m/m] wf |
| | | Arsen (As) | DIN EN ISO 16968 :2015 | <0,5 | mg/kg wf |
| | | Cadmium (Cd) | | <0,5 | mg/kg wf |
| | | Chrom (Cr) | | <1 | mg/kg wf |
| | | Kupfer (Cu) | | <1 | mg/kg wf |
| | | Quecksilber (Hg) | | <0,05 | mg/kg wf |
| | | Nickel (Ni) | | <1 | mg/kg wf |
| | | Blei (Pb) | | <10 | mg/kg wf |
| | | Zink (Zn) | | 9 | mg/kg wf |
| | | Mangan (Mn) | | 120 | mg/kg wf |
| | | Eisen (Fe) | | 10 | mg/kg wf |
| | | Aluminium (Al) | 8 | mg/kg wf | |
| | | Magnesium (Mg) | 99 | mg/kg wf | |
| | | Kalium (K) | DIN EN ISO 11885 :2009 (a) | 370 | mg/kg wf |
| | | Natrium (Na) | | 18 | mg/kg wf |
| | | Calcium (Ca) | | 920 | mg/kg wf |
| | | Phosphor (P) | | 40 | mg/kg wf |
| Schwefel (S) | 56 | mg/kg wf | | | |
| Silicium (Si) | 300 | mg/kg wf | | | |
| Stickstoffgehalt | DIN 51444 :2003 (a) | 610 | mg/kg wf | | |

roh = im Anlieferungszustand
wf = wasserfrei

Karen Kirchhübel

Karen Kirchhübel (stellv. Laborleiterin)

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Dieser Prüfbericht ersetzt Prüfbericht 2701433-1.
Dieser Prüfbericht bezieht sich ausschließlich auf die untersuchten Prüfmuster und darf nicht ohne Genehmigung des Prüflaboratoriums auszugsweise vervielfältigt werden. Aufbewahrung der Prüfmuster: 4 Wochen ab Datum des Prüfberichts.
Weitere Informationen siehe allg. Geschäftsbedingungen unter www.asg-analytik.de. Akkreditiert nach DIN EN ISO / IEC 17025.

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General Manager:
Dr. Th. Wilharm, J. Bernath
Amtsgericht Augsburg HRB 12297



Appendix 13

Alternative test method



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

JAN 03 2020

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Mr. Martin Westermayer
Windhager Zentralheizung Technik GmbH
Anton Windhager Straße 20
A 5201 Seekirchen

Dear Mr. Westermayer,

I am writing in response to your correspondence, dated October 22, 2019, regarding certification testing of your BioWIN series of pellet-fueled hydronic heaters. You are planning to test this model line to obtain 2020 certification under 40 CFR 60, Subpart QQQQ - Standards of Performance for New Residential Hydronic Heaters and Forced Air Furnaces (Subpart QQQQ), Section 60.5476(e). You are requesting an alternative certification testing procedure to use the Integrated Duty Cycle (IDC) Test Method for Certification of Thermostatically Controlled Pellet-Fired Hydronic Heating Appliances with external thermal storage: Measurement of Particulate Matter (PM), Carbon Monoxide (CO) Emissions and Heating Efficiency (Attachment dated 1/3/20) in lieu of the Method 28 WHH (40 CFR 60, Appendix A) procedures required by Subpart QQQQ.

In your correspondence, you are requesting an alternative certification testing procedure for your BioWIN Series of pellet-fueled hydronic heaters. This series consists of five heaters, the BioWIN 102, 152, 212, 262 and 332. You state that the pellets are either fed fully automatically with an external suction turbine from the pellet storage to the hopper, or manually fed into the hopper. The pellets are transported from the hopper by a stoker screw to the downpipe and fall in a metered quantity onto the combustion grate of the sturdy steel combustion chamber. Hot air is added by an automatic ignition element to ignite the pellets. The heat generated during combustion is used in the heat exchanger to heat the water. Flue gases produced during the combustion process are channelled outside through the chimney. The movement of the integrated cleaning mechanism cleans the heat exchanger automatically. The ash from the steel combustion chamber falls through an automatic sliding grate into an ash chamber where it is transported via an ash screw into an ash container. The boiler's output is controlled via a speed controlled inner diameter fan depending on boiler water temperature and on combustion temperature. You are requesting to use the IDC Method because EPA Method 28 WHH test procedure does not address the use of pellet fuel where as the IDC Method does include pellet fuel.

With the caveats set forth below, we are approving your alternative method request for certification testing of the BioWIN series of thermostatically-controlled hydronic heaters with the limitations explained below. This series of hydronic heaters cannot be sold with thermal storage that is less capacity than was used during certification testing. A copy of this letter must be included in each certification report.

As required in Subpart QQQQ, Section 60.5476(c)(6), the manufacturer or approved test lab must also measure the first hour of particulate matter emissions for each test run using a separate filter in one of the two parallel sampling trains. These results must be reported separately and also included in the total particulate matter emissions per run. Also, as required in Subpart QQQQ, Section 60.5476(a), the manufacturer must have the approved test laboratory measure the efficiency, heat output, and carbon monoxide emissions of the tested wood heater using CSA Method B415.1-10. For particulate matter emission concentrations, ASTM E2515-11 "Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel" must be used; four inch filters are acceptable

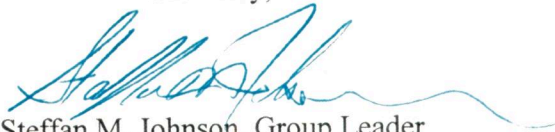
The following changes to ASTM E2515-11 "Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel" must be followed for the certification testing:

1. Filters must be weighed in pairs to reduce weighing error propagation. See ASTM E2515-11, Section 10.2.1, Analytical Procedure.
2. Sample filters must be Pall TX-40 or equivalent Teflon-coated glass fiber filters, and 47 mm, 90 mm, 100 mm, or 110 mm in diameter.
3. Only one point is allowed outside the +/- 10 percent proportionality range per test run.

The BioWIN series of hydronic heaters incorporates a low setting on the controller which is the design of the lowest heat output (Btu/hr) setting available to the user and corresponds to the lowest burn rate to be evaluated during certification testing; this is consistent with 40 CFR part 60, Subpart QQQQ, section 60.5476, which states "The burn rate for the low burn 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."

If you have additional questions regarding this approval, please contact Michael Toney of my staff at 919-541-5247 or toney.mike@epa.gov.

Sincerely,



Steffan M. Johnson, Group Leader
Measurement Technology Group

cc: Amanda Aldridge, EPA/OAQPS/OID
Adam Baumgart-Getz, EPA/OAQPS/OID
Rochelle Boyd, EPA/OAQPS/SPPD
Chuck French, EPA/OAQPS/SPPD
Rafael Sanchez, EPA/OECA
Michael Toney, EPA/OAQPS/AQAD

Integrated Duty Cycle (IDC) Test Method for Certification of Thermostatically Controlled Pellet-Fired Hydronic Heating Appliances with external thermal storage: Measurement of Particulate Matter (PM), Carbon Monoxide (CO) Emissions and Heating Efficiency

Note: This method does not include all the specifications (e.g. equipment and supplies) and procedures (e.g., sample and analytical) essential to its performance. Some material is incorporated by reference from other methods. Therefore, to obtain reliable results, persons using this method shall have a thorough knowledge of at least the following EPA Tests

- Method 1- Sample and Velocity Traverses for Stationary Sources
- Method 2- Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
- Method 3 – Gas Analysis for the Determination of Dry Molecular Weight
- Method 4 – Determination of Moisture Content in Stack Gases
- Method 5G – Determination of Particulate Matter from Appliances (Dilution Tunnel Sampling Location)
- Method 10 - Carbon Monoxide - Instrumental Analyzer

1. Scope and Application

- 1.1. This test method applies to automatic feed, wood-fired hydronic heating that utilizes an external buffer tank(s) (sometimes called thermal storage) as integral to the appliance operation. The units typically transfer heat through the circulation of a liquid heat exchange media such as water or a water-antifreeze mixture. Throughout this document, the term “water” will be used to denote any of the heat transfer liquids approved for use by the manufacturer.*
- 1.2. This test method measures particulate matter (PM) emissions, carbon monoxide, and delivered heating efficiency at specified heat demands based on the appliances rated heat capacity.*
- 1.3. Particulate emissions are measured by the dilution tunnel method as specified in ASTM E2515 *Standard Test Method for Determination of Particulate Matter Emissions Collected in a Dilution Tunnel* using only Emfab Pallflex filters. Additional particulate matter emissions measurements may also use the Tapered Element Oscillating Microbalance (TEOM) continuous PM method, as detailed in this test method.*
- 1.4. For this protocol, annual fuel use efficiency is represented by the average efficiency over the entire test run. Steady-state efficiency, which is reflective of efficiency measurements in current EPA Federal reference methods is determined by calculating the efficiency at the high load and low steady-state periods of the test run, which Phases 1, 2, and 5. Delivered efficiency is determined by measurement of the usable heat output (determined through measurement of the flow rate and temperature change of water*

circulated through a heat exchanger external to the appliance) and the heat input (determined from the mass of dry fuel burned and its higher heating value). Delivered efficiency does not attempt to account for pipeline loss.

- 1.5. Products covered by this test method include both pressurized and non-pressurized hydronic heating appliances intended to be fired with wood and for which the manufacturer specifies for indoor or outdoor installation. The system is commonly connected to a heat exchanger by insulated pipes and normally includes a pump to circulate heated liquid. These systems are used to heat structures such as homes, barns, schools, and greenhouses. They also provide heat for domestic hot water, spas, and swimming pools. These products may be used with or without external thermal storage only for the hot water service.
- 1.6. Distinguishing features of products covered by this standard include:
 - 1.6.1. The manufacturer specifies installation either inside a building or outside.
 - 1.6.2. Products that automatically feed fuels, such as pelletized wood or wood chips.
 - 1.6.3. An aquastat that controls the combustion air supply to maintain the liquid in the appliance within a predetermined temperature range.
 - 1.6.4. A chimney or vent that exhausts combustion products from the appliance.
- 1.7. The values stated are to be regarded as the standard, whether in I-P or SI units. The values given in parentheses are for information only.
- 1.8. Persons using this method should have a thorough knowledge of at least the following additional EPA test methods: Method 1, Method 2, Method 3, Method 4, Method 5, Method 5G, and Method 28.
- 1.9. Analyte. Particulate matter (PM). No CAS number assigned. Carbon monoxide (CO). No CAS number assigned.
- 1.10. Data Quality Objectives.
 - 1.10.1. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.
 - 1.10.2. Measurement of emissions and heating efficiency provides a uniform basis for comparison of product performance that is useful to the consumer. It is also required to relate emissions produced to the useful heat production.
 - 1.10.3. This is a laboratory method intended to capture operating periods that are representative of actual field use without excessive test burden.

2. Referenced Methods

- 2.1. CAN/CSA-B415.1: Performance Testing of Solid-Fuel-Burning or latest approved EPA version.
- 2.2. ASTM 2515: Standard Test Method for Determination of Particulate matter Emissions Collected in a Dilution Tunnel or latest approved EPA version.
- 2.3. NESCAUM Standard Operating Practices for Thermo 1405 TEOM
- 2.4. NIST Monograph 175, Standard Limits of Error

3. Definitions

- 3.1. Aquastat – A control device that opens or closes a circuit to control the rate of fuel consumption in response to the temperature of the heating media in the heating appliance.
- 3.2. Catch - any mass from the sample probe system other than the PM on the front filter.
- 3.3. Certification or audit test - a series of at least three test runs conducted for certification or audit purposes that meets specifications detailed in Section 8.
- 3.4. Delivered Efficiency – The percentage of heat available in a test fuel charge that the appliance delivers to a simulated heating load as specified in this test method.
- 3.5. Emission factor – the emission of a pollutant expressed in mass per unit of energy (typically) output from the appliance
- 3.6. Emission index – the emission of a pollutant expressed in mass per unit mass of fuel used
- 3.7. Emission rate – the emission of a pollutant expressed in mass per unit time
- 3.8. Firebox - the chamber in the appliance in which the test fuel charge is placed and combusted.
- 3.9. Heat output rate – The average rate of energy output from the appliance during a specific test period in Btu/hr (MJ/hr).
- 3.10. Hydronic Heating – A heating system in which a heat source supplies energy to a liquid heat exchange media such as water that is circulated to a heating load and returned to the heat source through pipes.
- 3.11. Manufacturer’s Rated Heat Output Capacity –The value in Btu/hr (MJ/hr) that the manufacturer specifies that a particular model of hydronic heating appliance is capable of supplying at its design capacity as verified by testing during Phase 1 and Phase 5 of the test protocol.
- 3.12. NIST – National Institute of Standards and Technology
- 3.13. Relative humidity measurement with accuracy of 2% RH between 5 and 95% RH.
- 3.14. Secondary air supply - air supply that introduces air to the appliance such that the burn rate is not altered by more than 10 percent when the secondary air supply is adjusted during the test run. The appliance manufacturer or test facility can document this through design drawings that show the secondary air is introduced only into a mixing chamber or secondary chamber outside the firebox.
- 3.15. Test – means the data for all test runs conducted on the heating appliance.

- 3.16. Test facility - the area in which the heating appliance is installed, operated, and sampled for emissions.
- 3.17. Test run - An individual emission test, which encompasses the time required to complete all specified phases of the test profile.
- 3.18. Thermopile - A device consisting of a number of thermocouples connected in series, used for measuring temperature differential.
- 3.19. Appliance - an enclosed, woodburning appliance capable of and intended for space heating or domestic water heating, as defined in the applicable regulation.

4. *Summary of Test Method*

- 4.1. *Dilution Tunnel*. Emissions are determined using the “dilution tunnel” method specified in ASTM E2515-11 *Standard Test Method for Determination of Particulate Matter Emissions Collected in a Dilution Tunnel*. The flow rate in the dilution tunnel is maintained at a constant level throughout the test cycle and accurately measured. Samples of the dilution tunnel flow stream are extracted at a constant flow rate and drawn through high-efficiency filters. The filters are equilibrated and weighed before and after each test to determine the emissions catch, and this value is multiplied by the ratio of tunnel flow to filter flow to determine the total particulate emissions produced in the test cycle. The method also includes optional use of a real-time particulate matter measurement that allows for providing one-minute data, which can be used to provide one hour and test phase emissions information.
- 4.2. *Particulate Matter*. PM emissions are determined using a dilution tunnel method specified in ASTM 2515-11 *Standard Test Method for Determination of Particulate matter Emissions Collected in a Dilution Tunnel* with exceptions as defined in Section 8 and 9.4 of this test method. The flow rate in the dilution tunnel is maintained at a constant level throughout the test cycle and accurately measured. Two different particulate sampling methods are used in this test method.
- 4.2.1. *Filter-based method*. Samples of the dilution tunnel flow stream are extracted at a constant flow rate and drawn through high-efficiency filters as defined in ASTM E2515-11 using Teflon coated filters such as Pallflex Emfab (TX40) with a maximum diameter of 47 mm, without organic binder, exhibiting at least 99.95 percent efficiency. The filters are equilibrated and weighed before and after the test to determine the emissions collected and this value is multiplied by the ratio of tunnel flow to filter flow to determine the total particulate emissions produced in the test cycle.
- 4.2.2. *Real-time PM Measurements*. The second method is a real-time particulate measurement method based on a Tapered Element Oscillating Microbalance (TEOM) instrument, Thermo model 1405 TEOM or its equivalent, operated using the specifications detailed in the document titled, “*NESCAUM Standard Operating Procedures for Using TEOM 1405 in a Dilution Tunnel*” available at: <https://www.nescaum.org/topics/test-methods>.
- 4.3. *Carbon Monoxide*. The CO measured in the flue, before dilution, is used in the stack loss efficiency determination.
- 4.4. *Combustion Efficiency*. The efficiency determination involves determination of stack losses. The stack loss determination involves measurement of the flue gas temperature, CO₂, and CO. This is combined with measured fuel heating value and moisture content

as well as assumed dry fuel ultimate analysis. The flue losses are then calculated as a percentage of the fuel input energy. This provides a stack loss efficiency.

- ▶ 4.5. *Operation.* Appliance operation is conducted on a cold-to-hot test cycle, meaning that the appliance starts the test run at room temperature and ends with the appliance in fully heated state. The appliance is operated at a variety of heat demand loads representing start-up emissions, high heat demand, low heat demand, cycling, idling, and recovery from night time set back. The appliance is operated through six heating phases during the test run. To complete the certification test, a minimum of three full test runs are averaged to determine the test results. For automatic feed systems, fuel is fed as determined by appliance delivery systems.

5. *Significance and Use*

- 5.1. The measurement of particulate matter emission rates is an important test method widely used in the practice of air pollution control.
 - 5.1.1. These measurements, when approved by state or federal agencies, are often required for the purpose of determining compliance with regulations and statutes.
 - 5.1.2. The measurements made before and after design modifications are necessary to demonstrate the effectiveness of design changes in reducing emissions and make this standard an important tool in manufacturers' research and development programs.
- 5.2. Measurement of heating efficiency provides a uniform basis for comparison of product performance that is useful to the consumer. It is also required to relate emissions produced to the useful heat production

6. ***Test Equipment and Supplies.*** The following items are required for sample collection:
- 6.1. *Anemometer.* A device capable of detecting air velocities less than 0.10 m/sec (20 ft/min), for measuring air velocities near the test appliance.
 - 6.2. *Barometer.* Aneroid or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg).
 - 6.3. *Draft Gauge.* Electromanometer or other device for the determination of flue draft or static pressure readable to within 0.50 Pa (0.002 in. H₂O)
 - 6.4. *Dilution Tunnel temperature and relative humidity measurement.* A probe capable of measuring tunnel temperature to within 0.5 C and tunnel RH to within 2%, such as the Omega HX85-A.
 - 6.5. *Flue Gas Temperature Measurement.* Must meet the requirements of CSA B415.1-2010, Clause 6.2.2.
 - 6.6. *Flue Gas Composition Measurement.* Must meet the requirements of CSA B415.1-2010, Clauses 6.3.1 through 6.3.3.
 - 6.7. *Heat Exchanger.* A water-to-water heat exchanger capable of dissipating the expected heat output from the system under test.
 - 6.8. *Humidity Gauge.* Psychrometer or hygrometer for measuring room humidity.
 - 6.9. *Insulated Solid Pack Chimney.* For installation of appliances. Solid pack insulated chimneys shall have a minimum of 2.5 cm (1 in.) solid-pack insulating material surrounding the entire flue and possess a label demonstrating conformance to U.L. 103 (incorporated by reference—see §60.17).
 - 6.10. *Lab Scale.* For measuring the mass of the test fuel charges. Accuracy of ± 0.01 pounds (± 0.00045 kg).
 - 6.11. *Optional Recirculation Pump.* Circulating pump used during the certification test to prevent temperature stratification, in the appliance, of liquid being heated.
 - 6.12. *Platform Scale and Monitor.* A platform scale capable of weighing the appliance under test and associated parts and accessories when completely filled with water to an accuracy of ± 0.10 pound (± 0.045 kg) and a readout resolution of ± 0.01 pound (± 0.00045 kg).

- 6.13. *Test Facility.* The test facility shall meet the following requirements during testing:
- 6.13.1. The test facility temperature shall be maintained between 18 and 32°C (65 and 90°F) during each test run.
 - 6.13.2. Air velocities within 0.6 m (2 ft) of the test appliance and exhaust system shall be less than 0.25 m/sec (50 ft/min) without fire in the unit.
 - 6.13.3. The flue shall discharge into the same space or into space freely communicating with the test facility. Any hood or similar device used to vent combustion products shall not induce a draft greater than 1.25 Pa (0.005 in. H₂O) on the appliance measured when the appliance is not operating.
 - 6.13.4. For test facilities with artificially induced barometric pressures (e.g., pressurized chambers), the barometric pressure in the test facility shall not exceed 775 mm Hg (30.5 in. Hg) during any test run.
- 6.14. *Test Facility Temperature Monitor.* A thermistor, RTD, or other equivalent device, located centrally in a vertically oriented 150 mm (6 in.) long, 50 mm (2 in.) diameter pipe shield that is open at both ends, capable of measuring temperature to within 1-degree Fahrenheit of expected temperatures.
- 6.15. *Appliance Flue.*
- 6.15.1. Steel flue pipe extending to 2.6 ±0.15 m (8.5 ±0.5 ft) above the top of the platform scale, and above this level, insulated solid pack type chimney extending to 4.6 ±0.3 m (15 ±1 ft) above the platform scale, and of the size specified by the appliance manufacturer. This applies to both freestanding and inserts type appliances.
 - 6.15.2. Other chimney types (e.g., solid pack insulated pipe) may be used in place of the steel flue pipe if the appliance manufacturer's written appliance specifications require such chimney for home installation (e.g., zero clearance appliance inserts). Such alternative chimney or flue pipe must remain and be sealed with the appliance following the certification test.
- 6.16. *Water Temperature Difference Measurement.* A Type –T ‘special limits’ thermopile with a minimum of 5 pairs of junctions shall be used to measure the temperature difference in water entering and leaving the heat exchanger. The temperature difference measurement uncertainty of this type of thermopile is equal to or less than ± 1.0 °F (± 0.5 °C). Other temperature measurement methods may be used if the temperature difference measurement uncertainty is equal to or less than ± 1.0 °F (± 0.50 °C). This measurement uncertainty shall include the temperature sensor, sensor well arrangement, piping arrangements, lead wire, and measurement / recording system. The response time of the temperature measurement system shall be less than half of the time interval at which temperature measurements are recorded.

6.17. *Water Flow Meter.* A water flow meter shall be installed in the inlet to the load side of the heat exchanger. The flow meter shall have an accuracy of $\pm 1\%$ of the measured flow.

6.17.1. *Appliance Side Water Flow Meter (optional).* A water flow meter with an accuracy of $\pm 1\%$ of the flow rate is recommended to monitor the supply-side water flow rate.

6.18. *Water Temperature Measurement.* Thermocouples or other temperature sensors to measure the water temperature at the inlet and outlet of the load side of the heat exchanger must meet the calibration requirements specified in 10.1 of this method.

6.19. *Appliance Temperature Monitors.* Seven, each capable of measuring temperature with standard Type J or K thermocouple accuracy of $\pm 0.75\%$ of expected absolute temperatures.

7. *Safety*

- 7.1. Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

- 7.2. These tests involve combustion of wood, which releases substantial amounts of heat and combustion products. The heating system also produces large quantities of very hot water and the potential for steam production and system pressurization. Appropriate precautions must be taken to protect personnel from burn hazards and respiration of products of combustion. Exposure of personnel to unsafe levels of carbon monoxide must be avoided, and the use of continuous ambient carbon monoxide monitoring is strongly recommended.

8. Sampling, Test Specimens, and Test Appliances

8.1. *Particulate Matter Sampling.* PM emissions allow the use of two options to obtain integrated results and one-hour emissions data.

8.1.1. **Option 1** - three ASTM E2515 trains will be used for this testing.

8.1.1.1. Proportionality shall be limited to $\pm 10\%$, using 10-minute data.

8.1.1.2. Train 1: Start-up Measurement. A measurement of the start-up phase will be reported using one ASTM 2515 train. This measurement will commence at the beginning of the test and ends sixty (60) minutes after commencing the test.

8.1.1.3. ASTM 2515 Trains 2 and 3: Integrated load measurement. Two, dual ASTM 2515 trains will measure particulate for the entire test run.

8.1.1.4. Option 3 use two ASTM 2515 trains, both pull one hour

8.1.2. **Option 2** – 2 ASTM 2515 trains and TEOM.

8.1.2.1. ASTM 2515 Trains 1 and 2: Integrated load measurement. Two, dual ASTM 2515 trains will measure particulate for the entire test run.

8.1.2.2. TEOM data will be collected at 10-second intervals and averaged up to 1-minute intervals for reporting. TEOM operation shall follow the procedures listed in the TEOM SOP detailed in Appendix A. TEOM data shall be recorded on an excel spreadsheet following the minimum data reporting requirements. Emissions from the ASTM 2515 trains shall serve as the primary PM emission measurement. The TEOM data will be used to report emissions for the first, one-hour period.

8.2. *Sample Collection.* The following reagents are required for sample collection:

8.2.1. Teflon coated glass fiber filters such as Pallflex Emfab (TX40) with a maximum diameter of 47 mm, without organic binder, exhibiting at least 99.95 percent efficiency.

8.2.2. Same as Method 5, in Section 7.2.

8.2.3. Sample Analysis. Two reagents are required for the sample analysis:

8.2.4. Acetone. Same as Method 5, in Section 7.2.

8.2.5. Saturated salt solution of magnesium chloride, if weigh room RH will exceed 40%.

8.3. *Test Fuel.* This method can be used with wood pellet fuels.

8.3.1. Pelletized fuels

8.3.1.1. Fuel used must be PFI, CANplus, ENPlus certified, or other equivalent fuel certification standard.

8.3.1.2. Test fuel must undergo and report ultimate/proximate analysis by an independent lab.

- 8.3.1.3. All fuels used for testing must have a temperature no greater than 75F when loaded into the appliance.
- 8.3.2. Wood chip fuels shall conform to the following requirements:
 - 8.3.2.1. Fuel used for testing must undergo ultimate/proximate analysis by an independent lab.
 - 8.3.2.2. Fuel used for testing must be characterized by ANSI/ASABE AD17225-4:2014 FEB2018 Solid biofuels — Fuel specifications and classes — Part 4: Graded wood chips

9. *Sample Collection, Preservation, Storage, and Transport*

- 9.1. *Test Specimens.* Appliances shall be supplied as complete appliances, including all controls and accessories necessary for installation at the test facility including thermal storage tank description and volume. A full set of specifications, designs, and assembly drawings shall be provided when the product is placed under certification of a third-party agency. The manufacturer shall provide a tank with the minimum volume needed for operation and any parts that are specific for operation, as shown in Method 28 WHH PTS. Examples of parts to be supplied by the manufacturer would be a thermostat or various sensors required for communicating tank temperature to the appliance, recirculation loops (if needed), specific pump (if needed), all fittings for coming off the tank, etc.
- 9.2. *User Guide.* The manufacturer must supply a one-page user guide that will direct certain portions of the test protocol. The User Guide must be provided to the lab and the consumer as a single sheet and documented in the test report. The user guide shall be the only directions provided and used by the testing facility for certification purposes; it shall address key user operations, and it shall conform to the following requirements. Manufacturers are not allowed to direct or inform any portion of testing or deviate from operations specified in the User Guide, as the User Guide is the only information that can be used to inform appliance operation during certification testing. User Guide Layout Requirements – the User Guide shall conform to the following design specifications:
 - 9.2.1. *Directions must be illustrated by text and pictures*
 - 9.2.1.1. Font size – minimum font size is 12.
 - 9.2.1.2. Use of columns allowed
 - 9.2.1.3. Margins – must have a minimum of ¾” inch margins
 - 9.2.1.4. A minimum of 40% of the user guide must use graphics or photos to support text directions.
 - 9.2.1.5. Must fit on a single side of an 8 x11.5-inch sheet of paper
 - 9.2.1.6. Must be provided in a laminated form to the consumer.

9.2.2. User Guide elements – The User Guide cannot contradict or deviate from user instructions provided in the appliance user manual. The User Guide shall include information on the following items.

9.2.2.1. Appliance preparation – what must be done to the appliance prior to starting a fire to include appliance setpoints and software settings. Settings must reflect use in high-temperature heating systems.

9.2.2.2. Fuel properties – what types of fuel and fuel moisture requirements are allowed for use in the appliance. The fuel properties detailed in the User Guide are for homeowner use, for certification testing, fuel requirements shall follow the protocols detailed in this method.

9.2.2.3. Start-up procedures – general guidelines for properly starting the appliance to include starting procedures and appliance settings to include software configurations.

9.2.2.4. Reloading procedures – If applicable, guidelines for properly reloading fuel once a fire has been started in the appliance.

9.3. *Pretest Recordkeeping.*

9.3.1. Record data and detailed information on all testing or burning completed on the appliance including all pre-test burns conducted at the testing facility or by the manufacturer at a maximum of 10-minute intervals. Aging conducted at the manufacturer shall conform to the same requirements as the test facility. This information shall include the amount of pellets burned, air settings, burn times and dates, appliance and stack temperature data.

9.4. *Modifications to ASTM 2515 requirements.*

9.4.1. Liquid water should not be present anywhere in the sampling system for a valid sample.

9.4.2. Dilution tunnel temperature and relative humidity shall be measured and logged near the sample probe to calculate tunnel dewpoint. Filter temperature shall be measured and logged using a measurement method with an accuracy of 0.5 degrees Celsius (C) or better.

9.4.3. For a valid test run the following conditions shall not exceed any of the following conditions for a period of more than five minutes in total:

9.4.3.1. Filter temperature shall remain between 80 and 90 deg. F (26.7 to 32.2 C)

9.4.3.2. The dilution tunnel temperature shall be no more than 104 deg. F (40 C) for any rolling 10-minute average.

9.4.3.3. Tunnel relative humidity shall not exceed 95%.

- 9.4.3.4. Tunnel dew point temperature shall be at least 3.6 deg. F (2 deg. C) less than filter temperature.
- 9.4.3.5. If any parameter is exceeded, the test report should explicitly note the results of the sampling train liquid water inspection.
- 9.4.4. Proportionality shall be limited to $\pm 10\%$, using, at a minimum, 10-minute data.
- 9.5. *Test Facility Conditions.*
- 9.5.1. Locate the test facility temperature monitor on the horizontal plane that includes the primary air intake opening for the appliance. Locate the temperature monitor 1 to 2 m (3 to 6 ft) from the front of the appliance in the 90° sector in front of the appliance.
Use an anemometer to measure the air velocity. Measure and record the room air velocity before the pretest ignition period (Section 8.7) and once immediately following the test run completion .
- 9.5.2. Measure and record the test facility's ambient relative humidity, barometric pressure, and temperature before and after each test run.
Measure and record the flue draft or static pressure in the flue at a location no greater than 0.3 m (1ft) above the flue connector at the appliance exhaust during the test run at the recording intervals
- 9.6. *Appliance Installation.*
- 9.6.1. Appliances shall be supplied as complete appliances, as described in marketing materials, including all controls and accessories necessary for installation in the test facility. A full set of specifications, installation and operating instructions, and design and assembly drawings shall be provided. The manufacturer's written installation and operating instructions are to be used as a guide in the set-up and testing of the appliance and shall be part of the test record.
- 9.6.2. Assemble the appliance and parts in conformance with the manufacturer's written installation instructions. A representative of the manufacturer may assist in appliance installation.
- 9.6.3. Place the appliance centrally on the platform scale capable of weighing the appliance fully loaded with a resolution of ± 0.10 lb (0.05 kg).
- 9.6.4. The appliance shall be fitted with the type of chimney recommended or provided by the manufacturer and extending to 15 ± 0.5 ft (4.6 ± 0.15 m) from the upper surface of the scale. If no flue or chimney system is recommended or provided by the manufacturer, connect the appliance to a flue of a diameter equal to the flue outlet of the appliance. The flue section from the appliance flue collar to 8 ± 0.5 feet above the scale shall be a single wall stove pipe, and the remainder of the flue shall be double-wall insulated Class A chimney.

9.7. *Optional Equipment Use*

9.7.1. A recirculation pump may be installed between connections at the top and bottom of the appliance to minimize thermal stratification if specified by the manufacturer's instructions shipped with the unit. If specified by the manufacturer, the manufacturer shall provide all piping, pumps, and controls necessary for the recirculation system. The pump shall not be installed in such a way as to change or affect the flow rate between the appliance and the heat exchanger.

9.7.2. If the manufacturer's instructions shipped with the unit specify that a thermal control valve or other device be installed and set to control the return water temperature to a specific set point, the valve or other device shall be installed and set per the manufacturer's written instructions to reflect a high-temperature installation, unless the manufacturer specifies that the appliance is for use only in low-temperature installations.

9.8. *Starting Weight.* Prior to filling the appliance with water, weigh and record the appliance mass.

9.9. *Heat Exchanger*

9.9.1. Plumb the unit to a water-to-water heat exchanger with sufficient capacity to draw off heat at the maximum rate anticipated. Route hoses and electrical cables and instrument wires in a manner that does not influence the weighing accuracy of the scale as indicated by placing dead weights on the platform and verifying the scale's accuracy.

9.9.2. Locate temperature sensors to measure the water temperature at the inlet and outlet of the load side of the heat exchanger.

9.9.3. Install a thermopile (or equivalent instrumentation) meeting the requirements of Section 6.3 to measure the water temperature difference between the inlet and outlet of the load side of the heat exchanger.

9.9.4. Install a calibrated water flow meter in the heat exchanger load side supply line. The water flow meter is to be installed on the cooling water inlet side of the heat exchanger so that it will operate at the temperature at which it is calibrated.

9.9.5. Place the heat exchanger in a box with 2 in. (50 mm) of expanded polystyrene (EPS) foam insulation surrounding it to minimize heat losses from the heat exchanger.

9.9.6. The reported heat output rate shall be based on measurements made on the load side of the heat exchanger.

9.9.7. Temperature instrumentation shall be installed in the appliance outlet and return lines. The average of the outlet and return water temperature on the supply side of the system shall be considered the average appliance temperature. Installation of a water flow meter in the supply side of the system is optional.

9.9.8. Fill the system with water. Determine the total weight of the water in the appliance when the water is circulating. Verify that the scale indicates a stable weight under operating conditions. Make sure air is purged properly.

10. Calibration, Standardization and Quality Control

10.1. *ASTM E2515-11*. Perform all calibrations required by ASTM E2515-11

10.2. *Water Temperature Sensors*. Temperature measuring equipment shall be calibrated before initial use and at least semi-annually thereafter. Calibrations shall follow NIST Monograph 175, Standard Limits of Error.

10.3. *Heat Exchanger Load Side Water Flow Meter*. The heat exchanger load side water flow meter shall be calibrated within the flow range used for the test run using NIST-traceable methods. Verify the calibration of the water flow meter before and after each test run and at least once during each test run by comparing the water flow rate indicated by the flow meter to the mass of water collected from the outlet of the heat exchanger over a timed interval. The volume of the collected water shall be determined based on the water density calculated from Section 13, Eq. 12, using the water temperature measured at the flow meter. The uncertainty in the verification procedure used shall be 1% or less. The water flow rate determined by the collection and weighing method shall be within 1% of the flow rate indicated by the water flow meter.

10.4. *Scales*. Perform a multipoint calibration (at least five points spanning the operational range) of the platform scale before its initial use. The scale manufacturer's calibration results are sufficient for this purpose. Before each certification test, audit the scale with the appliance in place by weighing at least one calibration weight (Class F) that corresponds to between 20 percent and 80 percent of the expected test fuel charge weight. If the scale cannot reproduce the value of the calibration weight within 0.0045 kg (0.01 lb.) or 1 percent of the expected test fuel charge weight, whichever is greater, recalibrate the scale before use with at least five calibration weights spanning the operational range of the scale. The scales used to weigh the appliance, and test fuel charge shall be calibrated using NIST-traceable methods at least once every 6 months.

10.5. *Balance (optional)*. Calibrate as described in Section 10.1.

10.6. *Anemometer*. Calibrate the anemometer as specified by the manufacturer's instructions before the first certification test and semiannually thereafter.

- 10.7. *Barometer*. Calibrate against a mercury barometer before the first certification test and semiannually thereafter.
- 10.8. *Draft Gauge*. Calibrate as per the manufacturer's instructions; a liquid manometer does not require calibration.
- 10.9. *Humidity Gauge*. Calibrate as per the manufacturer's instructions before the first certification test and semiannually thereafter
- 10.10. *Flue Gas Analyzers*. In accordance with CSA B415.1-2010, Clause 6.8.
- 10.11. *Weigh room conditions*. The following conditions shall be met:
- 10.11.1. The facility shall use an active ionizing air blower (or 210Polonium alpha sources) to neutralize charge associated with the filter. 210Polonium alpha sources must be replaced annually or more often.
- 10.11.2. Temperature range of 68 to 78 deg. F.
- 10.11.3. Relative humidity shall be no higher than 45%.
- 10.12. *Filter equilibration / conditioning post sample collection*. Use of desiccation is not allowed. Equilibrate filters at a relative humidity between 30 and 40% for at least 24 hours. A saturated salt solution of magnesium chloride (33% RH) can be used.
- 10.13. *Filter weight measurements*. Report the following filter measurements:
- 10.13.1. Day zero – initial filter measurement immediately after completing testing.
- 10.13.2. Final filter measurement or day seven measurement, whichever measurement comes first.
- 10.14. *Blanks*. Test reports shall measure and report data on blanks as follows:
- 10.14.1. Lab blank, which is removed from each filter batch, stored in a protective environment, and weighed during each weighing session.
- 10.14.2. Room blank collected during every test run. The blank shall be placed within 2 feet of the intake for the dilution air and shall be placed at a minimum of 10 feet away from any combustion activities.
- 10.15. Probe Catch: Report sampling system catch as a separate number from back filter catch.

11. Conditioning

- 11.1. *Appliance Aging.* Prior to testing, the appliance shall be operated for a minimum of 50 hours using a variety of heat demands. The conditioning may take place at the manufacturer's facility prior to testing or at the certification facility.
- 11.2. *Appliance Aging Documentation.* A appliance of any type shall be aged before initiating a certification test. The aging procedure shall be conducted and documented by the manufacturer or the certified testing laboratory. All aging data must be reported and shall include the hours of operation, heat demands for aging.
- 11.3. *Appliance Aging operations.* Operate the appliance using manufacturer designated fuel. The appliance shall be operated at a variety of burn phases. The test report shall detail the amount of fuel burned, fuel parameters (species, heat demands, and fuel types), air and control settings used, and note the time spent in each air setting phase.
 - 11.3.1. If the appliance uses a catalytic combustor, it must be engaged according to manufacturer's instructions and operate for at least 50 hours during the break-in period. Report hourly catalyst exit temperature data and the hours of operation.

12. Procedure.

- 12.1. A representative of the manufacturer may observe testing but may not provide instructions to the certification lab, in any form, with testing staff or equipment once the certification tests begin. The names of testing witnesses cannot be withheld as confidential business information (CBI).
- 12.2. During certification testing, the unit cannot be connected for remote access. Nor can the appliance be operated remotely. For example, the unit cannot be connected to the internet unless remote access is to allow for remote witnessing or recording of the test. Remote access may only be granted by the certification laboratory. If remote access is granted, witness list shall reflect those who have been granted remote witness capacity and provide recordings of remote activities as part of the test report.
- 12.3. For certification testing, all system control settings shall be tested with all controls and software set as-the manufacturer will ship or install, often referred to as default settings. These default settings shall be defined by the manufacturer, communicated to the lab, documented in the test report, and match those communicated in owner's manual and installation instructions to the installer or end-user. These control settings and the documentation of the control settings as to be provided to the installer or end-user shall be part of the test record.

Informational note: these units typically have an operating limit at about 180 °F and a safety high limit at about 195 °F. If the unit reaches the safety limit, a manual reset is commonly required. As noted above, the actual settings shall be based on the manufacturer's default settings.

- 12.3.1. Where the manufacturer defines several operational control logic parameters and heat load settings, one shall be defined in the appliance documentation as the default or

standard-setting. It is expected that this will be the configuration for use with a simple baseboard high-temperature heating system. This is the configuration to be followed for these tests. The manufacturer’s documentation shall define the other control settings as optional or alternative settings.

12.4. Sampling Equipment.

12.4.1. Prepare the sampling equipment as defined by ASTM E2515-11 with modifications defined in 9.4 of this method, and if using the TEOM, using the SOP referenced.

12.4.2. Sample Flow Corrections for Water Vapor: Corrections shall use the average of actual tunnel dew point measurements during a sample run, use of the assumed dew point value is prohibited.

12.5. Instructions

12.5.1. Appliance Operation and Adjustments. Set the air inlet supply controls as designated in the User Guide, as defined in Section 9.2 of this test method. Record all adjustments made to the air supply controls, adjustments to and additions or subtractions of fuel, and any other changes to appliance operations that occur during the test period. Record fuel weight data and appliance temperature measurements at 1-minute intervals.

12.5.2. Before each test run, the firebox shall be vacuumed. Testing shall begin without any ash or other materials in the appliance.

12.6. *Test Run Procedure.* The table below summarizes the phases that encompass a complete test run. Addition of cooling water during the testing is not allowed. A complete test run requires completion of all five phases of the test protocol, as described below.

| IDC Test Procedure Summary | |
|----------------------------|--|
| Start-up Phase | Startup per manufacturer’s instructions. Pull off heat as needed when approaching operating temperature limit and ramp up to 100% |
| Phase 1 | 100% heat demand 60 minutes |
| Phase 2 | 13% heat demand (+/-2%) for 120 minutes or after one cycle, whichever comes first. If unit begins to cycle within 0-30 minutes of Phase 2, 6 cycles must be completed in Phase 4. If the unit begins to cycle within 31-60 minutes of Phase 2, 4 cycles must be completed in Phase 4. If the unit cycles within 61-90 minutes of Phase 2, 3 cycles must be completed in Phase 4. If the unit cycles within 91-120 minutes of Phase 2, 2 cycles must be completed in Phase 4. If the unit does not cycle during Phase 2, only 1 cycle must be completed in Phase 4. |
| Phase 3 | No heat demand for 45 minutes |
| Phase 4 | Forced cycling - Must complete 1-6 cycles, as determined by cycling time in Phase 2. |

| | |
|---------|---|
| | <ul style="list-style-type: none"> • During on-cycle - cooling water is stopped, the system heats to maximum temperature limit • Off-cycle - Wait 30 minutes, then set cooling water at 100% heat demand until system reaches minimum operating temperature limit • Phase 4 ends after number of required cycles has been completed, and concludes the second 30 minute off period |
| Phase 5 | <p>100% heat demand for 60 minutes</p> <ul style="list-style-type: none"> • Stop cooling water if water jacket drops below minimum operating temperature limit and resume cooling water at 100% heat demand when water jacket reaches operating temperature setpoint |

12.6.1. Start-up Phase

12.6.1.1. Appliance operation – during this phase, the appliance shall start from a cold condition and ramp up until the heat demand is 100% of the appliances’ maximum rated heat output ¹ for a period of five minutes.

12.6.1.2. Definition for end of start-up phase – cold start phase shall end when the appliance is within the modulation setpoints, prescribed by manufacturer and maximum heat demand can be maintained for a period of at least five minutes without a rise in water and stack temperature (+/- 10°F).

Complete 60-minute average calculation to confirm as this will impact phase 2 setting.

12.6.1.3. Lockout access to thermal storage during the first 30 minutes of Phase 1.

12.6.2. The appliance shall remain at Phase 1 – 100% heat demand for a period of 60 minutes.

12.6.2.1.1. Appliance controls should target operation at the maximum firing rate. Following cold start, cooling water will not be turned on until after the appliance reaches appliance/storage setpoints, and storage is above operating conditions programmed by the manufacturer. After the burner has stabilized at maximum burn rate and the temperature has reached 160 °F, the cooling load shall be set to the nominal output rate.

12.6.2.1.2. The appliance shall fire at its maximum burn rate for the entire period. The appliance water temperature, however, may increase during this time period.

12.6.2.1.3. If at any time, the appliance temperature is rising and approaching the operating limit, the output rate shall be increased to prevent the appliance from cycling off or from modulating to a lower firing rate.

¹ If the maximum output is ± 10% of the manufacturers stated capacity, the appliance rating must be changed to reflect actual tested values.

- 12.6.2.2. Appliance temperature: For Run #1, the appliance shall be at ambient room temperature, which cannot exceed 80 F must room temperature. Before each test run and IR photo shall be taken of the appliance and thermal storage. For the first run (Run #1), the appliance and buffer tank (or thermal storage) shall not exceed 120 F. No appliance temperature requirements for Run #2 or #3. Temperature measurements for the external and internal temperatures shall be taken 15 minutes before starting the test and shall be reported in the test report.
- 12.6.2.3. Record and report the weight of the appliance at the beginning and end of Phase 1.
- 12.6.2.4. End of Phase 1. The end of Phase 1 is defined by a period of 60 minutes of maximum heat demand placed on the appliance.
- 12.6.2.5. To determine average maximum heat output, all replicates shall be averaged and no individual run shall have a heat output rate +/- 10%.
- 12.6.2.6. Heat Output Capacity Validation. During Phase 1, the unit must produce an average heat output rate that is within $\pm 10\%$ of the manufacturer's rated heat output capacity. If average heat output is not within these limits, the manufacturer's rated heat output capacity is considered not validated and must be changed. In such cases, the testing may be redone using an adjusted heat output capacity if requested by the manufacturer. If the manufacturer's rated heat output capacity is increased as a result of this requirement, the tests done in Phases 2, 3, and 4 may still meet the requirements of Table 1, and a re-test may not be required.
- 12.6.3. Phase 2 – Low Heat Demand Phase. This phase commences immediately after Phase*
- 12.6.3.1. Appliance operation – the appliance heat demand is reduced to 13%+/- 2% of the appliance's maximum rated heat output. The appliance stays at this heat demand for a period of 120 minutes or one complete cycle, whichever comes first. Ramp down to this heat load must be made in a period of fewer than 10 minutes. The test report shall indicate the time period used for ramp down.
- 12.6.3.2. Record and report the weight of the appliance at the beginning and end of Phase 2.
- 12.6.3.3. Operational Parameters: Heat demand on the appliance is placed at 13% +/- 2% of maximum output as the unit is delivered to the customer.
- 12.6.3.4. End of Phase – the end of Phase 2 is defined by the appliance is defined by a period of 120 minutes at 13% +/- 2% heat demand placed on the appliance or after one cycle, whichever comes first.
- 12.6.3.5. *The time at which the unit cycles in Phase 2 shall determine how many cycles must be completed in Phase 4.*

- 12.6.3.5.1.If unit begins to cycle within 0-30 minutes of Phase 2, 6 cycles must be completed in Phase 4.
- 12.6.3.5.2.If the unit begins to cycle within 31-60 minutes of Phase 2, 4 cycles must be completed in Phase 4.
- 12.6.3.5.3.If the unit cycles within 61-90 minutes of Phase 2, 3 cycles must be completed in Phase 4.
- 12.6.3.5.4.If the unit cycles within 91-120 minutes of Phase 2, 2 cycles must be completed in Phase 4. If the unit does not cycle during Phase 2, only 1 cycle must be completed in Phase 4.

12.6.4. Phase 3 – No Heat Demand (Idling) Phase. This phase commences immediately after Phase 2.

- 12.6.4.1. Appliance operation – Appliance heat demand is 0%, and the appliance is turned off. The appliance stays at this heat demand for a period of 45 minutes. Ramp down to this heat load must be made in a period of fewer than 5 minutes. The test report shall indicate the time period used for ramp down.
- 12.6.4.2. No appliance temperature requirements for Phase 3.
- 12.6.4.3. Record and report the weight of the appliance at the beginning and end of Phase 3.
- 12.6.4.4. End of Phase. The end of Phase 3 occurs when the appliance spends a minimum of 45 minutes at no load ends and the boiler cools to a setpoint where the boiler will cycle on at the beginning of Phase 4. This may be completed by manual setting a cooling load.

12.6.5. Phase 4 – Cyclic Operations

- 12.6.5.1.Appliance operation - During Phase 4 the unit shall complete the number of cycles as determined in Phase 2, as defined in 12.6.3.5.
 - 12.6.5.1.1.The appliance must complete the required number of on/off cycles. During on-cycle - cooling water is stopped, the appliance heats to maximum temperature limit. During the off-cycle – the appliance is turned off for a period of 30 minutes, then set cooling water 100% heat demand until appliance reaches minimum operating temperature limit, and the appliance’s controls receive a call for heat.
- 12.6.5.2. This phase emulates the operation of the appliance, responding to a thermostat call at the start of this phase, power the appliance back on. The heater and storage temperature at the time it powers on will determine whether there is a call for heat or not. This will be indicated by the appliance firing back up, which can be indicated through control status, or starting of the

combustion air/ induced draft fan or if it stays in an “idle” state, such as standby or slumber.

- 12.6.5.3. If there is a call for heat, the cooling water shall remain off until the appliance temperature rises to the operating limit, and the appliance controls act to minimize the burn rate in an “off” or “idle” state. The transition to this mode is determined either by the control status indication or the stopping of the combustion air / induced draft fan. This will indicate the end of the on-cycle and start of the off-cycle period. The time of the start of off-cycle will be recorded, and then the heater and storage will sit for 30 minutes. Following this, the cooling load shall be cycled on at 100%. This marks the end of the first cycle. Then allow cooling water flow to be adjusted for an output of 100% of nominal full load output. This pattern shall continue until the time at which the appliance operating controls act to restart the active combustion and reheat the appliance in an on-cycle. The transition to this active combustion mode is determined either by the control status indication or restarting of the combustion air/induced draft fan. This phase and the test ends when the appliance has again reached the operating limit temperature, and the appliance controls act to minimize the burn rate in an “off” or “idle” mode and then sat for a period of 30 minutes to complete the second cycle.
- 12.6.5.4. If, during this test, the appliance shuts down on the high-temperature safety control, requiring a manual reset, the test is a failed run.
- 12.6.5.5. Appliance temperature: no appliance temperature requirements for Phase 4.
- 12.6.5.6. Record the weight of the appliance at the beginning and end of Phase 4
- 12.6.5.7. Start of Phase – the cycling event begins in an off-cycle.
- 12.6.5.8. End of Phase – the end of Phase 4 occurs after the 30-minute period after the second cycling event is completed, and the appliance is in an off-cycle.

12.6.6. Phase 5 – Response to Setback Conditions

- 12.6.6.1. Appliance operation –. The cooling water shall be adjusted for an output of 100% of the nominal full-load output for 60 minutes. If the appliance system (heater and storage) drops below the minimum operating range, as specified by the manufacturer, cooling will stop temporarily until the heater returns to manufacturer specified operating temperature. Cooling water will then be adjusted to continue an output of 100%, or nominal load. The time at which cooling is stopped and continued shall be recorded.
- 12.6.6.2. Record the weight of the appliance at the beginning and end of the phase
- 12.6.6.3. End of Phase – the end of Phase 5 occurs when a period of 60 minutes of 100% heat demand has been placed on the appliance.

12.6.7. *End of the Test Run.* The test runs ends when all five phases of the test run have been completed in sequence.

12.6.7.1. *Test Run Completion.* At the end of the Phase 5 period, as prescribed in Section 8, stop the particulate sampling instruments and Overall Efficiency (SLM) measurements, and record the run time and all final measurement values.

12.6.7.2. At the end of the test run, continue to apply a thermal load to the heater to allow the remaining fuel to safely be consumed. No measurements are required during this period.

12.7. *Test run requirements.* The following are the pre-testing appliance use requirements for each test run.

12.7.1. Run 1 – appliance must be at lab temperature and wait a minimum of 48 hours without combustion before starting Run 1.

12.7.2. Run 2 – shall not operate for a minimum of 8 hours from the conclusion of Run 1 before commencing Run 2. Appliance coals and ash can remain in the appliance until 1 hour before conducting Run 2. All coals and ash must be removed before commencing Run 2.

12.7.3. Run 3 – shall wait a minimum 8 hours from the conclusion of Run 2 before commencing Run 3. Appliance coals and ash can remain in the appliance until 1 hour before conducting Run 3. All coals and ash must be removed before commencing Run 3.

12.8. Before initiating the compliance test, clean the flue with an appropriately sized wire chimney brush before each certification test. Test documentation should include the date and time of flue cleaning.

12.9. *Failure to Operate at All Test Conditions.* If an appliance cannot operate in all of the test Phases without achieving an appliance temperature that causes the safety high limit to be activated, requiring a manual reset, the test is a failed run. After two failed test runs, the unit is deemed to have failed the test, and the unit cannot be certified with this test method.

12.10. *Consecutive Test Runs.* Consecutive test runs may be conducted, provided that the requirements of Section 12.6 of this method are met.

12.11. *Test Series completion.* A complete test series is defined as the successful completion of three full test runs, as specified in Section 12.6 of this method.

12.11.1. If the appliance fails more than the two test runs, the appliance has failed the certification test.

12.12. *Additional Test Runs.* The testing laboratory may conduct more than three test runs. If more than three test runs are conducted, the results from all valid test runs shall be used in calculating the average emission rate. The measurement data and results of all test runs shall be reported regardless of which values are used in calculating the emission rate. No test run data can be eliminated from the reporting requirements of this method.

12.13. *Low Appliance Temperature.* If at any time, average water temperature falls below minimum operating temperatures set by the manufacturer, then cooling will be stopped until the water temperature averages reach temperature setpoint.

13. Calculation of Results – Calculation of Results

13.1. Nomenclature

E_T – Total particulate emissions for the full test run as determined per ASTM E2515-11 in grams

$E_{g/MJ}$ – Emissions rate in grams per megajoule of heat output

$E_{lb/mmBtu\ output}$ – Emissions rate in pounds per million Btu of heat output

$E_{g/kg}$ – Emissions factor in grams per kilogram of dry fuel burned

$E_{g/hr}$ – Emissions factor in grams per hour

HHV – Higher heating value of fuel = 8600 Btu/lb (19.990 MJ/kg)

LHV – Lower heating value of fuel = 7988 Btu/lb (18.567 MJ/kg)

ΔT – Temperature difference between water entering and exiting the heat exchanger

Q_{out} – Total heat output in BTU's (megajoules)

Q_{in} – Total heat input available in test fuel charge in BTU (megajoules)

M – Mass flow rate of water in lb/min (kg/min)

V_i – Volume of water indicated by a totalizing flow meter at the i th reading in gallons (liters)

V_f – Volumetric flow rate of water in heat exchange system in gallons per minute (liters/min)

Θ – Total length of test run in hours

t_i – Data sampling interval in minutes

η_{del} – Delivered heating efficiency in percent

F_i – Weighting factor for heat output category i

- T1 – Temperature of water at the inlet on the supply side of the heat exchanger
- T2 – Temperature of the water at the outlet on the supply side of the heat exchanger
- T3 – Temperature of 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, °F.
- T5 – Temperature of the hot water supply as it leaves the appliance/heater, °F.
- T6 – Temperature of return water as it enters the appliance/heater, °F.
- $T_{I_{avg}}$ – Average temperature of the appliance and water at start of the test
- $T_{I_{avg}} - (T1 + T2)/2$ at the start of the test, °F
- $T_{F_{avg}}$ – Average temperature of the appliance and water at the end of the test
- $T_{F_{avg}} - (T1 + T2)/2$ at the end of the test, °F
- TIS1 – Temperature at the inlet to the storage system at the start of the test.
- TIS2 – Temperature at the outlet from the storage system at the start of the test.
- TFS1 – Temperature at the inlet to the storage system at the end of the test.
- TFS2 – Temperature at the outlet from the storage system at the end of the test.
- TISavg – Average temperature of the storage system at the start of the test.
- $TIS_{avg} - (TIS1 + TIS2)/2$ at the end of the test.
- TFSavg – Average temperature of the storage system at the end of the test.
- $TFS_{avg} - (TFS1 + TFS2)/2$.
- MC – Fuel moisture content in percent dry basis

MC_i – Average moisture content as determined by ultimate/proximate analysis

σ – Density of water in pounds per gallon

C_p – Specific heat of water in Btu /lb, °F

C_{steel} – Specific heat of steel (0.1 Btu/ lb, °F)

W_{fuel} – Fuel charge weight in pounds (kg)

W_i – Weight of fuel in pounds (kg)

W_{app} – Weight of empty appliance in pounds

W_{wa} – Weight of water in the supply side of the system in pounds

$W_{StorageTank}$ – Weight of the storage tank empty in pounds (kg)

$W_{WaterStorage}$ – Weight of the water in the storage tank at $TISav$ in pounds (kg).

NOTE: For proportioning emission factors and rates per phase according to Appendix A, variables will have subscript added to determine the relevancy of phase i.e. $E_{T(P1)}$ indicates Total particulate emissions for Phase 1 and $E_{g/hr(P2)}$ indicates emissions factor in grams per hour for Phase 2.

13.2. *Test Run Reporting.*

13.2.1. Record all water temperatures, differential water temperatures, and water flow rates at time intervals of one minute or less. All data collected for regulatory purposes shall be reported at no time period shorter than one minute. Shorter collection times may be used for research but will not be considered for regulatory purposes.

13.2.2. Record data needed to determine Overall Efficiency (SLM) per the requirements of CSA B415.1-2010 Clauses 6.2.1, 6.2.2, 6.3, 8.5.7, 10.4.3 (a), 10.4.3(f), and 13.7.9.3

13.2.3. Measure and record the test room air temperature in accordance with the requirements of CSA B415.1-2010 Clauses 6.2.1, 8.5.7, and 10.4.3 (g).

13.2.4. Measure and record the flue gas temperature in accordance with the requirements of CSA B415.1-2010 Clauses 6.2.2, 8.5.7, and 10.4.3 (f).

13.2.5. Determine and record the Carbon Monoxide (CO) and Carbon Dioxide (CO₂) concentrations in the flue gas in accordance with CSA B415.1-2010 Clauses 6.3, 8.5.7, and 10.4.3 (i) and (j).

13.2.6. Measure and record the test fuel weight per the requirements of CSA B415.1-2010 Clauses 8.5.7 and 10.4.3 (h).

13.2.7. CSA B415.1-2010 Record the test run time per the requirements of Clause 10.4.3

13.2.8. Record and document all settings and adjustments, if any, made to the appliance as recommended/required by manufacturers instruction manual for different combustion conditions or heat loads. These may include temperature setpoints, under and over-fire air adjustment, or other adjustments that could be made by an operator to optimize or alter combustion. All such settings shall be included in the report for each test run.

13.2.9. Monitor the average heat output rate on the load side of the heat exchanger based on water temperatures and flow. If the heat output rate over a 10-minute averaging period gets close to the limit of the target range, adjust the water flow through the heat exchanger to compensate. Make changes as infrequently as possible while maintaining the target heat output rate.

13.3. *Measurements and Adjustments*

13.3.1. Modification to measurement procedure and the standards referenced therein on Averaging Period for Determination of Efficiency by the Stack Loss Method. The methods currently defined in Method 28 WHH allow averaging over 10-minute time periods for flue gas temperature, flue gas CO₂, and flue gas CO for the determination of the efficiency with the Stack Loss Method. However, under some cycling conditions, the “on” period may be short relative to this 10-minute period. For this reason, during cycling operation the averaging period for these parameters may not be longer than the burner-on period divided by 10. The averaging period need not be shorter than one minute. During the off period, under cycling operation, averaging periods as specified in EPA Method 28 WHH and the standards referenced therein may be used. Where short averaging times are used; however, the averaging period for fuel consumption may still be at 10 minutes. This average wood consumption rate shall be applied to all of the smaller time intervals included. The stack loss analysis must also use actual fuel values obtained from the required ultimate/proximate pellet analysis completed as part of the stack loss calculation.

13.4. *Emission Calculations.* Particulate matter, carbon dioxide, and carbon monoxide shall be calculated using the following methodology and reported in grams per hour, grams per kilogram and pounds per million British Therma Unit (Btu) per hour based on heat output:

13.4.1. Two PM measurements shall be reported

13.4.1.1. 60-minute reporting. Emissions from the first sixty minutes shall be reported. The 60 minute periods begins at match light. 60-minute data shall be collected and reported as a separate ASTM 2515-11 train or the TEOM data calculated per the SOP.

13.4.1.2. Integrated Result. The results two, dual ASTM E2515-11 trains, shall integrate into a single result the appliance performance over the five phases of this test method's operational protocol.

13.4.2. Particulate Matter emissions.

13.4.2.1. During the test run, particulate emissions shall be measured per the requirements of ASTM E2515-11, with exceptions noted in 9.4 of this test method. This involves two sampling trains providing an integrated measurement over the entire test period, Phases 1 through 5, and

13.4.2.1.1. A third ASTM 2515-11 train to obtain 60-minute reporting data, or

13.4.2.1.2. Use of a Tapered Element Oscillating Microbalance (TEOM) instrument, or equivalent, as per Appendix A to this test method. Section 9 of Appendix A prescribes the methodology to determine the total PM emitted during each Phase and for the entire test run in grams.

13.5. *Particulate Matter Emissions Rates.* After the test is completed determine the particulate matter emissions rate E_r in accordance with ASTM E2515-11 for each test run. If using ASTM E2515-11 for one-hour data, prepare calculations for each first hour of operation.

13.6. *Average Fuel Load Content.* Determine average fuel load content using the results of the ultimate/proximate analysis.

13.7. *Determine Heat Input.*

$$Q_{in} = (W_{fuel} / (1 + (MC/100))) \times HHV, \text{ BTU}$$

$$Q_{in \text{ LHV}} = (W_{fuel} / (1 + (MC/100))) \times LHV, \text{ BTU}$$

13.8. Determine Heat Output and Delivered Efficiency

$Q_{out} = \Sigma [\text{Heat output determined for each sampling time interval}] + \text{Change in heat stored in the appliance.}$

$$Q_{out} = [\Sigma (C_{pi} \cdot \Delta T \cdot M \cdot t_i)] + (W_{app} \cdot C_{steel} + C_{pa} W_{water}) \cdot (T_{Favg} - T_{iavg}), \text{ BTU}$$

Note: The subscript (i) indicates the parameter value for sampling time interval ti.

$M_i = \text{Mass flow rate} = \text{gal/min} \times \text{density of water (lb/gal)} = \text{lb/min}$

$M_i = V_{fi} \cdot \sigma_i, \text{ lb/min}$

$$\sigma_i = (62.56 + (-.0003413 \times T_{3i}) + (-.00006225 \times T_{3i}^2)) \cdot 0.1337, \text{ lbs/gal}$$

$$C_p = 1.0014 + (-.000003485 \times T_{3i}) \text{ Btu/lb, } ^\circ\text{F}$$

$$C_{steel} = 0.1 \text{ Btu/lb, } ^\circ\text{F}$$

$$C_{pa} = 1.0014 + (-.000003485 \times (T_{Iavg} + T_{Favg})/2), \text{ Btu/lb-}^\circ\text{F}$$

$$V_{fi} = (V_i - V_{i-1}) / (t_i - t_{i-1}), \text{ gal/min}$$

Note: V_i is the total water volume at the end of interval i and V_{i-1} is the total water volume at the beginning of the time interval. This calculation is necessary when a totalizing type water meter is used.

13.9. Determine Heat Output and Delivered Efficiency With External Thermal Storage

$Q_{out} = \Sigma$ [Heat output determined for each sampling time interval] + Change in heat stored in the appliance + Change in heat in storage tank.

$$Q_{out} = \Sigma [C_{pi} \cdot \Delta T_i \cdot M_i \cdot t_i] + (W_{app} \cdot C_{steel} + W_{water} \cdot C_{pa}) \cdot (T_{Favg} - T_{Iavg}) + (W_{StorageTank} \cdot C_{steel} + W_{WaterStorage} \cdot C_{pa}) \cdot (T_{FSavg} - T_{ISavg}) \text{ Btu (MJ)}$$

Note: The subscript (i) indicates the parameter value for sampling time interval t_i .

13.9.1. Determine heat output rate as:

$$\text{Heat Output Rate} = Q_{out} / \Theta, \text{ BTU/hr}$$

13.9.2. Determine emission rates and emission factors as:

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

$$E_{lb/MM BTU output} = (E_T / 453.59) / (Q_{output} \times 10^{-6}), \text{ lb/mmBtu Out}$$

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

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

13.9.3. Determine delivered efficiency as:

$$\eta_{del} = (Q_{out} / Q_{in}) \times 100, \%$$

$$\eta_{del LHV} = (Q_{out} / Q_{in LHV}) \times 100, \%$$

13.9.4. Determine η_{SLM} - Overall Efficiency (SLM) using Stack Loss

13.9.4.1. For determination of the average overall thermal efficiency (η_{SLM}) for the test run, use the data collected over the full test run and the calculations in accordance with CSA B415.1-10. The averaging period for determination of efficiency by the stack loss method allows averaging over 10-minute time periods for flue gas temperature, flue gas CO₂, and flue gas CO for the determination of the efficiency. However, under some cycling conditions, the “on” period may be short relative to this 10-minute period. For this reason, during cycling operation the averaging period for these parameters may not be longer than the burner on period divided by 10. The averaging period need not be shorter than one minute. During the off period, under cycling operation, the averaging periods specified may be used. Where short averaging times are used; however, the averaging period for fuel consumption may still be at 10

minutes. This average wood consumption rate shall be applied to all of the smaller time intervals included. Fuel values from ultimate proximate analysis shall be used to conduct stack loss calculations.

13.9.4.2. Whenever the CSA B415.1-10 overall efficiency is found to be lower than the overall efficiency based on load side measurements, as determined by this method, the test report must include a discussion of the reasons for this result. Any result which finds efficiency greater than 5% shall result in a failed test run.

13.10. *Determine Steady-State Efficiency.* Determined delivered efficiency over the five phases is representative of annual efficiency. For Steady-State efficiency of high and low heat demands, determine the delivered efficiency of the individual steady-state phases, Phases 1,2, and 5.

$\eta_{del(p1)}$ Delivered Efficiency of Phase 1, percent

$\eta_{del(p2)}$ Delivered Efficiency of Phase 2, percent

$\eta_{del(p5)}$ Delivered Efficiency of Phase 5, percent

$\eta_{del(p1)} = Q_{out(p1)} / Q_{in(p1)} \times 100, \%$

$\eta_{del(p2)} = Q_{out(p2)} / Q_{in(p2)} \times 100, \%$

$\eta_{del(p5)} = Q_{out(p5)} / Q_{in(p5)} \times 100, \%$

13.11. Carbon Monoxide Emissions.

For each minute of the test period, the carbon monoxide emission rate shall be calculated as:

$$CO_{g/min} = Q_{std} \cdot CO_s \cdot 3.30 \times 10^{-5}$$

Total CO emissions for each of the five test phases ($CO_{_1}$, $CO_{_2}$, $CO_{_3}$, $CO_{_4}$, $CO_{_5}$) shall be calculated as the sum of the emission rates for each of the 1-minute intervals. Total CO emission for the test run, COT, shall be calculated as the sum of $CO_{_1}$, $CO_{_2}$, $CO_{_3}$, $CO_{_4}$, and $CO_{_5}$. 10-minute averages can be used in place of 1-minute intervals if appropriate as 13.8.4.1.

- 14. Reporting Requirements.* The report shall include the following:
- 14.1. Introduction - no portion of the introduction may be claimed as CBI.
 - 14.1.1.* Purpose of test: certification, audit, efficiency, research, and development
 - 14.1.2.* Name and location of the laboratory conducting the test.
 - 14.1.3.* Wood appliance identification – manufacturer, model number/name, design type, description of the appliance tested, appliance condition, and date of receipt.
 - 14.1.4.* Test information – location of testing, date of tests, sampling methods used, number of test runs, a statement detailing any previous testing completed on the wood appliance.
 - 14.1.5.* A list of participants, their roles, and any observers present for the tests. The list shall include the participant's name, title, company, contact information and the purpose of their participation.
 - 14.1.6.* A statement that the test results apply only to the specific appliance tested.
 - 14.2. Summary and Discussion of Results - no portion of the introduction may be claimed as CBI.
 - 14.2.1.* Table of results to include test run number, average burn rate for entire run, particulate emission rate for full run, particulate emission rate for start-up, carbon monoxide emission rate for a full run, carbon monoxide for startup, efficiency, burn time – total and by phase.
 - 14.2.2.* If the TEOM is used for the entire test, the report shall contain the following:
 - 14.2.2.1. For each test run use the TEOM to apportion filter PM data and use real-time analyzer data for other emissions to report: $\Theta_1, \Theta_2, \Theta_3, \text{CO}, \text{CO}_2, \text{PM}$, and efficiency for (1) the start-up phase and the five individual phases. Calculated results for the emissions reported as total emissions in grams, pounds per million Btu output, grams per MJ, grams per kilogram of dry fuel and grams per hour, and pounds per hour.
 - 14.2.2.2. A statement of the estimated uncertainty of measurement of the emissions and efficiency test results.
 - 14.2.2.3. A plot of CO emission rate in grams/minute vs. time, based on 1-minute averages, for the entire test period, for each run. The report shall include a table reporting the maximum 1-minute, 5-minute, and 60-minute grams per hour on a rolling basis for the test run.
 - 14.2.2.4. A plot of CO₂ emission rate in grams/minute vs. time, based on 1-minute averages, for the entire test period, for each run. The report shall include a table reporting the maximum 1-minute, 5-minute, and 60-minute grams per hour on a rolling basis for the test run.
 - 14.2.2.5. A plot of PM emission rate in grams/hour vs. time, based on 1-minute averages, for the entire test period, for each run. The report shall include a table reporting the maximum 1-minute, 5-minute, and 60-minute grams per

hour on a rolling basis for the test run.

14.2.2.6. Summary of other data – test facility conditions, surface temperature averages, catalyst averages, pretest fuel weights, test fuel charge weights – total and by phase.

14.3. *Emission Calculations.* Particulate matter, carbon dioxide, and carbon monoxide shall be calculated using the following methodology and reported in grams per hour, grams per kilogram and pounds per million British Therma Unit (Btu) per hour based on heat output:

14.3.1. Two measurements shall be reported

14.3.1.1. Start-up. Emissions from match light until the end of the start-up phase shall be collected and reported as a separate element using two ASTM 2515-11 trains. One-hour data shall be reported by a third ASTM 2515-11 train or the TEOM data calculated per the SOP.

14.3.1.2. Integrated Result. The results two, dual ASTM E2515-11 trains shall integrate into a single result the appliance performance over the five phases of this test methods operational protocol.

14.3.2. Particulate Matter emissions.

14.3.2.1. During the test run, particulate emissions shall be measured per the requirements of ASTM E2515-11 with exceptions noted in 9.4 of this test method. This involves two sampling trains providing an integrated measurement over the entire test period, Phases 1 through 5.

14.3.2.2. During the entire test run, particulate concentration in the dilution tunnel shall also be measured in real time using a Tapered Element Oscillating Microbalance (TEOM) instrument, or equivalent, as per Appendix A to this test method. Section 9 of Appendix A prescribes the methodology to determine the total PM emitted during each Phase and for the entire test run in grams.

14.4. Discussion. - no portion of the discussion may be claimed as CBI.

14.4.1. Discussion shall include detailed information describing each test conducted on the appliance:

14.4.1.1. How the test was run

14.4.1.2. Specific test run problems and solutions

14.4.1.3. Test run result

14.5. Process description:

14.5.1. Data and drawings indicating the fire box size and location of the fuel charge.

14.5.2. Drawings and calculations used to determine firebox volume to include volume, height, width, and lengths, weight and volume adjustments. No portion of this section can be CBI.

14.5.3. Firebox configuration – At a minimum to include air supply locations and operation,

air supply introduction location, refractory location and dimensions, catalyst location, baffle and by-pass location and operation (include line drawings or photographs)

14.5.4. Process operation during test – shall supply details on air supply settings and adjustments. No portion of this section can be CBI.

14.5.5. Test fuel properties – species, density, fuel moisture, fuel temperature, and load details. No portion of this section can be CBI.

14.5.6. Sampling. No portion of this section can be CBI.

14.5.6.1. A description of the test procedures and test equipment including a schematic or other drawing showing the location of all required test equipment. Also, a description of test fuel sourcing, handling and storage practices shall be included.

14.5.6.2. Describe sampling location relative to appliance, include drawing or photographs.

14.5.6.3. Provide data on sampling blanks.

14.6. Quality Control and Assurance Procedures. No portion of this section can be CBI.

14.6.1. Calibration procedures and results certification procedures, sample and analysis procedures.

14.6.2. Test method quality control procedures to include leak-checks, volume meter checks, stratification (velocity) checks, proportionality results.

14.7. Appendices – No data contained in the appendices can be claimed as CBI.

14.7.1. Results and Example Calculations. Complete summary tables and accompanying calculations.

14.7.2. Raw data. Copies of all files or sheets for sampling measurement, temperatures records, and sample recovery data.

14.7.3. Sampling and Analytical procedures. Detailed description of procedures followed by laboratory personnel in conducting the certification test.

14.7.4. Calibration Results. Summary of all calibrations, check and audits pertinent to the certification.

14.7.5. Sampling and Operation Records. Copies of all uncorrected records of activities not included in raw data sheets (e.g. appliance door open, times and durations).

14.7.6. User Guide. Appliance instructions for operating the device during the test following the User Guide specifications detailed in Section 8.1.1.

14.7.7. Test Facility Information. Report test facility temperature, air velocity, and humidity information.

14.7.8. Test Equipment Calibration and Audit Information. Report calibration and audit results for the platform scale test fuel balance, test fuel moisture meter, and sampling equipment, including volume metering systems and gaseous analyzers.

14.7.9. Pre-test procedures. Report all pretest procedures conduct at the lab on the appliance

to burns, rates, and amounts.

- 14.7.10.* Details of deviations from, additions to or exclusions from the test method, and their data quality implications on the test results (if any), as well as information on specific test conditions, such as environmental conditions. An explanation of the deviations, additions, or exclusions shall be provided along with an analysis as to why these elements had no impact.
- 14.7.11.* All required data and applicable blanks for each test run shall be provided in spreadsheet format both in the printed report and in a computer file such that the data can be easily analyzed and calculations easily verified. Formulas used for all calculations shall be accessible for review.
- 14.7.12.* For each test run: report TEOM flow and temperature and verification of all TEOM parameters presented in the TEOM 1405 SOP.
- 14.7.13.* Raw data, calibration records, and other relevant documentation shall be retained by the laboratory for a minimum of 7 years.

Table 1A – Must complete a table for each test run, minimum of three
Data Summary Part A - Run 1

| Phase | Target Load | Actual Load | Phase Duration | Wood Consumed | Stack Loss Efficiency | Thermal Efficiency | Min Water Return Temp. |
|-----------|-------------|-------------|----------------|---------------|-----------------------|--------------------|------------------------|
| | Btu/hr | Btu/hr | hours | lbs | % | % | °F |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| Total Run | | | | | | | |

Data Summary Part A - Run 2

| Phase | Target Load | Actual Load | Phase Duration | Wood Consumed | Stack Loss Efficiency | Thermal Efficiency | Min Water Return Temp. |
|-----------|-------------|-------------|----------------|---------------|-----------------------|--------------------|------------------------|
| | Btu/hr | Btu/hr | hours | lbs | % | % | °F |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| Total Run | | | | | | | |

Data Summary Part A - Run 3

| Phase | Target Load | Actual Load | Phase Duration | Wood Consumed | Stack Loss Efficiency | Thermal Efficiency | Min Water Return Temp. |
|-----------|-------------|-------------|----------------|---------------|-----------------------|--------------------|------------------------|
| | Btu/hr | Btu/hr | hours | lbs | % | % | °F |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| Total Run | | | | | | | |

Table 1B – Must complete a table for each test run, minimum of three

Data Summary Part B – 60-minute test results

| Phase | EF _{co} | EI _{co} | ER _{co} | EF _{pm} | EI _{pm} | ER _{pm} | E _j | E _{rtj} | | |
|------------------------|--------------------|------------------|------------------|--------------------|------------------|------------------|----------------|------------------|--|--|
| | Lb/MMBtu output | g/kg fuel | g/hr | Lb/MMBtu output | g/kg fuel | g/hr | g | g | | |
| Run 1 | | | | | | | | | | |
| Run 2 | | | | | | | | | | |
| Run 3 | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| Average of all runs | | | | | | | | | | |

Table 1C Data Summary – Averages

| | EF _{aco} | EI _{aco} | ER _{aco} | EF _{apm} | EI _{apm} | ER _{apm} | Thermal Efficiency η_{TA} |
|------------------------------|--------------------|-------------------|-------------------|--------------------|-------------------|-------------------|--------------------------------------|
| | Lb/MMBtu output | g/kg fuel | Lb/hr | Lb/MMBtu output | g/kg fuel | Lb/hr | % |
| Test 1 | | | | | | | |
| Test 2 | | | | | | | |
| Test 3 | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Average of three tests | | | | | | | |

Appendix A
Standard Operation Procedures for Thermo 1405 TEOM®
for use in a dilution tunnel or with an extractive dilution system
Version 1.0a, May 17, 2019

Section 1. Introduction

This document covers operation concepts and procedures for use of the TEOM model 1405 to measure and report continuous particulate matter (PM) measurements in EPA Method 5G dilution tunnel or equivalent dilution method. The Thermo-Scientific model 1405 TEOM is designed for ambient real-time PM measurements. It is an inertial microbalance - a true continuous mass measurement method with resolution of 0.01 µg (0.00001 mg). The TEOM is highly configurable, allowing the instrument to be “tuned” to best meet the needs of a specific application. The version of the TEOM used here is the simplest, without any sample conditioning options such as “SES” or “FDMS”. For dilution tunnel PM measurements, the TEOM flows, temperatures, and timing settings are changed from the normal ambient settings. There are no hardware modifications needed. Instrument manuals, software, and related support information are available from the NESCAUM TEOM document collection.²

Flow Setting

Recommended flow setting is 0.5 liters per minute (lpm) at EPA STP. If very low PM concentrations consistently less than 5 mg/m³ are expected, higher settings of 1 to 3 lpm can be used. Higher flow gives better sensitivity but shorter filter life. The flow settings should be set to provide the needed sensitivity but also ensure reasonable filter life. For appliances where heavy loading is anticipated, a setting of 0.5 lpm shall be used. Appliances with lighter PM loading can use a setting of 1 or 2 lpm depending on the intended use of the data; high time resolution (10 seconds instead of 1 minute) requires higher flows to achieve the same sensitivity. The TEOM flow must be constant during a test run – it can not be changed while sampling.

Filter Temperature Zones Settings

The three TEOM filter temperature zones are normally set to 30 C (86 F). Temperatures can be set somewhat higher if laboratory temperature is expected to be over 80 F, but no higher than 33C (91F). Temperatures can not be changed during a sampling run. The TEOM filter temperature setting is always a trade-off between stability during highly dynamic burn

² The TEOM manual is referenced in this SOP, and is available here:

<https://www.thermofisher.com/order/catalog/product/TEOM1405>

Additional support documents are at <https://drive.google.com/open?id=0B4duMFtoHVUENk9uemxsHRJczA>

conditions, minimizing loss of semi-volatile organic carbon mass, and avoiding condensing conditions at the filter temperature. Water is considered a semi-volatile mass (SVM) component, but standard practice is to minimize the amount of water measured as part of the PM. Based on current data, 30 C represents an appropriate setting.

TEOM Filter Dynamics

Rapid changes in the sample matrix (PM, gases, water vapor) may result in transient TEOM PM (positive or negative) concentration excursions. This is not an instrument malfunction; it is a result of the mass dynamics occurring on both the TEOM and filter pull filters. The TEOM filter material (Emfab TX40), temperature (30 C), and filter loading are similar to the gravimetric sample train rate (the TEOM filter face velocity is 6.3 cm/sec at 0.5 lpm). Thus, the filter pull PM and TEOM PM measurements should be in agreement and highly correlated if both sampling systems are working properly.

While TEOM PM transients from filter dynamics are usually no longer than 1 or 2 minutes, there can be situations where these filter dynamics can result in data quality issues for an extended period of time. One example is a very rapid transition (a few minutes) from a very dirty burn (as much as 300 mg/m³ in the tunnel) to a very clean burn (a few mg/m³ or less), as experienced with some devices during startup or fuel reloads. For that scenario, it may be necessary to change the TEOM filter after a high loading phase to avoid a prolonged period of a large negative bias to the TEOM PM due to loss of SVM off of the filter from the high loading phase. See Section 6 for more information on when to do pre-emptive filter changes (filter changes done to prevent or minimize negative TEOM data).

The TEOM configuration used here allows for fast filter changes with minimal data loss (typically a few minutes) and does not require flows and temperatures to be within predefined instrument limits for valid data for PM concentrations to be reported. Critical instrument parameters are stored with the concentration data and can be used to invalidate data during review and processing as needed.

Instrument Software

RPCComm (serial port interface) is the legacy TEOM program and can be used to display the last 15 minutes of data on a graph, download data, and read all key operating parameters easily. The ePort program (ethernet interface) is used to control the instrument remotely and to download data. Both programs can be used at the same time.

Section 2. Overview of Routine Operation Procedures for Thermo 1405 TEOM

This section is a summary of routine operating procedures.

- A. Quality Assurance checks to be completed after initial installation, and routinely every 6 months:*
1. Modify system settings as detailed in Section 10
 2. Perform KO check detailed in Section 5
 3. Perform leak check detailed in Section 5
- B. Routine procedures before every test run to be conducted 2-3 hours prior to testing.*
1. Set TEOM filter temperature for the run. Changing this setting requires at least one hour before valid data can be collected. Detailed instructions on this element can be found in Section 3.
 - a. The TEOM filter temperature must be at least 1 C above the hottest lab temperature expected during the test. The normal setting is 30 C (84 F) but may be set as high as 33 C (91 F).
 - b. All three (3) temperatures zones - cap, air, case – must be set to the same value.
 2. Set TEOM flow settings for the run. Changing this setting requires at least one hour before valid data can be collected. Detailed instructions on this element can be found in Section 4. TEOM flow can only be changed before a test run – it can not be changed during a run when the TEOM is sampling.
 - a. Set flow
 - i. Anticipated concentrations $>5 \text{ mg/m}^3$: 0.5 lpm
 - ii. Anticipated concentrations $<5 \text{ mg/m}^3$: 1-3 lpm
 - b. Calibrate TEOM flows. This step must be completed whenever the flow is changed. An external mass flow meter such as the TSI 4140 is used for flow calibrations.
 3. Check the TEOM time and set as needed.

Changing the time causes an instrument reboot and loss of up to an hour of data. See note below.
 4. Initial filter change
 - a. Install a clean filter before each run.
 - b. Use the “Advanced” filter change mode.
 - c. Perform an external flow check with the clean filter or before the start of a run.
 - d. The net flow reading shall be within 2% of the TEOM flow setpoint.

C. *One hour before testing*

Check TEOM settings for appropriate temperature, flow and time settings. Perform an external flow check as detailed in Section 4 and record the results. For valid results the flow check should be within 2% of the TEOM flow setpoint.

D. *Testing Operations*

1. Before initiating the test, run the TEOM while sampling dilution tunnel or diluter air for at least 5 minutes. The change of pressure can cause a transient TEOM response.
2. Filter Changes are done pre-emptively as described in Section 6 and whenever the TEOM filter loading reaches 130%, as reported on the TEOM, or when the sample flow starts to drop. The 1405 does NOT have any clear visual warning that the filter needs changing, but it is possible to use the TEOM digital outputs (relay contact closures) to trigger an external alarm at any desired filter loading.

The “Advanced” filter change wizard mode shall be used to eliminate long equilibration period after the change; this stops the tapered element oscillation, resets the filter mass measurement, and simplifies filter changes. Detailed information on performing filter changes during testing is provided in Section 6 of this document.

3. At the end of the test perform an external flow check as detailed in Section 4 and record the result. For valid results flow check should be within 2% of the TEOM flow setpoint.
4. Download the test data using either the Thermo ePort software (preferred), RPComm, or to a USB thumb drive. Note: the data format may be different depending on how the data is downloaded.

Notes:

- It is normal for there to be “Warnings” present for the ambient T/RH sensors (not used). This is the only allowable warning once the system is warmed up and is in use for testing.
- When the TEOM is first turned on or rebooted, no data are recorded until the top of the next hour. As long as the TEOM is not rebooted, data will be recorded regardless of instrument status.
- When the time is changed, the instrument reboots (after many seconds of being hung, with no information on the screen). When it reboots, no data are recorded until after the top of the next hour (see above).
- TEOM PM concentrations are in micrograms per cubic meter, at EPA STP (25C and 1 atmosphere) unless the instrument configuration is changed. Filter mass loading is

reported in micrograms, with a resolution of 0.01 micrograms (10^{-8} grams).

Section 3. Filter Temperature Adjustment SOP for 1405 TEOM

The TEOM filter temperature has the capacity to be set between 30 and 55 degrees C, however for testing purposes the filter temperature should be set to between 30 and 33 C. If the temperature is too low (less than 1 C above room temperature), the instrument may not be able to maintain the temperature set-point, possibly resulting in loss of data. Temperatures higher than necessary may result in excessive loss of semi-volatile PM during sampling. There are three temperature settings - cap, air, case – that shall all be set to the same value.

Temperature Change Procedure.

The TEOM temperatures are set in the Instrument Conditions, Temperatures menu. Temperatures can not be changed during a sampling run.

Note: The **T-Air** temperature zone may take a very long time (30 minutes or more) to stabilize, especially when the temperature is higher than the setpoint. If the “Case” temperature is within 0.1 C of the setpoint, data are usually valid.

Section 4. Sample Flow Check and Adjustment for the Thermo 1405 TEOM

Checking the Sample Flow.

The TEOM should be warmed up for at least 30 minutes before checking or adjusting the sample flow. The sample flow can not be changed during a test run. The sample flow should be checked at the sensor inlet with an external mass flow meter that reads in STP; that flow should be within 2 % of the flow on the TEOM display. Flow checks must be done:

- A. at the start of every sampling day (with a clean filter),
- B. at the end of the run (with the dirty filter), and
- C. whenever the flow setting is changed.

Record the external flowmeter reading without flow as the zero and subtract that value from the flowmeter reading with flow to get the measured flow value.

If the post-test flow check (with a loaded filter) is lower than the initial flow check (with a clean filter), that is an indication of a possible leak. A leak test should also be performed whenever the flow check difference (between the TEOM display flow and the external flow meter flow) changes.

If the external flow (at EPA STP, with zero offset correction) is more than 5% off from the TEOM display flow, measure the flow without a filter in the TEOM. If the external flow check result is low with a filter but higher or correct without a filter, that is an indication of a leak.

If the flow is the same with and without a filter and out of spec, the flow calibration routine should be performed. This routine should also be performed whenever the sample flow setting is changed.

Flow settings.

The TEOM sample flow can be set to between 0.5 and 3.0 LPM (all flows are at EPA STP of 1 atm. and 25 C). Lower flow gives longer filter lifetime and less sensitivity. Higher flow gives shorter filter lifetime and more sensitivity. The flow should be set to provide reasonable filter lifetime (typically at least 30 minutes) for any given test scenario, since about 4 minutes of data are lost when the filter is changed.

For most cases, the flow should be set to 0.5 LPM. If a high loading burn (PM greater than 20 mg/m³) is anticipated, the flow must be set to 0.5 LPM. Flows higher than 1 LPM shall only be used when very light loading is expected (PM consistently below 2 to 3 mg/m³).

The sample flow is set in Instrument Conditions, Flows, Flow Rates. Flow is calibrated using the wizard at Service, Calibration, Flow Calibration (page 5-39 of the TEOM manual).

NOTE: The TEOM sample flow cannot be changed during a test run.

Section 5. Leak Test and KO Check Procedure for 1405 TEOM

The Leak Test and KO Checks described here do not need to be done on a routine basis. They should be done at least every 6 months, or as needed for troubleshooting.

Leak Check

A leak test measures the flow as reported by the TEOM's flow sensor with the inlet closed off. The TEOM leak test flow measurement must be corrected for the TEOM flowmeter's zero offset. To conduct a flow check, follow the procedures below:

1. With the TEOM warmed up for at least 30 minutes, read the TEOM reported flow with the pump turned off. This is the flowmeter zero reading.
2. Close off the inlet to the TEOM with a brass swage cap.
3. Turn on the TEOM pump.
4. Wait one minute and read the TEOM flow.
5. The leak test value is the difference between the reading without and with the pump on.
6. The leak test should be no greater than 0.05 lpm (net value).
7. Turn the pump off and remove the brass swage cap from the TEOM inlet.

KO Check

In addition to routine pre- and post-sampling flow checks, a KO check is another test that shall be completed to validate proper operation of the TEOM. KO checks confirm the calibration factor for the tapered element mass transducer. It is done once per year and as needed. See page 5-50 of the manual.

Section 6. Filter Change Procedure for 1405 TEOM

The TEOM measures the pressure drop across the filter as % of maximum (~ 100 to 130 %), shown on the instrument's display. A clean filter has a loading of about 5% at 0.5 LPM and ~ 7% at 1 LPM. Filter lifetime will vary widely depending on the PM concentrations being sampled. At very high PM concentrations (several hundred mg/m³), filter lifetime may be only 10 to 15 minutes. Under typical sampling conditions, lifetime is at least 30 minutes and up to an hour or more with concentrations in the 20 to 50 mg/m³ range. With care, filter changes can be done such that only a few minutes of data are lost.

The TEOM filter must always be changed before the filter mass loading becomes too high and the filter plugs and the sample flow drops. TEOM filters can also be changed before they overload to minimize negative data.

When TEOM data are the primary data source, The Teom filter gets changed whenever ANY of the following conditions are met. This minimizes negative or negatively biased Teom PM measurements.

2a. Filter plugs

2b. Filter mass loading exceeds 1000 ug AND the filter has been in use for at least 30 minutes. [both conditions have to be met]

2c. Persistent (at least several minutes) negative data of at least -2 mg/m³ is observed that is not due to instrument noise when concentrations are very clean.

For this purpose, negative Teom data should be set to 0 in the final data set.

Filter change procedure.

The following are filter handling procedures that shall be followed:

- A. Unused clean filters should be stored in the original box, with the silica gel desiccant.
- B. Two clean filters should be stored in the mass transducer.
- C. Filters should only be handled with the filter change tool that is stored inside the TEOM cabinet.

The TEOM manual has illustrated procedures for filter changes starting on page 5-6. Try to minimize the time the mass transducer is open to minimize the time needed to re-stabilize after the filter change.

1. The filter change menu can be located by pushing the Service, Maintenance, Replace Filter. Select Advanced option, and then Next to proceed.
2. Open the TEOM cabinet door, open the box of clean filters, and open the mass transducer. Remove the old filter by sliding the filter tool onto the filter and pulling straight out. Do not twist the tool (to prevent damage to the glass tapered element).

3. Pick up a new filter (stored inside the mass transducer) with the tool. Position it directly over the tapered element and push the filter on gently. Once the filter is on, remove the tool from the filter and fully seat the filter by pushing firmly straight down on the filter with the bottom of the tool (see section 3 of the manual for more information). Store another new filter in the mass transducer.
4. Close the mass transducer, replace the filter box cover, and close the cabinet. Restart the TEOM by completing the filter change wizard.
5. If the PM concentration as read on the RPComm graph hasn't stabilized within 5 minutes, or if the Frequency is close to 0 (~10 instead of a few hundred Hz) the filter may need to be resealed or is defective, or the sensor latch is not closed properly. Repeat the filter change "advanced" procedure and take the filter off and re-seat it. Push it on firmly with the back of the filter tool and make sure the sensor is properly closed and latched. After two attempts, restart the procedure with another new filter.

Note: the PM concentration on the TEOM display will read 0 after a filter change until the top of the next hour. When valid data are being collected, the RPComm graph will indicate the concentration, and the "Total Mass" on the TEOM display will read something other than "0.00".

► There is one exception to this: after an instrument reboot for any reason (including setting the time), data are not stored until after the top of the next hour, even if the RPComm graph is showing data and the Total Mass is not 0.

Section 7: Reserved for future use

Section 8: Data Storage and Download

The TEOM shall be set to store data every 10 seconds. There is storage for several days of data at this storage interval. Data can be downloaded while the TEOM is running.

Data are usually downloaded with the ePort software but if needed can also be downloaded to a USB thumb drive or with the RPComm TEOM software. The data file is in .CSV format for importing into a spreadsheet.

Data parameters are saved as follows:

1. Date, Time
2. PM-2.5 raw MC
3. PM-2.5 MC
4. PM-2.5 total mass
5. PM-2.5 30-Min MC
6. Operating mode
7. System status
8. PM-2.5 flow rate

9. PM-2.5 TEOM filter load
10. PM-2.5 TEOM filter pressure
11. Case temperature
12. Cap temperature
13. PM-2.5 air tube temperature
14. Enclosure temperature (temperature on the main TEOM circuit board)
15. PM-2.5 TEOM noise
16. PM-2.5 TEOM frequency
17. Vacuum pump pressure

The key parameters for data validation and analysis are:

1. Date and Time – reported as the end of the average interval
2. PM2.5 raw - PM2.5 raw is the same as PM2.5 MC except it is always reported even when the instrument status is invalid. This minimizes loss of data but also requires manual editing of the data file to remove invalid PM concentrations based on review of the data and critical parameters such as flow and temperatures. Concentration is in $\mu\text{g}/\text{m}^3$. A zero value for Mass Conc indicates no data.
3. PM2.5 total mass - the mass loading on the TEOM filter in μg .
4. PM2.5 flow rate - Flow is SLPM unless something else is used in the instrument configuration.
5. PM2.5 TEOM filter load - filter loading as % of maximum.
6. Case temperature, in degrees C.
7. Noise is a data stability metric and should normally be less than 0.10 when pm concentrations are low or zero.

Section 9. Data Validation and Calculations

TEOM data are recorded every 10 seconds to minimize data loss during filter changes. Data validation is performed on the 10 second data and then usually averaged up to 1-minute intervals for reporting use.

TEOM data are valid when all flows and temperatures are within the defined operating ranges specified below.

1. "Case" temperature is stable and within 0.1 deg C of set-point. Other temperatures can be off as long as the Case temperature is stable and close to the set-point.
2. Flow reported by the instrument should be within 5% of the flow setpoint.

Because of the way the Teom is run here [with a wait time of 0], it never invalidates any data. Thus the data must always be reviewed and cleaned up manually. The wait time is set to 0 to minimize data loss during a filter change, or when the "Cap" temperature is out of range but the data are ok. The Teom reports a concentration of 0 or repeating values when there are no valid data.

The "Raw MC" PM concentration parameter is reported regardless of instrument conditions and thus includes invalid data that need to be removed during data validation. Normally the only data that need to be removed are during a filter change that occurs during a run. When a filter is changed, the last valid concentration value is repeated until new valid data are available. These repeating data are removed manually during validation and considered as "missing" data.

Note: For cumulative PM emission measurements (total grams of PM emitted during a burn phase or run), missing data shall be filled in with best-estimates based on the 1-minute PM concentrations immediately before and after the filter change. Otherwise, the effective emissions for the period with missing data are zero, creating a negative bias in the measurement.

It is common for the TEOM PM concentration to be somewhat negative during some burn phases. This happens when the TEOM filter mass loading is large and PM emissions are relatively low (e.g., for a clean burn phase that follows a dirty burn phase), and the TEOM filter loses mass. This can be controlled by pre-emptive filter changes as described in Section 6. Small negative concentration up to a few mg/m³ can still occur however. To minimize measurement bias, these small negative concentrations should always be set to 0 during data processing. Large and rapid negative data swings in concentration may indicate a problem with the instrument and should normally be considered invalid or missing data (not set to 0).

The output of the TEOM is PM concentration in µg/m³ at 25 C and 1 Atmosphere (29.92 inches Hg) pressure. To correct TEOM data to the test or reporting conditions use the following:

$$\text{PM at local T and P} = \text{PM at STP} * (298/T) * (P/29.92)$$

The 1-minute TEOM PM concentration is converted into grams/hour using the stack flow as follows.

Stack flow from the vane anemometer (in m/s at stack temperature) is converted to cubic meters per minute at STP (25 C and 1 ATM.) using the stack diameter and temperature. Flow is then multiplied by Teom PM concentration (at STP) in grams per cubic meter to get PM emission rate in grams per minute. Multiply that by 60 to get grams per hour at 1-minute intervals. The average of all 1-minute PM emission rate measurements is the run-average grams per hour value.

Note: Proportionality with stack flow is not needed for PM emission rates from Teom PM data, since all of the data (stack flow, stack temperature, and PM concentration) are processed into PM emission rates using 1-minute data.

TEOM data can be used to apportion the PM emission rate (g/h) measured by a Method 5G or E2515 regulatory sample train to multiple burn phases by applying a correction factor to the 1-minute Teom data. The correction factor is the ratio of filter pull full run g/h to TEOM full run g/h. The 1-minute TEOM data is then adjusted by this correction factor.

For calculation of lbs/mmbtu, total grams PM emitted is calculated by multiplying the average g/h rate for the test period of interest times the number of hours of that test period. Grams are converted to lbs by multiplying grams by 453.6.

Section 10: TEOM Configuration Changes for Fast Response and High PM Concentrations, and List of TEOM Parameter Configuration Values.

These settings are for the 1405 TEOM as used in this application that are different from instrument default settings. See the 1405 manual for detailed information on how to change these values.

1. Remove the A and B factors [+3 and x1.03] that are used for PM10 FEM status. “Mass Constant A” is set to zero, and “Mass Constant B” is set to 1.00.
2. Change system filtering and wait time settings:
TM (Total Mass Avg time) from 300 to 15 seconds
MR-MC (Mass Rate/Mass Conc Avg time) from 300 to 15 seconds
Wait Time from 1800 to 0 seconds (disabled)
3. Change the sample flow from 3.0 to 0.5 lpm. The bypass flow is set to 0.
4. Change all 3 temperature zones [Case, Air, Cap] to 30 C.
5. Set both the “Avg” and “Std” T/P to 25 C / 1 atm - this is the default for systems without the external temperature sensor. Select Passive and Standard as shown below.

Instrument Conditions->Flows->Flow Control

| | | | |
|--------------------------------|---------|-------------------------------------|----------|
| Volumetric Flow Control: | | Report to the following conditions: | |
| Active | Passive | Actual | Standard |
| Standard temperature: 25.00 °C | | Standard pressure: 1.00 atm | |
| Average temperature: 25.00 °C | | Average pressure: 1.00 atm | |

6. Change the Data Storage interval to 10 seconds.

A complete list of 1405 TEOM Settings that are modified from instrument defaults are listed below:

| PRC | Description | Config Value | Unit | |
|-----|--------------------------------|--------------|---|---|
| 12 | storage interval | 10 | sec | |
| 28 | system wait time | 0 | sec | |
| 35 | mass average time | 15 | sec | See also PRC392 -- MPMC |
| 48 | case temperature set point | 30 | Deg C or higher as needed to maintain a stable case T | See also PRC 115 -- air tube |
| 59 | cap temperature set point | 30 | Deg C or higher as needed to maintain a stable case T | |
| 74 | average temperature set point | 25 | C | These are for reporting PM at EPA STP |
| 75 | standard temperature set point | 25 | C | These are for reporting PM at EPA STP |
| 76 | average pressure set point | 1 | atm | These are for reporting PM at EPA STP |
| 77 | standard pressure set point | 1 | atm | These are for reporting PM at EPA STP |
| 91 | bypass flow mass set point | 0 | | Can be used as a baseline param for rpcomm plots. |
| 115 | TEOMA air tube set point | 30 | Deg C, or higher as needed to maintain a stable filter T; see also PRC 48 and 59. | |
| 136 | analog output1 minimum | -5000 | optional -- ug/m3 as needed for RPComm plot scaling | |
| 144 | analog output1 maximum | 50000 | optional -- ug/m3 as needed for RPComm plot scaling | |
| 227 | TEOMA flow set point | 1 | lpm; or 0.5 to 2 lpm as needed; flow must be recalibrated if changed! | |
| 392 | MPMC average time | 15 | sec | |
| 407 | TEOMA mass constant A | 0 | | |
| 408 | TEOMA mass constant B | 1 | | |

Note: all 3 temperatures must be set to the same value.

Data Logging Parameters.

| <u>prc</u> | <u>description</u> | <u>var name in data file</u> | <u>Unit</u> |
|------------|---------------------------|------------------------------|-------------|
| 244 | raw mass conc | TEOMAMCRaw | ug/m3 |
| 245 | mass conc | TEOMAMC | ug/m3 |
| 243 | total filter mass loading | TEOMATotalMass | ug/m3 |
| 7 | operating mode | OperatingMode | # |
| 8 | system status | StatusCondition | # |
| 225 | flow rate (STP) | TEOMAFlowMass | lpm |
| 241 | filter pressure | TEOMAFilterPressure | raw |
| 242 | filter load % | TEOMAFilterLoad | % of max |
| 47 | case temperature | CaseHeatTemp | C |
| 58 | cap temperature | CapHeatTemp | C |
| 237 | air tube temperature | TEOMAAirTubeHeatTemp | C |
| 258 | noise | TEOMANoise | ug |
| 257 | frequency | TEOMAFrequency | Hz |



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

MAR 06 2018

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Ms. Kelli O'Brien
Lab Manager
ClearStak
99 Canal Street
Putnam, CT 06260

Dear Ms. O'Brien,

I am writing in response to your letter dated March 4, 2018, regarding certification testing of the Nova model wood stove, a prototype single burn rate wood stove manufactured by MF Fire. You are requesting to use alternative test procedures for recovery and preparation of the particulate matter (PM) samples from the front half filter and probe assembly. In particular, you propose use of the acetone probe rinse and filter sample recovery and preparation procedures described in sections 8.7 and 11.0 of Method 5, Determination of Particulate Matter Emissions from Stationary Sources (40 CFR 60, Appendix A), in lieu of the procedures in section 10.2.2 of ASTM E2515-11, Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel which is required under 40 CFR 60, Subparts AAA and QQQQ.

The difference between the sample recovery and preparation procedures of Method 5 and ASTM E2515-11 is that Method 5 determines PM in the probe and filter assembly by (1) collecting PM in the probe through acetone rinses of the probe, drying down the rinse in beakers, dessication, followed by weighing and (2) removal of the filter, dessicating, and then weighing, as opposed to ASTM E2515-11 where the entire 100+ gram probe assembly is weighed before and after a test run. We understand that ClearStak typically performs gravimetric analysis of their PM samples (acetone rinses and filters) at an offsite location and not in the wood heater emission testing laboratory to ensure quality low mass (e.g., milligram) measurements uninfluenced by ground vibrations caused by daily operations of testing facilities.

You state that through past experience, you have found that probe PM collected through acetone rinses which are then transported in sample jars offer far less possible sample contamination than handling the front half probe and filter assembly. You propose to collect the acetone rinses after testing according to section 8.7 of Method 5, transport them to your laboratory, then transfer the rinses from the jars to clean and desiccated pre-weighed 100 mL beakers where they are dried down and desiccated according to section 11.2.2 of Method 5, and finally weighed according ASTM E2515-11 in 6-hour intervals until two consecutive weights are achieved within 0.2mg. Likewise, the filters (which were pre-weighed before testing as required in section 8.1.3 of Method 5) are recovered according to section 8.7 of Method 5, transported to the laboratory, dessicated according to section 11.2.1 of Method 5, and weighed according ASTM E2515-11.

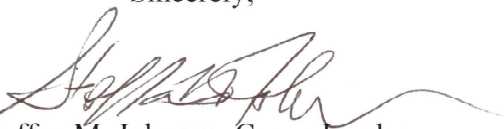
We understand ClearStak is requesting to use these alternative procedures for PM recovery, dry down, and desiccation of the front half probe and filter assembly samples for ASTM E2515-11 testing of MF Fire's prototype single burn rate stove, Nova, and for all future ASTM E2515-11 emissions testing of residential wood heaters, hydronic heaters, and forced-air furnaces per 40 CFR Part 60 Subparts AAA and QQQQ.

With this letter, we are approving your alternative test procedures detailed above in conjunction with ASTM E2515-11 for certification testing of the MF Fire's prototype single burn rate stove, Nova, as well as all wood heaters, hydronic heaters, and forced-air furnaces subject to 40 CFR Part 60 Subpart AAA and QQQQ. A copy of this letter must be included in each certification test report where this alternative test method is utilized.

It is reasonable that this alternative test method approval be broadly applicable to certification testing of all wood heaters, hydronic heaters, and forced-air furnaces subject to the requirements of 40 CFR part 60, Subparts AAA and QQQQ. For this reason, we will post this letter as ALT-126 on our website at <http://www3.epa.gov/ttn/emc/approalt.html> for use by other interested parties. This alternative method approval is valid until such time that Subparts AAA and QQQQ are revised or replaced to require a different certification method, and at such time, this alternative will be reconsidered and possibly withdrawn.

If you have additional questions regarding this approval, please contact Michael Toney of my staff at 919-541-5247 or toney.mike@epa.gov.

Sincerely,



Steffan M. Johnson, Group Leader
Measurement Technology Group

cc: Amanda Aldridge, EPA/OAQPS/OID
Adam Baumgart-Getz, EPA/OAQPS/OID
Rafael Sanchez, EPA/OECA
Michael Toney, EPA/OAQPS/AQAD

Appendix 14

Operating and installation manuals

BIOWIN 2 TOUCH

FOR USE IN CANADA / USA



PELLET BOILER

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IMPORTANT INFORMATION FOR SYSTEM OPERATORS

Dear Heating System Owner,

We would like to congratulate you on your new environmentally friendly heating system. With the purchase of this high-quality product by Windhager, you have selected a system that provides more comfort and optimised fuel consumption while utilising an environmentally friendly means of saving resources. Your boiler was manufactured under strict ISO 9001-certified standards, was subjected to extensive tests and all the components are recyclable.

We have provided specific information and important tips regarding systems operation, unit functions and cleaning.

This manual contains data with US units. The units in the original manual are European units. If there is a data conflict between these units, the data with European units is always valid.

The original manual is written in German – this is an English translation. In case of conflicts, the German version is always valid.

Note.



Operation of the boiler together with the InfoWIN Touch display and operating unit is described in a separate InfoWIN Touch operating manual. Please pay close attention to these instructions. Familiarity with the material in this document will allow you to enjoy long-term operation of the boiler. We wish you all the best with your Windhager boiler.

1. General information

As required by the United States Department of Environmental Protection the following information is given for the: BioWIN 2 Touch wood pellet fired central heating boilers. Manufactured by Windhager Zentralheizung Technik GmbH, Anton Windhager Strasse 20, Seekirchen 5201, Austria

The BioWIN 2 Touch boilers have the following thermal output levels and comply with EPA 2020 requirements:

- BioWIN 102 from 10.2 kBTU/hr (3 kW) to 33.8 kBTU/hr (9.9 kW)
- BioWIN 152 from 15.3 kBTU/hr (4.5 kW) to 51.2 kBTU/hr (15 kW)
- BioWIN 212 from 21.5 kBTU/hr (6.3 kW) to 71.7 kBTU/hr (21kW)
- BioWIN 262 from 26.6 kBTU/hr (7.8 kW) to 88.4 kBTU/hr (25.9 kW)
- BioWIN 332 from 33.4 kBTU/hr (9.8 kW) to 110.9 kBTU/hr (32.5 kW)

The BioWIN 2 Touch boilers efficiency at nominal output was measured by a test laboratory using the HHV of the fuel.

- BioWIN 102: TBD
- BioWIN 152: TBD
- BioWIN 212: TBD
- BioWIN 262: TBD
- BioWIN 332: TBD

Your BioWIN 2 Touch boiler 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.

Your BioWIN 2 Touch boiler is equipped with automatic fuel loading. There are no further loading instructions. Solely PFI Premium 100% wood pellets shall be used.

Materials such as trash, plastics, gasoline, rubber, naphtha, household garbage, material treated with petroleum products such as particleboard, railroad ties, and pressure treated wood.

Burning these materials may result in release of toxic fumes or render the heater ineffective and cause smoke.

Your BioWIN 2 Touch is equipped with an automatic ignition and starts itself when required by building load. Thus, no further ignition procedures are to be followed.

There are no user adjustments for the air controls required.

Important information for system operators

It is important to have BioWIN2 Touch boiler serviced by a trained professional who is aware of the importance to ensure that:

- there are no inlet air restrictions in or around your boiler's combustion blower
- the air passages within your boiler are free of debris(ash, creosote, etc.)
- the Flue pipe and chimney are clean and free of debris / restrictions
- combustion chamber door (when closed and secured) and the ash box seal are airtight.

Ash removal is completely automatic. 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 or on the ground, away from all combustible materials, pending final disposal. The ashes should be retained in the closed container until all cinders have thoroughly cooled.

A person or persons responsible for the operation of a hydronic heater must comply with all applicable laws or requirements, such as State laws or regulations as well as local ordinances.

A person or persons operating a hydronic heater should be aware that they are responsible for operation in such a manner that does not create a public or private nuisance condition.

The manufacturer's distance and stack height recommendations and the requirements in any applicable laws or other requirements may not always be adequate to prevent nuisance conditions due to terrain or other factors.

Your BioWIN2 Touch should be installed with a minimum stack height of 16 feet. Providing correct draft as given in the Installation manual.

Draft is the force, which moves air from the appliance up through the chimney. The amount of draft depends on the length of the chimney, local geography nearby obstructions and other factors.

Too much draft may cause excessive temperatures in the appliance and may damage parts in the catalytic combustor.

Inadequate draft may cause backpuffing into the room and 'plugging' of the chimney, or the catalyst.

Inadequate draft will cause the appliance to leak smoke into the room through appliance and chimney connector joints.

Your BioWIN2 Touch is not a catalytic type burner.

You should never use a combustion appliance in your home without an installed smoke and CO detector.

Your local fire department usually has good advice on placement of these detectors and how many your home needs for complete coverage.

Complete important installation information is found in the installation manual.

The chapters „Important information for system operators“ and "Operation" are intended for both users and qualified contractors.



Note.

This wood heating appliance needs periodic inspection and repair for proper operation. It is against federal law to operate this wood heating appliance in a manner inconsistent with operating instructions in the manual.



Note.

Read these instructions carefully before using the appliance and retain them for future reference. Pass on the instructions to a new user if required.

1.1 Relevant documents

- Operating manual InfoWIN Touch, installation instructions BioWIN 2 Touch
- Operating and installation instructions for system components

1.2 Safety instructions and other symbols in this documentation

1.2.1 Structure of safety instructions



KEYWORD Type of risk

Here, possible consequences are listed that may result from failure to observe the safety instructions.
 ► Steps to prevent the risk are listed.

1.2.2 Symbols, type of risk or meaning

| Symbol | Type of risk or meaning |
|--------|---|
| | Injury |
| | Electrocution |
| | Material losses (appliance damage, consequential losses and environmental pollution) |
| | Information or tips |

| Symbol | Type of risk or meaning |
|--------|---|
| | Risk of burns |
| | Risk of crushing |
| | Appliance disposal This symbol means that the parts indicated must not be disposed of with domestic waste. |
| | This symbol indicates that you have to do something. The action you need to take is described step by step. |

1.2.3 Keywords

| KEYWORD | Meaning |
|----------------------------|--|
| DANGER | Ignoring the warnings identified by this symbol can lead to serious injuries or death . |
| WARNING | Ignoring the warnings identified by this symbol can lead to injury . |
| CAUTION | Ignoring the warnings identified by this symbol can lead to malfunction of or damage to the boiler or heating system . |
| Information or tips | The blocks of text identified by this symbol provide information and tips for operation. ► Read these texts carefully. |

1.3 Liability exclusion

All work should be performed exclusively by trained personnel. Local safety regulations must be complied with in all cases; in the event of a conflict and/or contradiction between these regulations and the working instructions in this document (e.g., impairment), then the local regulations should be adhered to in any event and the working instruction should not be carried out; WINDHAGER ZENTRALHEIZUNG GMBH, ÖSTERREICH and WINDHAGER ZENTRALHEIZUNG TECHNIK GmbH, ÖSTERREICH do not accept any liability for any injury to persons or damage to property caused by incorrectly following the instructions and/or violating the local safety regulations! Subject to modifications. No liability is accepted for errors in translation.

1.4 Spare parts

For spare parts, please contact the Customer Service partner.

1.5 Data plate

The data plate bears important specifications relating to the unit, such as its type, factory number and year of manufacture. If you need a spare part or have to contact Windhager Customer Service or your customer service partner due to a malfunction, please first make a note of this data from the data plate. The data plate is located on the front of the equipment, behind the cladding door below the control panel – Fig. 2.



1..... Data plate

Fig.2 Data plate

2. Safety

The boiler together with its accessories complies with the latest state of the art as well as the relevant safety regulations, and is operated with electric current (110 V AC). Improper installation or repair can pose the danger of life-threatening electric shock. Installation may be performed only by appropriately qualified technicians.

2.1 Manufacturer's obligations

Our products are manufactured in accordance with the essential requirements of the various applicable guidelines. They therefore carry the **CE** label and are supplied with all the required documentation.

Technical details subject to change.

We as the manufacturer cannot be held liable in the following cases:

- Incorrect use of the unit.
- Failure to perform proper full service on the unit.
- Incorrect installation of the unit.

2.2 Installer's obligations

The installer is the person responsible for installing the unit. The installer must comply with the following instructions:

- ▶ Read and follow all instructions supplied with the unit.
- ▶ Carry out installation in accordance with the applicable standards and specifications.
- ▶ Explain to the operator how the system works.
- ▶ Make the operator aware of his obligation to inspect and maintain the unit.
- ▶ Hand over all operating manuals to the operator.

2.3 Operator's obligations

To ensure that the unit operates at optimum performance, the operator must follow these instructions:

- ▶ Only adults who have received instruction from Windhager Customer Service or a heating technician may operate the system.
- ▶ The operator must have read and understood the instructions contained in the documentation.
- ▶ Installation and initial start-up must be performed by appropriately qualified technicians.
- ▶ Make sure the installer explains how the system works.
- ▶ Perform all the necessary checks and full service.
- ▶ Keep the instructions in good condition and store them near the boiler.



DANGER Injury

This unit is not intended for use by persons (including children) who have physical or mental disabilities or sensory impairment or who have no experience or knowledge of the correct use of the unit, unless supervised or trained by a person responsible for their safety. Children should be supervised to ensure they do not play with the unit.

2.4 General safety information



DANGER Injury

Please follow the safety instructions (symbols) on the appliance!

Please refer to the instructions in chapter 7. Safety instructions on side 13!



DANGER Electrocution

Turning off the on/off button on the InfoWIN Touch does not mean the boiler and its accessories are completely without power.

- ▶ Therefore, you must de-energise the boiler (e.g. by unplugging the main power plug) when carrying out cleaning or repair work.
-



WARNING Risk of crushing from rotating auger

- ▶ If you have to touch these parts, always de-energise the boiler.
-



WARNING Risk of burns

- ▶ Before touching these surfaces, you must switch off the boiler and let it cool.
-

2.5 Sources of danger

2.5.1 Power failure (or if the induced draught fan is not running)



WARNING Risk of explosive combustion.

Do not open the combustion chamber door, there is an increased risk of explosive combustion when opening the combustion chamber door. A self-test is performed following a power failure during combustion and then operation is continued automatically.

2.5.2 Burner bowl



WARNING Risk of explosive combustion.

Never fill the burner bowl with pellets by hand. Excessive combustion material in the burner bowl means that the pellets will not be ignited optimally. Too much low-temperature carburisation gas will be generated and this can lead to explosive combustion.

2.5.3 Entering the pellet storage room, storage container

All energy sources are subject to safety regulations, which must be observed when working with fuels, heating systems, and storage rooms. This also applies to pellet storage.

After the storage room is filled, odorless carbon monoxide (CO) may be produced, and there may be insufficient oxygen present. For this reason, do not enter the pellet storage room for 6 weeks after it has been filled. Only persons trained for working in confined spaces may enter the storage room for the purpose of measuring gas levels before any work is carried out.

Please also follow the instructions on the pellet storage room safety notice:

- No access to unauthorised persons, keep children away from the pellet store.
- Ensure sufficient ventilation before entering. Keep the door open while inside.
- Only enter the storage room under the supervision of a second person standing outside. .
- No smoking, flames or other sources of ignition are permitted.
- Risk of injury from moving parts.
- Pellet boilers must be switched off at least 15 minutes before filling.
- Fill in accordance with the instructions of the boiler and pellet suppliers.
- Protect pellets from damp.

If you feel unwell, leave the storage room immediately and seek medical advice.



DANGER Attention, risk of suffocation.

Do not attempt to enter an unventilated storage room.

2.5.4 Combustion air

Never seal openings that have been provided for ventilation.

Important information for system operators

3. Fuel

The boilers/heaters are designed to burn the following fuels:

Pellets according to EN ISO 17225-2 A1, DIN-Plus or UZ38, or Super Premium Wood Pellets listed in the Pellets Fuel Institute (PFI) Standard.

Significant criteria based on the standards are as follows:

| | |
|---|---|
| Diameter 0.25 in / 6 mm | Length: 5-40 mm / 0.20-1.6 in. |
| Smooth surface | Bulk density: 600-700 kg/m ³ (37.5-43.7 lb/ft ³) |
| Residual moisture content max. 10 % | Energy content 16,3 – 19 MJ/kg = 4,6 – 5,3 kWh/kg |
| Ash content max. 0.7 % (with 1022 °C) | Abraded particles max. 2.5 % |
| Chemical/synthetic binding agents are strictly prohibited | No impurities from varnish or paint residues, etc. |

This boiler/heater is equipped for the following type of fuel only and must not be used with any fuel other than listed below:

- Super Premium Wood Pellets listed in the Pellets Fuel Institute (PFI) Standard.
- Wood Pellets listed in the EN ISO 17225-2 A1 standard.
- Wood Pellets listed in the DIN-Plus or UZ38 standard.

These pellets must fulfill following requirements:

| Fuel Property | General requirements | |
|--|----------------------|------------------|
| Device specific - Mandatory | | |
| Heating Value | 7737 – 8511 BTU/lb | 5.0 – 5.5 kWh/kg |
| Ash Fusion | 2192 °F | 1200 °C |
| Diameter | 0.25 inches | 6 mm |
| Fuel Property | PFI Super Premium | |
| Normative Information | | |
| Bulk Density, lb./cubic foot | 40.0 - 46.0 | |
| Pellet Durability Index | ≥ 96.5 | |
| Fines, % (at the mill gate) | ≤ 0.50 | |
| Inorganic Ash, % | ≤ 0.05 | |
| Length, % greater than 1.50 inches / 38.1 mm | ≤ 1 | |
| Moisture, % | ≤ 8.0 | |
| Chloride, ppm | ≤ 300 | |

Store pellets in a dry, safe place. Follow local and building codes when storing pellets.

The use of lower quality pellets will lead to malfunctions, increasing the need for service. It will also lead to the loss of warranty.

The use of any fuel other than listed above may result in fire and explosion!

Consequences of quality fluctuations:

Pellets are 100% unprocessed wood, so minor fluctuations in fuel quality are normal and reflect the natural origins of the material. These quality fluctuations affect the level of dirt, the ash content and therefore the cleaning intervals. A reduction in cleaning intervals due to fluctuations in pellet quality cannot be remedied as part of a repair under guarantee!

The use of lower quality pellets will lead to malfunctions, increasing the need for service. It will also lead to the loss of warranty. Make your pellet supplier aware of these quality requirements before ordering and seek confirmation upon delivery.

4. Commissioning and operation

A Windhager representative or one of its partners must commission your new Windhager boiler system. Our representatives will ensure that all systems are thoroughly checked and can provide additional information at the time of commissioning. Installation and routine maintenance performed by a qualified Windhager representative will ensure the optimal performance and service life of your boiler system. This will also ensure that this technologically advanced system provides the benefits of safe, environmentally friendly, and energy-saving operation.

The following preconditions must be met before the commissioning:

- The boiler is installed and connected properly.
- System fully wired up electrically.
- System flushed, filled and vented – heat load must be available.
- Hot water tank connected to domestic water and filled.
- Sufficient quantity of fuel available.
- The customer must be present during commissioning.

The commissioning cannot be carried out if any of these points are not complete. The customer may be charged for any unnecessary costs arising as a result of incorrect start-up.

Commissioning by Windhager Customer Service or a heating technician are part of the warranty requirements.



Note.

During the first few weeks after start-up, condensation can occur in the combustion chamber, ash pan and on the heating surfaces. This has no effect on the function and service life of the boiler.

5. Safety device and function checks

Check the function of all safety devices (such as Pressure Relief Valve and Low Water Cut-off, and others if required and installed) annually, according to the manufacturers' recommendations.



DANGER Injury

To prevent burns and other injuries resulting from contact with hot water, test all safety devices only when unit is turned off and has cooled completely.

If you have an annual maintenance contract with a certified Windhager partner, these tests will be completed during their routine maintenance work.

It is required that the function of the system and related safety equipment be checked and certified yearly by a qualified technician (installer, heating system contractor).

At two-year intervals, the heating water condition must be checked by a heating expert (see BioWIN 2 Touch installation instructions – heating water); this is to prevent corrosion and sediment accumulation in the heating system and boiler/heater. For systems using more than 1,500 liters (396.3 gallons) of water (e.g., systems with accumulator tanks), this inspection is required on an annual basis.

In the event of repair work requiring a change of water in the heating system, the heating water is to be checked within 4 to 6 weeks after the repair work.

Corrosion and sediment resulting from improper heating water are not covered by the guarantee and warranty.

Important information for system operators

6.1 Entering the pellet storage room, storage container

All energy sources are subject to safety regulations, which must be observed when working with fuels, heating systems, and storage rooms. This also applies to pellet storage.

After the storage room is filled, odorless carbon monoxide (CO) may be produced, and there may be insufficient oxygen present. For this reason, do not enter the pellet storage room for 6 weeks after it has been filled. Only persons trained for working in confined spaces may enter the storage room for the purpose of measuring gas levels before any work is carried out.

Please also follow the instructions on the pellet storage room safety notice:

- No access to unauthorised persons, keep children away from the pellet store.
- Ensure sufficient ventilation before entering. Keep the door open while inside.
- Only enter the storage room under the supervision of a second person standing outside. .
- No smoking, flames or other sources of ignition are permitted.
- Risk of injury from moving parts.
- Pellet boilers must be switched off at least 15 minutes before filling.
- Fill in accordance with the instructions of the boiler and pellet suppliers.
- Protect pellets from damp.

If you feel unwell, leave the storage room immediately and seek medical advice.



DANGER Attention, risk of suffocation.

Do not attempt to enter an unventilated storage room.

7. Safety instructions



DANGER Risk of fire or explosion.

Do not use chemicals or fluids to start the fire.



CAUTION Health and environmental hazard.

Do not burn garbage, gasoline, naphtha, engine oil, or other inappropriate materials.



WARNING Opening heating chamber door can crush and cut.

When opening door, never insert hands between the door and frame on the hinge side of the heating chamber.



WARNING Opening heating chamber door can crush and cut.

When closing door, never insert hands between the door and frame of the heating chamber. Be aware of other people, especially children.



WARNING Entanglement hazard.

Do not open cover of auger conveyor when heating. Handle with care when servicing charging screw.



WARNING Ash tray can crush and cut.

Never insert hands between ash tray and frame. Never insert hands into closing bracket. Never insert hands between ash tray and closing bracket.

Important information for system operators



WARNING Cover plate for pellet chamber can crush and cut.

Use caution when opening the cover plate. Only authorized personnel are allowed to open cover plate.



WARNING Closing pellet chamber door can crush and cut.

Never insert hands between door and frame, or between door and closing bracket of the pellet chamber when closing the door. Never insert hands into the hinge area when opening door.



WARNING Opening pellet chamber door can crush and cut.

Never insert hands between door and frame on the hinge side of the pellet chamber when opening door. Never insert hands between door and closing bracket.



WARNING Removing the ash tray can crush and cut.

Never insert hands between frame of boiler/heater and ash tray when removing the ash tray.



WARNING Mounting the ash tray can crush and cut.

Never insert hands between frame of boiler/heater and ash tray when removing the ash tray.



WARNING Displacing the ash tray can crush and cut.

When moving the ash tray, never insert hands between floor of the heating boiler and ash tray.



WARNING Pinch point hazard.

Never insert hands between the cover plate and housing of heating chamber when opening or closing.



DANGER Smoke gas.

Ensure adequate ventilation in the boiler room. Smoke gas may cause poisoning.



WARNING Hot water and hot steam. Injury hazard.

Safety devices (such as the relief valve) will open automatically and release hot water or hot steam. Keep away from safety devices. Do not operate safety devices manually when system water is hot or when device is in operation.



DANGER Attention. Risk of fire.

Lack of water can lead to fire in pellet hopper.
Do not operate this device when water level in water container is below minimum!
Do not use fluids other than pure water.
Monitor the water level monthly and refill to minimum level when necessary.
Always keep water container closed with original lid.- Art. no. 007073 - grip plug.
See BioWIN 2 Touch operating manual for monitoring and refill procedures.

Important information for system operators



DANGER Risk of fire or explosion.

Exposure may result in severe injury or death.

Do not fill with garbage, waste oil, gasoline, other flammable liquids, or any fuel other than those listed on the rating plate.



Do not use chemicals to ignite fuel.

Do not use chemicals, sprays, or flammable substances to clean combustion room or any other burner component.



Do not use boiler/heater cleaners.

Do not manually fill or light burner.

Do not smoke! Do not expose to open flame.



Do not expose to ignition sources.

Do not open combustion chamber door during operation, power failure, or alarms.



WARNING Fall hazard.

Do not sit, stand, or walk on machine. Keep children away.



DANGER Attention. Risk of fire.

Do not vacuum hot ash - may cause fire in vacuum cleaner.

Prior to vacuuming ash or dirt, wait until unit has shut down completely and has cooled for at least 2 hours.



WARNING Machine starts automatically.

Moving parts can crush and cut.

Do not remove guarding.



Do not touch rotating parts.

Keep children away.

Keep pets away.



DANGER Hazardous voltage.

Do not remove cover.

Keep away from electric components.

Disconnect power before servicing or cleaning.



WARNING Burn hazard – hot surface.

Do not touch frame, cover, or inside of heating chamber during heating.

Allow heating chamber to cool completely before cleaning and servicing.

Keep children and pets away from heating chamber.

Do not touch backside, chimney, or any other pipework during operation.

Maximum draft marked on nameplate.



WARNING Injury hazard.

All components/surfaces remain hot for a long period of time after turning off unit!

Before cleaning or touching combustion chamber or any other components, turn off unit completely and allow to cool for at least 2 hours

Use heat-resistant gloves.

Use tools provided.

Important information for system operators



WARNING Health hazard.

Combustion particulates may contain harmful substances.
Use a fine-dust face mask during cleaning.



WARNING Rotating parts can crush and dismember.

Keep hands out of feed opening.
Do not remove cover during normal operation.



WARNING Hand crush hazard.

Automatic start-up if safety switch is activated.
Do not push safety switch.
Moving parts behind the combustion chamber door may start automatically, which can lead to loss of fingers or other serious bodily injury.
Disconnect power before opening the combustion chamber door.



WARNING Risk of health hazard.

Do not connect to an existing boiler/heater system.



WARNING Crush hazard.

Open the cover of the electronic unit until it is secured in the open position. If not secured, it may fall unexpectedly.



WARNING Risk of hand injury.

Use caution when opening the cleaning flap, as it can open suddenly.
When opening the cleaning flap, use the tool provided and wear protective gloves.



WARNING Pinch point hazard.

Use caution when closing the cover of the smoke funnel chamber.



WARNING Crush hazard.

Remain alert and aware of surroundings when moving the machine with crane or fork lift.



DANGER Smoke gas.

Mount a warning plate against smoke gas on the boiler room door.



WARNING Health hazard.

In case of an unexpected fire or if flue pipe turns red, disconnect power if the plug, main switch, or main circuit breaker is safe to reach. Call the fire department (911) and evacuate the building. Do not enter smoke-filled rooms to disconnect power.



WARNING Injury hazard by hot water or steam.

Safety devices (such as relief or drain valve) will open automatically and relieve hot water or steam. Keep away from safety devices. Do not manually operate safety devices when the system is hot.

Important information for system operators



WARNING Health hazard from chemical substances.

Some states list chemical substances known to cause cancer, birth defects, death, serious illness, or other reproductive harm in propositions. This product may contain such substances, either from the fuel, fuel combustion, or in components of the product itself.



WARNING Necessary tasks.

The heat exchanger, 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 each 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.



WARNING Pellet feed system: service, maintenance and rules

The pellet feed system operates automatically. All service and maintenance must be completed by trained specialists only. Do not alter the equipment or accessories in any way.

For use in combination with Windhager BioWIN 2 Touch pellet-fueled central heating boiler/furnace only.

Do not use to transport any material other than wood pellet fuel listed on the boiler nameplate or in the boiler manuals.

Do not use for vacuum cleaning.

The pellet feed system starts automatically and will make noise. People who are easily startled or have cardiac problems should keep away.



DANGER Pellet feed unit: Risk of fire or explosion.

Can lead to serious injury/death! Ground suction hoses must be installed as described in the installation manual at every connection to avoid static sparking/dust ignition. The pellet feed unit is for use with the day hopper only. The feed unit must be braced, anchored, or strapped to avoid falling/shifting during an earthquake. Instructions can be obtained from your local Windhager dealer or wholesaler.



Pellet feed automatic changeover unit: Fire and explosion hazard

Fire and explosion hazard can lead to serious injury or death.

Do not use the pellet feed automatic changeover unit inside pellet storage room or where there is a lot of dust present. Connect delivery hoses to pellet feed automatic changeover unit as described in the installation manual to avoid static sparking or dust ignition.



WARNING Pellet feed automatic changeover unit: injury hazard by moving parts and electricity

Can lead to serious injury or death.

Device starts automatically. Device restarts automatically after power failure.

Do not remove cover.

This part should be serviced by trained personnel only.



WARNING Clearances and installation instructions

Minimum clearances from combustible or noncombustible construction:

2 inches left, 12 inches back, 24 inches top (right),

6 inches right side, 22 inches front.

Access to the back side is required to allow the service of parts such as the drain valve, relief valve, and inspection fittings.

This unit is for dry indoor installation only. Not for installation on combustible flooring. Not for installation in manufactured homes or mobile homes.

Important information for system operators



DANGER Risk of serious bodily injury or death.

This boiler/heater is equipped for one type of wood pellet only. Read the nameplate behind top lid for the correct type of pellet. Do not use this boiler/heater with any fuel other than the one listed on the name plate. Failure to use the correct fuel may cause problems resulting in death, serious bodily injury or property damage.



DANGER Attention. Risk of fire.

Do not operate with incorrect draft. Check nameplate behind top lid for correct draft.
Do not operate while refilling the bulk hopper.
Do not operate with door or ash removal covering open or when the ash box is removed.
Do not store fuel or other combustible material in the boiler room.
Regularly inspect and clean flues and chimney.
Have a trained professional regularly inspect safety devices, such as the relief and drain valves.



WARNING

For supply connections, only use 10 AWG or larger wires acceptable for at least 176 °F (80 °C) on a GFCI circuit!

OPERATION

8. Opening the cladding door



WARNING Risk of burns

► Before opening the cladding door of the boiler, ensure that it is switched off via the **ON/OFF button** (see Fig. 3) and allowed to cool down (display is blank).

- Raise the cover and remove; locate the Allen key.
- Insert the Allen key, turn a quarter turn to the left and open the cladding door – Fig. 6, Fig. 7.



Fig. 6 Open the cladding door with the Allen key



Fig. 7 Cladding door open

9. Functional description, components and operating controls BioWIN 2 Touch

The BioWIN2 Touch automatically fires when the control system signals a heating requirement. Following „purging“ (safety function), ignition starts and the pellet auger switches on. The burner bowl is automatically filled with pellets. When flame formation has been detected (by the thermocontrol sensor), the boiler enters flame stabilisation mode and then control mode (modulation) which maintains to the specified boiler temperature setpoint. The boiler enters burnout mode if the output drops below the minimum nominal thermal output or no heating requirement is signalled by the control system. The induced draught fan continues to run until the burner bowl has cooled down.

9.1 BioWIN 2 Touch Klassik/Klassik-L

The boiler pellet hopper is loaded by hand. A motor moves the heating surface cleaning system vertically and the heating surfaces remain clean. The cleaning residues from the heating surfaces drop into the rear ash chamber; the combustion residues from the burner bowl drop into the ash pan. In the event of a cleaning request, the ash has to be removed by hand.

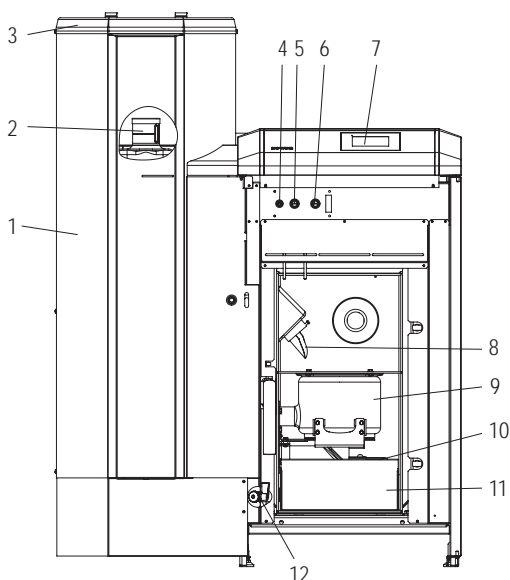


Fig. 8 BioWIN 2 Touch Klassik without cladding door or combustion chamber door

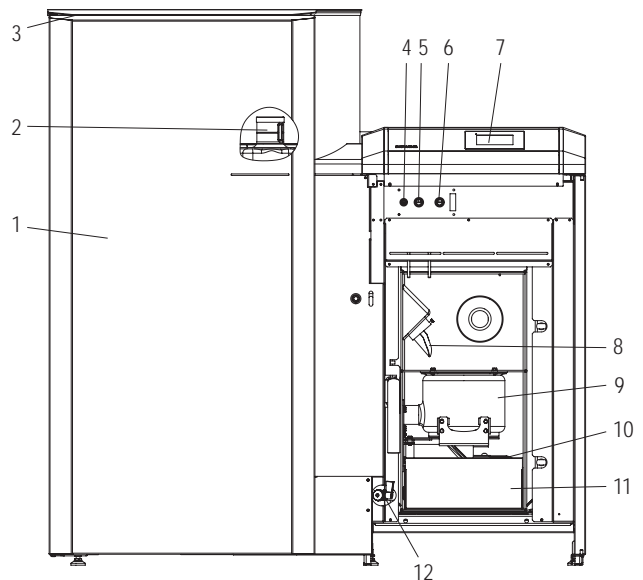


Fig. 9 BioWIN 2 Touch Klassik-L without cladding door or combustion chamber door

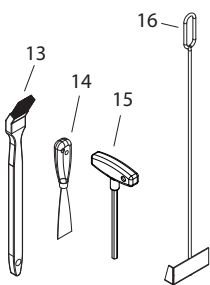


Fig.10 Cleaning and operating implements

- 1..... Pellet boiler pellet hopper
- 2..... Water tank for burn-back safeguard (behind the boiler pellet hopper)
- 3..... Filling cover for pellet boiler pellet hopper
- 4 T 6.3 A device fuse
- 5..... Safety thermostat auger tube
- 6 Safety thermostat boiler temperature
- 7..... InfoWIN Touch display and operating unit
- 8 Down chute

- 9 Burner bowl
- 10 Cover for the heat exchanger ash chamber
- 11 Ash pan
- 12..... Drain cock
- 13..... Cleaning brush
- 14..... Spatula
- 15..... Allen key
- 16..... Scraper

9.2 BioWIN 2 Touch Exklusiv-S/Exklusiv-SL

Version as BioWIN 2 Touch Klassik/Klassik-L, but in addition with automatic ash conveyor into an ash box

Fully automatic ash conveyor:

During fully automatic ash removal, the ash is transported out of the combustion chamber and the heating surfaces into the side ash box under the boiler pellet hopper using a motor and auger. Pellets only have a low ash content (approx. 0.5 %). The container therefore only needs emptying 1 to 3 times a year.

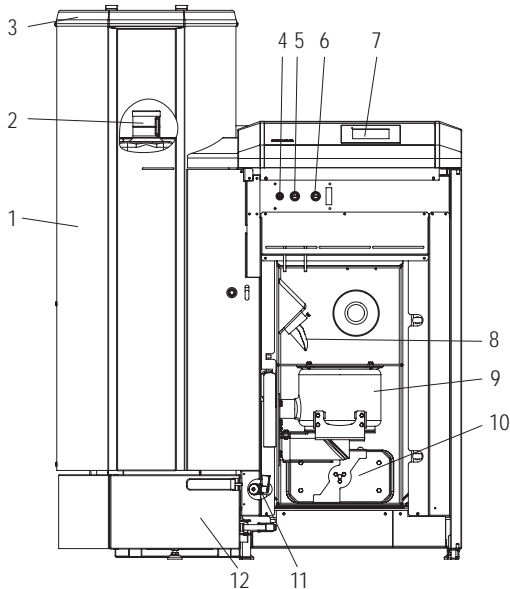


Fig. 11 BioWIN 2 Touch Exklusiv-S without cladding door or combustion chamber door

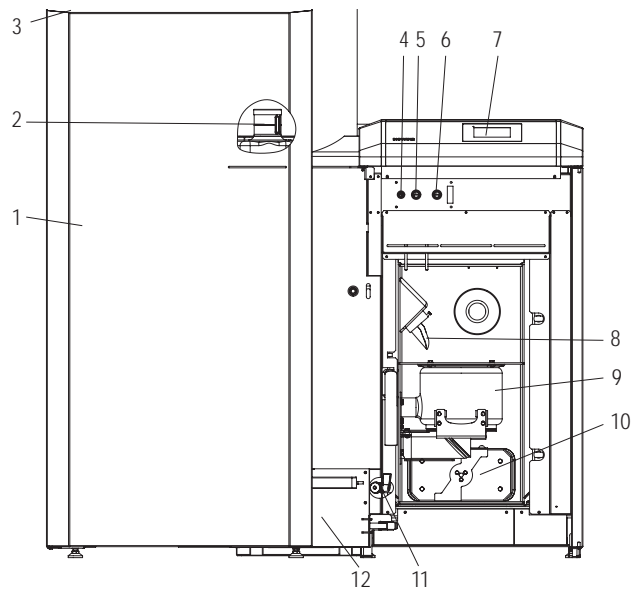


Fig. 12 BioWIN 2 Touch Exklusiv-SL without cladding door or combustion chamber door

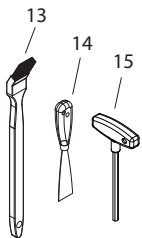


Fig. 13 Cleaning and operating implements

- | | |
|--|---|
| 1..... Pellet boiler pellet hopper | 9 Burner bowl |
| 2..... Water tank for burn-back safeguard (behind the boiler pellet hopper) | 10 Cover for the heat exchanger ash chamber |
| 3..... Filling cover for pellet boiler pellet hopper | 11 Drain cock |
| 4 T 6.3 A device fuse | 12 Ash box |
| 5..... Safety thermostat auger tube | 13..... Cleaning brush |
| 6 Safety thermostat boiler temperature | 14..... Spatula |
| 7..... InfoWIN Touch display and operating unit | 15..... Allen key |
| 8 Down chute | |

9.3 BioWIN 2 Touch Premium / Exklusiv

Version as BioWIN 2 Touch Klassik/Exklusiv-S, but in addition with fully automatic pellet feed

The pellet feed uses a suction turbine to fill the BioWIN 2 Touch boiler pellet hopper fully automatically with pellets from a pellet storage room or storage container. The pellet feed is switched on by the lower fill level switch (proximity switch) in the boiler pellet hopper or at the end of the enable time or the beginning of the start time, and runs until the boiler pellet hopper is full. Filling is not started if the boiler is in heating mode or the feed has been blocked by the control unit (outside the enable time, e.g. at night). If the boiler is operating when filling is necessary, the boiler switches to burnout mode.

When there are several suction probes, switching between the probes is executed automatically. The system changes to the next suction probe after the boiler pellet hopper has been filled a certain number of times. This means the storage room is emptied as evenly as possible.

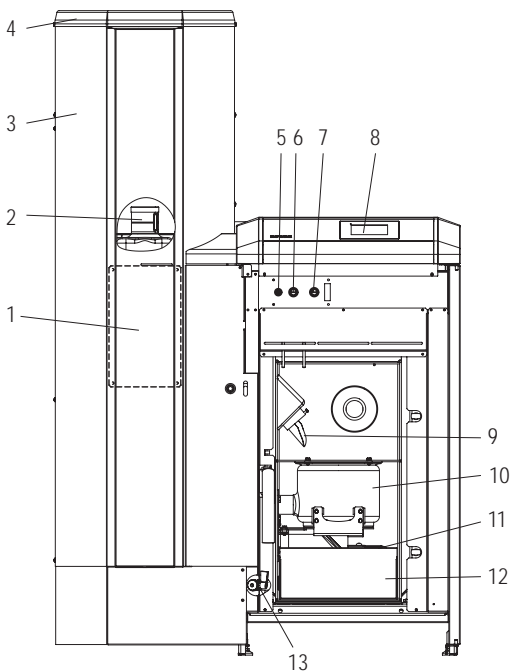


Fig. 14 BioWIN 2 Touch Premium without cladding door or combustion chamber door

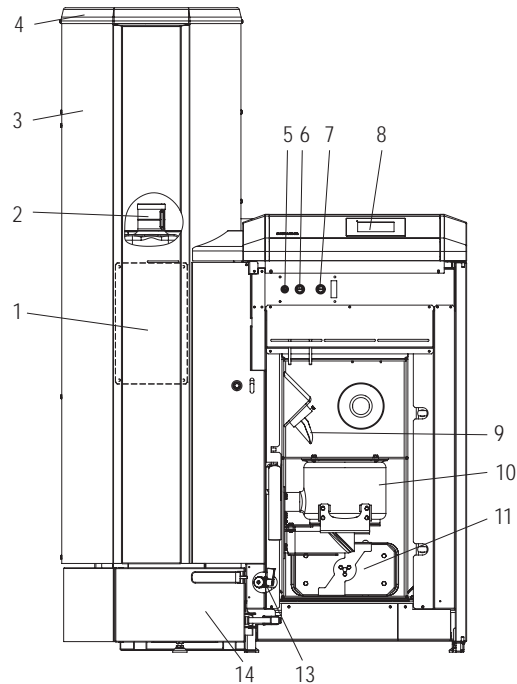


Fig. 15 BioWIN 2 Touch Exklusiv without cladding door or combustion chamber door

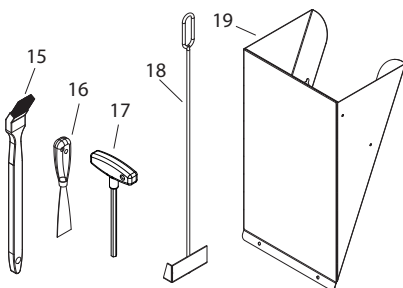


Fig. 16 Cleaning and operating implements

- | | |
|--|--|
| 1..... Inspection cover for boiler pellet hopper under other cover | 11..... Cover for the heat exchanger ash chamber |
| 2..... Water tank (behind the boiler pellet hopper) | 12..... Ash pan |
| 3..... Pellet boiler pellet hopper | 13..... Drain cock |
| 4..... Fully automated pellet feed | 14..... Ash box |
| 5..... T 6.3 A device fuse | 15..... Cleaning brush |
| 6..... Safety thermostat auger tube | 16..... Spatula |
| 7..... Safety thermostat boiler temperature | 17..... Allen key |
| 8..... InfoWIN Touch display and operating unit | 18..... Scraper (only with BioWIN 2 Touch Premium) |
| 9..... Down chute | 19..... Pellet chute ¹ (accessory) |
| 10..... Burner bowl | |

¹ Pellet chute for temporary use only or when manually filling the boiler pellet hopper, if feed is not complete.

10. Functional description function module INF F05

10.1 External heating demand (INF F05 W)

An external heating demand can be enabled with a 0 - 10 V DC analogue signal or a digital extra-low or low-voltage input. Depending on the input used, the function module INF F05 W determines a temperature set point which is transmitted to the other MES INFINITY or MES^{PLUS} function modules.

10.1.1 Heating demand 0 - 10 V DC

The 0 - 10 V DC analogue signal is connected at the input (terminal 4). Depending on the voltage, a boiler set point is calculated and set.

| | |
|---------------|-----------------------|
| 0 - 1.5 V DC | No heating demand |
| 1.5 - 10 V DC | Set point 15 - 100 °C |

10.1.2 Digital potential-free extra-low-voltage contacts (5 V DC)

A potential-free contact is connected at the input (terminal 8). If the contact is closed, the set value for „Set temperature ext. heating demand“ (see Section 3.5.2) is transferred.

A potential-free contact is connected at the input (terminal 5). If the contact is closed, the set value for "Digital set point DHW" (see Section 3.5.2) is transferred.

10.1.3 Digital low-voltage input (230 V AC)

If there is voltage at the input (plug X104.1 and X104.4), the set value for "Set temperature ext. heating demand" (see Section 3.5.2) is transferred.

10.1.4 Pump control with relay

When, in the „Service level“, „Pump control“ is set to „Yes“, the pump control with relay function option can be enabled under the menu item „Operator level“ → „Pump control“ → „Relay“.



Note.

The pump control with relay function can only be enabled if the collective alarm function is not enabled.

The pump is switched on or off by the relay depending on the selected function. A heating circuit pump or transfer pump (boiler pump – special function) can be controlled with the relay:

Heating circuit pump

With the function „Operator level“ → „Pump control“ → „Heating circuit pump“, a heating circuit pump can be controlled in conjunction with an external heating demand.

The heating circuit pump is switched on when:

- There is an external heating demand (0 -10 V DC, digital potential-free contact 7 - 8, digital low-voltage input);
- The boiler excess temperature protection function is active;
- The boiler start-up relief protection function is off.

The heating circuit pump is switched off when:

- The external heating demand is no longer available and the pump over run of 10 minutes has elapsed;
- The boiler start-up relief protection function is active.

Operation

Transfer pump

With the function „**Operator level**“ → „**Pump control**“ → „**Transfer pump**“, a transfer pump can be controlled in conjunction with an MES INFINITY function module (heating circuit or buffer load/burner). With this function, energy can be pumped from a heat generator to a more distant heating circuit (load circuit).

The transfer pump is switched on when:

- A heating demand is transferred from a MES INFINITY function module;
- The boiler excess temperature protection function is active;
- The boiler start-up relief protection function is off.

The transfer pump is switched off when:

- The heating demand of the MES INFINITY function module is no longer available and the pump over run of 10 minutes has elapsed;
- The boiler start-up relief protection function is active.

Boiler pump – special function

With the special function „**Operator level** → „**Pump control**“ → „**Boiler pump**“, a boiler pump (heat generator pump) can be controlled.

The boiler pump is switched on when:

- The burner of the automatic boiler is switched on;
- The boiler excess temperature protection function is active;
- The boiler start-up relief protection function is off.

The boiler pump is switched off when:

- The burner of the automatic boiler is locked out and the pump over run of 10 min. has elapsed;
- The boiler start-up relief protection function is active.

Buffer loading pump

This function is only possible with the cascade function – see Section 2.3.

10.2 Collective alarm (INF F05 S)

Depending on the setting in the menu item „**Operator level**“ → „**Collective alarm**“ (see Section 3.5.3), the relay closes in the event of an alarm, fault or information message.

A 230 V AC digital input (plug X104.1 and X104.2) can also be used to trigger the collective alarm as an option. If the input is enabled, the error text "Error message E1" is displayed.

10.3 Cascade function (INF F05 K)

In a pellet cascade system, the function module INF F05 K controls the buffer loading pump. This pump is controlled by means of speed regulation via PWM signal or 0 - 10 V DC. The cascade function must be enabled under „**Service level**“ → „**Cascade function**“ – see Section 5.2.

A separate INF F05 K function module is required for each boiler in the system. This must be paired with the associated firing automate (see Section 5.4.2).

In the menu item "**Operator level**" → "**Pump control**" → "**Assigned to boiler**", it is possible to check whether the connection with the firing automate is correct. The boiler numbers of the firing automates and the function modules must correspond (also see Cascade system start-up).

10.3.1 Pump control with speed regulation



Note.

The speed regulation with PWM signal function is only possible with high-efficiency pumps from the Windhager delivery range.

Operation

The function must be enabled under „**Service level**“ → „**Pump control**“ → „**Yes**“ – see Section 5.2. For speed regulation, a 0 - 10 V DC or PWM signal is available and is set under „**Operator level**“ → „**Pump control**“ → „**Speed regulation**“ .

The buffer load is optimised with speed regulation. The speed of the pump is regulated depending on the specifications of the KAS+ cascade module. This control specification is determined depending on the boiler model (maximum possible power) with different outputs.

The calculated speed is restricted by the adjusters under "**Operator level** → "**Pump control**" → "**Min. speed**" and "**Max. speed**" – see Section 3.5.1.

10.3.2 Buffer loading pump

With the function „**Operator level**“ → „**Pump control**“ → „**Buffer loading pump**“, a buffer can be loaded in conjunction with a Windhager heat generator (boiler). A cascade module (KAS+) is required for this function.

The buffer loading pump is switched on when:

- A heating demand is available from an MES INFINITY or an external heating demand is available;
- The KAS+ cascade module controls the pump;
- The boiler start-up relief protection function is off;
- The boiler excess temperature protection function is active.

The buffer loading pump is switched off when:

- The heating demand from an MES INFINITY function module or an external heating demand is no longer available and the pump over run of 10 minutes has elapsed;
- The KAS+ cascade module locks the pump and the pump over run of 10 min. has elapsed;
- The boiler start-up relief protection function is active.

10.3.3 Boiler pump

For special systems only, can only be set after consultation with Windhager Zentralheizung.

10.3.4 Assigned to boiler (heat generator)

If the function module is linked to a KAS+ cascade module and a heat generator (boiler), the associated (linked) boiler number is displayed under "**Operator level**" → "**Pump control**" → "**Assigned to boiler**". This boiler number can be set at the heat generator (boiler).

10.4 General functions

10.4.1 Boiler start-up relief and excess temperature protection functions

The boiler protection functions protect the boiler against corrosion and excess temperature.

If the start-up relief function is active, the pump is switched off depending on the temperature or the speed is reduced. If the excess temperature protection function is active, the pump is forced on and the speed is set to max.

10.4.2 Pumps seizing

The transfer, buffer loading and/or boiler pumps are switched on once a week (Wednesday at 11:59) for 10 sec. if there is no heating demand.

10.4.3 Set point offset

For special systems only, can only be set after consultation with Windhager Zentralheizung.

11. Check before switching on



DANGER Injury

Check all the following items before switching on.

- ▶ System pressure (system water pressure):
The system must be filled and vented. With the system cold, pressure should be at least 14.5 psi / 1.0 bar (maximum 11.6 psi / 1.8 bar). If you have any questions, your installer will gladly answer them.
- ▶ Ventilation:
Please make sure the boiler room is well ventilated. The air supply must be free of dust.
- ▶ Flue:
Please have the chimney sweeper check the flue, and, if necessary, clean it.
- ▶ Water tank:
For level check in water tank for burn-back safeguard – see section 24. Water tank level on side 41.

12. Filling the boiler pellet hopper

12.1 Manual filling, BioWIN 2 Touch Klassik/Klassik-L/Exklusiv-S/Exklusiv-SL

Open the boiler pellet hopper cover and fill the hopper up to max. 0.39 in (1 cm) below the top. Close the cover.


Operation with external supply of combustion air

The cover on the boiler pellet hopper is monitored by a safety switch. The boiler cannot be operated when the lid is open. If the lid is opened during operation, after 4 mins the boiler switches to burnout.

12.2 Fully automatic filling, BioWIN 2 Touch Premium/Exklusiv

The boiler pellet hopper is filled by the fully automatic pellet feed. Windhager Customer Service or the customer service partner will perform the first fill (start-up), put the boiler and its pellet feed into service and familiarise the customer with the operation and cleaning of the boiler, with reference to the operating manual.

13. Heating system operation

The BioWIN 2 Touch should not be switched off with the ON/OFF button  on the InfoWIN Touch or disconnected from the power supply via the main power plug. The heating system should be shut down by switching it off at the control system.




CAUTION Material losses

The frost protection function is **not active** when the boiler is switched off (ON/OFF button ).



CAUTION Material losses

The seize protection for cleaning the heating surfaces and for the ash conveyor (is switched on briefly every day at 12:00) is **not active** when the boiler is switched off (ON/OFF button ).



Note.

Operation of the **BioWIN 2 Touch** together with the InfoWIN Touch display and operating unit is described in a **separate operating manual** for each method.

13.1 Turning the boiler on



1. Touch the InfoWIN Touch, then press the  turn on button and confirm “Boiler On”. During power-up, the system is identified (read in), the self-test starts automatically and the load screen  is displayed. After a successful self-test, the homescreen is displayed.
2. Set the **operating mode switch** on the remote control (installed in the living area) to “**Automatic operation**”.



Fig. 17 BioWIN 2 Touch boiler with InfoWIN Touch

13.2 Emergency operation

In the event the control system fails, selecting “Manual mode” using the InfoWIN Touch (see the InfoWIN Touch operating manual) will activate emergency operation to maintain heat and hot water.

CARE, CLEANING AND FULL SERVICE

14. Overview of intervals between cleaning (Full service)

The BioWIN 2 Touch is equipped with a cleaning and ash removal interval display. The „Cleaning“ and „Main cleaning“ cleaning request is displayed on the InfoWIN Touch and must be confirmed after cleaning/ash removal has finished – see section 14.1.

A clean boiler saves fuel and operates efficiently. Therefore always clean your boiler as required when the cleaning and ash removal request is displayed.

The cleaning and ash removal intervals may be reduced or extended depending on the pellets used (e.g. ash proportion), the power consumed by the heating system (frequently switching ON and OFF) and the boiler size of the BioWIN 2 Touch (10 to 33 kW).

Full service is required in addition to cleaning. This is also shown in the display as „Full service“ and is carried out by Windhager Customer Service or a heating technician. It is a prerequisite for the warranty conditions.



Note.

Note for cascade systems (system with 2 or 3 BioWINs): When cleaning, only the boiler that is actually going to be cleaned need be shut down, the other boiler(s) may continue to operate.

| | BioWIN 2 Touch Klassik/Klassik-L/Premium | | BioWIN 2 Touch Exklusiv/Exklusiv-S/Exklusiv-SL | |
|---|--|---|---|--|
| | Display | What needs to be done? | Display | What needs to be done? |
| Cleaning | "Cleaning" Info 520 at 1433 lb (650 kg) "Emergency operation. Cleaning" Error 320 | Empty the ash pan and remove ash from below the heat exchanger (see section 17) Clean the thermocontrol sensor (see section 19.1) Confirm cleaning (see section 14.1) | "Cleaning" Info 522 at 7716 lb (3500 kg) "Emergency operation. Cleaning" Error 322 | Empty ash box (see section 18) Clean combustion chamber and burner bowl (see section 19) Confirm cleaning (see section 14.1) |
| Main cleaning | "Main cleaning" Info 521 at 8598 lb (3900 kg) "Emergency operation. Main cleaning" Error 321 | Empty the ash pan and remove ash from below the heat exchanger (see section 17) Clean combustion chamber and burner bowl (see section 19) Clean top heat exchangers and induced draught fan wheel (see section 20) Vacuum out exhaust pipe to flue (see section 21) Check water tank level (see section 24) Confirm main cleaning (see section 14.1) | "Main cleaning" Info 523 at 15432 lb (7000 kg) "Emergency operation. Main cleaning" Error 323 | Empty ash box (see section 18) Clean combustion chamber and burner bowl (see section 19) Clean top heat exchangers and induced draught fan wheel (see section 20) Vacuum out exhaust pipe to flue (see section 21) Check water tank level (see section 24) Confirm main cleaning (see section 14.1) |
| Full service | "Full service" Info 524 at 2500 operating hours "Full service" Error 324 | Have full service carried out by Windhager Customer Service or a heating technician within the next 3 months. This is a prerequisite for the warranty conditions. (see section 27) | "Full service" Info 524 at 2500 operating hours "Full service" Error 324 | Have full service carried out by Windhager Customer Service or a heating technician within the next 3 months. This is a prerequisite for the warranty conditions. (see section 27) |
| At least once per heating season | Clean boiler pellet hopper and feed unit flap (see section 25) Storage room or storage container (see section 26) | | | |

14.1 Confirming cleaning or main cleaning – Resetting the cleaning request



CAUTION Material losses

Boiler cleaning must **not be** confirmed if cleaning has not been carried out.

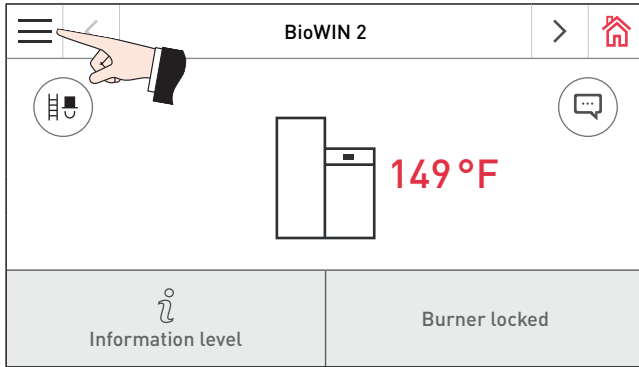


Fig. 18 Homescreen

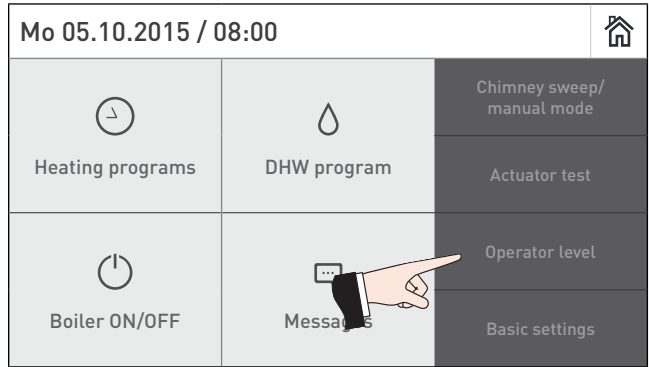


Fig. 19

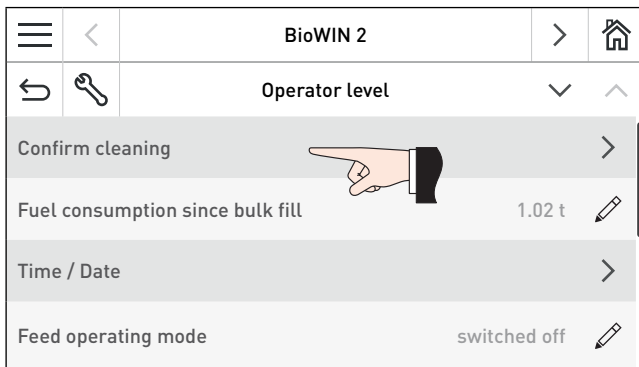


Fig. 20 BioWIN 2 Touch operator level

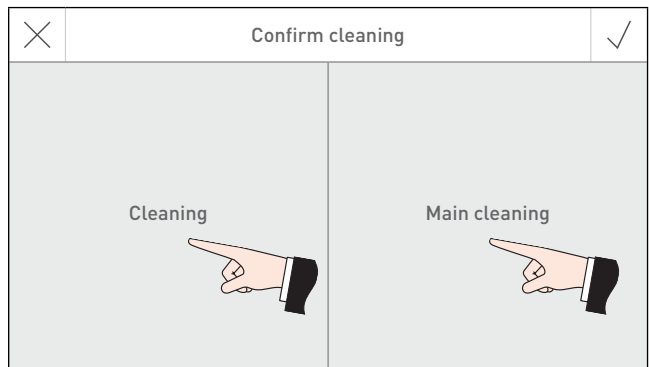


Fig. 21 Selecting cleaning or main cleaning

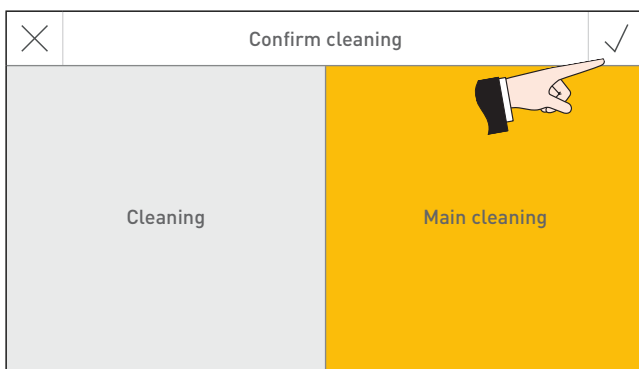
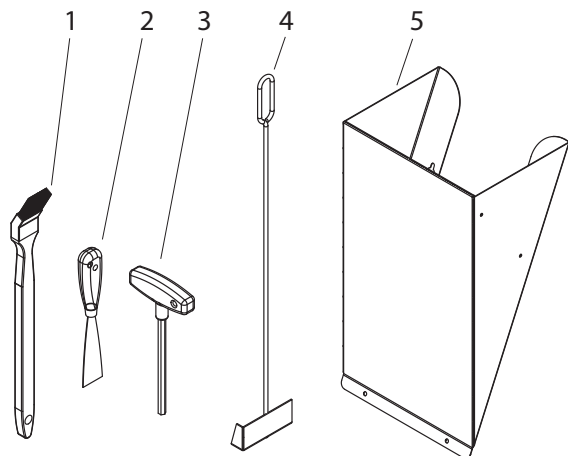


Fig. 22 Confirm cleaning or main cleaning

15. Cleaning and operating implements



- 1..... Cleaning brush
- 2..... Spatula
- 3..... Allen key
- 4 Scraper (only with BioWIN 2 Touch Klassik/Klassik-L/Premium)
- 5..... Pellet chute¹ (accessory for BioWIN 2 Touch Premium/Exklusiv only)
- 6 Folder containing instructions

Fig.23 Cleaning and operating implements

¹ Pellet chute for temporary use only or when manually filling the boiler pellet hopper, if feed is not complete.

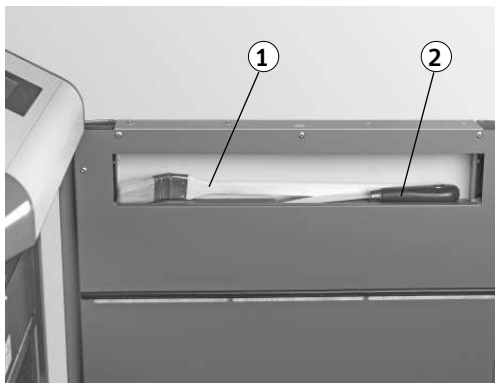


Fig.24 Cleaning brush and spatula on inside of cladding door

16. Care of cladding and InfoWIN Touch

Clean the boiler cladding and InfoWIN Touch with a damp cloth as needed. In the event of heavy soiling, use soapy water or diluted suds (do not use caustic chemicals or sharp cleaning instruments).

17. Emptying the ash pan and removing ash from below the heat exchanger

BioWIN 2 Touch Klassik / Klassik-L / Premium



DANGER Attention. Risk of fire.

Do not open the combustion chamber door during operation.

- ▶ Always turn the boiler off first with the ON/OFF button and wait until burnout mode has finished.



WARNING Injury hazard.

All components/surfaces remain hot for a long period of time after turning off unit!

Before cleaning or touching combustion chamber or any other components, turn off unit completely and allow to cool for at least 2 hours

Use heat-resistant gloves.

Use tools provided.



WARNING Ash tray can crush and cut.

Never insert hands between ash tray and frame. Never insert hands into closing bracket. Never insert hands between ash tray and closing bracket.



WARNING Moving the ash tray can crush and cut.

Never insert hands between frame or floor of boiler and ash tray when moving the ash tray.



WARNING Mounting the ash tray can crush and cut.

Never insert hands between frame of boiler/heater and ash tray when removing the ash tray.



DANGER Attention. Risk of fire.

Risk of fire if ash hasn't cooled! Store ash in a locked, non-combustible container on a non-combustible base for at least 48 hours before removing.



CAUTION Health and environmental hazard.

The ash may be loaded with heavy metals, which may affect soil fertility. Therefore, ash is not suitable as a fertilizer and should be disposed of with residual waste – see also chapter 22 and 23.

- ▶ Turn off the boiler with the ON/OFF button on the InfoWIN Touch (Fig. 25 – see also the InfoWIN Touch operating manual) and wait until burnout mode has finished (approx. 20 minutes).
- ▶ Open the cladding door and combustion chamber door – Fig. 26 – see also Section 8.

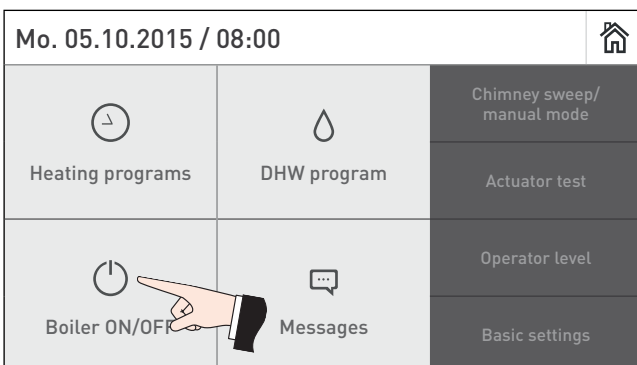


Fig. 25 Turn off the BioWIN2 Touch



Fig. 26 Open the cladding door and combustion chamber door

Care, cleaning and full service

- ▶ Remove the ash pan and place it in front of the boiler – Fig. 27.
- ▶ Use the Allen key to turn down the handle on the cover (heat exchanger) in a clockwise direction and remove the cover – Fig. 28.



Fig. 27 Remove the ash pan and place it in front of the boiler

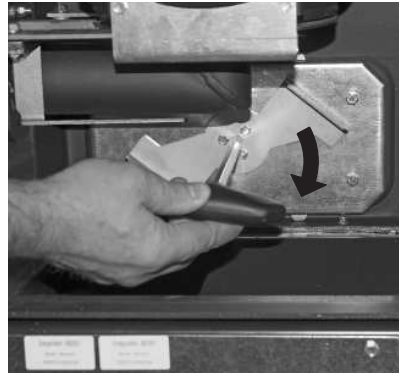


Fig. 28 Turn handle and remove cover

- ▶ Use the scraper to remove ash from underneath the heat exchanger into the ash pan – Fig. 29.

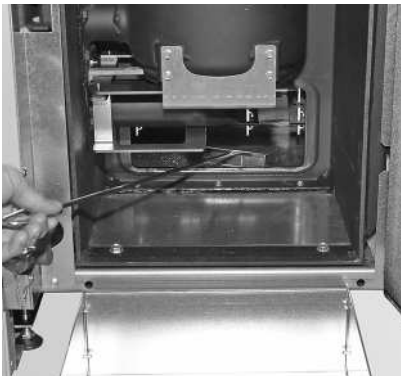


Fig. 29 Remove ash from below heat exchanger into ash pan

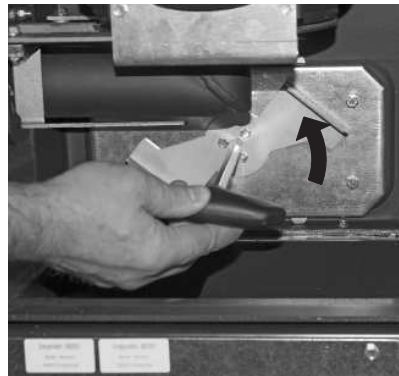


Fig. 30 Rotate handle in an anti-clockwise direction

Assembly:

- ▶ Clean away all ash, the heat exchanger cover should fit/seal tightly.
- ▶ Position the cover (heat exchanger) and turn the handle as far as it will go in a clockwise direction – Fig. 30.
- ▶ Push the ash pan into place.
- ▶ Close the combustion chamber door and the cladding door and switch the BioWIN 2 Touch back on with the ON/OFF button.
- ▶ Confirm the cleaning request once "Cleaning" is complete – see section 14.1.



CAUTION Material losses

- ▶ When reinstalling the ash pan and cover, ensure that they are in the correct position and are airtight.
-

18. Emptying the ash box

BioWIN 2 Touch Exklusiv / Exklusiv-S / Exklusiv-SL



DANGER Attention. Risk of fire.

Do not open the combustion chamber door during operation.

- ▶ Always turn the boiler off first with the ON/OFF button and wait until burnout mode has finished.
-



WARNING Injury hazard.

All components/surfaces remain hot for a long period of time after turning off unit!

Before cleaning or touching combustion chamber or any other components, turn off unit completely and allow to cool for at least 2 hours

Use heat-resistant gloves.

Use tools provided.



WARNING Ash tray can crush and cut.

Never insert hands between ash tray and frame. Never insert hands into closing bracket. Never insert hands between ash tray and closing bracket.



WARNING Moving the ash tray can crush and cut.

Never insert hands between frame or floor of boiler and ash tray when moving the ash tray.



WARNING Mounting the ash tray can crush and cut.

Never insert hands between frame of boiler/heater and ash tray when removing the ash tray.



DANGER Attention. Risk of fire.

Risk of fire if ash hasn't cooled! Store ash in a locked, non-combustible container on a non-combustible base for at least 48 hours before removing.



CAUTION Health and environmental hazard.

The ash may be loaded with heavy metals, which may affect soil fertility. Therefore, ash is not suitable as a fertilizer and should be disposed of with residual waste – see also chapter 22 and 23.

- ▶ Turn off the boiler with the ON/OFF button on the InfoWIN Touch (Fig. 25 – see also the InfoWIN Touch operating manual) and wait until burnout mode has finished (approx. 20 minutes).
- ▶ Open the cladding door and combustion chamber door – Fig. 26 – see also Section 8.
- ▶ Pull handle on the ash box out until stop is reached so that the side openings in the ash box are sealed – Fig. 31.
- ▶ Release the bracket fastener at the bottom right – Fig. 32.



Fig. 31 Pull out the handle



Fig. 32 Open the bracket fastener

- ▶ Push the ash box slightly to the left and pull it out – Fig. 33, Fig. 34.
- ▶ Release the side bracket fasteners, remove the cover and empty the ash box – Fig. 35, Fig. 36.



Fig. 33 Push the ash box slightly to the left

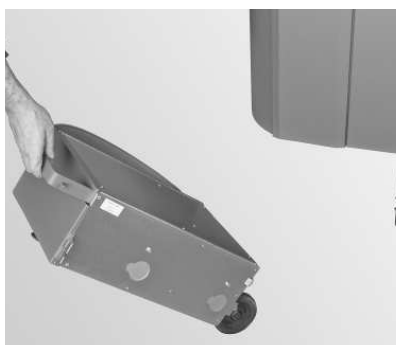


Fig. 34 Take out the ash box



Fig. 35 Open the side bracket fasteners, remove the cover and empty the ash box



Fig. 36 Empty the ash box



Note.

The size of the box is related to the max. ash content of the pellets. If the ash box is not full when a cleaning request is issued, then the ash content will be lower.

Assembly:

- ▶ Reinstall the ash box by working through these steps in reverse order.
- ▶ **Important:** Slide the ash box handle all the way back in.



CAUTION Material losses

- ▶ When reinstalling the ash box and cover, check they are in the correct position and are sealed – danger of induced air.
-



DANGER Attention. Risk of fire.

The boiler must not be operated without the ash box.

19. Cleaning the combustion chamber and burner bowl



DANGER Attention. Risk of fire.

Do not open the combustion chamber door during operation.

- ▶ Always turn the boiler off first with the ON/OFF button and wait until burnout mode has finished.

It is essential to let the boiler cool down before cleaning the combustion chamber. Before cleaning with a vacuum cleaner, check that there are no longer any embers in the combustion residue.



WARNING Injury hazard.

All components/surfaces remain hot for a long period of time after turning off unit!

Before cleaning or touching combustion chamber or any other components, turn off unit completely and allow to cool for at least 2 hours

Use heat-resistant gloves.

Use tools provided.



WARNING Ash tray can crush and cut.

Never insert hands between ash tray and frame. Never insert hands into closing bracket. Never insert hands between ash tray and closing bracket.



WARNING Moving the ash tray can crush and cut.

Never insert hands between frame or floor of boiler and ash tray when moving the ash tray.



WARNING Mounting the ash tray can crush and cut.

Never insert hands between frame of boiler/heater and ash tray when removing the ash tray.



DANGER Attention. Risk of fire.

Risk of fire if ash hasn't cooled! Store ash in a locked, non-combustible container on a non-combustible base for at least 48 hours before removing.



CAUTION Health and environmental hazard.

The ash may be loaded with heavy metals, which may affect soil fertility. Therefore, ash is not suitable as a fertilizer and should be disposed of with residual waste – see also chapter 22 and 23.

- ▶ Turn off the boiler with the ON/OFF button on the InfoWIN Touch (Fig. 25 – see also the InfoWIN Touch operating manual) and wait until burnout mode has finished (approx. 20 minutes).
- ▶ Open the cladding door and combustion chamber door – Fig. 26 – see also Section 8.

19.1 Cleaning the thermocontrol sensor and down chute

- ▶ If necessary, remove fly ash from the thermocontrol sensor with a cleaning brush. The thermocontrol sensor is located in the combustion chamber – Fig. 37.
- ▶ If necessary, use a screwdriver to clean the inside of the down chute – Fig. 38.
- ▶ Remove combustion residue from the combustion chamber with a vacuum cleaner – Fig. 39.



Fig. 37 Clean the thermocontrol sensor



Fig. 38 Clean the down chute



Fig. 39 Remove combustion residue from the combustion chamber

19.2 Cleaning the burner bowl

- ▶ Lift the bottom and top part of the cone out of the burner bowl – Fig. 40, Fig. 41.
- ▶ Remove all traces of sediment accumulation from the cones with a brush or scrape off with the spatula – Fig. 42, Fig. 43.



Fig. 40 Lift out top part of cone



Fig. 41 Lift out bottom part of cone



Fig. 42 Clean cone



Fig. 43 Clean cone



CAUTION Material losses

- ▶ When cleaning the boiler, always first remove all the ash from the combustion chamber. Do not remove the primary air pin for cleaning until afterwards.

- ▶ Vacuum out the burner bowl (Fig. 44), remove the primary air pin and carefully clean the holes with a small screwdriver or drill bit if necessary (holes must be clear) – Fig. 45, Fig. 46.
- ▶ All secondary air holes in the burner bowl must be kept clear – Fig. 47.



Fig. 44 Vacuum out the burner bowl



Fig. 45 Take out the primary air pin



Fig. 46 Clean the primary air pin carefully



Fig. 47 Clean the secondary air holes in the burner bowl

Care, cleaning and full service

- ▶ Remove combustion residue from the burner bowl with a vacuum cleaner. Vacuum the ash out of the primary air tube (in the middle of the burner bowl) – Fig. 48.



CAUTION Material losses

- ▶ Before inserting the primary air pin, once again vacuum out the primary air tube in the middle of the burner bowl. Make sure there is no debris in the tube (to avoid damage to the ignition element.).



Fig. 48 Vacuum out the primary air tube in the centre of the burner bowl

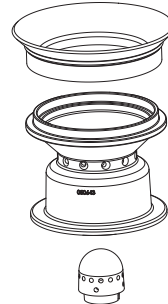


Fig. 49 Top and bottom part of cone, primary air pin

Assembly:

- ▶ Reassemble the burner by working through these steps in reverse order (Fig. 49).
- ▶ Confirm the cleaning request once "Cleaning" is complete – see section 14.1.

20. Cleaning the top heat exchangers and induced draught fan wheel

- ▶ Turn off the BioWIN2 Touch with the ON/OFF button on the InfoWIN Touch (Fig. 50 – see also the InfoWIN Touch operating manual) and wait until the display goes blank (approx. 20 minutes).



DANGER Electrocutation

Turning off the on/off button on the InfoWIN Touch does not mean the boiler and its accessories are completely without power.

- ▶ Therefore, you must de-energise the boiler (e.g. by unplugging the main power plug) when carrying out cleaning or repair work – Fig. 53.



WARNING Risk of burns

- ▶ Before touching the screw connections and heat exchanger cover, you must switch off the boiler and let it cool.

- ▶ Lift off the top cover – Fig. 51.

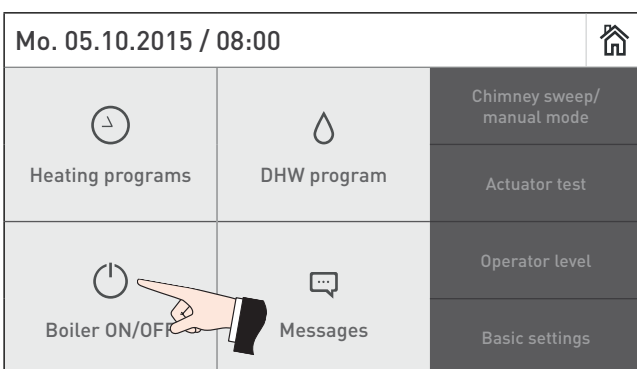


Fig. 50 Turn off the BioWIN2 Touch



Fig. 51 Lift off the top cover

Care, cleaning and full service

- ▶ Take the insulation off the heat exchanger cover – Fig. 52.
- ▶ Connect the device power plug – Fig. 53.
- ▶ Unscrew the screw connection on the cover and lift the cover out – Fig. 54, Fig. 55.

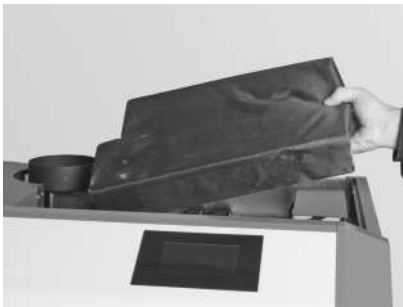


Fig. 52 Remove the insulation

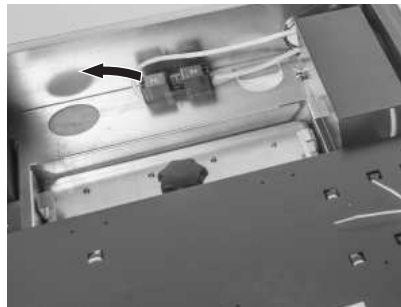


Fig. 53 Disconnect the device power plug

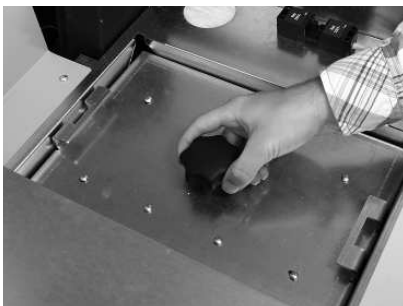


Fig. 54 Unscrew the screw connection

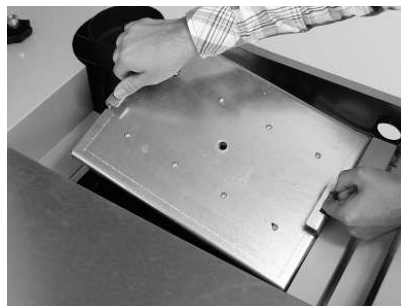


Fig. 55 Lift off the cover

- ▶ Clean the induced draught fan wheel with a brush – Fig. 56.
- ▶ Clean the top of the heat exchangers with a spatula and brush – Fig. 57.
- ▶ Vacuum out the ash from the heat exchangers – Fig. 58.



Fig. 56 Clean and vacuum the induced draught fan wheel



Fig. 57 Clean the heat exchangers



Fig. 58 Vacuum out the ash

Assembly:

- ▶ By working through these steps in reverse order.

21. Exhaust pipe to flue

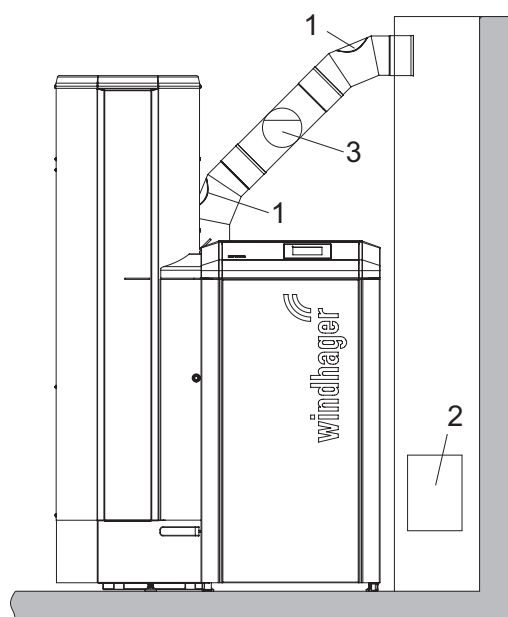


DANGER Attention. Risk of fire.

► Always turn the boiler off first with the ON/OFF button and wait until burnout mode has finished.

It is essential to let the boiler cool down before cleaning the Exhaust pipe to flue. Before cleaning with a vacuum cleaner, check that there are no longer any embers in the combustion residue.

- Clean/vacuum out the exhaust pipe (pipe connecting the pellet boiler and flue) around the cleaning aperture – Fig. 59.



- 1..... Cleaning aperture in exhaust pipe (provided by customer)
2..... Cleaning aperture in flue
3..... Energy-saving draft stabiliser/explosion flap

Fig. 59 Cleaning apertures in exhaust pipe – view from front, (drawing does not show exhaust pipe insulation)

22. Disposal of ashes

Ashes should be placed in a steel container with a tight lid. The container should be closed and placed on a non-combustible floor or on the ground, well away from all combustible materials, while waiting final disposal. If the ashes are to be buried in soil or otherwise locally dispersed, they should be kept in the closed container until completely cooled.

23. Creosote - formation and need for removal

When wood is burned slowly, it produces tar and other organic vapors, which combine with moisture to form creosote. Creosote vapors condense when in a relatively cool chimney flue of a slow-burning fire. As a result, creosote residue accumulates on the flue lining. When ignited, creosote creates an extremely hot fire.

Especially in CANADA:

During the heating season, the chimney and chimney connector should be inspected at least twice per month to determine if a creosote buildup has occurred. At the very least, they should be checked annually.

If creosote has accumulated, it should be removed to reduce the risk of a chimney fire.

Especially in the USA:

During the heating season, the chimney and chimney connector should be inspected at least twice per month to determine if a creosote buildup has occurred.

If creosote has accumulated, it should be removed to reduce the risk of a chimney fire.

24. Water tank level

- ▶ Check the level in the water tank (approx. 8 litres) at every cleaning and service interval and re-fill with water if necessary. The water level must not fall below the min. mark.
- ▶ Remove the plug from the water tank and top up – Fig. 60.

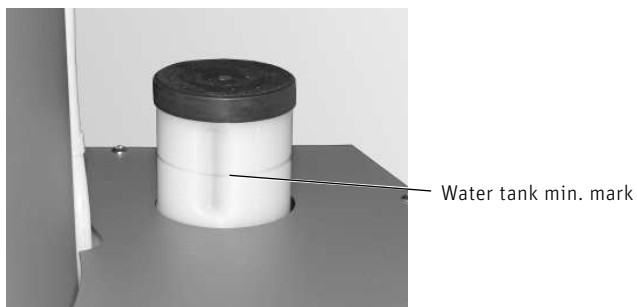


Fig. 60 Fill the water tank

- ▶ Confirm the cleaning request once “Main cleaning” is complete – see section 14.1.

25. Cleaning the boiler pellet hopper and feed unit flap, and re-filling the boiler pellet hopper in an emergency

(BioWIN 2 Touch Premium / Exklusiv only)

It is necessary to clean the boiler pellet hopper and/or flap in the feed unit if too much dust has collected or there are foreign bodies in the boiler pellet hopper.

If pellets cannot be fed into the boiler pellet hopper via the fully automatic pellet feed, it can be emergency re-filled by hand via the inspection cover.

- ▶ Turn off the BioWIN 2 Touch with the ON/OFF button on the InfoWIN Touch (Fig. 61 – see also the InfoWIN Touch operating manual) and wait until the display goes blank (approx. 20 minutes).



WARNING Risk of crushing from rotating auger

- ▶ Before opening the inspection cover, always disconnect the boiler from the power supply. Disconnect the device power plug – Fig. 64

- ▶ Lift off the top cover – Fig. 62.

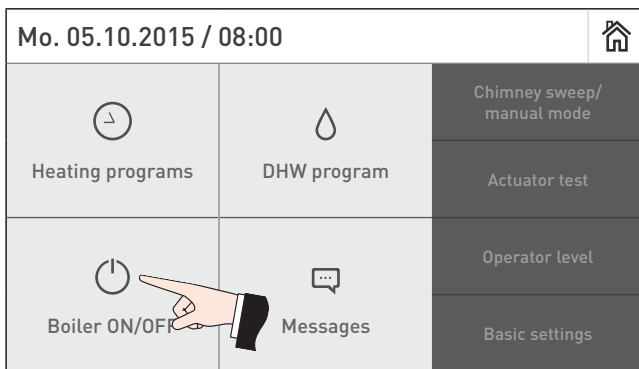


Fig. 61 Turn off the BioWIN 2 Touch



Fig. 62 Lift off the top cover

- ▶ Take the insulation off the heat exchanger cover – Fig. 63.

- ▶ Connect the device power plug – Fig. 64.



Fig. 63 Remove the insulation



Fig. 64 Disconnect the device power plug

Care, cleaning and full service

- ▶ Place a container for the pellets at the front.
- ▶ Remove the bottom screw from the boiler pellet hopper cover; push the cover down and remove it (hooked on with a bayonet lock) – Fig. 65, Fig. 66.
- ▶ Remove the screws from the inspection cover and carefully lift it off. Pellets may spill out depending on how high a level of them there is inside – Fig. 67.



Fig. 65 Remove the screws



Fig. 66 Push down the cover and remove (bayonet lock)



Fig. 67 Remove the screws and take off the inspection cover

25.1 Clean the boiler pellet hopper and the feed flap

- ▶ Remove pellets and dust from the boiler pellet hopper.
- ▶ Remove dust from the feed unit flap and proximity switch (Fig. 68, Fig. 69); check that the flap opens and closes smoothly. It must make full contact with the seal when closed.



Fig. 68 Feed unit flap



Fig. 69 Feed unit proximity switch

25.2 Emergency re-fill of the boiler pellet hopper

- ▶ Fill pellets into the boiler pellet hopper through the inspection cover using a small bucket or shovel, or attach Pellet chute (accessory – pellet chute for temporary use only or when manually filling the boiler pellet hopper, if feed is not complete.) and then add the pellets – Fig. 70.
- ▶ Mount the inspection cover as a means of anti-contact protection in front of the opening to the auger conveyor – Fig. 70.



DANGER Attention. Risk of fire.

In the BioWIN 2 Touch model with external combustion air supply, the inspection cover must always be firmly closed when the system is in operation.

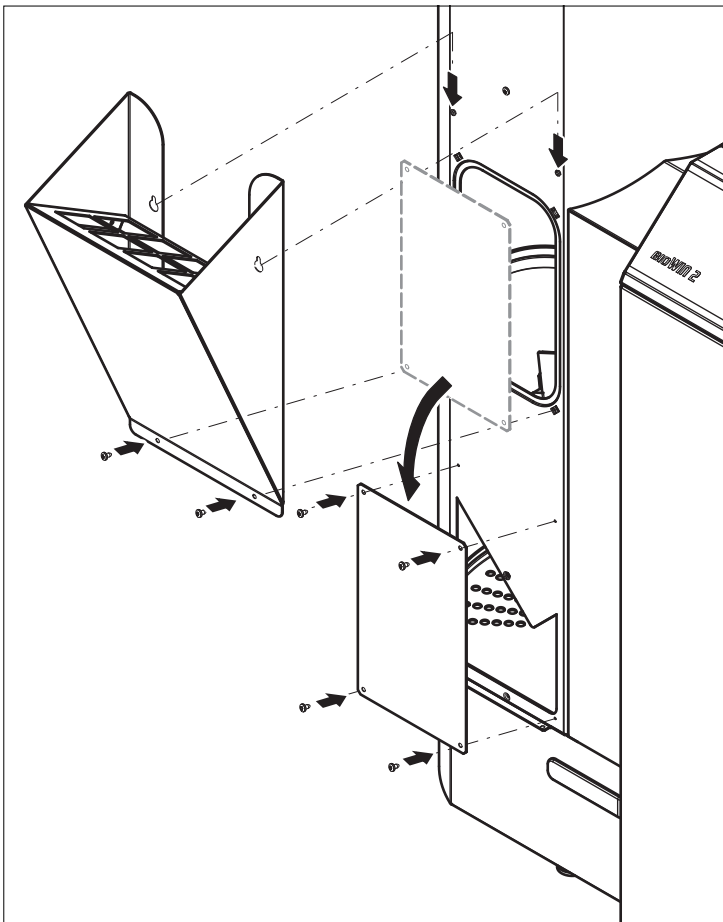


Fig. 70 Mount the Pellet chute and inspection cover

Assembly:

- ▶ By working through these steps in reverse order.

26. Storage room or storage container

(BioWIN 2 Touch Premium/Exklusiv only)



DANGER Attention, risk of suffocation.

Please also note the hazard information in section 2.5.3 Entering the pellet storage room, storage container on side 9. Do not attempt to enter an unventilated storage room (particularly buried tanks).



DANGER Injury

No access for unauthorized persons. Keep children away.



DANGER Injury

Do not enter until ventilated - keep door open during access to room.



DANGER Injury

Enter the storage room only under the supervision of a second person standing outside.



DANGER Risk of fire or explosion.

Pellet dust is flammable and may explode under certain circumstances if it becomes airborne. Keep pellet dust and its disposal container away from any source of ignition.



DANGER Attention. Risk of fire.

Before filling, turn off pellet boiler for a minimum of 15 minutes.



DANGER Attention. Risk of fire.

Before filling, turn off pellet boiler for a minimum of 15 minutes.



WARNING Entanglement hazard.

Risk of injury by moving parts.



WARNING Injury

Pellet dust may contain harmful substances - use a fine dust mask when handling.



CAUTION Material losses

Protect wood pellets from moisture.



CAUTION Material losses

When entering the pellet storage room or storage container, do not stand on the pellets around the suction probe.

Care, cleaning and full service

Before filling the pellet storage room or storage container, check the following:

- ▶ Whether the storage room is free of foreign bodies.
- ▶ Whether a lot of dust has settled on the floor over time.
Please note: A layer of dust on top of the pellets is normal because the dust that is present migrates to the surface when the pellets gush out during removal.
- ▶ Whether pellets have swelled up against the wall if the storage room is not fully dry.

Tip.



Pellet dust is totally organic and can therefore be disposed of as organic waste.

Leading pellet suppliers recommend fully emptying the storage room every 2 to 3 years. You can deactivate automatic changeover between the suction probes using the InfoWIN Touch (see the InfoWIN Touch operating manual). This allows you to fully empty the storage room for one probe and remove the dust around that particular suction probe. If you repeat this process each year with different probes, you will be cleaning all the suction probes regularly.



CAUTION Material losses

When entering the pellet storage room or bulk hopper, do not stand on the pellets surrounding the suction probe.

27. Full service

In addition to cleaning your pellet boiler, full service is also required. This is also shown in the display as “Full service” (Fig. 71) and is carried out by Windhager Customer Service or a heating technician. It is a prerequisite for the warranty conditions. Full service must be arranged following a request on the InfoWIN Touch (info 524 or error 324) .

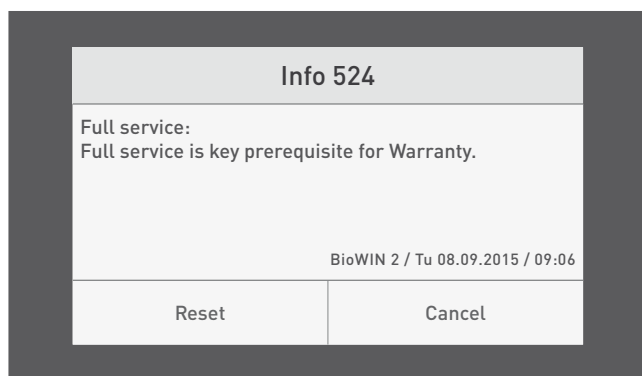
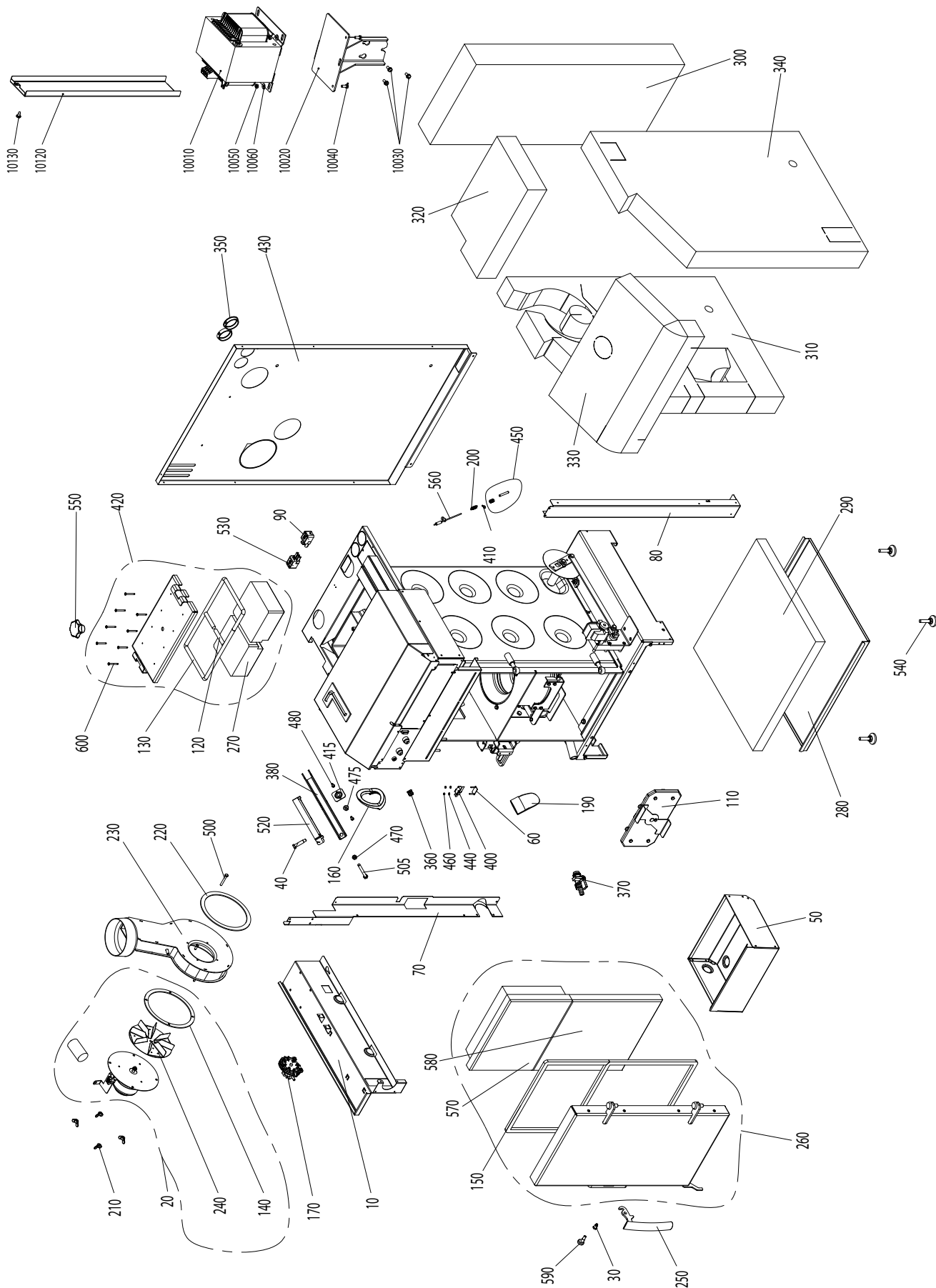


Fig. 71 Display “Full service”

28. Spare parts

28.1 BioWIN 2 Touch pellet boiler



Care, cleaning and full service

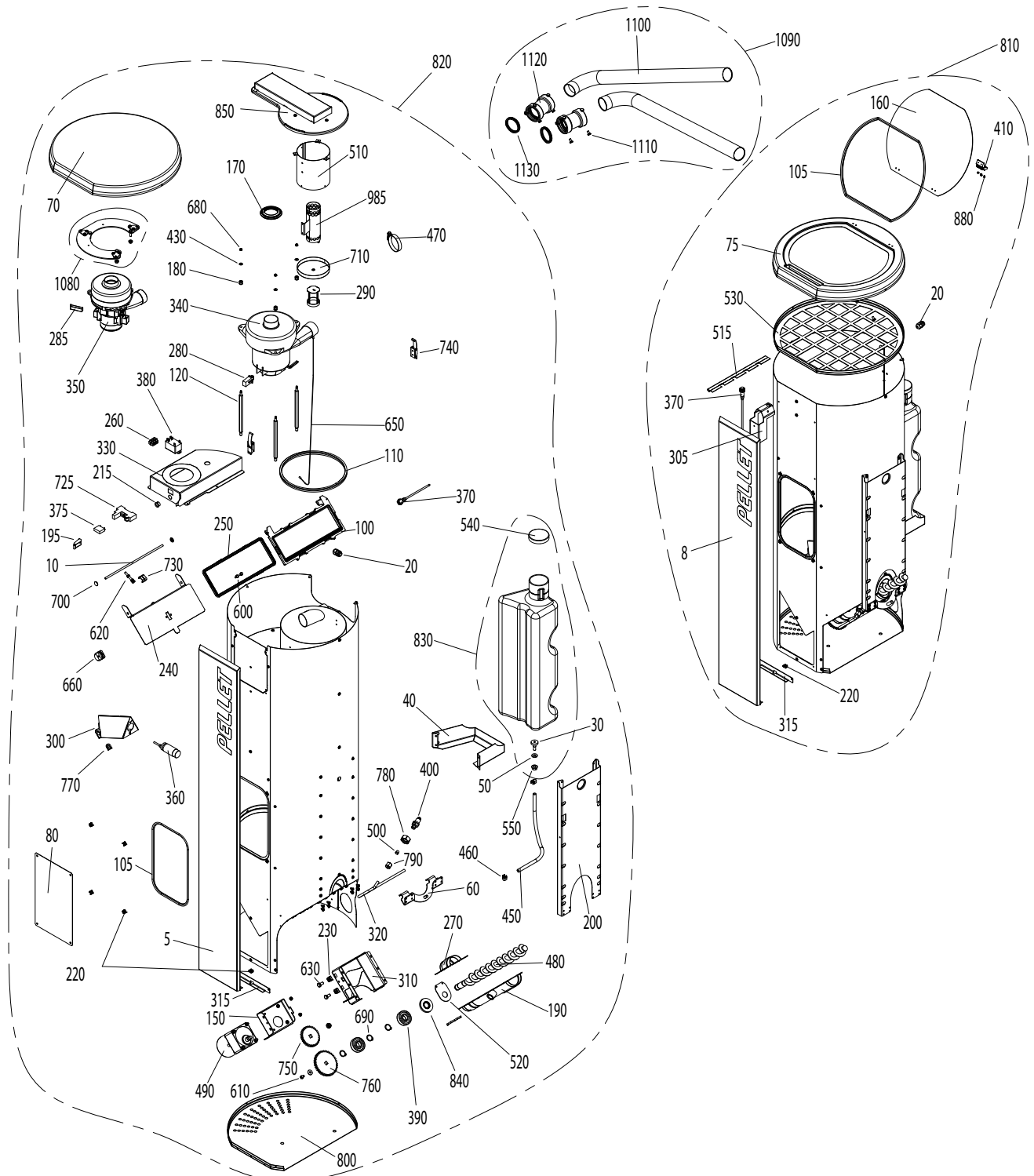
| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|---|-------------------|-------------------|---------------|
| 10 | Cover plate BW2/BW2T 21-33, BWL/BW2P 21/26 | 048991 | 048991 | 048991 |
| 10 | Cover plate BW2/BW2T 10/15, BWL 10/15, BW2P 10/15 | 050918 | 050918 | 050918 |
| 20 | Blower incl. gaskets BW2/BW2T/BWL 10-26, BW2P 10-26 | 053010 | 053010 | 053010 |
| 20 | Blower incl. gaskets BW2/BW2T 33, BW-XL | 054674 | 054674 | 054674 |
| 30 | Axle for door handle LWK18-30, LWPT18-50, BW2/BW2T 10-33, BWL10-26, BW2P 10-26 | 048881 | 048881 | 048881 |
| 40 | Collar screw M8 x 33,5 x 43,5 | 013813 | 013813 | 013813 |
| 50 | Ash pan BW2, BW2T, BWL | 055000 | 055000 | 055000 |
| 60 | Mounting support for microswitch, complete BW2/BW2T 10-33, BWL, BW2P | 051045 | 051045 | 051045 |
| 70 | Spare part set cover left incl. warning stickers: englisch/french BioWIN2T NA | 054381 | 054381 | 054381 |
| 80 | Cover, right BW2/BW2T 10-33, BWL, BW2P | 048609 | 048609 | 048609 |
| 90 | Socket connector RST25I3S B1 ZR3SV | 012573 | 012573 | 012573 |
| 110 | Cover complete, heating surface | 051056 | 051056 | 051056 |
| 120 | Sealing cord, short BW2/BW2T 21-33, BWL21/26, BW2P 21/26 | 051040 | 051040 | 051040 |
| 120 | Sealing cord, short BW2/BW2T 10/15, BWL10/15, BW2P 10/15 | 051041 | 051041 | 051041 |
| 130 | Sealing cord for cleaning cover BW2/BW2T 21-33, BWL21/26, BW2P 21/26 | 051017 | 051017 | 051017 |
| 130 | Sealing cord for cleaning cover BW2/BW2T 10/15, BWL10/15, BW2P 10/15 | 051034 | 051034 | 051034 |
| 140 | Gasket blower box seal BW2/BW2T 10-26, BWL10-26, BW2P 10-26 | 051006 | 051006 | 051006 |
| 140 | Gasket blower box BW2/BW2T 33 | 054673 | 054673 | 054673 |
| 150 | Heating door seal BW2/BW2T 10-33, BWL10-26, BW2P 10-26 | 048916 | 048916 | 048916 |
| 160 | Auger tube seal silicone 6OSH BW2/BW2T 10-33, BWL10-26, BW2P 10-26 | 048926 | 048926 | 048926 |
| 170 | Differential pressure watchdog FW, BW2/BW2T 10-33, BWXL 35-60, BWL 10-26 | 045404 | 045404 | 045404 |
| 170 | Differential pressure transmitter Typ 401 BW2P | 055019 | 055019 | 055019 |
| 190 | Down chute BW2/BW2T 10-33, BWL 10-26, BW2P 10-2 | 048921 | 048921 | 048921 |
| 200 | Combustion chamber sensor spring | 050647 | 050647 | 050647 |
| 210 | Wing nut DIN315-M6 | 019410 | 019410 | 019410 |
| 220 | Blower seal | 051005 | 051005 | 051005 |
| 230 | Blower box for BioWIN BW2/BW2T/BWL 10-26 | 053234 | 053234 | 053234 |
| 230 | Blower box incl. gasket BW2/BW2T 33 | 054672 | 054672 | 054672 |
| 240 | Blower wheel Ø160 x 25 for BioWIN2 102 - 262 | 052951 | 052951 | 052951 |
| 240 | Blower wheel Ø210 BW-XL, BW2T 33 | 054460 | 054460 | 054460 |
| 250 | Boiler handle LW, BW2, BW2T, BWL, BW2P | 007480 | 007480 | 007480 |
| 260 | Spare part set heating door incl. warning stickers: englisch/french BioWIN2T NA | 054379 | 054379 | 054379 |
| 270 | Insulating stone for cleaning cover BW2/BW2T/BWL 10/15, BW2P 10/15 | 050636 | 050636 | 050636 |
| 270 | Insulating stone for cleaning cover W2/BW2T 21-33, BWL 21/26, BW2P 21/26 | 051007 | 051007 | 051007 |
| 280 | Cup insulation BW2/BW2T 10-33, BWL 10-26 | 048863 | 048863 | 048863 |
| 290 | Insulation floor BW2/BW2T 10-33, BWL 10-26 | 048864 | 048864 | 048864 |
| 300 | Insulation rear BW2/BW2T 10-33, BWL 10-26 | 051116 | 051116 | 051116 |
| 310 | Insulation left BW2/BW2T/BWL 21/26 | 051117 | 051117 | 051117 |
| 310 | Insulation left BW2/BW2T/BWL 10/15 | 051119 | 051119 | 051119 |
| 310 | Insulation left BW2/BW2T 33 | 054455 | 054455 | 054455 |
| 320 | Insulation heating surface cleaning BW/BW2T/BWL 10/15 | 048910 | 048910 | 048910 |
| 320 | Insulation heating surface cleaning BW/BW2T 21-33, BWL 21/26 | 048958 | 048958 | 048958 |
| 330 | Insulation top BW2/BW2T 10-33, BWL 10-26, BW2P 10-26 | 048911 | 048911 | 048911 |
| 340 | Insulation right BW2/BW2T 21-33, BWL 21/26 | 048907 | 048907 | 048907 |
| 340 | Insulation right BW2/BW2T/BWL 10/15 | 050924 | 050924 | 050924 |
| 350 | Cable feed-through 2400 black Ø 50 BW/BW2/BW2T, BWXL, BWL, MWP WZS, BW2P | 004096 | 004096 | 004096 |
| 360 | Cage nut M 8 BW2/BW2T 10-33, BWL 10-26, BW2P | 051112 | 051112 | 051112 |
| 370 | KFE cock | 004385 | 004385 | 004385 |
| 380 | Pellet container clamp BW2/BW2T 10-33, BWL 10-26, BW2P 10-26 | 048611 | 048611 | 048611 |
| 400 | Microswitch with lever EF83161.8 BW2/BW2T 10-33, BWL 10-26, BW2P 10-26 | 007632 | 007632 | 007632 |
| 410 | Eyelet M6 | 031274 | 031274 | 031274 |
| 415 | Plate flanged nut BW2/BW2T 10-33, BWL 10-26, BW2P | 052484 | 052484 | 052484 |
| 420 | Cleaning cover, complete BW2/BW2T 21-33, BWL 21/26, BW2P 21/26 | 048870 | 048870 | 048870 |
| 420 | Cleaning cover, complete BW2/BW2T/BWL 10/15, BW2P 10/15 | 050477 | 050477 | 050477 |
| 430 | Spare part set rear cladding incl. warning stickers: englisch/french BioWIN2T NA 21/26 NA | 054382 | 054382 | 054382 |
| 430 | Spare part set rear cladding incl. warning stickers: englisch/french BioWIN2T NA 10/15 NA | 056346 | 056346 | 056346 |
| 440 | Disc 3 DIN134 | 021474 | 021474 | 021474 |
| 450 | Protective tube for combustion chamber sensor, complete | 051069 | 051069 | 051069 |
| 460 | Hexagon nut M3 DIN 934 | 016551 | 016551 | 016551 |
| 470 | Hexagon nut M8 DIN 934 V2 | 015992 | 015992 | 015992 |

Care, cleaning and full service

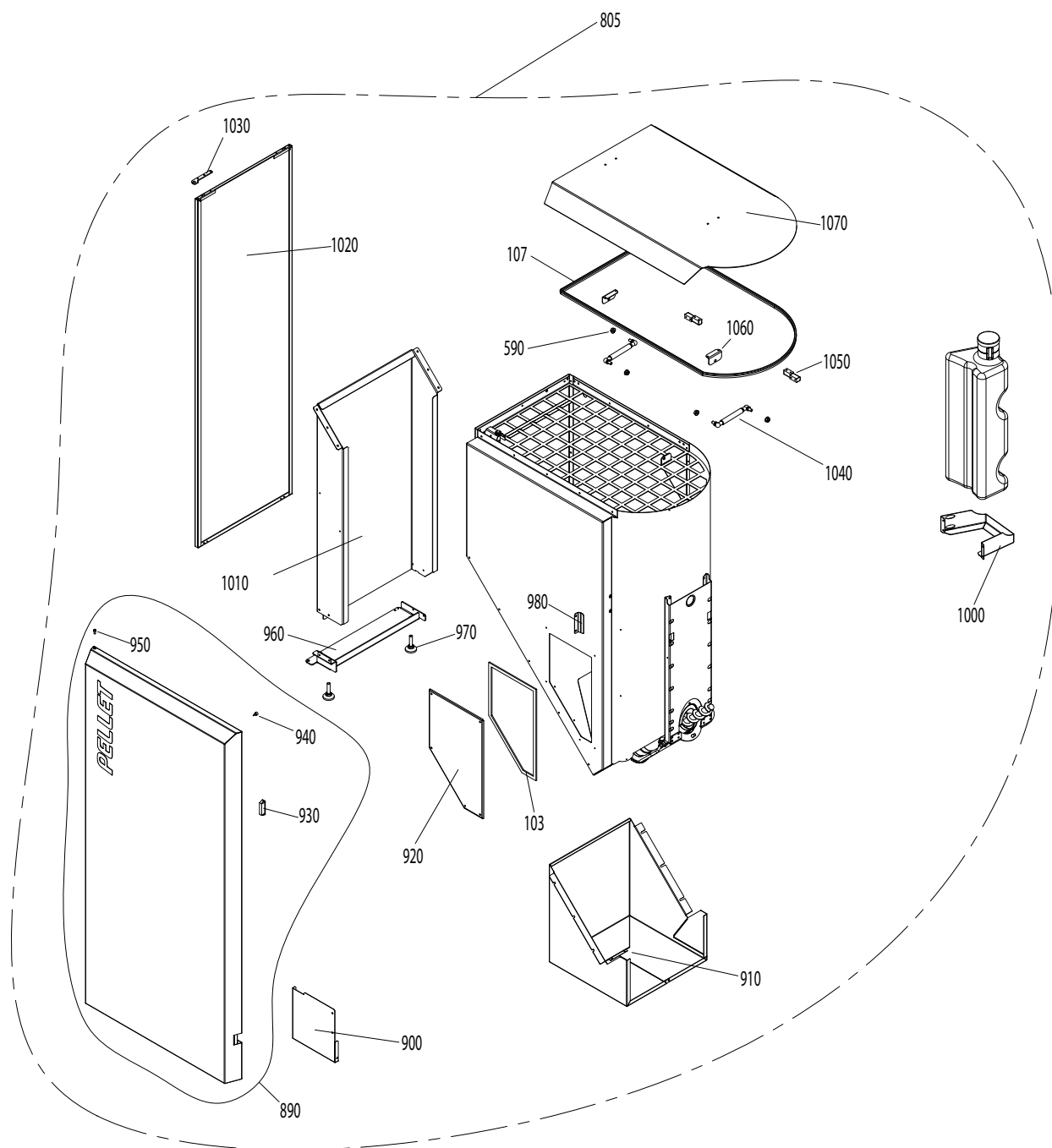
| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-------|---|-------------------|-------------------|---------------|
| 475 | Hexagon nut M8 with flange and gearing | 016553 | 016553 | 016553 |
| 480 | Hexagon screw M5x12 DIN 7500 (not illustrated) | 031545 | 031545 | 031545 |
| 500 | Hexagon screw M6x45 DIN933 | 021504 | 021504 | 021504 |
| 505 | Hexagon screw M8x80 DIN 933 | 016461 | 016461 | 016461 |
| 515 | Silicone hose 5 x 8mm for FireWIN | 016022 | 016022 | 016022 |
| 520 | Clamping rail 10-33, BWL 10-26, BW2P 10-26 | 048975 | 048975 | 048975 |
| 530 | Plug connector RST25I3S S1 ZR3SV | 012574 | 012574 | 012574 |
| 540 | Leg M10 x 40 | 009990 | 009990 | 009990 |
| 550 | Star handle M12 x 35 LWP, BW2, BW2T, BWL, BW2P | 005125 | 005125 | 005125 |
| 560 | Thermocouple | 007626 | 007626 | 007626 |
| 570 | Door stone BW2/BW2T 10-33, BWL 10-26, BW2P 10-26 | 048914 | 048914 | 048914 |
| 580 | Door stone bottom BW2/BW2T 10-33, BWL 10-26, BW2P 10-26 | 050447 | 050447 | 050447 |
| 590 | Locking pin BW2/BW2T 10-33, BWL 10-26, BW2P | 051004 | 051004 | 051004 |
| 600 | Cylinder drilling screw 4.2 x 38 DIN7504 | 016719 | 016719 | 016719 |
| 10010 | Transformer 2 kVA , AC 115 V to AC 230 V | 013839 | 013839 | 013839 |
| 10020 | Transformer bracket for BioWIN2TNA | 056230 | 056230 | 056230 |
| 10030 | Hexagon screw M5x12 DIN 7500 (not illustrated) | 031545 | 031545 | 031545 |
| 10040 | Hexagon screw Niro DIN 933 - M5x12 - A2 for HMX, FireWIN, VarioWIN" | 017020 | 017020 | 017020 |
| 10050 | Hexagon nut M5 DIN 934 | 016586 | 016586 | 016586 |
| 10060 | Disc 5 DIN134 | 018309 | 018309 | 018309 |
| 10070 | Cable transformer - main plug BioWIN2T NA | 056321 | 056321 | 056321 |
| 10080 | Cable transformer - 110V main plug BioWIN2T NA | 056329 | 056329 | 056329 |
| 10090 | Cable electric panel - funtion modules INFF05 BioWIN2TNA | 056220 | 056220 | 056220 |
| 10100 | Set for function module INFF05 NA for external heating demand and pump control" | 056320 | 056320 | 056320 |
| 10120 | Cable conduit hopper BioWIN2TNA | 056222 | 056222 | 056222 |
| 10130 | Cheese head screw M5x10 Taptite | 051386 | 051386 | 051386 |

28.2 Reserve supply container – BioWIN 2 Touch

28.2.1 Reserve supply container with suction feed and reserve supply container 236 lb / 107 kg - without suction feed



28.2.2 Reserve supply container L 441 lb / 200 kg



| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|---|-------------------|-------------------|---------------|
| 5 | Cover panel hopper Premium BW2T 10-33, BWL 10-26, BW2P 10-26 | 054361 | 054361 | 054361 |
| 8 | Cover panel hopper Klassik BW2T 10-33, BWL 10-26 | 054363 | 054363 | 054363 |
| 10 | Feed axle PMX, BW, BW2, BW2T, BWL, BW2P | 042452 | 042452 | 042452 |
| 20 | Mount connections PG9 | 006340 | 006340 | 006340 |
| 30 | Water tank support PMX, BW2, BW2T, BWL, BW2P | 006877 | 006877 | 006877 |
| 40 | Water tank support | 051107 | 051107 | 051107 |
| 50 | Support plate, motor PMX, BW2, BW2T, BWL, BW2P | 006851 | 006851 | 006851 |
| 60 | Fastening bracket BW2, BW2T, BWL, BW2P | 048974 | 048974 | 048974 |
| 70 | Hopper lid Exklusiv/Premium BW2T 10-33, BWL 10-26, BW2P 10-26 | 054346 | 054346 | 054346 |
| 75 | Hopper lid Klassik BW2T 10-33, BWL 10-26 | 054348 | 054348 | 054348 |
| 80 | Inspection lid for hopper BW2, BWL, BW2P | 050868 | 050868 | 050868 |
| 100 | Seal frame BW, BW2, BW2T, BWL, BW2P | 031254 | 031254 | 031254 |

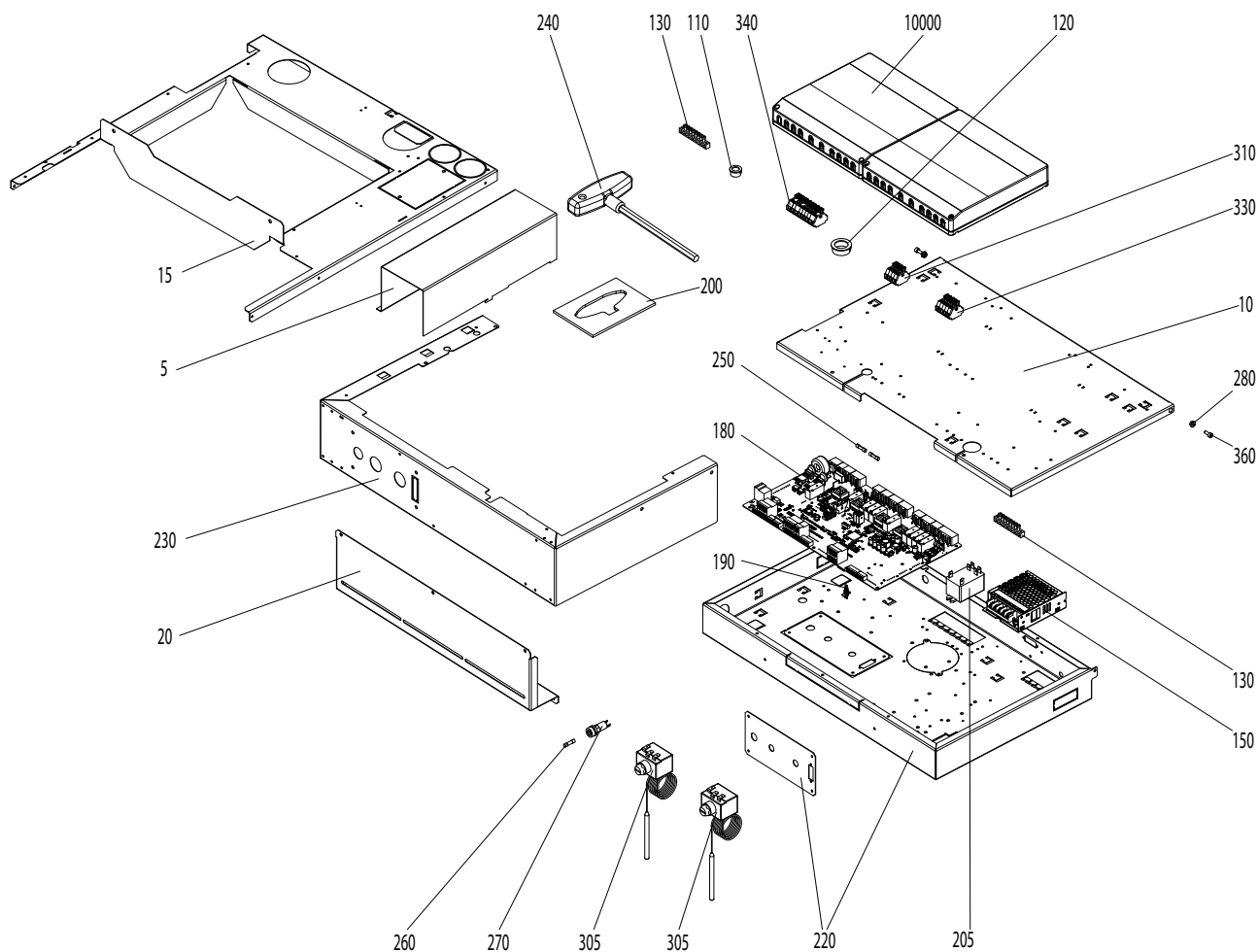
Care, cleaning and full service

| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|--|-------------------|-------------------|---------------|
| 103 | Container seal BW, VAE, FW, BWXL, BW2, BW2T, BWL, BW2P | 046665 | 046665 | 046665 |
| 105 | Hopper seal | 053465 | 053465 | 053465 |
| 107 | Hopper seal 200 kg BW2, BW2T 10-33, BWL10-26, PW | 053467 | 053467 | 053467 |
| 110 | Seal section (cyclone) | 042232 | 042232 | 042232 |
| 120 | Distance bolt BW10-26 ab Los 30, BW2, BW2T, BWL, BW2P | 031256 | 031256 | 031256 |
| 130 | Cheese head screw M5x10 Taptite | 051386 | 051386 | 051386 |
| 140 | Cheese head screw M5x10 Taptite | 051386 | 051386 | 051386 |
| 150 | Flange, auger motor BW2, BW2T 10-33, BWL 10-26, BW2P 10-26 | 051114 | 051114 | 051114 |
| 160 | Filling lid BW2T 10-33, BWL 10-26 | 054349 | 054349 | 054349 |
| 170 | Blower seal | 031253 | 031253 | 031253 |
| 180 | Rubber grommet DK 6-9-12-7 | 009559 | 009559 | 009559 |
| 190 | Half-collar auger tube BW2, BW2T, BWL, BW2P | 053540 | 053540 | 053540 |
| 195 | Bracket | 005077 | 005077 | 005077 |
| 200 | Retaining bracket, pellet tank BW2, BW2T, BWL, BW2P | 048976 | 048976 | 048976 |
| 210 | Cable feed with relay BW2, BW2T, BWL | 045048 | 045048 | 045048 |
| 210 | Wiring harness feed unit incl relais BW2T, BWL, BW2P | 055305 | 055305 | 055305 |
| 215 | Cable feed-through Ø 16 | 009542 | 009542 | 009542 |
| 220 | Cage nut M5 | 051388 | 051388 | 051388 |
| 230 | Cage nut M 8 BW2/BW2T 10-33, BWL 10-26, BW2P | 051112 | 051112 | 051112 |
| 240 | Receptacle flap BW2, BW2T, BWL, BW2P | 045955 | 045955 | 045955 |
| 250 | Flap seal BW10-26 ab Los30, BW2, BW2T, BWL, BW2P | 031257 | 031257 | 031257 |
| 260 | Terminal, 3-pin OE/KM,PSX, BW2T, BWL, BW2P | 000965 | 000965 | 000965 |
| 270 | Clamp collar OE/KM,PSX, BW2T, BWL, BW2P | 048967 | 048967 | 048967 |
| 280 | Set of carbon brushes (2 pcs.) AMETEK/Lamb for PMX, BioWIN 10-26 | 046194 | 046194 | 046194 |
| 285 | Set of carbon brushes (2pcs.) motor suction turbine 230V ebetec 15m BW2T, BWL, BW2P" | 054653 | 054653 | 054653 |
| 290 | Piston set BW2, BW2T, BWL, BW2P | 042035 | 042035 | 042035 |
| 300 | Bracket for proximity sensor bracket BW2T, BWL, BW2P | 048970 | 048970 | 048970 |
| 305 | Bracket for proximity sensor bracket lid BW2, BW2T, BWL | 051786 | 051786 | 051786 |
| 310 | Bracket for auger motor BW2, BW2T, BWL, BW2P | 048891 | 048891 | 048891 |
| 315 | L- bracket cover BW2T, BWL, BW2P | 054424 | 054424 | 054424 |
| 320 | Back-burn safeguard lead BW2, BW2T, BWL, BW2P | 050867 | 050867 | 050867 |
| 330 | Air duct BW2, BW2T, BWL, BW2P | 050866 | 050866 | 050866 |
| 340 | Blower motor 122151-12 for feed Conversion instructions for use with PMX 15-26 are enclosed! for BioWIN 10-26, PMX,BioWIN XL 35-60 | 044667 | 044667 | 044667 |
| 350 | Motor for suction turbine 15m, 230V, 1450W BW2T, BWL, BW2P | 006242 | 006242 | 006242 |
| 360 | Proximity switch with connection cable 340mm | 007825 | 007825 | 007825 |
| 370 | Proximity switch M12, inductive | 006832 | 006832 | 006832 |
| 375 | Relay 30A 250V AC 1pole BW2, BW2T, BWL, BW2P | 005026 | 005026 | 005026 |
| 380 | Relay 30A 250V BW2, BW2T, BWL, BW2P | 005067 | 005067 | 005067 |
| 390 | Grooved ball bearing VAE, BW XL, BWL, BW2P | 012499 | 012499 | 012499 |
| 400 | Burn-back protection completely assembled for PMX, BioWIN 10-26 | 042510 | 042510 | 042510 |
| 410 | Hinge M345 BW2, BW2T, BWL, BW2P | 050990 | 050990 | 050990 |
| 420 | U-washer DIN 125 - M10 | 018058 | 018058 | 018058 |
| 430 | Disc 5 DIN134 | 018309 | 018309 | 018309 |
| 440 | Disc 6 ISO 7093 | 031753 | 031753 | 031753 |
| 450 | Hose-PVC 7X2mm 450mm | 055827 | 055827 | 055827 |
| 460 | Hose clip ABA 11 PMX, BW2, BW2T, BWL, BW2P | 006874 | 006874 | 006874 |
| 470 | Hose clip 40-60 changeover | 006875 | 006875 | 006875 |
| 480 | Auger BW2, BW2T, BWL, BW2P | 051544 | 051544 | 051544 |
| 490 | Auger motor SPG 4,8 rpm | 050901 | 050901 | 050901 |
| 500 | Cutting ring DL8 07-151 BW, BW2, BW2T, BWL, BW2P | 006378 | 006378 | 006378 |
| 510 | Partition plate BW, BW2 until January 31 2015 | 045951 | 045951 | 045951 |
| 510 | Partition plate BW2 From February 2015) BW2T, BWL, BW2P | 052480 | 052480 | 052480 |
| 515 | Protection plate for cable BW2, BW2T, BWL | 051790 | 051790 | 051790 |
| 520 | Protective cover for auger BW2, BW2T, BWL, BW2P | 048971 | 048971 | 048971 |
| 540 | Protection cover GPN 690 | 051397 | 051397 | 051397 |
| 550 | Hexagon nut M10 with flange and gearing (not illustrated) | 016567 | 016567 | 016567 |
| 560 | Hexagon nut M5 with flange and gearing (not illustrated) | 016565 | 016565 | 016565 |
| 570 | Hexagon nut M5 DIN 934 | 016586 | 016586 | 016586 |
| 580 | Hexagon nut M6 DIN 934 | 016594 | 016594 | 016594 |

Care, cleaning and full service

| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|------|--|-------------------|-------------------|---------------|
| 590 | Hexagon nut M8 with flange and gearing | 016553 | 016553 | 016553 |
| 600 | Hexagon screw M5x12 DIN 7500 (not illustrated) | 031545 | 031545 | 031545 |
| 610 | Hexagon screw M6x12 DIN 933 (not illustrated) | 017051 | 017051 | 017051 |
| 620 | Hexagon screw M6x45 DIN933 | 021504 | 021504 | 021504 |
| 630 | Hexagon screw M8x16 DIN 933 | 015134 | 015134 | 015134 |
| 640 | Hexagon screw M8x20 DIN 933 (not illustrated) | 017086 | 017086 | 017086 |
| 650 | Steel rope 702x1,5mm beidseits mit Endnippel BW2, BW2T, BWL, BW2P | 031258 | 031258 | 031258 |
| 660 | Cable pulley BW2, BW2T, BWL, BW2 | 031261 | 031261 | 031261 |
| 670 | Countersinking screw M4x20 DIN965 gv KS (not illustrated) | 031096 | 031096 | 031096 |
| 680 | Lock nut M5 | 016727 | 016727 | 016727 |
| 690 | Locking ring Ø20x1.2 | 016171 | 016171 | 016171 |
| 700 | Lock washer Ø 6 | 006897 | 006897 | 006897 |
| 710 | Sieve with eye BW10-26 ab Los30, BW2, BW2T, BWL, BW2P | 045949 | 045949 | 045949 |
| 725 | Base for relay | 005043 | 005043 | 005043 |
| 730 | Tension adjuster for steel rope BW2, BW2T, BWL, BW2P | 045952 | 045952 | 045952 |
| 740 | Spring lock | 009546 | 009546 | 009546 |
| 750 | Spur gear M2 Z36 M2 Z36 BW2, BW2T, BWL, BW2P | 050869 | 050869 | 050869 |
| 760 | Spur gear M2 Z45 AE, BW2, BW2T, BWL, BW2P | 045771 | 045771 | 045771 |
| 770 | Grommet 10x17.5x1.2 | 003208 | 003208 | 003208 |
| 780 | Union nut 3/8" | 013749 | 013749 | 013749 |
| 790 | Union nut 3/8" Union nut ML8 GV BW, BW2, BW2T, BWL, BW2P | 006351 | 006351 | 006351 |
| 800 | Pellet container cladding BW2, BW2T, BWL, BW2P | 048986 | 048986 | 048986 |
| 805 | BIO081T-FMP-D hopper 200kg for BioWIN2T BWK102LT-262LT / BWE102SLT-332 SLT / BWL102L-262L (lite) | 055652 | 055652 | 055652 |
| 810 | BIO91T-FMP-D hopper 107kg BW2T BWK102T-262T / BWE102ST-332ST / BWL102-262 (lite) | 055651 | 055651 | 055651 |
| 820 | BIO092T-FMP-D hopper BW2 T Premium/Exklusiv (up to 25m) | 055649 | 055649 | 055649 |
| 820 | BIO99T-FMP-D hopper for BioWIN2 T BWP102T - 262T / BWE102T - 332T (up to 15m) | 055650 | 055650 | 055650 |
| 830 | Water tank BW2, BW2T, BWL, BW2P | 050379 | 050379 | 050379 |
| 840 | Shaft seal ring DIN 3760AS AD52 ID20 | 048903 | 048903 | 048903 |
| 850 | Cyclone cover, fully sealed, new ET for BioWIN 10-26 from batch 30, BW2T, BWL, BW2P | 046166 | 046166 | 046166 |
| 850 | Cyclone cover from February 2015 | 053466 | 053466 | 053466 |
| 860 | Cylinder screw 2.9x16 (not illustrated) | 019836 | 019836 | 019836 |
| 870 | Cylinder screw 4.2x13 DIN7981SP (not illustrated) | 018139 | 018139 | 018139 |
| 880 | Cylinder screw M3x5 | 016768 | 016768 | 016768 |
| 890 | Cladding door hopper set BW2T, BWL | 054439 | 054439 | 054439 |
| 900 | Cover, hopper BW2T, BWL | 054350 | 054350 | 054350 |
| 910 | CoverPB BW2/BW2T/BWL, BW2P | 051755 | 051755 | 051755 |
| 920 | Maintenance cover hopper BW2, BW2T, BWL | 051754 | 051754 | 051754 |
| 930 | Magnetic lock, black VAE, LWP, LWK, BW2T, BWL | 001760 | 001760 | 001760 |
| 940 | Silicone buffer | 000299 | 000299 | 000299 |
| 950 | Cylinder screw M5x10 ISO 4762 (not illustrated) | 004237 | 004237 | 004237 |
| 960 | Door mounting, bottom BW2, BW2T, BWL | 051753 | 051753 | 051753 |
| 970 | Leg M10 x 40 | 009990 | 009990 | 009990 |
| 980 | Magnetic sheet hopper BW2, BW2T, BWL | 051773 | 051773 | 051773 |
| 985 | Suction pipe BW2, BW2T, BWL, BW2P | 052482 | 052482 | 052482 |
| 1000 | Water tank support BW2, BW2T, BWL, | 051771 | 051771 | 051771 |
| 1010 | Pedestal BW2, BW2T, BWL | 051614 | 051614 | 051614 |
| 1020 | Cladding left hopper BW2T, BWL | 054352 | 054352 | 054352 |
| 1030 | Door mounting top BW2T, BWL | 051752 | 051752 | 051752 |
| 1040 | Gas spring 4534DS 0100 N | 012600 | 012600 | 012600 |
| 1050 | Southco hinge | 044802 | 044802 | 044802 |
| 1060 | L-bracket BW2, BW2T, BWL | 051751 | 051751 | 051751 |
| 1070 | Hopper lid BW2T, BWL | 054365 | 054365 | 054365 |
| 1080 | Intermediate plate fan assembled BW2, BW2T, BWL, BW2P | 054449 | 054449 | 054449 |
| 1090 | DUO006 steel tube guide for hoses in vicinity of flue gas pipe | 504051 | 504051 | 504051 |
| 1100 | FIRE045 Pipes for straight feed | 045902 | 045902 | 045902 |
| 1110 | Hexagon screw DIN 933 - M6x10 - 8.8 - galvanisedfor VarioWIN, FireWIN | 015026 | 015026 | 015026 |
| 1120 | Bushing BW2 galvanized | 053715 | 053715 | 053715 |
| 1130 | Lip seal, Ø=50 for FireWIN, VarioWIN | 031250 | 031250 | 031250 |

28.3 Control panel – BioWIN 2 Touch

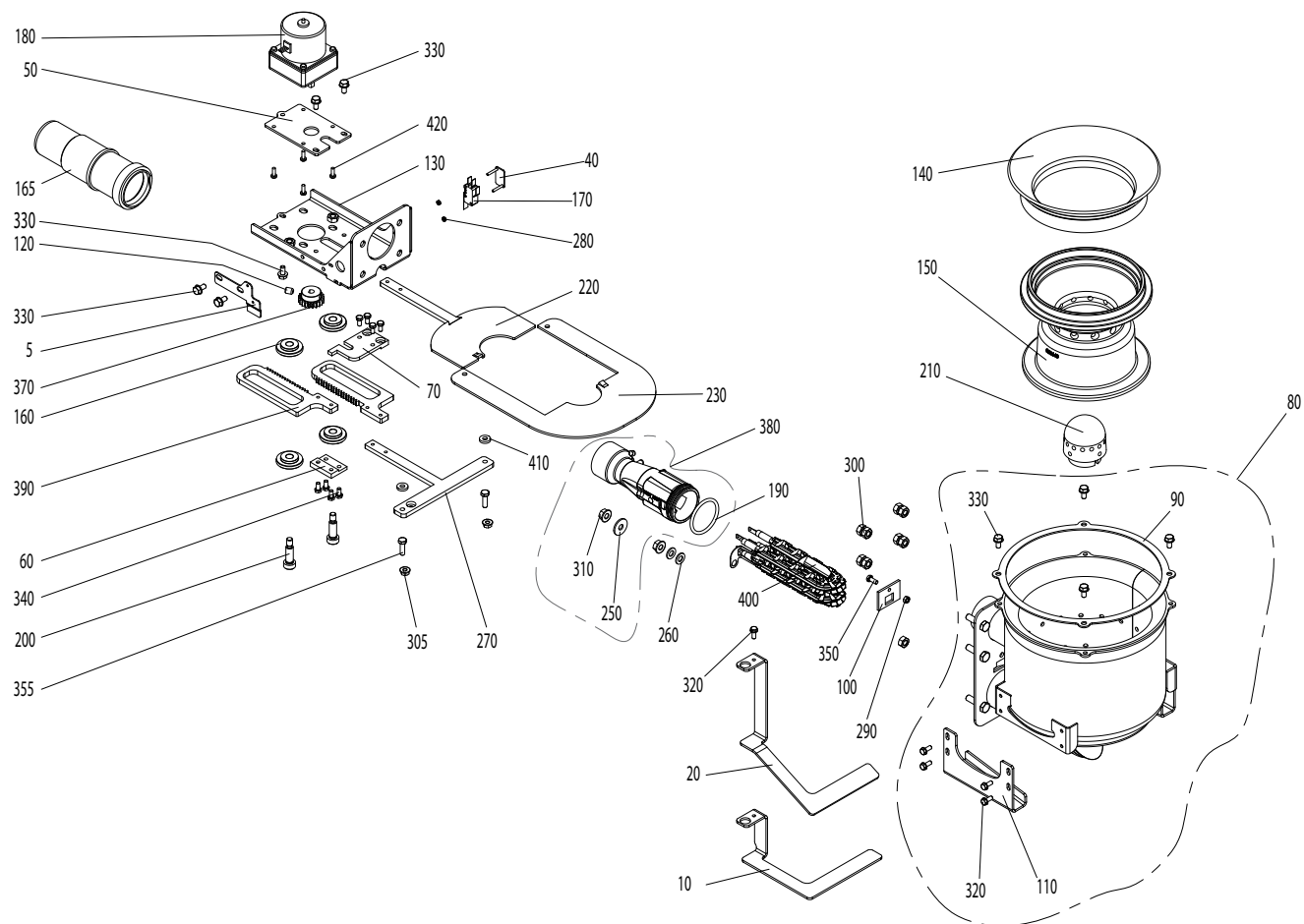


| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|---|-------------------|-------------------|---------------|
| 5 | Cover cable conduit BW2/BW2T/BWL/BW2P 10/15 | 054093 | 054093 | 054093 |
| 5 | Cover for cable conduit BW2/BW2T 21/33, BWL/BW2P 21/26 | 054334 | 054334 | 054334 |
| 7 | Plug set for flue gas thermosthat and airflap | 055825 | 055825 | 055825 |
| 10 | Spare part set cover electric panel incl. warning stickers BioWIN2T NA | 054380 | 054380 | 054380 |
| 15 | Electric panel BW2T/BWL/BW2P 10/15 | 054090 | 054090 | 054090 |
| 15 | Electric panel BW2T 21/33, BWL/BW2P 21/26 | 054097 | 054097 | 054097 |
| 20 | Retaining plate | 048902 | 048902 | 048902 |
| 30 | Wiring harness 230V BW2T, BWL, BW2P (de-ashing, auger conveyor, ignition) | 055184 | 055184 | 055184 |
| 40 | Electronic assebbly (wires/cables) supply compl. BW2P, XL | 055171 | 055171 | 055171 |
| 60 | Cable fan BW2T, BWL, BW2P | 055172 | 055172 | 055172 |
| 70 | Wiring harness 2 x STB and fuse | 055169 | 055169 | 055169 |
| 75 | Cable Lon InfoWIN Touch BW2T, BWL, BW2P | 055185 | 055185 | 055185 |
| 80 | Wiring harness - Lon BW2P / XL | 055181 | 055181 | 055181 |
| 90 | Wiring harness 12V BW2T, BWL, BW2P (pressure transmitter, limit switch de-ashing, proximity sensor hopper empty, door switch) | 055183 | 055183 | 055183 |
| 100 | Wiring harness for ash removal and heating surface cleaning BW2T, BWL, BW2P | 055175 | 055175 | 055175 |
| 110 | Cable feed-through Ø 16 | 009542 | 009542 | 009542 |
| 120 | Cable feed-through 2160 black Ø 28 | 009536 | 009536 | 009536 |
| 130 | Terminal bar MS 8-pin 8x8mm for VarioWIN,FireWIN, BioWIN XL 35-60 | 009929 | 009929 | 009929 |
| 140 | Oval-head screw 3.2x16 (not illustrated) | 018190 | 018190 | 018190 |
| 145 | Mains connection socket 3-pin for MIRA,ETX,PMX,BioWIN10-26,LogWIN Premium 180-505, EasyWIN Premium 180,BioWIN XL 35-60, FireWIN | 041430 | 041430 | 041430 |
| 150 | Power supply 24V, 1.5A | 002057 | 002057 | 002057 |

Care, cleaning and full service

| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-------|---|-------------------|-------------------|---------------|
| 180 | PCB FMP-D for pellet, Generation D with software BW2T, BW2XL, BW2P" | 055567 | 055567 | 055567 |
| 190 | PCB holder VAE, FW, BW10-26, BWXL, BW2, BW2T, LWPT, PW24-103, BWL | 007609 | 007609 | 007609 |
| 200 | Hexagon screw BW2T, BWL, BW2P | 054438 | 054438 | 054438 |
| 205 | Relay 16A AC 2 polar 12V DC | 005075 | 005075 | 005075 |
| 210 | Flue gas sensor PT1000 BW2, BW2T, PW24-103, BWL, BW2P | 007620 | 007620 | 007620 |
| 220 | Control panel bottom LWPT, BW2T, BWL, BW2P | 052994 | 052994 | 052994 |
| 230 | Control panel surface BW2T, BWL, BW2P | 054089 | 054089 | 054089 |
| 240 | Hexagon pin key with T-handle 10x200 for VarioWIN, BioWIN XL 35-60 | 027392 | 027392 | 027392 |
| 250 | Fuse 1 A T 5x20 ceramic tube | 006900 | 006900 | 006900 |
| 260 | 6.3A fuse (not illustrated) | 003228 | 003228 | 003228 |
| 270 | Spare part set fuseholder incl. conversion instructions | 055193 | 055193 | 055193 |
| 280 | Hexagon nut M4 with flange and gearing, galvanized | 016564 | 016564 | 016564 |
| 290 | MESO09M Immersion sensor for hot water tank, buffer, solid fuel, or third-party boiler | 502186 | 502186 | 502186 |
| 300 | Thermocouple | 007624 | 007624 | 007624 |
| 305 | Thermostat LS1+100-6U | 005672 | 005672 | 005672 |
| 310 | Wago terminal block 261 5pcs."ext. Heating demand" 1-4 | 006835 | 006835 | 006835 |
| 330 | Wago terminal block 261 6-pce. heating requirement/probe switching for BioWIN 10-26, BioWIN XL 35-60 (*not illustrated) | 006719 | 006719 | 006719 |
| 340 | Wago terminal block 261; 11-pin safety 1-11 for FireWIN, VarioWIN | 009891 | 009891 | 009891 |
| 355 | Wago terminal block 261; 2-pin WMS 1-2, 3-piece for VarioWIN, FireWIN | 009948 | 009948 | 009948 |
| 360 | Cylinder screw M 4 x 10 - 8.8 ISO 4762 | 016782 | 016782 | 016782 |
| 370 | Cylinder screw 4.2x13 DIN7981ST (not illustrated) | 018140 | 018140 | 018140 |
| 10000 | Set for function module INFF05 NA for external heating demand and pump control | 056320 | 056320 | 056320 |
| 10010 | Cable transformer - main plug BioWIN2T NA | 056321 | 056321 | 056321 |
| 10020 | Cable transformer - 110V main plug BioWIN2T NA | 056329 | 056329 | 056329 |
| 10030 | Cable electric panel - funtion modules INFF05 BioWIN2TNA | 056220 | 056220 | 056220 |
| 10040 | Set for function module INFF05 NA for external heating demand and pump control | 056320 | 056320 | 056320 |

28.4 Burner – BioWIN 2 Touch

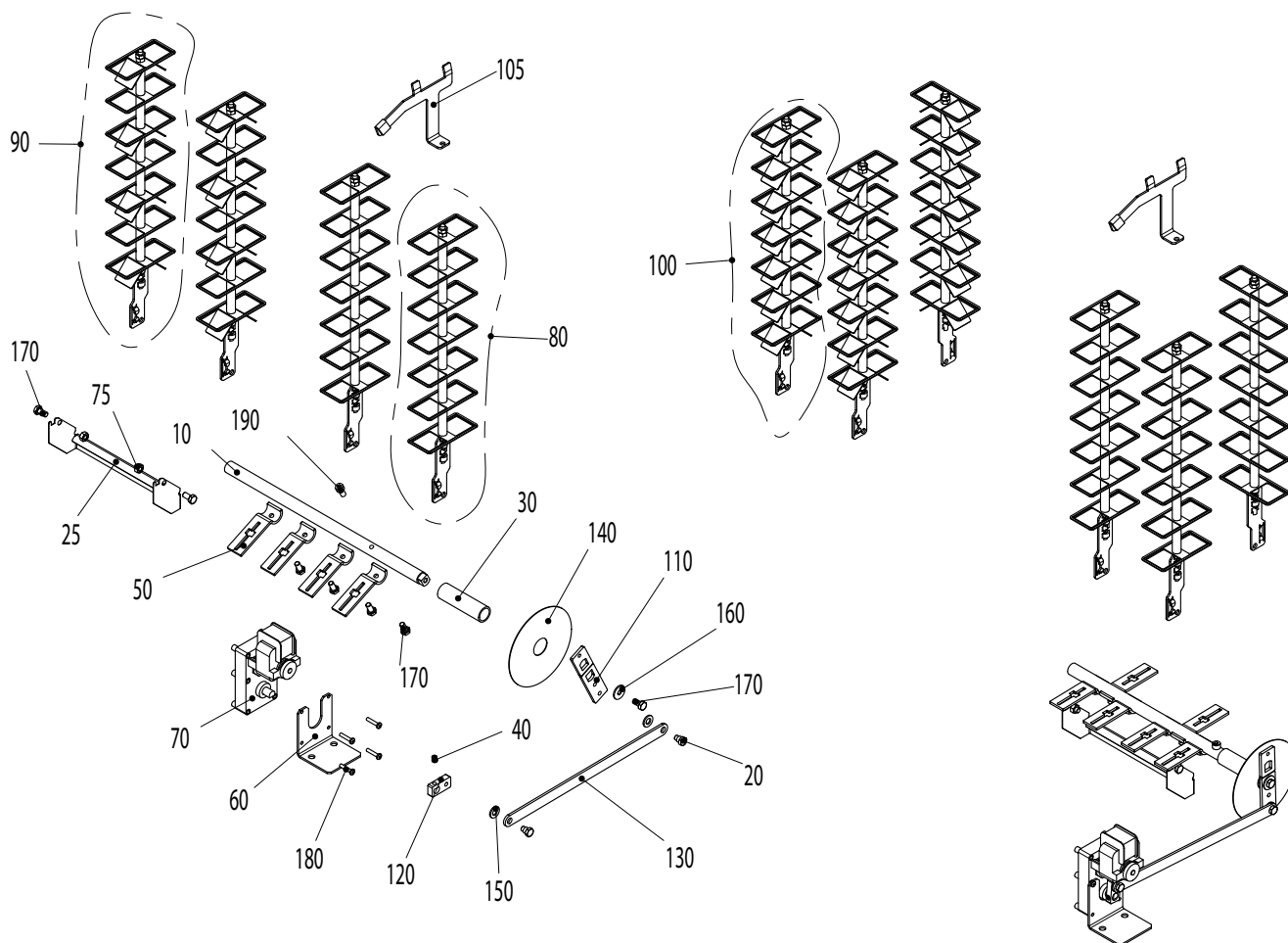


| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|--|-------------------|-------------------|---------------|
| 5 | Stop plate BW2, BW2T, BWL, BW2P | 053544 | 053544 | 053544 |
| 10 | Ash stop plate, Klassik, Premium BW2K/P., BW2T, BWL, BW2P | 051048 | 051048 | 051048 |
| 20 | Ash stop plate, Exclusive BWE2, BW2T, BWL, BW2P | 051046 | 051046 | 051046 |
| 40 | Mounting support for microswitch, complete BW2/BW2T 10-33, BWL, BW2P | 051045 | 051045 | 051045 |
| 50 | Bracket mounting plate BW2, BW2T, BWL, BW2P | 050632 | 050632 | 050632 |
| 60 | Mounting plate BW2, BW2T, BWL, BW2P | 050649 | 050649 | 050649 |
| 70 | Mounting plate, top BW2, BW2T, BWL, BW2P | 051042 | 051042 | 051042 |
| 80 | Burner BW2, BW2T, BWL, BW2P | 051065 | 051065 | 051065 |
| 90 | Blower seal BW10-26 ab Los30, BW2, BW2T, BWL, BW2P | 048861 | 048861 | 048861 |
| 100 | Driving rod feed-through BW2, BW2T, BWL, BW2P | 048841 | 048841 | 048841 |
| 110 | Grate plate guide BW2, BW2T, BWL, BW2P | 048842 | 048842 | 048842 |
| 120 | Setscrew M8x10 DIN916 | 033112 | 033112 | 033112 |
| 125 | Cable - ignition element for BW1, BW2, FireWIN and VarioWIN | 053643 | 053643 | 053643 |
| 130 | Bracket for shake-out BW2, BW2T, BWL, BW2P | 050639 | 050639 | 050639 |
| 140 | Cone, top part 45° BW2, BW2T, BWL, BW2P | 050642 | 050642 | 050642 |
| 150 | Cone, bottom part | 050643 | 048941 | 048941 |
| 160 | Bearing for vibrating drive | 007125 | 007125 | 007125 |
| 165 | Sleeve socket BW2T 21-33, BW2P 21/26 | - | 055660 | 055660 |
| 170 | Microswitch with lever EF83161.8 BW2/BW2T 10-33, BWL 10-26, BW2P 10-26 | 007632 | 007632 | 007632 |
| 180 | Motor shake-out BW2, BW2T, BWL, BW2P | 012561 | 012561 | 012561 |
| 190 | O-ring FPM70 45 x 4 PMX, FW, VAE, BW2, BW2T, BWL, BW2P | 006849 | 006849 | 006849 |
| 200 | Shoulder screw M8 10x25 ISO 7379 | 017048 | 017048 | 017048 |
| 210 | Primary air pin | 007210 | 047774 | 047774 |
| 220 | Grate plate, left PMX, FW, VAE, BW2, BW2T, BWL, BW2P | 051051 | 051051 | 051051 |
| 230 | Grate plate, right BW10-26, BW2T, BWL, BW2P | 053539 | 053539 | 053539 |
| 240 | Disc 3 DIN134 | - | 021474 | 021474 |

Care, cleaning and full service

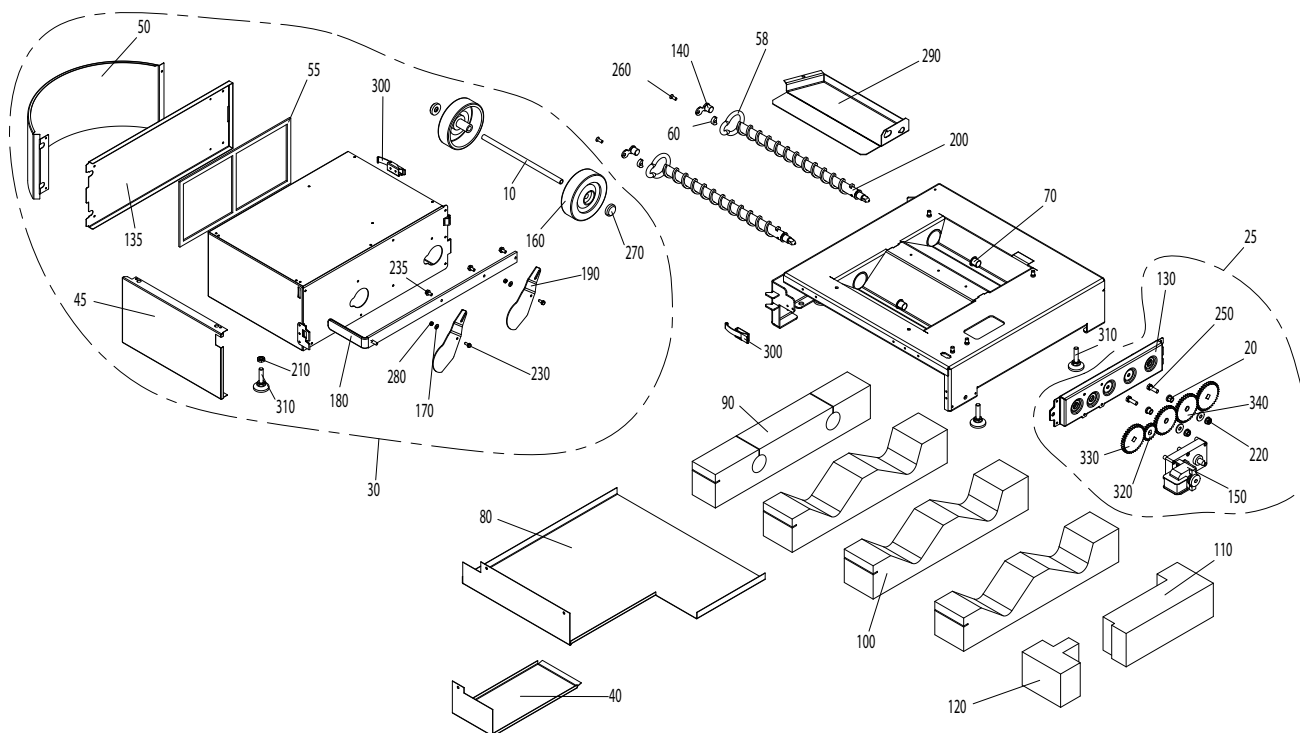
| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|--|-------------------|-------------------|---------------|
| 250 | Disc 8 ISO 7093 | 031755 | 031755 | 031755 |
| 260 | Disc 8 ISO 7089 | 024779 | 024779 | 024779 |
| 270 | Grate plate scraper | 051023 | 051023 | 051023 |
| 280 | Hexagon nut M3 DIN 934 | 016551 | 016551 | 016551 |
| 290 | Hexagon nut M5 DIN 934 | 017035 | 017035 | 017035 |
| 300 | Hexagon nut M8 DIN 934 | 031153 | 031153 | 031153 |
| 305 | Hexagon nut with flange and gearing M6 | 016566 | 016566 | 016566 |
| 310 | Hexagon nut M8 with flange and gearing | 016553 | 016553 | 016553 |
| 320 | Hexagon screw M5x12 DIN 7500 (not illustrated) | 031545 | 031545 | 031545 |
| 330 | Hexagon screw M6x12 DIN 7500 | 031549 | 031549 | 031549 |
| 340 | Hexagon screw M5x10 DIN 933 | 016756 | 016756 | 016756 |
| 350 | Hexagon screw DIN 933 - M5x16 - 8.8 - galvanized | 015025 | 015025 | 015025 |
| 355 | Hexagon screw M6x20 DIN 933 | 015471 | 015471 | 015471 |
| 370 | Spur gear M1,5; Z21 | 007222 | 007222 | 007222 |
| 380 | Venturi nozzle | 051066 | 051067 | 051067 |
| 390 | Steering rack BioWin2 10-26 BW2/BW2T/BWL/BW2P 10-26 | 048161 | 048161 | 048161 |
| 400 | Ignition element BioWIN10-26, FireWIN from lot 15, VarioWIN from lot 15, BioWIN XL, LWK" | 055201 | 055201 | 055201 |
| 402 | Ignition element with cable | 053851 | 053851 | 053851 |
| 410 | Intermediate plate | 051054 | 051054 | 051054 |
| 420 | Cylinder screw M4x12 DIN 7985 | 016780 | 016780 | 016780 |

28.5 Heating surface cleaning – BioWIN 2 Touch



| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|--|-------------------|-------------------|---------------|
| 10 | Axle heating surface BW2/BW2T/BWL/BW2P 10-26 | 048882 | 048882 | 048882 |
| 20 | Collar screw | 012502 | 012502 | 012502 |
| 25 | Ash sheet BW2T, BWL, BW2P | 051624 | 051624 | 051624 |
| 30 | Distance rod BW2T, BWL, BW2P | 048980 | 048980 | 048980 |
| 40 | Setscrew M8x10 DIN916 | 033112 | 033112 | 033112 |
| 50 | Lever for cleaning heating surfaces BW2, BW2T, BWL, BW2P | 051547 | 051547 | 051547 |
| 60 | L-bracket, motorheating surface BW2, BW2T, BWL, BW2P | 051121 | 051121 | 051121 |
| 70 | Motor PMX15, BWE10-60, BW2, BW2T, PW, BWL, BW2P | 044665 | 044665 | 044665 |
| 75 | Hexagon nut M8 DIN 934 V2 | 015992 | 015992 | 015992 |
| 80 | Clearer flat | 051609 | 051609 | - |
| 90 | Clearer flat with turbulator | 051610 | 051610 | 054671 |
| 100 | Clearer flat pre assembled BW2/BW2T/BWL/BW2P 21/26 | 051611 | 051611 | - |
| 105 | Cleaning plate for combustion chamber BW2, BW2T, BWL, BW2P | 051076 | 051076 | 051076 |
| 110 | Shaker lever 1 heating surface cleaning BW2P | 055134 | 055134 | 055134 |
| 120 | Shaker lever 2 heating surface cleaning BW2, BW2T, BWL, BW2P | 048885 | 048885 | 048885 |
| 130 | Shaker lever 3 | 051367 | 051367 | 051367 |
| 140 | Disc BW2, BW2T, BWL, BWP2 | 051122 | 051122 | 051122 |
| 150 | Disc 10 ISO7089 | 024780 | 024780 | 024780 |
| 160 | Disc 8 ISO 7093 | 031755 | 031755 | 031755 |
| 170 | Hexagon screw M8x16 DIN 933 | 016721 | 016721 | 016721 |
| 180 | Cylinder screw M5x25 ISO 7045 | 016837 | 016837 | 016837 |
| 190 | Cylinder screw M8x16 ISO 4762 | 016773 | 016773 | 016773 |

28.6 Ash box – BioWIN 2 Touch

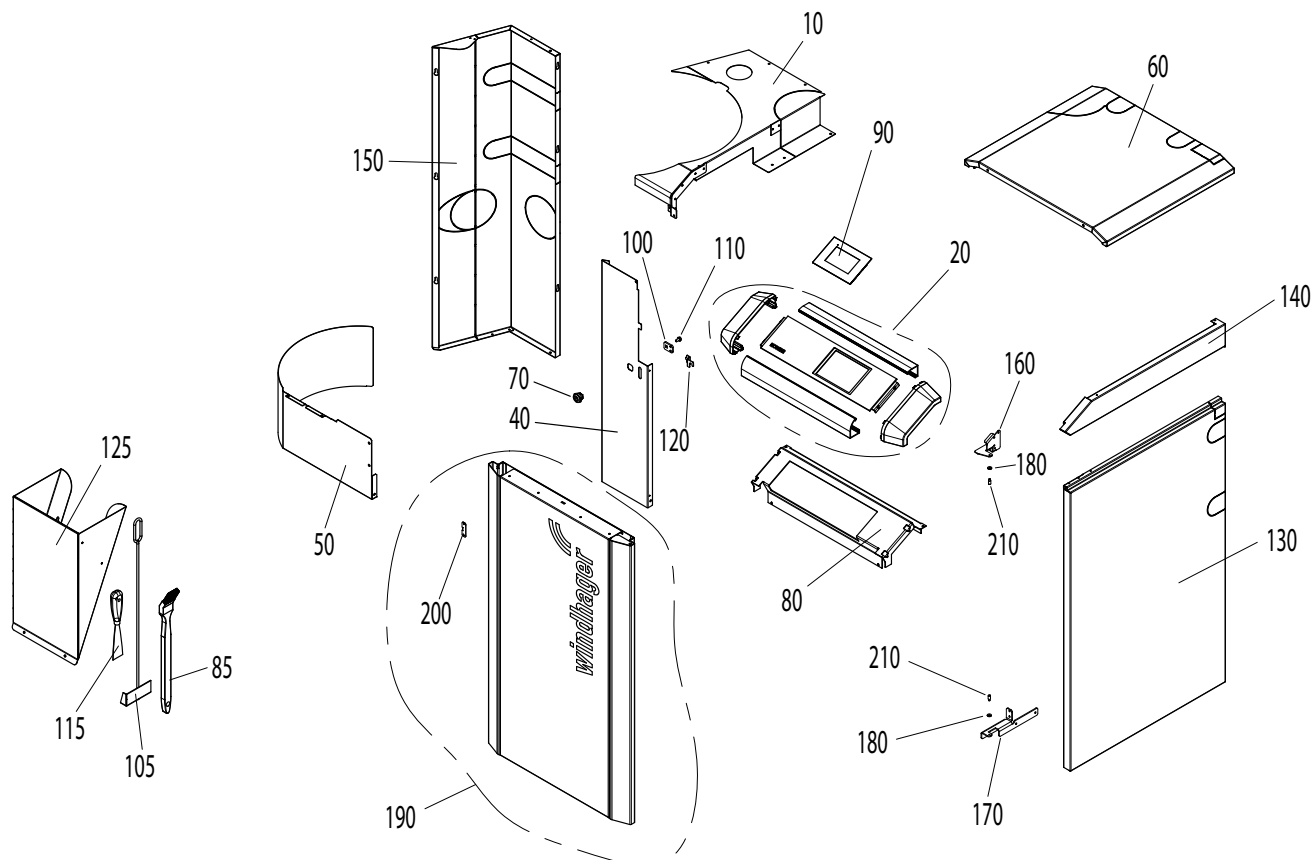


| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|--|-------------------|-------------------|---------------|
| 10 | Ash box axle | 051379 | 051379 | 051379 |
| 20 | Ash conveyor bearing bush PMX, BWE100-600, BW2, BW2T, BW2P, PW | 006745 | 006745 | 006745 |
| 25 | Ash removal, completely pre- mounted, BioWIN2 BW2, BW2T, BW2P | 054418 | 054418 | 054418 |
| 30 | BIO90T Ash box, cpl for BW2T 10-33kW | 054414 | 054414 | 054414 |
| 40 | Cover for ash conveyor motor BW2, BW2T, BW2P | 051125 | 051125 | 051125 |
| 45 | Cover ash box BW2T, BW2P" | 054342 | 054342 | 054342 |
| 50 | Cover ash box lid curve BW2T, BW2P | 054343 | 054343 | 054343 |
| 55 | Container seal BW, VAE, FW, BWXL, BW2, BW2T, BWL, BW2P | 046665 | 046665 | 046665 |
| 58 | Gasket flange BW2, BW2P | 054679 | 054679 | 054679 |
| 60 | Distance BW2, BW2T, BW2P | 048573 | 048573 | 048573 |
| 70 | Friction bearing with connector | 012508 | 012508 | 012508 |
| 80 | Cup insulation BW2, BW2T, BW2P | 051124 | 051124 | 051124 |
| 90 | Ash pipe insulation | 051126 | 051126 | 051126 |
| 100 | Insulation ash chamber BW2, BW2T, BW2P | 051127 | 051127 | 051127 |
| 110 | Insulation Motor, rear BW2, BW2T, BW2P | 051128 | 051128 | 051128 |
| 120 | Insulation Motor, front BW2, BW2T, BW2P | 051129 | 051129 | 051129 |
| 130 | Bracket for ash conveyor BW2, BW2T, BW2P | 048572 | 048572 | 048572 |
| 135 | Ash box flap BW2, BW2T, BW2P | 051635 | 051635 | 051635 |
| 140 | Auger bearing BW2, BW2T, BW2P | 051120 | 051120 | 051120 |
| 150 | Motor PMX15, BWE10-60, BW2, BW2T, PW, BWL, BW2P | 044665 | 044665 | 044665 |
| 160 | Wheel AG 125-12 | 006888 | 006888 | 006888 |
| 170 | Disc 5 DIN134 | 018309 | 018309 | 018309 |
| 180 | Sheet slider BW2T, BW2P | 054444 | 054444 | 054444 |
| 190 | Slider ash box BW2 | 050689 | 050689 | 050689 |
| 200 | Auger PMX15, BWE10-60, BW2, BW2T, PW, BWL, BW2P | 051542 | 051542 | 051542 |
| 210 | Hexagon nut M10 DIN 439 | 031156 | 031156 | 031156 |
| 220 | Hexagon nut M8 with flange and gearing | 016553 | 016553 | 016553 |
| 230 | Hexagon screw M5x12 DIN 7500 (not illustrated) | 031545 | 031545 | 031545 |
| 235 | Hexagon screw M6x12 DIN 7500 | 031549 | 031549 | 031549 |
| 240 | Hexagon screw M8x20 DIN 933 (not illustrated) | 017086 | 017086 | 017086 |
| 250 | Hexagon screw M8x25 DIN 933 | 017191 | 017191 | 017191 |
| 260 | Countersinking screw M6x16 | 016863 | 016863 | 016863 |
| 270 | Washer Ø12 | 006889 | 006889 | 006889 |
| 280 | Lock nut M5 | 016727 | 016727 | 016727 |
| 290 | Ash box base BW2, BW2T, BW2P | 050692 | 050692 | 050692 |

Care, cleaning and full service

| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|--|----------------|----------------|------------|
| 300 | Spring lock | 009546 | 009546 | 009546 |
| 310 | Leg M10 x 40 | 009990 | 009990 | 009990 |
| 320 | Spur gear M2 Z20 BWXL60, BW2, BW2T, BW2P | 047543 | 047543 | 047543 |
| 330 | Spur gear M2 Z36 M2 Z36 BW2, BW2T, BWL, BW2P | 050869 | 050869 | 050869 |
| 340 | Spur gear M2 Z36 Ø12 BW2, BW2T, BW2P | 048566 | 048566 | 048566 |

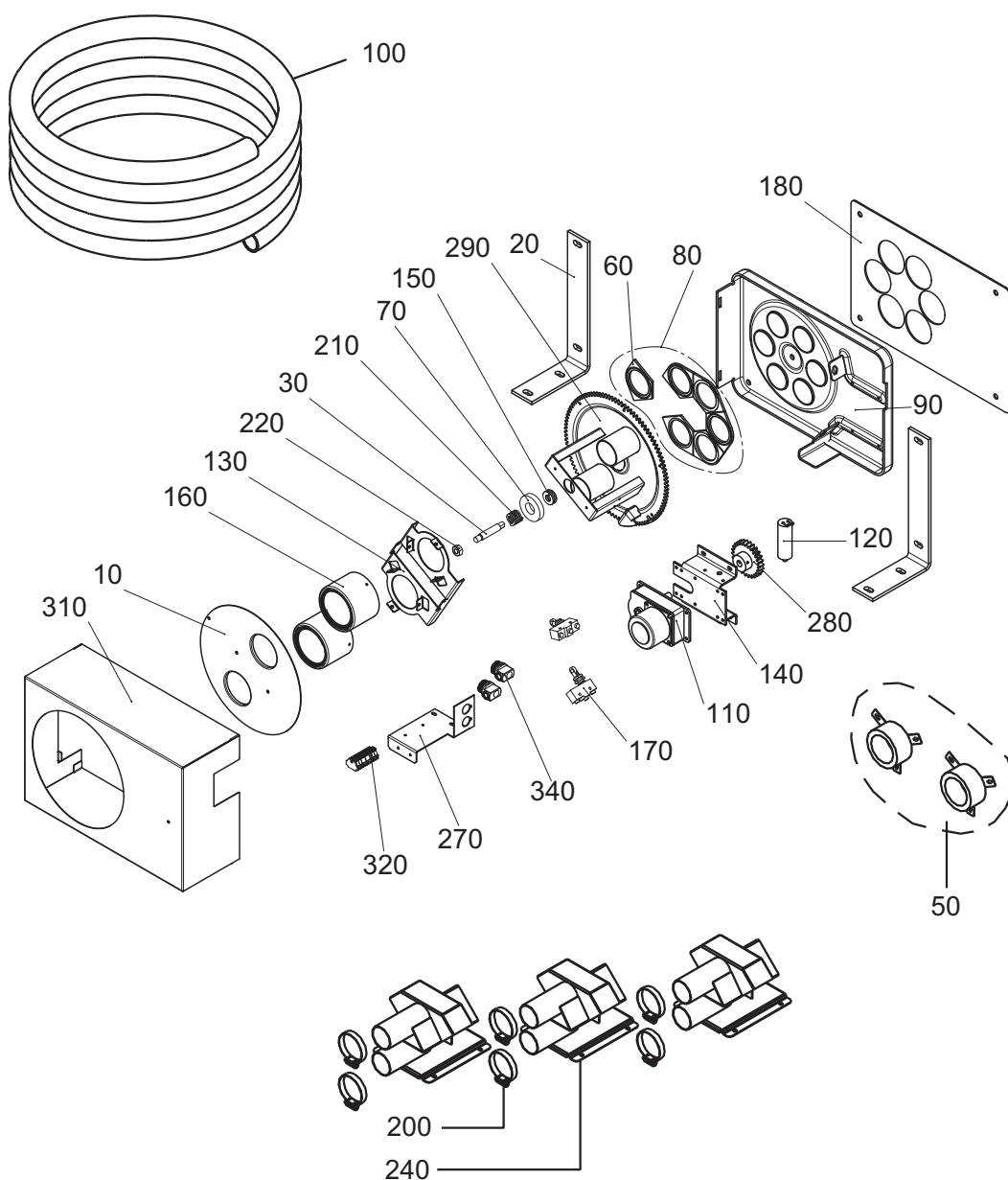
28.7 Cladding – BioWIN 2 Touch



| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|--|----------------|----------------|------------|
| 10 | Cover rear, left BW2T 21/26, BW2P 21/26 | 054442 | 054442 | 054442 |
| 10 | Cover rear, left BW2T 10/15, BW2P 10/15 | 054443 | 054443 | 054443 |
| 20 | Switch panel compl. BW2T, BW2P | 054440 | 054440 | 054440 |
| 40 | Cover, left BW2T, BWL, BW2P | 054356 | 054356 | 054356 |
| 50 | BIO87T Pellet container cover BW2 TKlassik/Premium | 054407 | 054407 | 054407 |
| 60 | Lid coated BW2T 10/15, BW2P 10/15 | 054121 | 054121 | 054121 |
| 60 | Lid coated BW2T 21/26, BW2P 21/26 | 054132 | 054132 | 054132 |
| 70 | Turning bolt | 012256 | 012256 | 012256 |
| 80 | Panel BW2T, BW2P | 054072 | 054072 | 054072 |
| 85 | Cleaning brush BW2, BW2P | 017090 | 017090 | 017090 |
| 90 | INF8 MES INFINITY InfoWIN Touch | 001009 | 001009 | 001009 |
| 100 | Driver BWXL 35-60, BW2, BW2T, BWL, BW2P | 047891 | 047891 | 047891 |
| 105 | Scratcher | 072192 | 072192 | 072192 |
| 110 | Hexagon screw M6x12 DIN 7500 | 031549 | 031549 | 031549 |
| 115 | Spatula | 009540 | 009540 | 009540 |
| 120 | Locking plate BWXL60, BW2, BW2T, BWL, BW2P | 047892 | 047892 | 047892 |
| 125 | BIO063 Pellet chute for manual hopper filling | 051759 | 051759 | 051759 |
| 130 | Cladding right BW2T/BW2P 10/15 | 054359 | 054359 | 054359 |
| 130 | Cladding right BW2T/BW2P 21/26 | 054360 | 054360 | 054360 |

| No. | Spare part designation | BioWIN 102/152 | BioWIN 212/262 | BioWIN 332 |
|-----|---|----------------|----------------|------------|
| 140 | Cladding right-top BW2T/BW2P 10/15 | 054075 | 054075 | 054075 |
| 140 | Cladding right-top BW2T/BW2P 21/26 | 054325 | 054325 | 054325 |
| 150 | Cladding left BW2T/BWL/BW2P 10/15 | 054353 | 054353 | 054353 |
| 150 | Cladding left BW2T/BWL/BW2P 21/26 | 054355 | 054355 | 054355 |
| 160 | Door mounting top BW2T, BW2P | 054077 | 054077 | 054077 |
| 170 | Door mounting bottom BW2T, BW2P | 054076 | 054076 | 054076 |
| 180 | Disc 5 DIN134 | 018309 | 018309 | 018309 |
| 190 | Cladding door complete set BW2T, BW2P | 054441 | 054441 | 054441 |
| 200 | Clamping plate BW2, BW2T, BWL, BW2P | 047893 | 047893 | 047893 |
| 210 | Dog point screw | 015507 | 015507 | 015507 |
| 220 | Cylinder screw 4.2x13 DIN7981SP (not illustrated) | 018139 | 018139 | 018139 |

28.8 3-way changeover unit



Care, cleaning and full service

| No. | Spare part designation | Spare part no. |
|-----|---|----------------|
| 10 | Cover disc for fire protection - PMX042 and BIO021 | 042444 |
| 10 | Cover disc with entry - BIO020 | 045982 |
| 20 | Retaining bracket | 046284 |
| 30 | Bolt for mounting | 006927 |
| 40 | Fire protection collars (2x) for 3-way changeover unit – (BIO021) | 045987 |
| 50 | Fire protection collars (2x) for masonry attachment | 503330 |
| 60 | Seal ring | 006884 |
| 70 | Axial bearing seal | 006929 |
| 80 | Seal set for feed | 042534 |
| 90 | Flange plate | 045975 |
| 100 | Delivery and return hose | 505110 |
| 110 | Gear motor | 046617 |
| 120 | Capacitor F48/3 0.82 | 007335 |
| 130 | Fire protection collar bracket | 045979 |
| 140 | Motor bracket | 042441 |
| 150 | Axial ball bearing | 006925 |
| 160 | Collar, complete with insert | 042539 |
| 170 | Microswitch | 006936 |
| 180 | Mounting plate | 045988 |
| 190 | Relay (for shut-off unit) – not illustrated | 005496 |
| 200 | Hose clip for pellet feed | 006875 |
| 210 | Spiral spring | 006926 |
| 220 | Hexagon nut M10 | 016616 |
| 230 | Base for relay (for shut-off unit) – not illustrated | 009908 |
| 240 | Pellet feed probe | 045304 |
| 250 | Clamping pin 4 x 20 – not illustrated | 018666 |
| 260 | Clamping pin 4 x 30 – not illustrated | 018665 |
| 270 | Connector bracket | 045332 |
| 280 | Galvanised spur gear – not illustrated | 006930 |
| 290 | End disc | 045974 |
| 300 | U-washer M10 | 018058 |
| 310 | Cladding | 046872 |
| 320 | Wago terminal block | 006921 |
| 330 | Time relay (for shut-off unit) – not illustrated | 003642 |
| 340 | Strain relief | 001884 |

DISPOSAL/RECYCLING

Disposing of the packaging

The packaging material (wooden crate, cardboard boxes, inserts, plastic films and plastic bags, etc.) must be disposed of correctly in line with the local legal provisions and regulations.

Disposing of components or the boiler

To dispose of defective components or the heating system (e.g. boiler or control system) after the product life has expired, please observe the following information:

- ▶ Dispose of the items correctly, i.e. separate the parts to be disposed of into material groups.
- ▶ Do not simply dispose of electrical or electronic waste with the general waste under any circumstances; instead, use the public collection points provided for this purpose.
- ▶ As a matter of principle, dispose of items in a way that is as sustainable as possible and that is in line with the current environmental protection, reprocessing and disposal technology.

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BIOWIN 2 TOUCH

FOR USE IN CANADA / USA



PELLET BOILER

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IMPORTANT INFORMATION

This manual contains data with US units. The units in the original manual are European units. If there is a data conflict between these units, the data with European units is always valid.

The original manual is written in German – this is an English translation. In case of conflicts, the German version is always valid.

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1. General information

As required by the United States Department of Environmental Protection the following information is given for the: BioWIN 2 Touch wood pellet fired central heating boilers. Manufactured by Windhager Zentralheizung Technik GmbH, Anton Windhager Strasse 20, Seekirchen 5201, Austria

The BioWIN 2 Touch boilers have the following thermal output levels and comply with EPA 2020 requirements:

- BioWIN 102 from 10.2 kBTU/hr (3 kW) to 33.8 kBTU/hr (9.9 kW)
- BioWIN 152 from 15.3 kBTU/hr (4.5 kW) to 51.2 kBTU/hr (15 kW)
- BioWIN 212 from 21.5 kBTU/hr (6.3 kW) to 71.7 kBTU/hr (21kW)
- BioWIN 262 from 26.6 kBTU/hr (7.8 kW) to 88.4 kBTU/hr (25.9 kW)
- BioWIN 332 from 33.4 kBTU/hr (9.8 kW) to 110.9 kBTU/hr (32.5 kW)

The BioWIN 2 Touch boilers efficiency at nominal output was measured by a test laboratory using the HHV of the fuel.

- BioWIN 102: TBD
- BioWIN 152: TBD
- BioWIN 212: TBD
- BioWIN 262: TBD
- BioWIN 332: TBD

Your BioWIN 2 Touch boiler 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.

Your BioWIN 2 Touch boiler is equipped with automatic fuel loading. There are no further loading instructions. Solely PFI Premium 100% wood pellets shall be used.

Materials such as trash, plastics, gasoline, rubber, naphtha, household garbage, material treated with petroleum products such as particleboard, railroad ties, and pressure treated wood.

Burning these materials may result in release of toxic fumes or render the heater ineffective and cause smoke.

Your BioWIN 2 Touch is equipped with an automatic ignition and starts itself when required by building load. Thus, no further ignition procedures are to be followed.

There are no user adjustments for the air controls required.

It is important to have BioWIN 2 TouchNA boiler serviced by a trained professional who is aware of the importance to ensure that:

- there are no inlet air restrictions in or around your boiler's combustion blower
- the air passages within your boiler are free of debris(ash, creosote, etc.)
- the Flue pipe and chimney are clean and free of debris / restrictions
- combustion chamber door (when closed and secured) and the ash box seal are airtight.

Ash removal is completely automatic. 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 or on the ground, away from all combustible materials, pending final disposal. The ashes should be retained in the closed container until all cinders have thoroughly cooled.

A person or persons responsible for the operation of a hydronic heater must comply with all applicable laws or requirements, such as State laws or regulations as well as local ordinances.

A person or persons operating a hydronic heater should be aware that they are responsible for operation in such a manner that does not create a public or private nuisance condition.

The manufacturer's distance and stack height recommendations and the requirements in any applicable laws or other requirements may not always be adequate to prevent nuisance conditions due to terrain or other factors.

Important information

Your BioWIN2 Touch should be installed with a minimum stack height of 16 feet. Providing correct draft as given in the Installation manual.

Draft is the force, which moves air from the appliance up through the chimney. The amount of draft depends on the length of the chimney, local geography nearby obstructions and other factors.

Too much draft may cause excessive temperatures in the appliance and may damage parts in the catalytic combustor.

Inadequate draft may cause backpuffing into the room and 'plugging' of the chimney, or the catalyst.

Inadequate draft will cause the appliance to leak smoke into the room through appliance and chimney connector joints.

Your BioWIN2 Touch is not a catalytic type burner.

You should never use a combustion appliance in your home without an installed smoke and CO detector.

Your local fire department usually has good advice on placement of these detectors and how many your home needs for complete coverage.

Complete important installation information is found in the installation manual.



Note.

This wood heating appliance needs periodic inspection and repair for proper operation. It is against federal law to operate this wood heating appliance in a manner inconsistent with operating instructions in the manual.

1.1 Relevant documents

- Operating manual and installation instructions BioWIN2 Touch
- Operating and installation instructions for system components

1.2 Safety instructions and other symbols in this documentation

1.2.1 Structure of safety instructions



KEYWORD Type of risk

Here, possible consequences are listed that may result from failure to observe the safety instructions.

► Steps to prevent the risk are listed.

1.2.2 Symbols, type of risk or meaning

| Symbol | Type of risk or meaning |
|--------|---|
| | Injury |
| | Electrocution |
| | Material losses (appliance damage, consequential losses and environmental pollution) |
| | Information or tips |

| Symbol | Type of risk or meaning |
|--------|---|
| | Risk of burns |
| | Risk of crushing |
| | Appliance disposal This symbol means that the parts indicated must not be disposed of with domestic waste. |
| | This symbol indicates that you have to do something. The action you need to take is described step by step. |

Important information

1.2.3 Keywords

| KEYWORD | Meaning |
|----------------------------|--|
| DANGER | Ignoring the warnings identified by this symbol can lead to serious injuries or death . |
| WARNING | Ignoring the warnings identified by this symbol can lead to injury . |
| CAUTION | Ignoring the warnings identified by this symbol can lead to malfunction of or damage to the boiler or heating system . |
| Information or tips | The blocks of text identified by this symbol provide information and tips for operation. ▶ Read these texts carefully. |

2. Safety

The boiler together with its accessories complies with the latest state of the art as well as the relevant safety regulations, and is operated with electric current (110 V AC). Improper installation or repair can pose the danger of life-threatening electric shock. Installation may be performed only by appropriately qualified technicians.

2.1 General safety information



DANGER Injury

Please follow the safety instructions (symbols) on the appliance!

Please refer to the instructions in chapter 2.3 Safety instructions on side 7!



DANGER Injury

The specified safety requirements are to be followed in accordance with nationally applicable regulations, standards, and guidelines.



DANGER Electrocution

Turning off the on/off button on the InfoWIN Touch does not mean the boiler and its accessories are completely without power.

▶ Therefore, you must de-energise the boiler (e.g. by unplugging the main power plug) when carrying out cleaning or repair work.



WARNING Risk of crushing from rotating auger

▶ If you have to touch these parts, always de-energise the boiler.



WARNING Risk of burns

▶ Before touching these surfaces, you must switch off the boiler and let it cool.



DANGER Injury

▶ Also read and observe the safety information in the operating manual.

Important information

2.2 Liability exclusion

All work should be performed exclusively by trained personnel. Local safety regulations must be complied with in all cases; in the event of a conflict and/or contradiction between these regulations and the working instructions in this document (e.g., impairment), then the local regulations should be adhered to in any event and the working instruction should not be carried out; WINDHAGER ZENTRALHEIZUNG GMBH, ÖSTERREICH and WINDHAGER ZENTRALHEIZUNG TECHNIK GmbH, ÖSTERREICH do not accept any liability for any injury to persons or damage to property caused by incorrectly following the instructions and/or violating the local safety regulations! Subject to modifications. No liability is accepted for errors in translation.

2.3 Safety instructions



DANGER Risk of fire or explosion.

Do not use chemicals or fluids to start the fire.



CAUTION Health and environmental hazard.

Do not burn garbage, gasoline, naphtha, engine oil, or other inappropriate materials.



WARNING Opening heating chamber door can crush and cut.

When opening door, never insert hands between the door and frame on the hinge side of the heating chamber.



WARNING Opening heating chamber door can crush and cut.

When closing door, never insert hands between the door and frame of the heating chamber. Be aware of other people, especially children.



WARNING Entanglement hazard.

Do not open cover of auger conveyor when heating. Handle with care when servicing charging screw.



WARNING Ash tray can crush and cut.

Never insert hands between ash tray and frame.
Never insert hands into closing bracket.
Never insert hands between ash tray and closing bracket.



WARNING Cover plate for pellet chamber can crush and cut.

Use caution when opening the cover plate. Only authorized personnel are allowed to open cover plate.



WARNING Closing pellet chamber door can crush and cut.

Never insert hands between door and frame, or between door and closing bracket of the pellet chamber when closing the door. Never insert hands into the hinge area when opening door.



WARNING Opening pellet chamber door can crush and cut.

Never insert hands between door and frame on the hinge side of the pellet chamber when opening door. Never insert hands between door and closing bracket.

Important information



WARNING Removing the ash tray can crush and cut.

Never insert hands between frame of boiler/heater and ash tray when removing the ash tray.



WARNING Mounting the ash tray can crush and cut.

Never insert hands between frame of boiler/heater and ash tray when removing the ash tray.



WARNING Displacing the ash tray can crush and cut.

When moving the ash tray, never insert hands between floor of the heating boiler and ash tray.



WARNING Pinch point hazard.

Never insert hands between the cover plate and housing of heating chamber when opening or closing.



DANGER Smoke gas.

Ensure adequate ventilation in the boiler room. Smoke gas may cause poisoning.



WARNING Hot water and hot steam. Injury hazard.

Safety devices (such as the relief valve) will open automatically and release hot water or hot steam. Keep away from safety devices. Do not operate safety devices manually when system water is hot or when device is in operation.



DANGER Attention. Risk of fire.

Lack of water can lead to fire in pellet hopper.
Do not operate this device when water level in water container is below minimum!
Do not use fluids other than pure water.
Monitor the water level monthly and refill to minimum level when necessary.
Always keep water container closed with original lid.- Art. no. 007073 - grip plug.
See BioWIN 2 Touch operating manual for monitoring and refill procedures.



DANGER Risk of fire or explosion.

Exposure may result in severe injury or death.
Do not fill with garbage, waste oil, gasoline, other flammable liquids, or any fuel other than those listed on the rating plate.



Do not use chemicals to ignite fuel.



Do not use chemicals, sprays, or flammable substances to clean combustion room or any other burner component.



Do not use boiler/heater cleaners.

Do not manually fill or light burner.

Do not smoke! Do not expose to open flame.

Do not expose to ignition sources.

Do not open combustion chamber door during operation, power failure, or alarms.



WARNING Fall hazard.

Do not sit, stand, or walk on machine. Keep children away.

Important information



DANGER Attention. Risk of fire.

Do not vacuum hot ash - may cause fire in vacuum cleaner.
Prior to vacuuming ash or dirt, wait until unit has shut down completely and has cooled for at least 2 hours.



WARNING Machine starts automatically.

Moving parts can crush and cut.

Do not remove guarding.

Do not touch rotating parts.



Keep children away.

Keep pets away.



DANGER Hazardous voltage.

Do not remove cover.

Keep away from electric components.

Disconnect power before servicing or cleaning.



WARNING Burn hazard – hot surface.

Do not touch frame, cover, or inside of heating chamber during heating.

Allow heating chamber to cool completely before cleaning and servicing.

Keep children and pets away from heating chamber.

Do not touch backside, chimney, or any other pipework during operation.

Maximum draft marked on nameplate.



WARNING Injury hazard.

All components/surfaces remain hot for a long period of time after turning off unit!

Before cleaning or touching combustion chamber or any other components, turn off unit completely and allow to cool for at least 2 hours

Use heat-resistant gloves.

Use tools provided.



WARNING Health hazard.

Combustion particulates may contain harmful substances.

Use a fine-dust face mask during cleaning.



WARNING Rotating parts can crush and dismember.

Keep hands out of feed opening.

Do not remove cover during normal operation.



WARNING Hand crush hazard.

Automatic start-up if safety switch is activated.

Do not push safety switch.

Moving parts behind the combustion chamber door may start automatically, which can lead to loss of fingers or other serious bodily injury.

Disconnect power before opening the combustion chamber door.

Important information



WARNING Risk of health hazard.

Do not connect to an existing boiler/heater system.



WARNING Crush hazard.

Open the cover of the electronic unit until it is secured in the open position. If not secured, it may fall unexpectedly.



WARNING Risk of hand injury.

Use caution when opening the cleaning flap, as it can open suddenly. When opening the cleaning flap, use the tool provided and wear protective gloves.



WARNING Pinch point hazard.

Use caution when closing the cover of the smoke funnel chamber.



WARNING Crush hazard.

Remain alert and aware of surroundings when moving the machine with crane or fork lift.



DANGER Smoke gas.

Mount a warning plate against smoke gas on the boiler room door.



WARNING Health hazard.

In case of an unexpected fire or if flue pipe turns red, disconnect power if the plug, main switch, or main circuit breaker is safe to reach. Call the fire department (911) and evacuate the building. Do not enter smoke-filled rooms to disconnect power.



WARNING Injury hazard by hot water or steam.

Safety devices (such as relief or drain valve) will open automatically and relieve hot water or steam. Keep away from safety devices. Do not manually operate safety devices when the system is hot.



WARNING Health hazard from chemical substances.

Some states list chemical substances known to cause cancer, birth defects, death, serious illness, or other reproductive harm in propositions. This product may contain such substances, either from the fuel, fuel combustion, or in components of the product itself.



WARNING Necessary tasks.

The heat exchanger, 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 each 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.



Important information



WARNING Pellet feed system: service, maintenance and rules

The pellet feed system operates automatically. All service and maintenance must be completed by trained specialists only. Do not alter the equipment or accessories in any way.

For use in combination with Windhager BioWIN 2 Touch pellet-fueled central heating boiler/furnace only.

Do not use to transport any material other than wood pellet fuel listed on the boiler nameplate or in the boiler manuals.

Do not use for vacuum cleaning.

The pellet feed system starts automatically and will make noise. People who are easily startled or have cardiac problems should keep away.



DANGER Pellet feed unit: Risk of fire or explosion.

Can lead to serious injury/death! Ground suction hoses must be installed as described in the installation manual at every connection to avoid static sparking/dust ignition. The pellet feed unit is for use with the day hopper only. The feed unit must be braced, anchored, or strapped to avoid falling/shifting during an earthquake. Instructions can be obtained from your local Windhager dealer or wholesaler.



Pellet feed automatic changeover unit: Risk of fire or explosion.

Risk of fire or explosion. can lead to serious injury or death.

Do not use the pellet feed automatic changeover unit inside pellet storage room or where there is a lot of dust present. Connect delivery hoses to pellet feed automatic changeover unit as described in the installation manual to avoid static sparking or dust ignition.



WARNING Pellet feed automatic changeover unit: injury hazard by moving parts and electricity

Can lead to serious injury or death.

Device starts automatically. Device restarts automatically after power failure.

Do not remove cover.

This part should be serviced by trained personnel only.



WARNING Clearances and installation instructions

Minimum clearances from combustible or noncombustible construction:

2 inches left, 12 inches back, 24 inches top (right),

6 inches right side, 22 inches front.

Access to the back side is required to allow the service of parts such as the drain valve, relief valve, and inspection fittings.

This unit is for dry indoor installation only. Not for installation on combustible flooring. Not for installation in manufactured homes or mobile homes.



DANGER Risk of serious bodily injury or death.

This boiler/heater is equipped for one type of wood pellet only. Read the nameplate behind top lid for the correct type of pellet. Do not use this boiler/heater with any fuel other than the one listed on the name plate. Failure to use the correct fuel may cause problems resulting in death, serious bodily injury or property damage.



DANGER Attention. Risk of fire.

Do not operate with incorrect draft. Check nameplate behind top lid for correct draft.

Do not operate while refilling the bulk hopper.

Do not operate with door or ash removal covering open or when the ash box is removed.

Do not store fuel or other combustible material in the boiler room.

Regularly inspect and clean flues and chimney.

Have a trained professional regularly inspect safety devices, such as the relief and drain valves.



WARNING

For supply connections, only use 10 AWG or larger wires acceptable for at least 176 °F (80 °C) on a GFCI circuit!

Important information

3. Flue

A properly dimensioned flue is required for the optimal and safe function of this device.

The design of the entire flue system must meet local building codes, and all components must meet UL 2523 / UL 103. All relevant data to size a flue properly is listed under “technical data for flue gas calculations.”

Because of the device’s low minimum flue gas temperature, a moisture and water resistant flue gas system is required. The use of a double wall stainless steel system is required.

A brick chimney may be used if it is damp and water resistant (e.g., refractory brick), properly insulated, and fulfills the requirements of technical calculations. In the case of an existing chimney that is non-damp and water resistant, a single wall stainless steel pipe that is properly designed and insulated may be used. In either case, ask a local building inspector or flue expert for the correct design and flue sizing.

For directions on installing and supporting your chimney, follow instructions provided by your flue system’s manufacturer.

A pressure relief valve needs to be installed in the flue gas system. Whenever possible, a barometric damper should be installed according to local building codes. DO NOT install a barometric damper in sleeping or living areas!



DANGER Injury

The use of galvanized flue gas pipes is at your own risk - this may cause condensation and consequently damage the pipes.



DANGER Injury

Draft regulators which open inwards and outwards can release fumes which can lead to asphyxiation.

The minimum draft required at the flue gas collar is -0.02 in H₂O (-0.05 mbar).

The maximum draft allowed at the flue gas collar is -0.08 in H₂O (-0.2 mbar).

The minimum flue pipe diameter required is 5.1 inches / 130 mm. The use of a flue pipe diameter greater than 5.9 inches / 150 mm first requires a calculation from your local building inspector or flue expert.



CAUTION Material losses

Frequently, overhaul of existing systems involves oversized flue cross-sections or flues not designed for lowtemperature operation. We suggest an evaluation by the local building inspector before installing the boiler system. In this way appropriate modifications can be made to the flue before system installation (see technical data for flue calculation values).

3.1 Adjusting the barometric damper

Adjust barometric damper according to the manufacturer’s instructions. To access the measurement opening, remove the back lid and plug at the flue gas collar. Measure the draft with an appropriate analyzer. Adjust for the flue draft listed on the boiler/heater name plate. Replace the plug and close the lid after measuring the draft.



CAUTION Material losses

Do not alter for increased firing for any reason!

READ and FOLLOW installation instructions for proper flue sizing and flue design! All flue systems must meet UL103. All flue systems must be water resistant (stainless steel) and insulated (double wall system).

DO NOT INSTALL BAROMETRIC DAMPER OR PRESSURE RELIEF VALVE IN LIVING OR SLEEPING AREA!

4. Boiler room/installation room

Important information for the design of the boiler house, fuel store.



DANGER Injury

The configuration of the entire system must comply with the requirements of regional legislation, local planning, applicable regulations, standards and guidelines.

- The minimum clearances for connections, cleaning and full service must be complied with – see section 11.5 Minimum clearances for fire protection, cleaning and full service on side 25.
- Sufficient ventilation of the set-up area must be provided. See section 10. Combustion air on side 19.
- The boiler may only be installed in a dry location.
- The boiler may not be installed in rooms that are dusty or humid.

Permissible limit values: Humidity: max. 85 % at room temperature of 77 °F / 25 °C (non-condensing)
Room temperature: 35.6 °F to 104 °F / +2 to +40 °C

- Do not allow pets or other animals to enter the boiler room or installation room. Install appropriate barriers across openings.
- In the event of floodwater, switch off the boiler in good time and disconnect it from the mains before water enters the boiling room or installation room. You must remember to replace all components that come into contact with water before you put the boiler back into operation.
- Sufficient lighting must be provided for service and full service.

5. Fuel storage

The pellets must be stored in a dry location in order to achieve trouble-free operation with optimum combustion at maximum efficiency. The pellets can be stored in bulk in a storage room, sheet steel tank, fabric tank or buried tank. The requirements for pellet storage are defined in ÖNORM M7137 for Austria, the VDI 3464 for Germany, or the Pellets Fuel Institute (PFI) Standard for the USA/Canada.

See the separate planning documents for planning information about pellet storage.

Maximum transport length and height for pellet feed system:

These maximum values require a stable electricity supply (minimum 110 V AC under load!).

| |
|--|
| max. 82 ft / 25 m distance ¹ at max. 5.9 ft / 1.8 m height difference ² |
| max. 50 ft / 15 m distance ¹ at max. 9.2 ft / 2.8 m height difference ² |
| max. 33 ft / 10 m distance ¹ at max. 14.8 ft / 4.5 m height difference ² |

¹ From the furthest probe to the pellet boiler

² Height difference: sum of lengths of all rising pipes belonging to the feed hose



CAUTION Material losses

The pellets must be transported carefully in and out of the storage room in order to maintain good pellet quality.

Important information

BioWIN 2 Touch (3 probes):

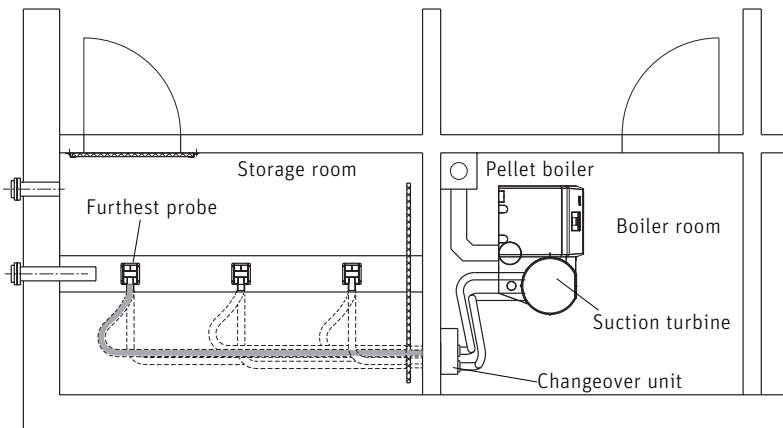


Fig.2 Storage room, boiler room – plan view

6. Initial commissioning and operating instructions

A Windhager representative or one of its partners must commission your new Windhager boiler system. Our representatives will ensure that all systems are thoroughly checked and can provide additional information at the time of commissioning. Installation and routine maintenance performed by a qualified Windhager representative will ensure the optimal performance and service life of your boiler system. This will also ensure that this technologically advanced system provides the benefits of safe, environmentally friendly, and energy-saving operation.

The following preconditions must be met before scheduling the boiler commissioning:

- ▶ Boiler installed correctly.
- ▶ System fully wired up electrically.
- ▶ System flushed, filled and vented – heat load must be available (e.g. functioning heating system connected).
- ▶ Sufficient quantity of fuel available.
- ▶ The customer must be present during commissioning.

The commissioning cannot be carried out if any of these points are not complete. The customer will be charged for any unnecessary costs arising as a result of incorrect commissioning.

Commissioning and maintenance by Windhager Customer Service or a customer service partner are part of the guarantee requirements of the enclosed “guarantee limitations”.

7. Disposal/recycling

Disposing of the packaging

The packaging material (wooden crate, cardboard boxes, inserts, plastic films and plastic bags, etc.) must be disposed of correctly in line with the local legal provisions and regulations.

Disposing of components or the boiler

To dispose of defective components or the heating system (e.g. boiler or control system) after the product life has expired, please observe the following information:

- ▶ Dispose of the items correctly, i.e. separate the parts to be disposed of into material groups.
- ▶ Do not simply dispose of electrical or electronic waste with the general waste under any circumstances; instead, use the public collection points provided for this purpose.
- ▶ As a matter of principle, dispose of items in a way that is as sustainable as possible and that is in line with the current environmental protection, reprocessing and disposal technology.

FOR THE INSTALLER

8. Scope of supply, packaging



DANGER Risk of suffocation from plastic films.

Plastic films, bags and so on can become dangerous ‘toys’ in a child’s hands. Therefore, never leave packaging material unattended or allow children to get hold of it.

When delivered, the boiler and integral fuel hopper are covered in a plastic bag and packed inside a stable crate. Cladding and installation parts are in separate boxes. Cleaning devices are packed inside the boiler.

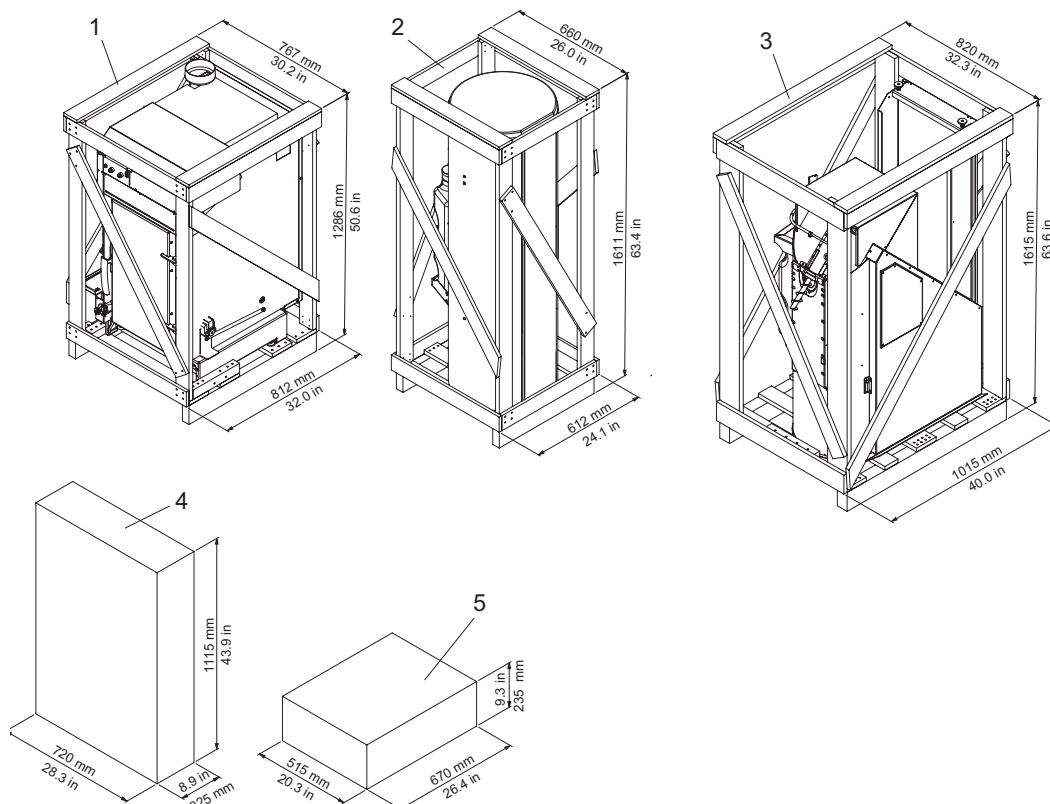


Fig.3 BioWIN 2 Touch scope of supply

| BioWIN2 Touch | | Transport weight including crate/packaging | | | | | | | |
|---------------|--|--|--------------------|----------------|--------------------|-----------------|--------------------|----------------|--------------------|
| | | Klassik | | Premium | | Exklusiv | | Exklusiv-S | |
| | | BioWIN 102/152 | BioWIN 212/262/332 | BioWIN 102/152 | BioWIN 212/262/332 | BioWIN 102/152T | BioWIN 212/262/332 | BioWIN 102/152 | BioWIN 212/262/332 |
| 1 | Boiler incl. transport crate | 450 (204) | 496 (225) | 450 (204) | 496 (225) | 481 (218) | 527 (239) | 481 (218) | 527 (239) |
| | Net boiler weight | 410 (186) | 456 (207) | 410 (186) | 456 (207) | 441 (200) | 487 (221) | 441 (200) | 487 (221) |
| | Smallest boiler weight (excl. heating door, cleaning cover, cone/pin, coating surface cover) | 344 (156) | 390 (177) | 344 (156) | 390 (177) | 375 (170) | 421 (191) | 375 (170) | 421 (191) |
| 2 | Boiler 236 lb / 107 kg pellet hopper incl. transport crate | 93 (42) | | 123 (56) | | 123 (56) | | 93 (42) | |
| | Net boiler 236 lb / 107 kg pellet hopper | 62 (28) | | 93 (42) | | 93 (42) | | 62 (28) | |
| 3 | Boiler 441 lb / 200 kg pellet hopper incl. transport crate | 236 (107) | | - | | - | | 236 (107) | |
| | Net boiler 441 lb / 200 kg pellet hopper | 179 (81) | | - | | - | | 179 (81) | |
| 4 | Cladding | 73 (33) | | | | | | | |
| 5 | Ash box | - | | | | 26 (12) | | | |

For diverse accessories for boiler and storage room, see price list.

9. System

9.1 Area of use

These boilers/heaters are designed and approved as heat generators for hot water heating systems with permissible flow temperatures of up to 194 °F / 90 °C. The max. boiler temperature is limited in the factory to 167 °F / 75°C. In the service level, the max. boiler temperature can be increased to 185 °F / 85 °C. To do this, a buffer has to be installed, which is loaded by the BioWIN 2 Touch.

9.2 Standards

The following UL listed components must be completely unobstructed on the boiler/heater:

- Pressure Relief Valve with 30 psi opening pressure Article no.: 003493
- Low Water Cut-Off with Manual Reset for 110–120 V 15 A Article no.: 003495
- Pressure Gauge Article no.: 003494
- Expansion Tank with at least 15% total system water volume capacity Article no.: 003496, 003497, 003498
- Automatic Air Vent Article no.: 003499

READ and FOLLOW installation instructions for proper flue sizing and flue design!

All flue systems must meet UL103. All flue systems must be water resistant (stainless steel) and insulated (double wall system).

DO NOT INSTALL BAROMETRIC DAMPER OR PRESSURE RELIEF VALVE IN LIVING OR SLEEPING AREA!

9.3 Return temperature

The standard return flow temperature increase allows the BioWIN2 Touch to operate with a return temperature down to a minimum of 68 °F / 20 °C. No external return flow temperature increase is required.

Exception: Systems with a buffer, in which the buffer is loaded directly from BioWIN 2 Touch with a return hold-up group. The minimum required return temperature is 113 °F (45 °C).

9.4 Thermal storage (buffer tank)

Only commercially available vessels designed as thermal storage tanks may be used. Additionally, all thermal storage pressure vessels greater than 119 gallons must have American Society of Mechanical Engineering certification.

The BioWIN 2 Touch central heater shall be installed with a minimum thermal storage (buffer):

| Boiler model | Minimum required thermal storage |
|-----------------------|----------------------------------|
| BioWIN 2 Touch 102 NA | ≥ 119 gal |
| BioWIN 2 Touch 152 NA | ≥ 119 gal |
| BioWIN 2 Touch 212 NA | ≥ 238 gal |
| BioWIN 2 Touch 262 NA | ≥ 238 gal |
| BioWIN 2 Touch 332 NA | ≥ 238 gal |



CAUTION Material losses

If using a buffer or accumulator tank, the BioWIN 2 Touch return flow temperature must be maintained – see hydraulic diagram in the planning documents.

9.5 Operation by control

This is only possible with the **function module INF F05 W** (fitted as standard); the control must fulfil the following demands:

- Minimum boiler temperature and start-up relief:
The consumer pumps (heating circuit and domestic hot water pumps) may only be switched on at a boiler temperature of more than 122 °F / 50 °C if the burner is on, and will be switched off when the boiler temperature is less than 113 °F / 45 °C.
- Pump over run:
A over run of at least 10 minutes will be observed for all consumer pumps and a minimum heat load must be ensured during the burnout phase.
- The system specific control settings must be set so that the boiler runs on average for at least 1.5 hours (shorter operating times cause more contamination of the boiler and greater wear and tear).

9.6 System water



CAUTION Material losses

The chemical composition of the heating water must conform with local legislation and meet the directives, guidelines and standards.

Applicable for Austria (excerpt from ÖNORM H 5195):

- a) According to ÖNORM H 5195, the condition of the heating water must be checked every 2 years by a heating technician in order to avoid corrosion and sediment accumulation in the heating system.
- b) The pipe lines and heating appliances should be thoroughly rinsed before the boiler is connected.
- c) To protect the boiler from contamination from the heating system, **installation of a dirt trap** is required in old or existing systems with maintenance cocks installed in the return line.
- d) If oxygen diffusion or sludge build-up cannot be prevented, the system must be segregated using a heat exchanger.
- e) If antifreeze is used, a **minimum volume of 25 % antifreeze** is required, otherwise corrosion prevention is not guaranteed.

The heating system must only be filled with fresh, untreated drinking water (pH between 8.2 and 10.0). Observe the information in the table to avoid any problems with the boiler or system. If one or more of the conditions cannot be met, it is recommended to treat the heating water. In cases of improperly cleaned systems or poor water quality, the guarantee and warranty are void.

Heating water quality

| | |
|-------------------------|----------------------|
| Acidity | 8.2 – 10.0 pH |
| Electrical conductivity | ≤ 800 µS/cm at 25 °C |
| Chloride | ≤ 30 mg/l |
| Other substances | < 1 mg/l |

Water hardness according to ÖNORM H5195-1 (2010 edition)

Highest permissible hardness of filling water for heating systems, heat generator with a water content of > 0.3 l/kW: Specific water volume of the system < 1.55 gal/kBTU (20 l/kW): *

| Overall performance of heat output | Total alkaline earth | °dH | °fH |
|------------------------------------|----------------------|------------|-----|
| ≤ 170.6 kBTU/hr | up to 3.0 mmol/l | up to 16.8 | 30 |
| > 170.6 kBTU/hr to ≤ 682.4 kBTU/hr | up to 2.0 mmol/l | up to 11.2 | 20 |

Specific water volume of the system ≥ 1.55 gal/kBTU (20 l/kW) but < 3.87 gal/kBTU (50 l/kW) : *

| Overall performance of heat output | Total alkaline earth | °dH | °fH |
|------------------------------------|----------------------|------------|-----|
| ≤ 170.6 kBTU/hr | up to 2.0 mmol/l | up to 11.2 | 20 |
| > 170.6 kBTU/hr to ≤ 682.4 kBTU/hr | up to 1.0 mmol/l | up to 5.6 | 10 |

For the installer

Specific water volume of the system ≥ 3.87 gal/kBTU (50 l/kW) : *

| Overall performance of heat output | Total alkaline earth | °dH | °fH |
|---|----------------------|-----------|-----|
| ≤ 170.6 kBTU/hr | up to 1.0 mmol/l | up to 5.6 | 10 |
| > 170.6 kBTU/hr to ≤ 682.4 kBTU/hr | up to 0.5 mmol/l | up to 2.8 | 5 |

* At an annual replenishment of maximum 5% of the system's water content; additionally, we comply with ÖNORM H5195 part 1 and VDI 2035 T1.

Important general comments on water quality

The boilers are intended for operation with clean, good quality tap or drinking water. The water should be clear and free from visible impurities and suspended matter.

Most heating systems are comprised of different materials. Therefore, a water treatment is recommended to prevent or limit problems (metal corrosion, calcification and sludge formation, microbiological contamination, chemical changes in unprepared system water).

Reduce the oxygen volume in the heating circuit as much as possible.

Annually refill a maximum of 5 % of the system's water capacity.

Important general comments on water quality for new systems

New systems must be fully cleaned from any residue (plastic waste, lubricants, etc.) by means of a universal cleaning agent. Rinse with a minimum of three times the installation volume of the central heating system. Cleaning with chemical products must be done by a professional. Carefully rinse the system until the rinse water is clear and free from any impurities.

The water must not be softened to less than 0.5°dH, as water any softer harms the system. An inhibitor must be used in combination with a water softener.

Important general comments on water quality for existing systems

- De-sludge the system.
- Rinse the system.
- Clean the system with a universal cleaning agent to remove waste material (copper, fiber mass, welding paste).
- Carefully rinse the system until the water is clean and free of any impurities. Check the connection tightness of the combustion air supply and extraction.

The thorough cleaning of the system must be performed by a professional. A sufficient and controlled flow is required to remove all impurities and residues from the heating circuit. In the case of cleaning with chemical products, the above points are especially important for avoiding any residues from corrosive products.

In the event of considerable impurities/clogging (deposits of lime), the boiler must be cleaned by a professional with appropriate tools.

Circulation filter/dirt trap

The installation of a dirt trap is recommended. In accordance with ÖNORM H5195, a filter size of ≤ 25 μ m is required.

Water treatment

The compatibility of the product with all system materials must be checked when using a water treatment system. Observe the manufacturer's instructions.

The water must be regularly checked, and if necessary, changed.

Practical advice:

The system's water quality must be regularly checked by a professional (at least every two years), especially after filling or refilling the water. Record all treatment measures in a report to document the maintenance work on the boiler and system.



CAUTION Material losses

If using a buffer, the BioWIN 2 Touch return flow temperature must be increased – see hydraulic diagram in the planning documents.

9.7 Water-side resistance (pressure loss)

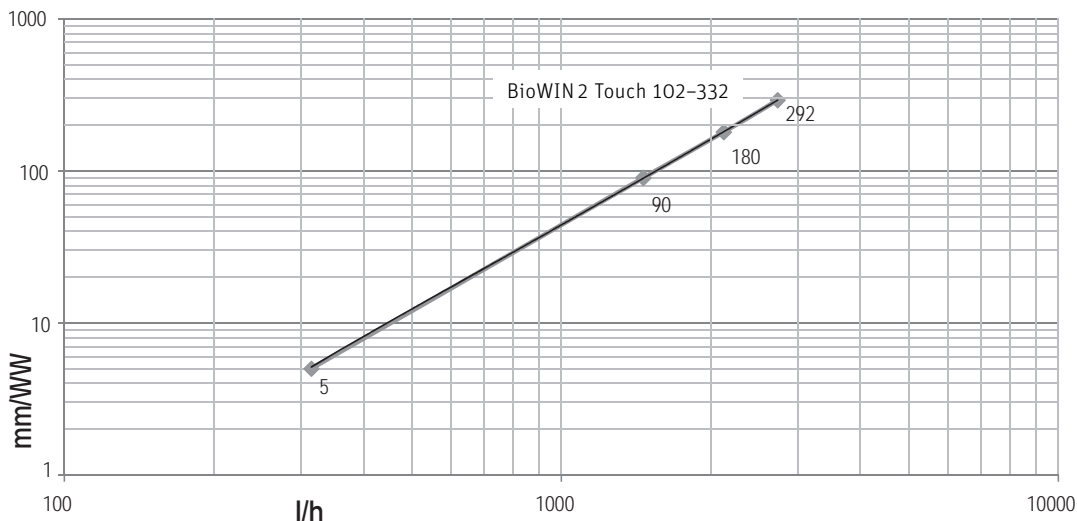


Diagram 1 Water-side resistance – BioWIN2 Touch 102-332

10. Combustion air



DANGER Injury

The configuration of the entire system must comply with the requirements of regional legislation, applicable regulations, standards and guidelines.

An adequate supply of combustion air is essential for the appliance's safe and efficient operation. The combustion air must be free from pollutants (gases, vapours and dusts).



CAUTION Material losses

Malfunctions or complaints occasioned by inadequate combustion air will not be covered by the warranty.

10.1 Combustion air supply directly from the installation room

If combustion air is drawn directly by the system from the boiler/heater room, the room must be adequately ventilated. The combustion air should be directed near the boiler.

The area of the free minimum cross-section must be 0.39 in² / 2.5 cm² per kW of the boiler's nominal total output¹.

The opening to the outdoors for combustion air should be designed as follows:

- the flow of air must not be restricted in any way by the weather (e.g., snow, leaves),
- the free cross-section area remains the same when taking the cover grille, discs etc. into consideration.

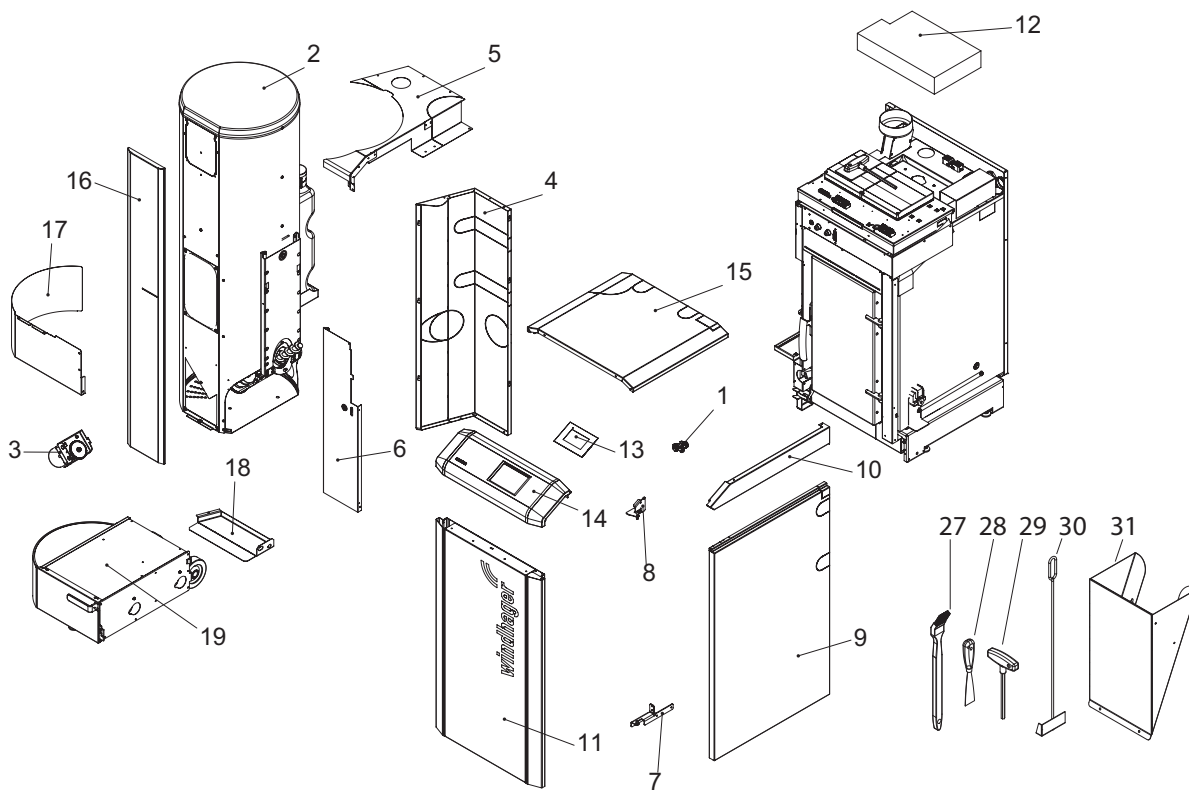
The installation must comply with the requirements of the Authority having jurisdiction over the installation.

10.2 External combustion air supply

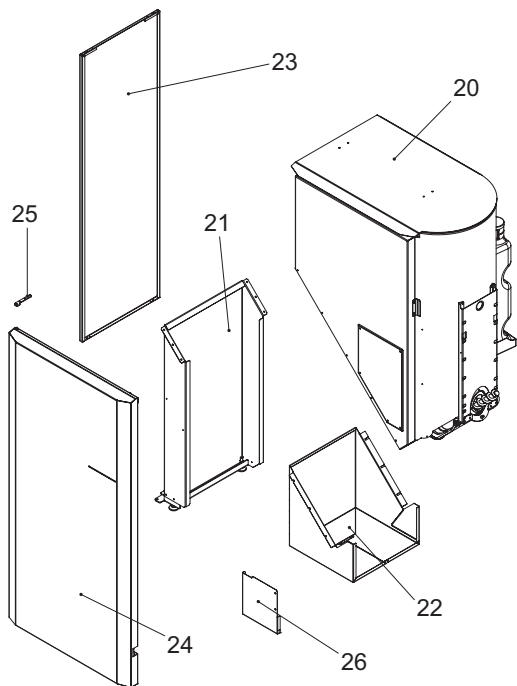
See the planning documents or "Adapter for external combustion air supply BIO 060", "Shut-off unit BIO 0602" and "Switch for integral fuel hopper cover BIO 0601" instructions.

11. Installation sequence

11.1 Parts designations for installation



- 1..... Drain cock¹
- 2..... Integral fuel hopper
- 3..... Auger motor
- 4 Rear left side cladding
- 5..... Top cladding
- 6..... Front cladding
- 7..... Bottom door hinge
- 8 Top door hinge
- 9 Side panel
- 10 Top part of cladding for side panel
- 11..... Cladding door
- 12..... Heat exchanger insulation
- 13..... InfoWIN^{TOUCH}
- 14..... Operating panel
- 15..... Cover
- 16..... Integral fuel hopper cover
- 17..... Bottom cover for integral fuel hopper (only in Klassik/Premium)
- 18..... Ash box base (only Exklusiv/Exklusiv-S)
- 19..... Ash box (only Exklusiv/Exklusiv-S)



- Integral fuel hopper L 441 lb / 200 kg:**
- 20 Integral fuel hopper L 441 lb / 200 kg
- 21..... Pedestal
- 22..... Cover
- 23..... Left side panel
- 24 Cladding door
- 25..... Top door mounting
- 26 Cover

- Cleaning and operating implements**
- 27..... Cleaning brush
- 28 Spatula
- 29 Allen key and sponge-rubber holder
- 30 Scraper (only with Klassik, Klassik-L and Premium)
- 31..... Pellet chute² (accessory for Premium/Exklusiv only)

¹ located in the pellet boiler ash chamber

² Pellet chute for temporary use only or when manually filling the integral fuel hopper, if feed is not complete.

Fig. 4 Parts for installation

11.2 Positioning and installation

It is recommended to **transport the boiler and integral fuel hopper to the place of installation inside the crate and by lift truck**. If transporting via stairs or similar, the boiler should be secured appropriately. For installation dimensions and weights, see Fig. 5, Fig. 6 and Section 5 of the technical data.

If it is not possible to take it in with the transport crate, we recommend transporting the boiler with a sack truck and ratchet strap – see Fig. 11, Fig. 12.

11.2.1 Removing the crate



CAUTION Material losses

The base of the boiler is secured to the floor plate by 2 screws positioned on either side – Fig. 5.

Boiler and integral fuel hopper in crate

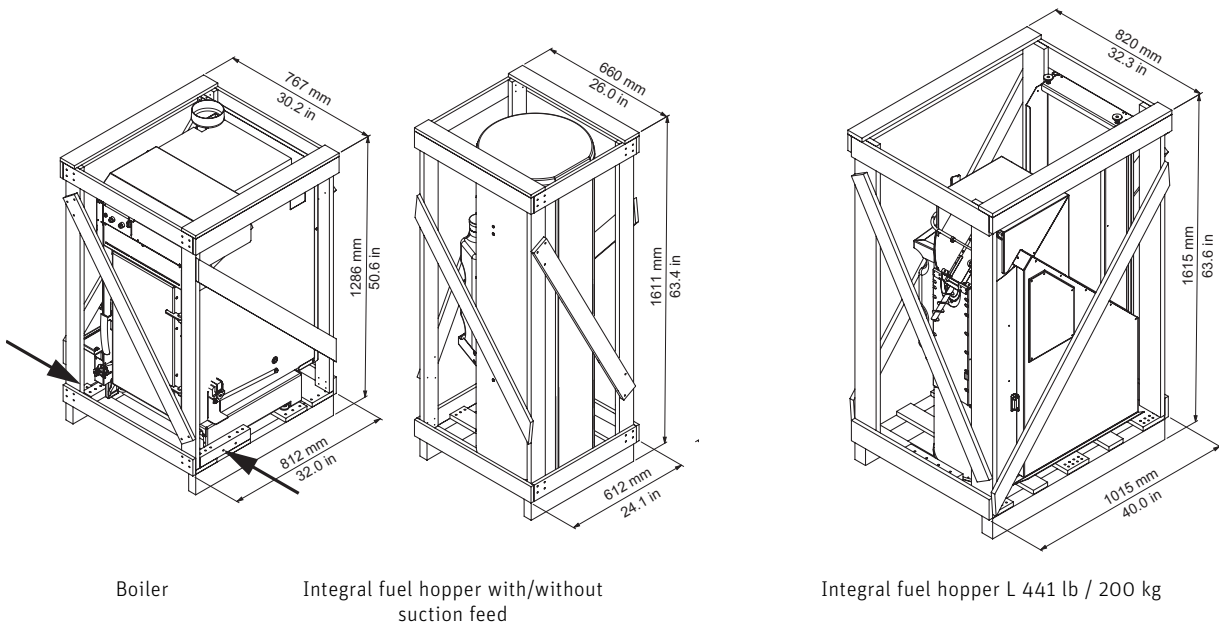


Fig. 5

Boiler and integral fuel hopper without crate

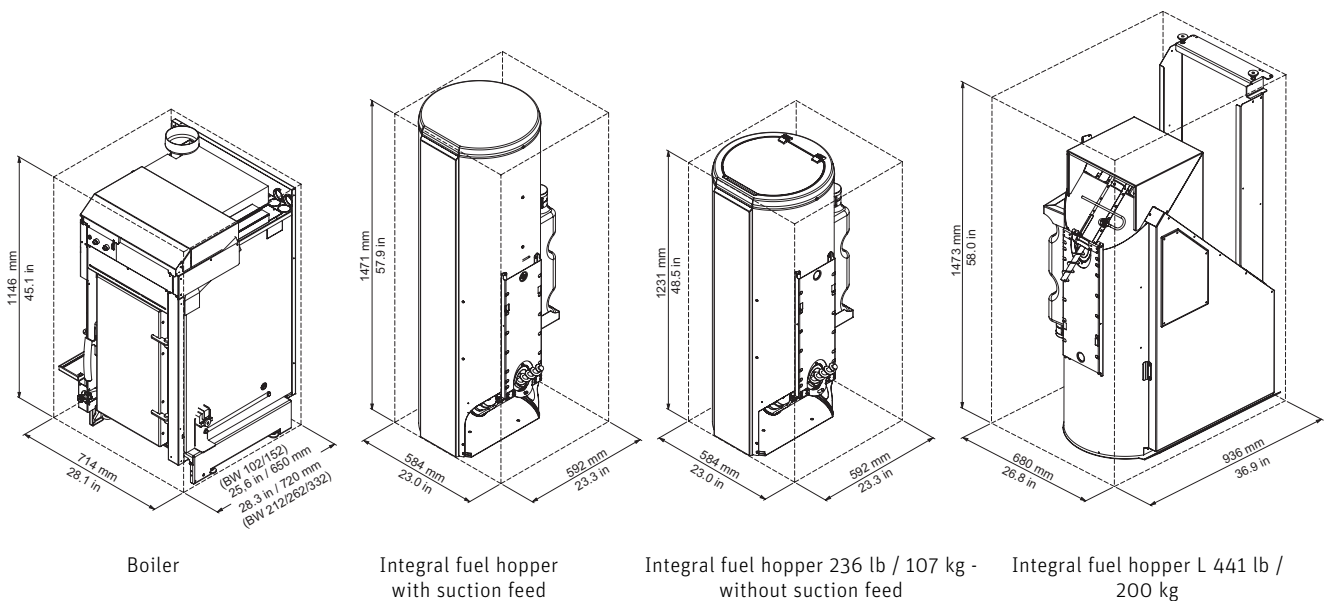


Fig. 6

For the installer

11.2.2 Taking the boiler off the installation pallet and transporting it to where it is to be installed

- a) By hand – Fig. 7–Fig. 10.
- b) With a suitable sack truck and ratchet strap – Fig. 11–Fig. 12.
- c) with eyelet and crane (not included) – Fig. 13, Fig. 14.

a) By hand



Fig. 7 Remove side pieces of wooden frame



Fig. 8 Use planks from crate as ramp



Fig. 9 Grip position for auger tube and flue outlets



Fig. 10 Move boiler off pallet

b) With sack truck and ratchet strap



Fig. 11 Secure boiler to sack truck with ratchet strap



Fig. 12 Lift boiler off pallet with sack truck

For the installer

c) with eyelet and crane (not included)

Screw eyelet M12 for the crane hook to the screw connection of the threaded bolt on the heat exchanger cover and lift the boiler off the pallet with the crane.



DANGER Injury

Before using the eye to lift the boiler, remove the integral fuel hopper and the cladding.



Fig. 13 Mount the eyelet (not included) for the crane hook



Fig. 14 Lift the boiler off the pallet

11.3 Remove the desiccant bags

Remove the desiccant bags from the pellet hopper, the switch board, and the burner – Fig. 15 to Fig. 18.

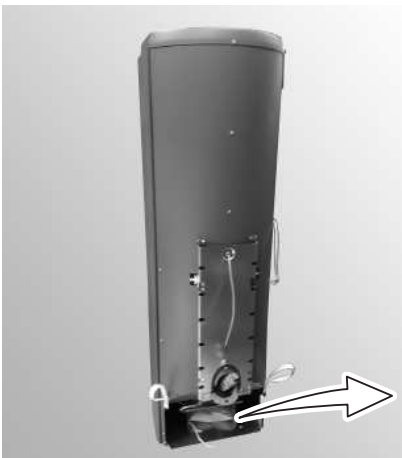


Fig. 15 Remove from the pellet hopper

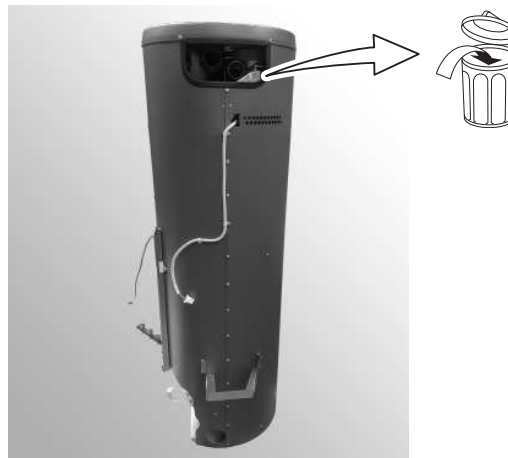


Fig. 16 Remove from the pellet hopper

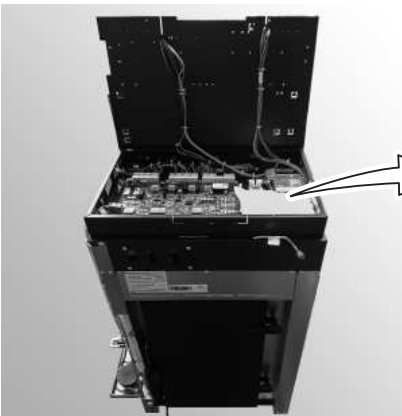


Fig. 17 Remove from the switch board

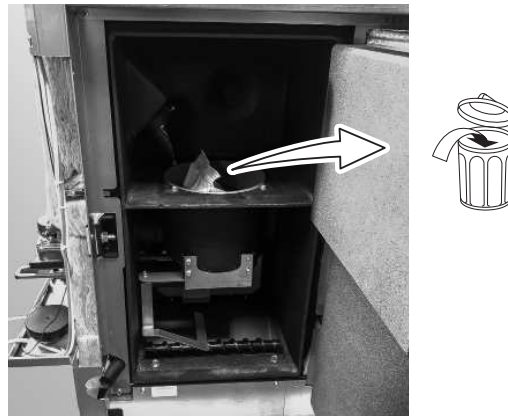


Fig. 18 Remove from the burner

11.4 Installation (observe minimum clearances – Section 11.5)

The boiler can be installed flush to the wall. Before installation, the rear panel has to be removed. You also have to cut into the insulation and seal the flow and return connections – Fig. 19.



Note.

Care must be taken with regard to wall-flush installation to ensure that the piping is sealed completely before actually installing the boiler. If necessary test under pressure by using the drain cock – see section 11.6.

The boiler may be installed directly onto a non-combustible surface and does not require special plinth or superimposed hearth, however if a plinth or hearth is not used the area around the appliance should be identified with paint or change in surface finish as required in Approved Document J (ADJ). If a plinth or hearth is provided, its size must comply with ADJ and be solid enough and large enough to ensure that the four set screws used to adjust and get the boiler level in all plains make contact properly.

Connection options for flow and return pipes

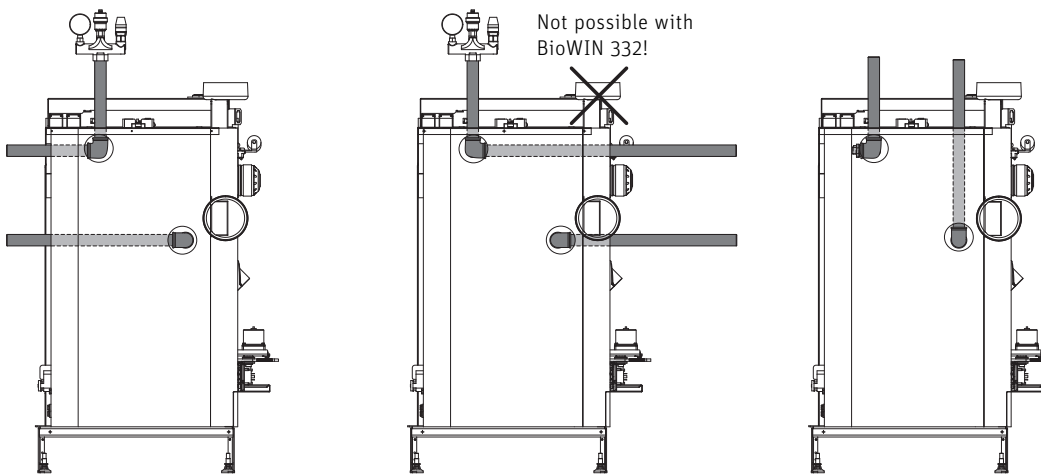


Fig. 19 Connection options for flow and return pipes – view from behind without rear panel

11.5 Minimum clearances for fire protection, cleaning and full service

The following minimum clearances from flammable materials and for connections, cleaning and full service must be complied with.



DANGER Injury

Follow the installation guidelines for plant rooms. The configuration of the flue must comply with technical fire protection requirements in accordance with the applicable regulations, standards and guidelines.

| Minimum clearances between flue pipe (piece connecting to flue) and combustible components | |
|--|---|
| 15.7 ¹ in / 400 ¹ mm | for an uninsulated exhaust pipe |
| 3.9 ¹ in / 100 ¹ mm | for an insulated flue pipe (min. 0.79 in / 2 cm insulation thickness) |
| 1.97 ¹ in / 50 ² mm | for tested, double-walled flue system |

¹ DIN V 18 160-1

² in accordance with approval/identification of system flue

Flue connection top

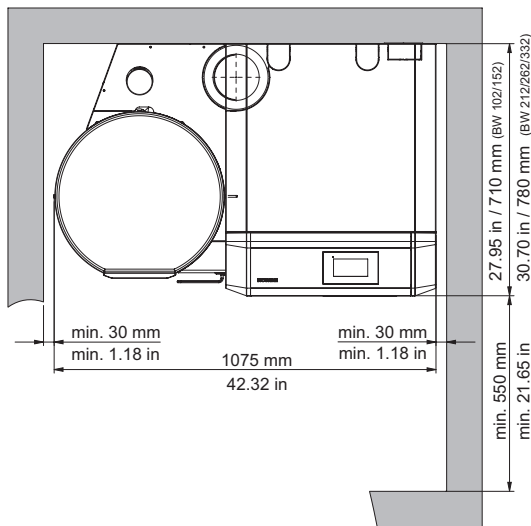


Fig. 20 BioWIN 2 Touch Exklusiv/Premium/Exklusiv-S/Klassik – view from top

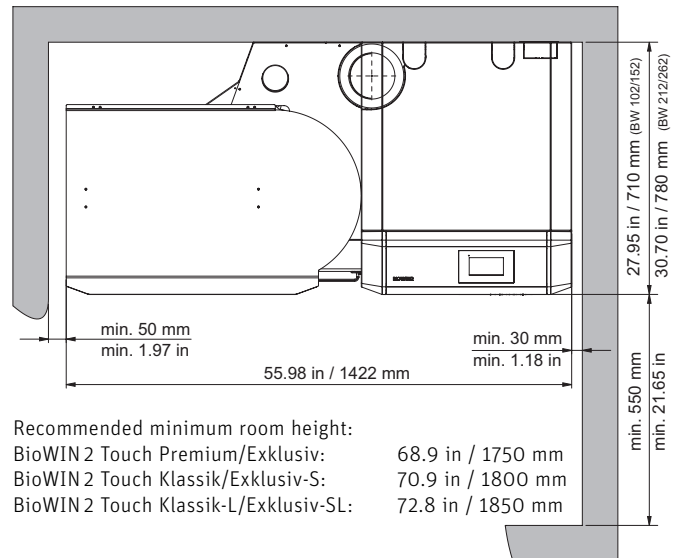


Fig. 21 BioWIN 2 Touch Exklusiv-SL/Klassik-L – view from top

Flue connection rear

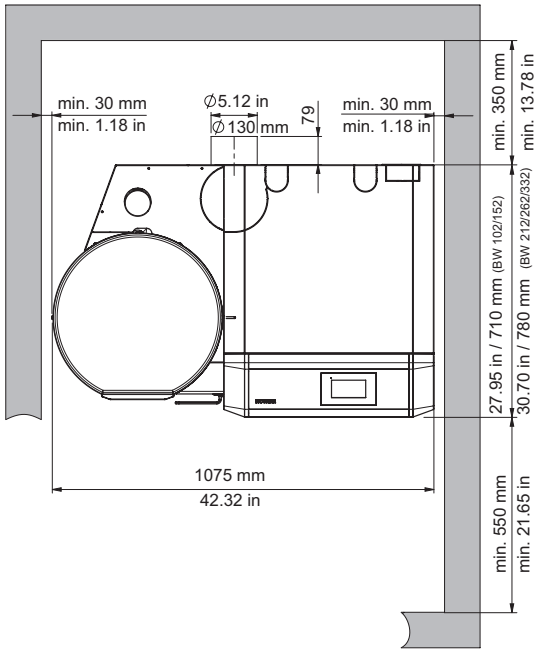


Fig. 22 BioWIN 2 Touch Exklusiv/Premium/Exklusiv-S/Klassik – view from top

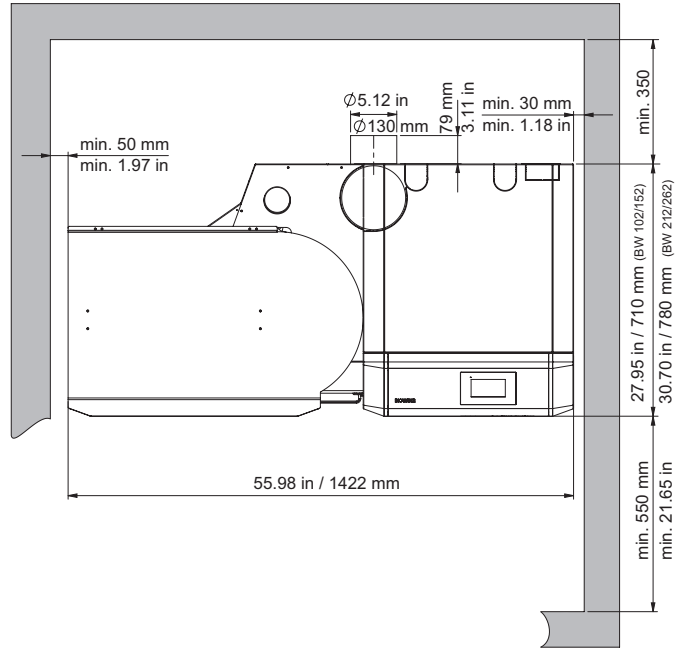


Fig. 23 BioWIN 2 Touch Exklusiv-SL/Klassik-L – view from top

11.6 Installing the drain cock

- ▶ Remove the handle from the drain cock – Fig. 24.
- ▶ Screw the drain cock into the base of the boiler on the left-hand side. The handle must be positioned on the right. Re-attach the handle – Fig. 25.



Fig. 24 Remove the handle from the drain cock



Fig. 25 Screw the drain cock (handle positioned on right) into place and re-attach the handle

11.7 Moving the flue connection to the rear

On delivery, the flue connection is at the top. The flue connection can be moved to the rear by reassembling induced draught fan.

- ▶ Take the insulation off the heat exchanger cover – Fig. 26.
- ▶ Unscrew the screw connection on the cover and lift the cover out – Fig. 27, Fig. 28.
- ▶ Punch out the cut-out on the back panel – Fig. 29.



Fig. 26 Remove the insulation



Fig. 27 Remove the screw connection



Fig. 28 Remove the cover



Fig. 29 Punch out the cut-out

- ▶ Remove insulation from all around the induced draught fan – Fig. 30.
- ▶ Cut open the cable ties around the induced draught fan cable – Fig. 31.

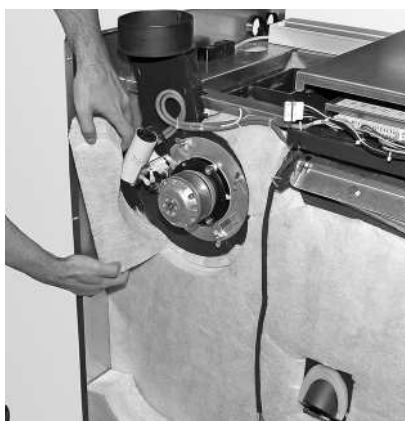


Fig. 30 Remove insulation around the induced draught fan

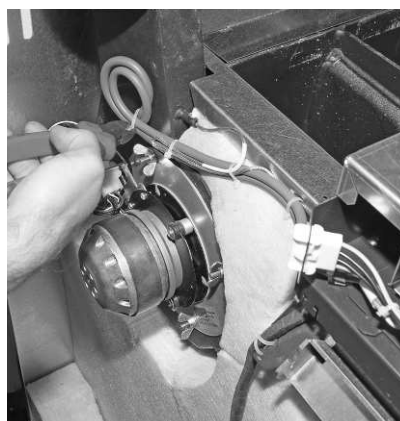


Fig. 31 Cut open the cable ties

For the installer

- ▶ Remove the 4 bolts from the inside of the heat exchanger – Fig. 32. Carefully remove the induced draught fan.



CAUTION Material losses

Do not damage the seal between the induced draught fan and the boiler.

- ▶ Re-screw the induced draught fan into place adjusted by 90° – Fig. 33.
- ▶ Insert insulation (included, on side at base of induced draught fan) at the top around the flue outlet – Fig. 34.

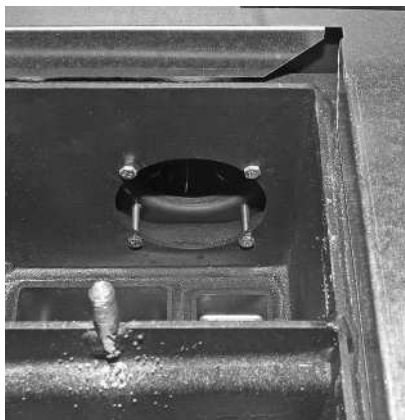


Fig. 32 Remove 4 bolts



Bundle cables together, and secured away from the induced draught fan.

Fig. 33 Re-screw the induced draught fan into place adjusted by 90°



Fig. 34 Attach the insulation (included, on side at base of induced draught fan)

11.8 Installing the integral fuel hopper

only for 441 lb / 200 kg integral fuel hopper

Removing the integral fuel hopper crate 441 lb / 200 kg

- ▶ Remove both fastening straps – Fig. 35.
- ▶ Remove wooden crate. **Caution:** The cladding door is loose inside the crate.
- ▶ Dismount the side panel from the integral fuel hopper: Remove both cross-headed screws from the top (Fig. 36) and take off the side panel – Fig. 37.
- ▶ Remove the foot: Remove 3 screws from each side (Fig. 38) and take off the foot –Fig. 39.



CAUTION Material losses

The foot **must** be dismantled. Otherwise, it is not possible to install the tank correctly on the boiler; leaks or inleaked air would result.

- ▶ Lift the integral fuel hopper off the pallet and rotate it by 180° – Fig. 40.

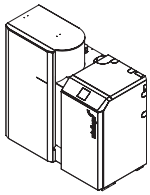


Fig. 35 Remove the fastening straps

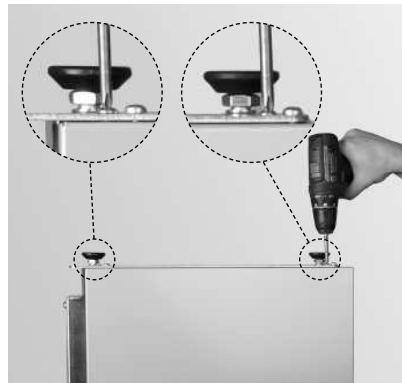


Fig. 36 Remove 1 cross-headed screw in each case



Fig. 37 Take off the side panel

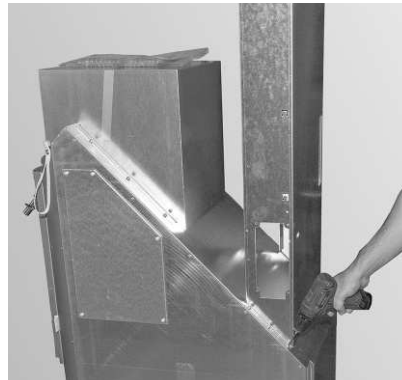


Fig. 38 Remove 6 screws



Fig. 39 Remove the foot



Fig. 40 Turn the integral fuel hopper to the correct position

For the installer

for all integral fuel hopper

- ▶ Together with the auger, insert the integral fuel hopper into the auger tube (Fig. 41). Hook into place with the 2 hooks (marked yellow) – Fig. 42.

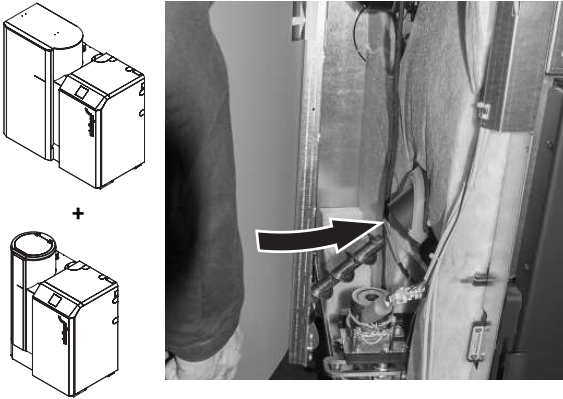


Fig. 41 Insert the auger conveyor into bottom of the auger tube



Fig. 42 Suspend the integral fuel hopper from 2 hooks, marked

- ▶ Tighten the M8 bolt at the top as firmly as possible (as marked) – Fig. 43.
- ▶ Secure the integral fuel hopper at the bottom next to the auger tube with an M8x25 hexagon bolt (provided in plastic bag attached to integral fuel hopper) – Fig. 44. Ensure mount is flush with auger tube before fully tightening. (Do not tighten if above action as described in Fig. 43 has been fully undertaken).

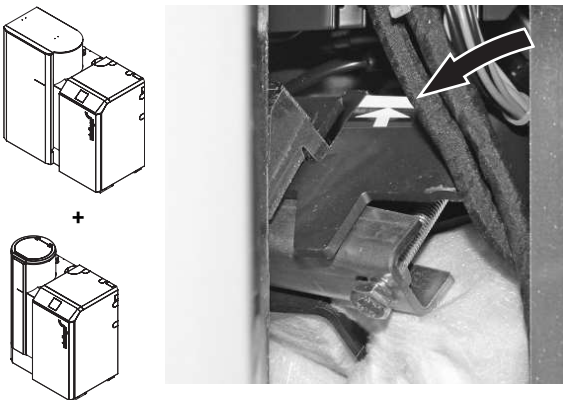


Fig. 43 Tighten the fastening at the top as firmly as possible (as marked)

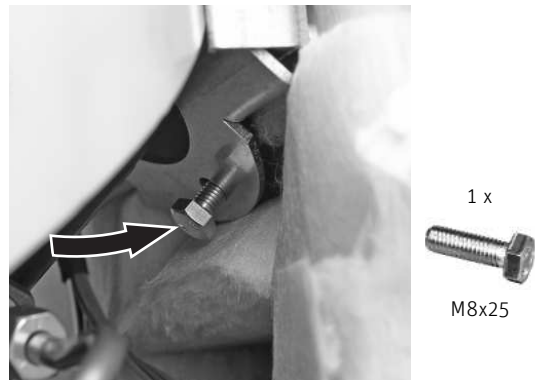


Fig. 44 Secure the integral fuel hopper at the bottom with M8x25

only for 236 lb / 107 kg or with automatic pellet feed integral fuel hopper

- ▶ Dismount the cover from the integral fuel hopper by removing the screw at the bottom (Fig. 45), then pushing the cover down and taking it off (it is hooked on with a bayonet lock) – Fig. 46.



Fig. 45 Dismount the cover, removing 1 screw

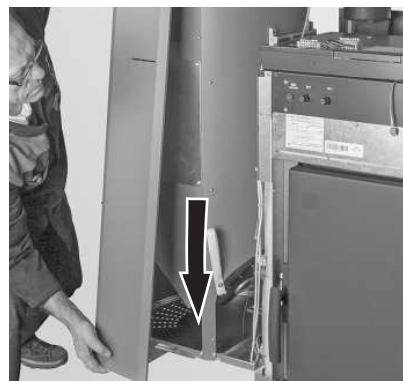


Fig. 46 Push down the cover and remove (bayonet lock)

For the installer

only for 441 lb / 200 kg integral fuel hopper

- ▶ Remove cover from integral fuel hopper by **just loosening** the 3 screws on each side and then taking out and removing the cover – Fig. 47.

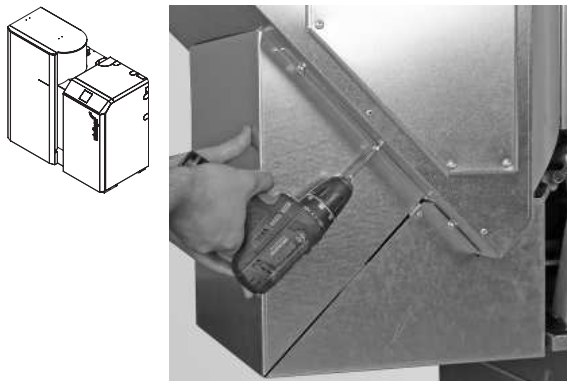


Fig. 47 Loosen the 3 screws on each side and take off cover.

for all integral fuel hopper

- ▶ Insert the sensor for the safety thermostat auger tube into the holder completely – Fig. 48



CAUTION Material losses

The capillary tube must not be bent.

- ▶ Suspend the auger motor (located in the pellet boiler combustion chamber) at the rear via the lug and at the front with the locator pin – Fig. 49.
- ▶ Secure the auger motor at the front with 2 M8x16 screws – Fig. 50.
- ▶ Screw the gear to the auger at the bottom of the integral fuel hopper with M6x12 bolts and a U-washer – Fig. 51.
- ▶ Connect the plug for the auger motor and the proximity switch – Fig. 52.

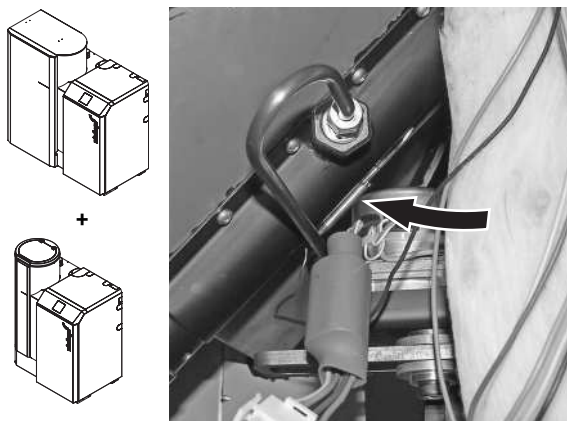


Fig. 48 Insert the sensor for the safety thermostat auger tube as far as it will go

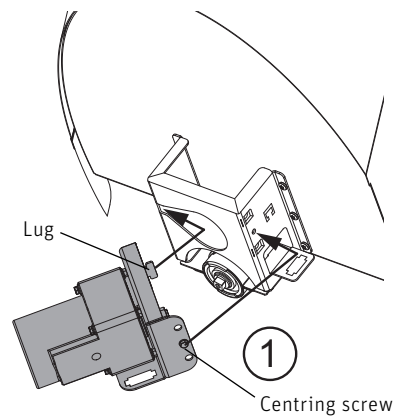


Fig. 49 Hook the auger motor into place

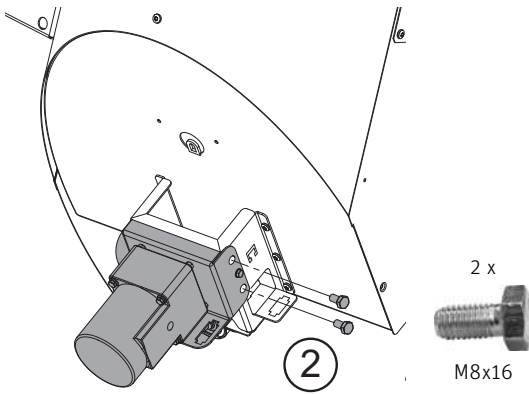


Fig.50 Screw the auger motor into place

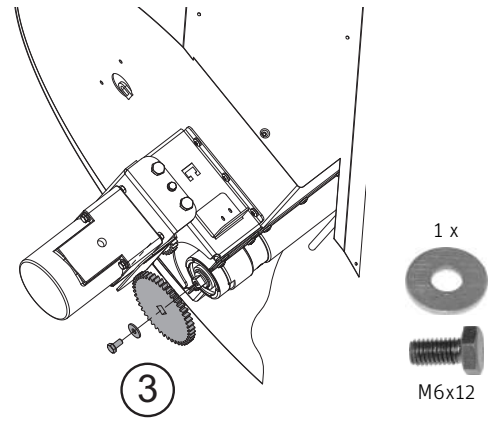


Fig.51 Mount the gear

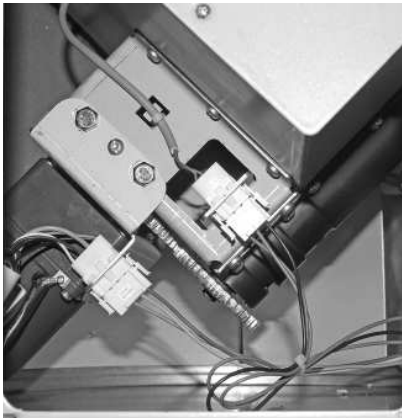


Fig.52 Connect the plug for the auger motor and the proximity switch

only for 236 lb / 107 kg or with automatic pellet feed integral fuel hopper

- ▶ Reattach the cover to the integral fuel hopper and secure with 1 self-tapping screw – Fig. 53.



Fig.53 Attach the cover and secure with 1 self-tapping screw

For the installer

only for 441 lb / 200 kg integral fuel hopper

- ▶ Hook the cover back into place and secure by tightening the screws – Fig. 54, Fig. 55.
- ▶ Mount pedestal by screwing 3 screws into each side of the base – Fig. 56, Fig. 57.

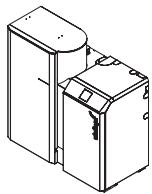


Fig. 54 Hook cover into place



Fig. 55 Tighten screws

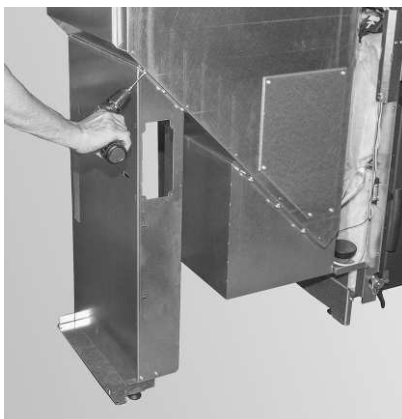


Fig. 56 Secure pedestal with 3 screws at each side



Fig. 57 Secure pedestal with 3 screws at each side



for BioWIN 212 / BioWIN 262 / BioWIN 332 only

- ▶ Attach the supplied elongated sleeve to the intake pipe at the burner. The recess must be at the back – Fig. 58, Fig. 59.

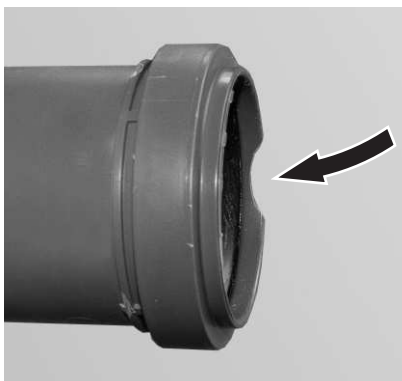


Fig. 58 Elongated sleeve with recess at the back



Fig. 59 Elongated sleeve attached to intake pipe at burner.

For the installer

only for BioWIN 2 Touch Premium/Exklusiv or with automatic pellet feed

- ▶ Connect the suction turbine main power plug – Fig. 60.
- ▶ Open the cover on the control panel – Fig. 61.
- ▶ Route the cable with plug for the upper proximity switch from the integral fuel hopper into the control panel and connect it to plug Y18 – Fig. 62.

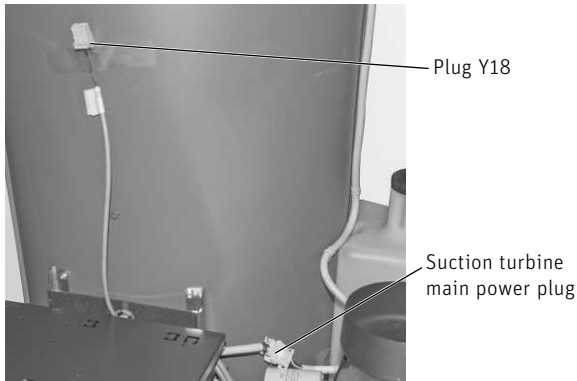


Fig. 60 Connect the suction turbine main power plug



Fig. 61 Open the cover

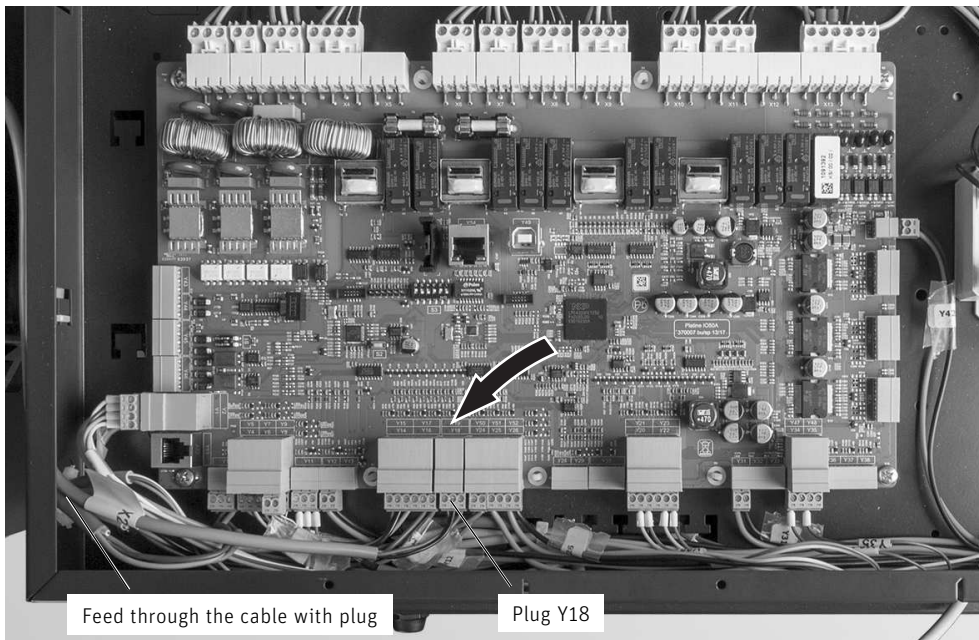


Fig. 62 Connect the proximity switch (plug Y18)

11.9 Integral fuel hopper cladding

only for 236 lb / 107 kg or with automatic pellet feed integral fuel hopper

- ▶ Hook the cladding at the rear left into the bayonet locks – Fig. 63, Fig. 64.

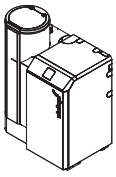


Fig. 63 Bayonet lock



Fig. 64 Remove the adhesive tape from the water tank and hook on the cladding

- ▶ If the flue connection is at the top, punch out the cut-out on the cladding at top left – Fig. 65. If the flue connection is at the rear, do not punch out.

Punch out the cladding = top flue connection

Do not punch out cladding = rear flue connection



CAUTION Material losses

- ▶ Carefully insert or position the cladding, top left, to ensure that the integral fuel hopper is not scratched at the front – Fig. 66.



Fig. 65 Punch out the cut-out only if the flue connection is at the top



Fig. 66 Position the cladding carefully at the top left

For the installer

- ▶ Carefully insert the cladding, top left, lay the cable from the suction turbine main power plug into the notch and secure cladding with 6 self-tapping screws – Fig. 67.

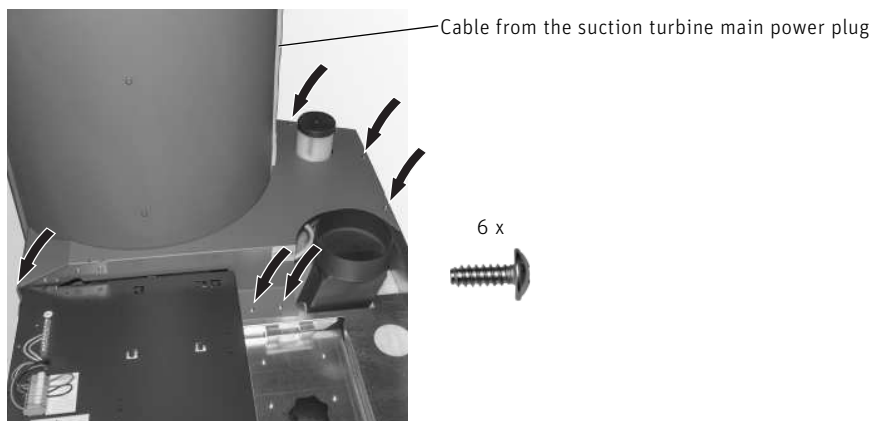


Fig. 67 Secure the cladding with 6 self-tapping screws

- ▶ Hook the cladding into place at the front, left and right (3 bayonet locks) – Fig. 68. Secure with 3 self-tapping screws – Fig. 69. First remove the cleaning brush stuck on the inside.



Fig. 68 Insert the front cladding



Fig. 69 Secure the front cladding with screws

For the installer

only for 441 lb / 200 kg integral fuel hopper

- ▶ Cut through the web at the bottom and the top on the rear left cladding (Fig. 70) and bend the cladding slightly – Fig. 71.
- ▶ Hook the rear left cladding into the bayonet locks – Fig. 72, Fig. 73.

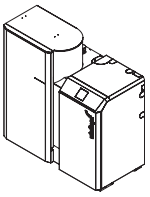


Fig. 70 Cut through web at top and bottom

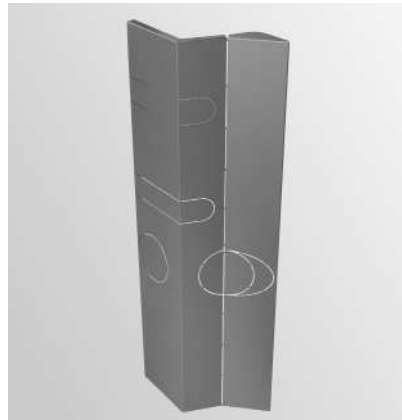


Fig. 71 Bend the cladding slightly



Fig. 72 Bayonet lock



Fig. 73 Hook up cladding

- ▶ Pinch off the corner at the top left cladding cut-out – Fig. 74.
- ▶ If the flue connection is at the top, punch out the cut-out on the cladding at top left – Fig. 75. If the flue connection is at the rear, do not punch out.

Punch out the cladding = top flue connection
Do not punch out cladding = rear flue connection



Fig. 74 Pinch off the corner of the cladding at top left



Fig. 75 Punch out the cut-out only if the flue connection is at the top

For the installer



CAUTION Material losses

- ▶ Carefully insert or position the cladding, top left, to ensure that the integral fuel hopper is not scratched at the front – Fig. 76.

- ▶ Carefully insert the cladding at top left and secure it with 6 self-tapping screws – Fig. 77.

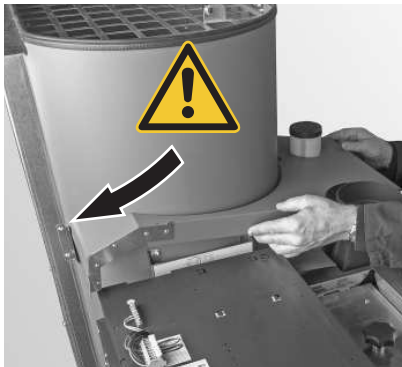


Fig. 76 Position the cladding carefully at the top left

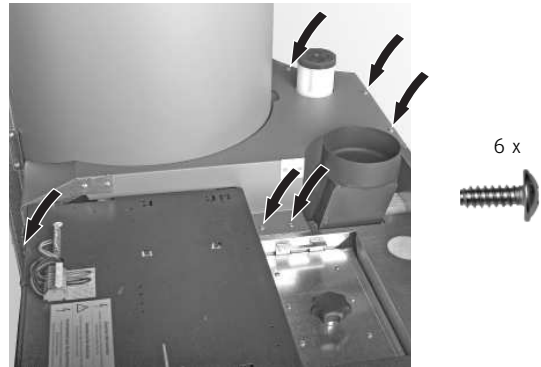


Fig. 77 Secure the cladding with 6 self-tapping screws

- ▶ Hook the cladding into place at the front, left and right (3 bayonet locks) – Fig. 78. Secure with 3 self-tapping screws – Fig. 79.



Fig. 78 Insert the front cladding

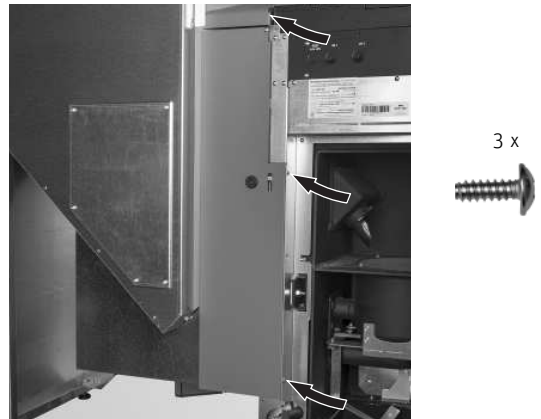


Fig. 79 Secure the front cladding with screws

- ▶ Fasten the bottom front cover with 2 screws – Fig. 80.

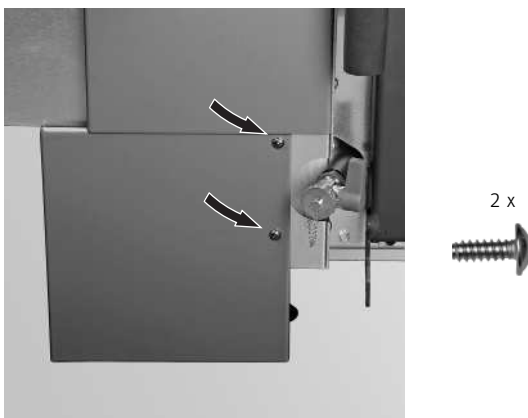


Fig. 80 Install the cover

For the installer

- ▶ Hook the side panel into position at bottom left (Fig. 81) and secure on the inside of the weekly use container with 2 screws – Fig. 82.



Fig. 81 Hook bottom left side panel into position

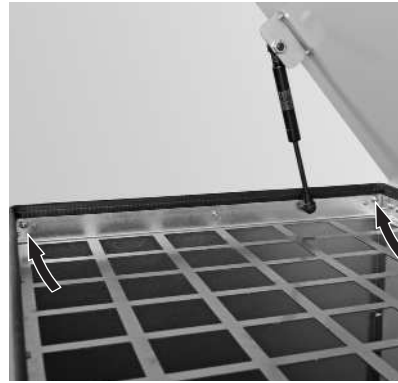


Fig. 82 Secure the top left side panel on the inside of the weekly use container with 2 screws

- ▶ Hook the cladding door into the hinges at the bottom – Fig. 83.
- ▶ Secure door hinge at top together with fitted cladding door with 3 self-tapping screws – Fig. 84.

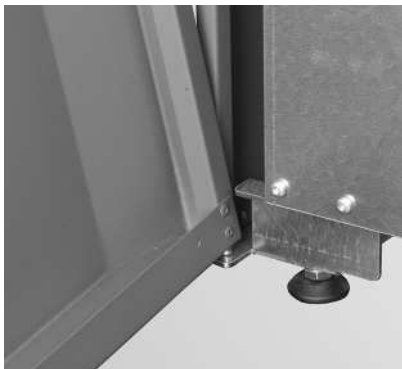


Fig. 83 Hook in the cladding door at the bottom



Fig. 84 Screw the door hinge and fitted cladding door into position

11.10 Aligning the boiler horizontally

- ▶ Move the boiler into position and use the 4 adjustable feet to level the boiler. To level the boiler, place the spirit level on top of the door frame or seal steel sheet at the front – Fig. 85.



Tip.

- ▶ If access is restricted to the right hand side of the boiler set the right rear foot to its mid position before positioning.

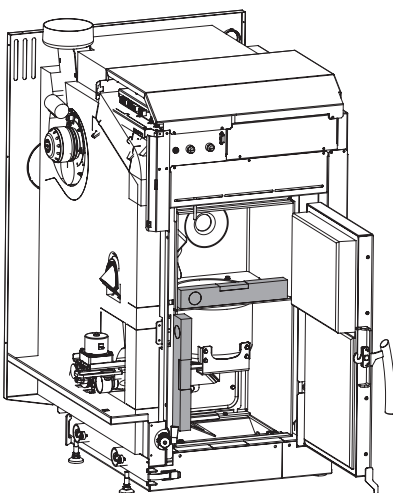
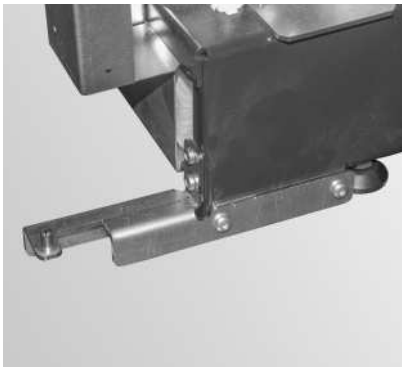


Fig. 85 Align the boiler with a spirit level

11.11 Cladding door and side panel

- ▶ Secure the bottom of the door hinge with 4 self-threading M5x10 TT screws – Fig. 86.
- ▶ Leave the door hinge loose at the top as it should be allowed to move and screw on with 2 self-tapping screws – Fig. 87.



4 x
M5x10 TT



2 x

Fig. 86 Screw on the bottom door hinge

Fig. 87 Screw on the top door hinge loosely

- ▶ Hook the side panel into the 4 bayonet locks – Fig. 88, Fig. 89.

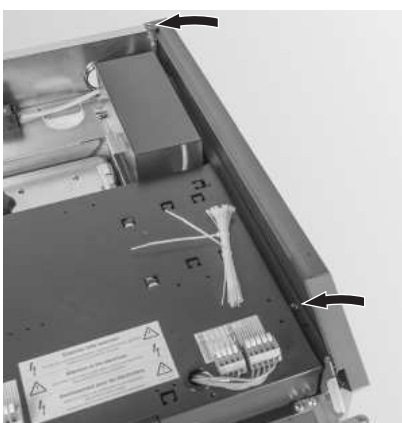


Fig. 88 Bayonet lock



Fig. 89 Hook in the side panel

- ▶ Attach the top part of the cladding to the side panel on the right and secure with 2 self-tapping screws – Fig. 90.



2 x

Fig. 90 Attach and screw on the top part of the cladding

For the installer

- ▶ Hook the top and bottom of the cladding door into the hinges (Fig. 91) and tighten the top door hinge – Fig. 92.
- ▶ Screw the side panel to the door hinge with 4 self-tapping screws – Fig. 92.



Fig. 91 Fit the cladding door at the top and bottom



Fig. 92 Tighten the top door hinge and screw the side panel into place with 4 self-tapping screws

11.12 InfoWIN Touch and operating panel

- ▶ Insert the connecting cable for the InfoWIN Touch through the opening on the operating panel, hook on the operating panel and secure it to the rear of the cladding with 2 self-tapping screws – Fig. 93.
- ▶ Connect the InfoWIN Touch connecting cable (Fig. 94) and insert InfoWIN Touch into the operating panel (with the connection plug at the top) – Fig. 95.

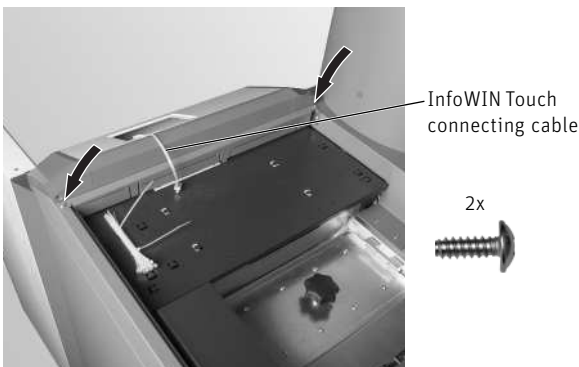


Fig. 93 Insert the connecting cable, hook and screw on the operating panel



Fig. 94 Connect the InfoWIN Touch connecting cable and insert InfoWIN Touch into the operating panel (with the plug at the top)



Fig. 95 Insert InfoWIN Touch into the operating panel

11.13 Cladding cover and insulation

- ▶ If the **flue connection is at the top**, punch out the cut-out on the cladding cover – Fig. 96. If the flue connection is at the rear, do not punch out.

Punch out the cladding cover = flue connection at the top

Do not punch out cladding cover = flue connection at the rear

- ▶ Place the insulation on the heat exchanger cover – Fig. 97.
- ▶ Place the cladding cover on the boiler – Fig. 98.

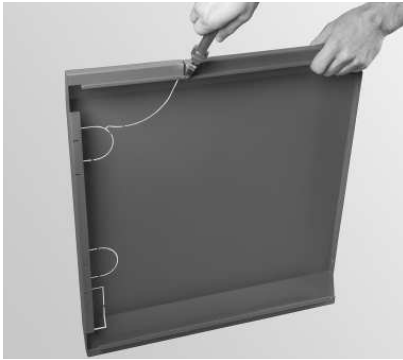


Fig. 96 Punch out the cut-out only if the flue connection is at the top

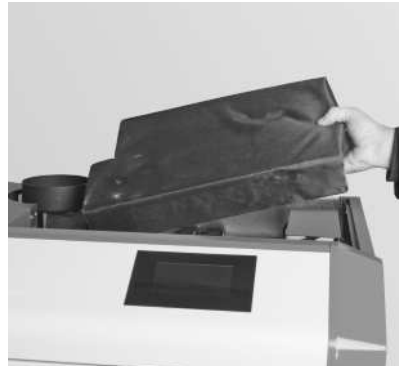


Fig. 97 Apply insulation



Fig. 98 Fit the cladding cover

11.14 Ash box and cover below the integral fuel hopper

If you have not already done so, move the boiler into its final position (observe minimum clearances, see section 11.5 and, using the four set screws, align horizontally or inclined slightly upwards towards the rear – see also section 11.10.

Ash box only for BioWIN 2 Touch Exklusiv/Exklusiv-S:

- ▶ – **Just hook on** the ash box base underneath the integral fuel hopper and bend the front part down to the floor level – Fig. 99.
- ▶ – Insert the ash box at a slight angle from the left and push in the ash box handle completely, leaving the openings on the side of the ash box open – Fig. 100.
- ▶ – Close the bracket fastener – Fig. 101.
- ▶ – Adjust the ash-box foot (BioWIN 2 Touch Exklusiv/Exklusiv-S only) on the boiler – Fig. 102.



Tip.

The floor underneath the ash box has to be level.

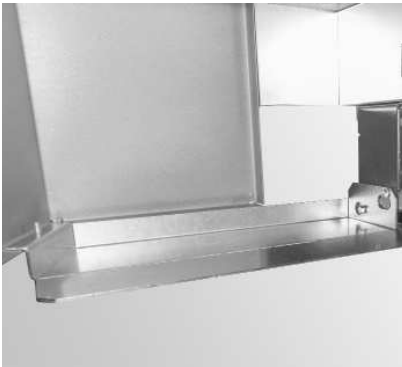


Fig. 99 Just hook on the ash box base.



Fig. 100 Insert the ash box at a slight angle from the left and push in the ash box handle completely



Fig. 101 Close the ash box fastener

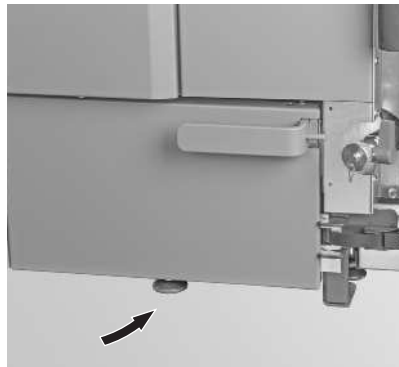


Fig. 102 Adjust the foot

For the installer

Cover below the integral fuel hopper only for BioWIN 2 Touch Klassik/Premium:

- ▶ Screw the bottom cover for the bottom integral fuel hopper into position with 4 self-tapping screws – Fig. 103.

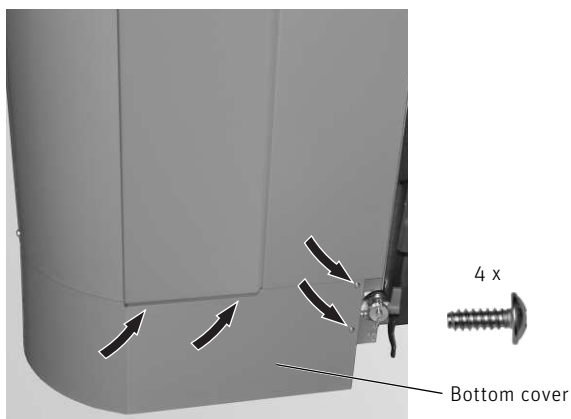


Fig. 103 Install the bottom cover for the integral fuel hopper (BioWIN 2 Touch Klassik/Premium only)

11.15 Installing the feed and return air hose (BioWIN 2 Touch Premium/Exklusiv only)

- ▶ Expose approx. 1.97 in / 5 cm of the flexible earth leads on all hose ends and bend inwards into the hose – Fig. 104.

Important: See also the notes on installing the feed and return air hose in the instructions provided for storage room accessories (changeover unit).

- ▶ Remove the 4 screws for the integral fuel hopper cover and take off the cover – Fig. 105.
- ▶ Attach the fastening clips to the hoses and connect – Fig. 105.



Note.

If you have problems connecting, dampen connections with water (do not use lubricants).

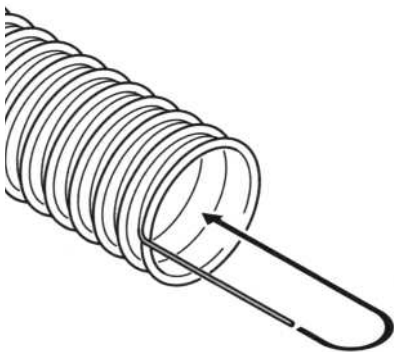


Fig. 104 Expose the flexible earth leads, bend inwards



Fig. 105 Install the feed and return air hose



DANGER Pellet feed unit: Risk of fire or explosion.

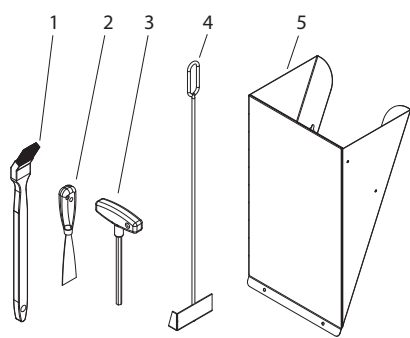
Can lead to serious injury/death! Ground suction hoses must be installed as described in the installation manual at every connection to avoid static sparking/dust ignition. The pellet feed unit is for use with the day hopper only. The feed unit must be braced, anchored, or strapped to avoid falling/shifting during an earthquake. Instructions can be obtained from your local Windhager dealer or wholesaler.

Pellet feed automatic changeover unit: Risk of fire or explosion.

Risk of fire or explosion. can lead to serious injury or death.

Do not use the pellet feed automatic changeover unit inside pellet storage room or where there is a lot of dust present. Connect delivery hoses to pellet feed automatic changeover unit as described in the installation manual to avoid static sparking or dust ignition.

11.16 Cleaning and operating implements



- 1..... Cleaning brush
- 2..... Spatula
- 3..... Allen key and sponge-rubber holder
- 4 Scraper (only with BioWIN2 Touch Klassik, Klassik-L and Premium)
- 5..... Pellet chute¹ (accessory, not included for BioWIN2 Touch Premium/Exklusiv only)

Fig.106 Cleaning and operating implements

¹ Pellet chute for temporary use only or when manually filling the integral fuel hopper, if auto feed system is not complete.

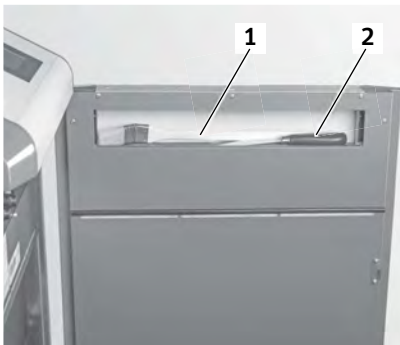


Fig.107 Cleaning brush and spatula on inside of cladding door

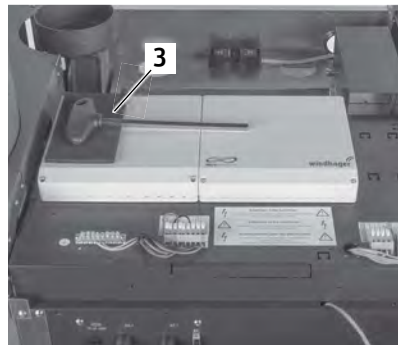


Fig.108 Stick on the sponge-rubber holder

11.17 Installing the connecting flue pipe

Comply with the minimum clearances in Section 11.5.

- a) Install the flue pipe upward to the flue (45° is the ideal angle). Maximum flue pipe length 9.84 ft / 3 m.



CAUTION Material losses

Any section of this exhaust line that is horizontal or inclined less than 30 degrees cannot be more than 3.28 ft / 1 m in length.

- b) Avoid 90° bends, 45° bends are better.
- c) Make the flue connection at 45° if possible.
- d) Do not push the flue pipe too far into the flue.
- e) **Do not seal the connecting flue pipe completely** into the flue. Connect the connecting flue pipe to the chimney system with a flexible seal. (The fan can cause sound transmissions that create noise pollution).
- f) Always fit flue pipes together with the sleeve pointing upwards (smaller diameter end of stainless steel flue accessory fits exactly onto flue outlet in the BioWIN 2 Touch), so that any condensation flowing back cannot leak out of the flue pipe.
- The parts must be secured with pipe clamps to ensure adequate leak-tightness and stability. Pipelines must not sag.
- g) The entire flue line should be insulated to a minimum of 0.07 ft / 20 mm thickness in order to prevent or minimise condensation.
- h) The entire flue line has to be able to be cleaned, i.e. appropriate cleaning openings [1] must be included. The first cleaning opening has to be in the first bend of the flue pipe.
- i) Measuring opening for flue measurement: The measuring opening must be outside the boiler, so use a pipe with a measuring opening or use a stainless steel drill to make a hole in diameter in the stainless steel flue pipe.
-



CAUTION Material losses

Access must be enabled to the water tank (for checking and refilling) and to the induced draught fan (for service and full service work). Therefore do not lay the flue pipe directly over the top.



DANGER Injury

The configuration of the flue connection must comply with fire protection requirements in accordance with the applicable legislation, regulations, guidelines and standards – see also section 11.5 Minimum clearances for fire protection, cleaning and full service on side 25.

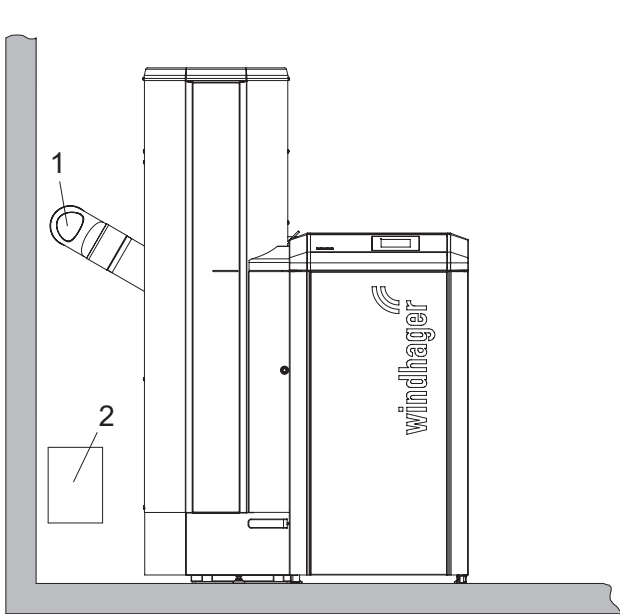


Fig. 109 Flue connection at rear – view from front

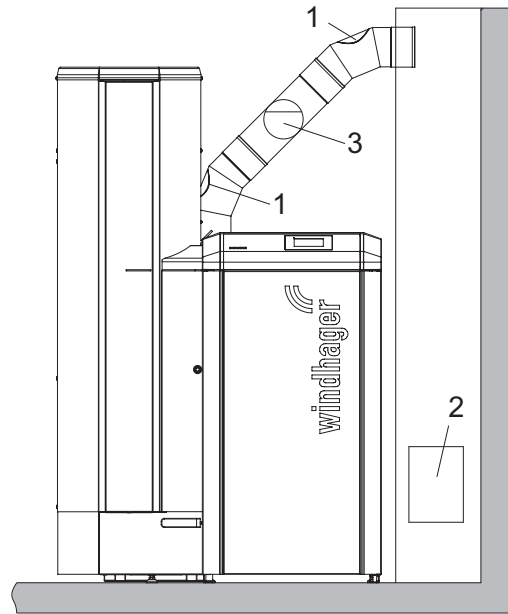


Fig. 110 Flue connection at top – view from front

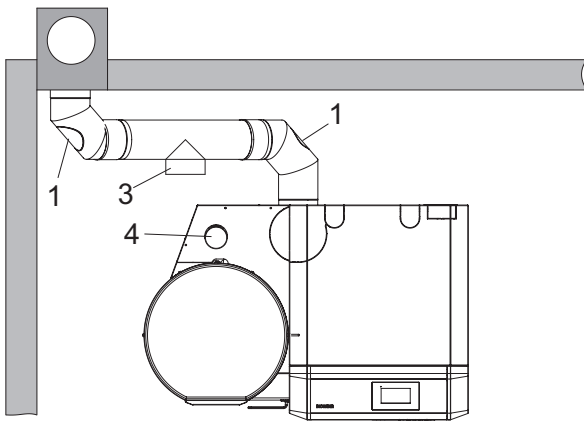


Fig. 111 Flue connection at rear – view from top

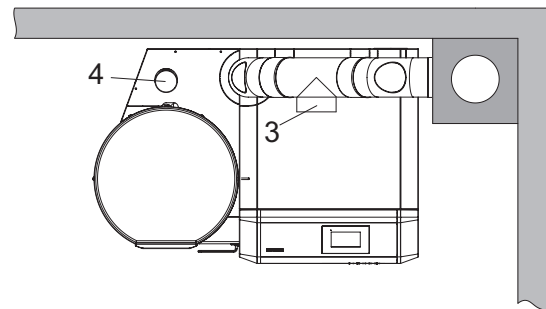


Fig. 112 Flue connection at top – view from top

- 1.....Cleaning opening in flue pipe
- 2.....Cleaning aperture in flue
- 3.....Energy-saving draft stabiliser/explosion flap
- 4 Water tank level or filler pipe

FOR THE ELECTRICIAN

12. Electrical connections

Mains connection: 110 VAC, 60 Hz, fuse 25 A slow-blow

The boiler and related accessories are designed to be installed only in dry areas (protection type IP 20). Installation of electrical components may only be performed by a qualified electrician and must fully comply with Approved Document P and all electrical standards in place at the time of the installation.



DANGER Electrocutation

The phases of the 110 V electrical power supply must be connected correctly.
The mains connection must be protected against short circuit with a 25 A delayed-action fuse.

We recommend using fine-wire PVC sheathed cables, e.g. 3 x AWG 15 nominal cross-section.

Each boiler is pre-wired and internally fused with a **T 6.3 A** fine-wire fuse to protect against short circuit.

In areas with increased power surge risk (e.g. lightning strikes in regions prone to storms), we recommend installation of an appropriate surge protector.



Fig. 113 Control panel for BioWIN2 Touch 102-332



CAUTION Material losses

Electrical cables must not touch heating and flue pipes, nor must they come in contact with non-insulated boiler components. They are to be sufficiently braced and provided with a protective conduit.

The Main power plug is located at the top rear of the heat exchanger cover – Fig. 120. The electrical connections are located in or behind the control panel. The motherboard is located inside the control panel and the connection terminals on the outside on the control panel cover (screwless cage-spring-type terminals).

Changeover unit (if present):

Two separate cables are needed to connect the changeover unit.

- For the limit switches, a 12 V DC cable: min. 3 x AWG 17 (no ground). We recommend using a shielded cable if the cable is longer than 16.4 ft / 5 m
- For the motor, a 110–230 V AC cable: 4 x AWG 15

To access the control panel:

- ▶ Remove the cladding cover – Fig. 114.
- ▶ Take the insulation off the heat exchanger cover – Fig. 115.
- ▶ Remove the operating panel by loosening the 4 screws at the back of it – Fig. 116. Take the operating panel off from the top, pull out the InfoWIN Touch cable and hook the front of the operating panel into the door (service position) – Fig. 117.
- ▶ Open the cover.

For the electrician

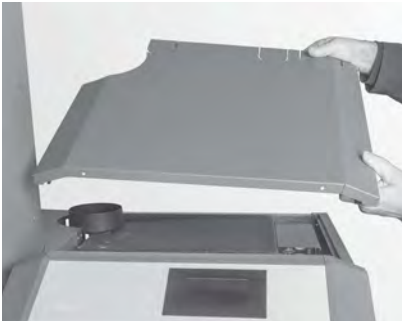


Fig. 114 Remove the cladding cover

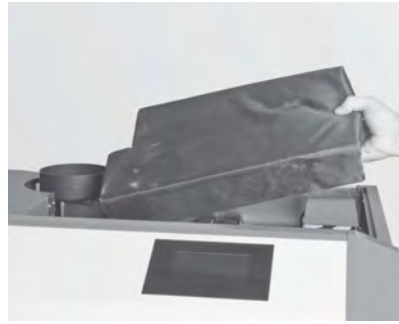


Fig. 115 Remove the insulation



Fig. 116 Loosen the 4 screws on the operating panel

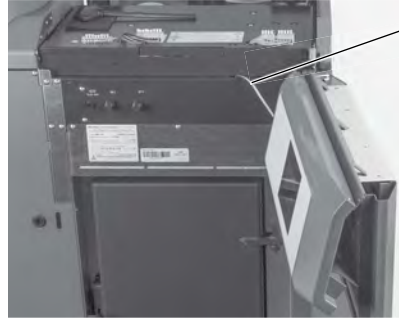


Fig. 117 Hook the operating panel into the door (service position), open the cover

- ▶ The terminal block connection (screw less cage-spring-type terminals) should be established with fine-wire PVC-sheathed cables. The cables can be laid from the top, bottom, right and rear, through the pre-punched feed-throughs (Fig. 118).

For connection diagrams for the control system, see the separate function module instructions; for other connection diagrams, see Section 6.

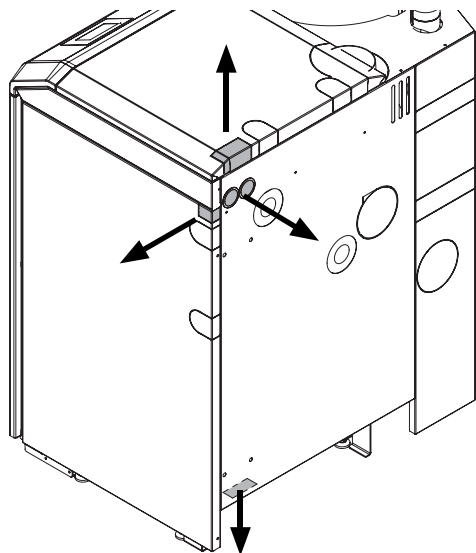


Fig. 118 Cable feed-throughs in the cladding of the BioWIN 2 Touch – view from rear

13. Connecting the function modules

See the separate instructions for the respective function modules.

14. Operating with external control

This is only possible with the **special function external heating requirement function module INF F05 W** (accessories) – see Section 9.5 Operation by control on side 17. For the connection diagram, see the separate instructions for the "special function" function module.

15. Installing covers

- ▶ Bend the cable feed-throughs inwards on the operating panel, attach the operating panel and secure it with 4 self-tapping screws – Fig. 119.
- ▶ Stick on the sponge-rubber holder for the Allen key – Fig. 119.
- ▶ Insert or connect the main power plug – Fig. 120.
- ▶ Place the insulation on the heat exchanger cover – Fig. 121.
- ▶ Fit the cladding cover – Fig. 122.

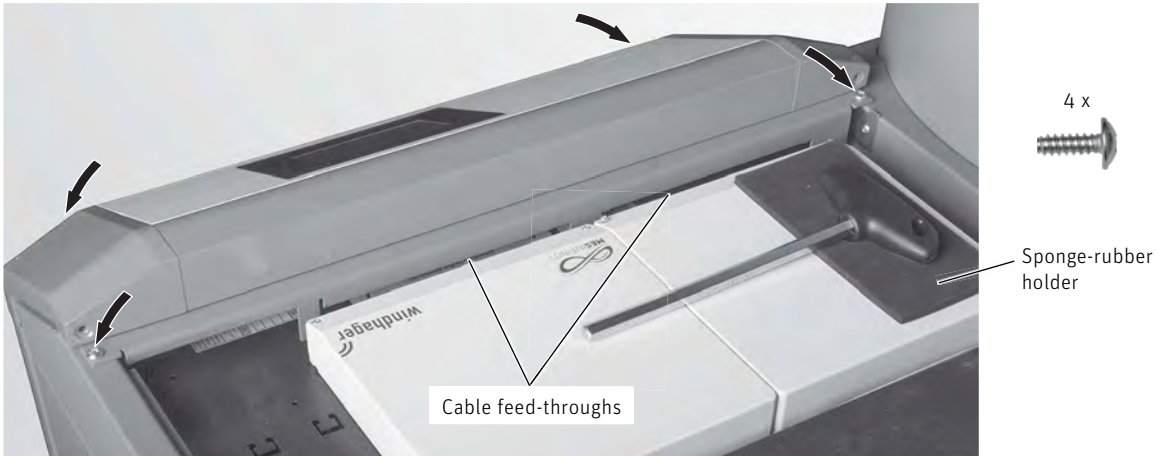


Fig. 119 Attach and screw on the operating panel

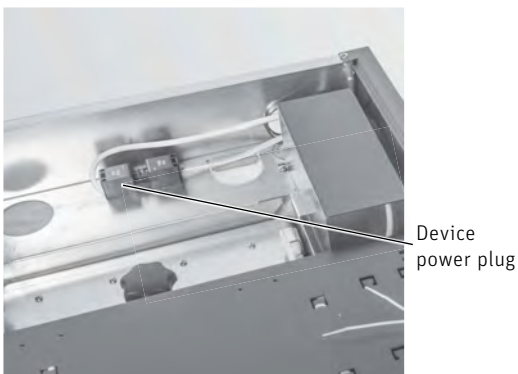


Fig. 120 Insert or connect the mains power plug

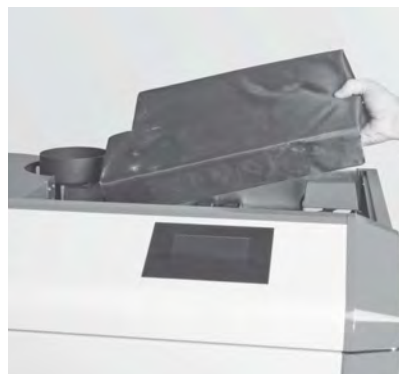


Fig. 121 Apply insulation



Fig. 122 Fit the cladding cover



CAUTION Material losses

- ▶ After connecting the cables, remove all remaining assembly materials (e.g. wire strands) from the control panel.

FOR THE SERVICE TECHNICIAN

16. Commissioning and operating instructions

The Windhager Customer Service or customer service partner will start the boiler/heater and familiarize the customer with the system operations and cleaning procedures. Start-up and maintenance are part of the guarantee requirements of the "Warranty conditions".

We recommend that you obtain a full service agreement.

17. Service and repair work

Service and repair may be performed only by appropriately qualified technicians.



DANGER Electrocutation

The ON/OFF Button does not turn OFF the power! The boiler/heater and all accessories are still energized! To turn OFF the power (e.g., for repairs), disconnect the main power via the main circuit breaker.



DANGER Electrocutation

After the emergency shut-off switch trips, the boiler and accessories are not completely without power.

- ▶ When replacing system components (pumps, mixers, etc.), you must prevent all power input (e.g. by disconnecting the device power plug).

Please note:

- ▶ Disconnect the device power plug before opening the control panel for service or repair purposes. Remove the cladding cover (Fig. 123), followed by the insulation covering the heat exchanger cover.
- ▶ Disconnect the device power plug – Fig. 124.



Fig. 123 Take off the cladding cover, remove the insulation

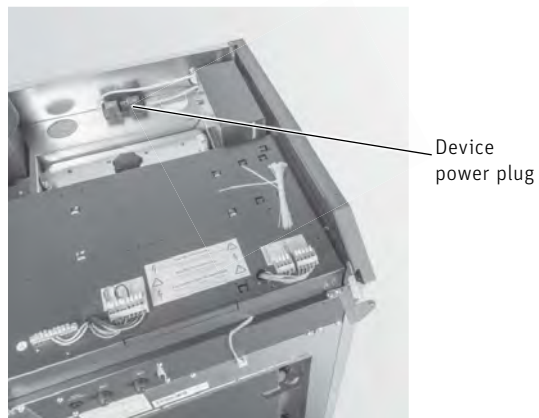


Fig. 124 Disconnect the device power plug

TECHNICAL DATA

18. Technical data – function module INF F05 W/S/K

| | Function module INF F05 W/S/K |
|---|---|
| Operating voltage | 230 V AC ±10 % |
| Power consumption – Operation max. – Stand-by max. | 7 W 1.0 W |
| Ambient temperature – Operation – Storage/transport | 0 °C - +50 °C -10 °C - +60 °C |
| Ambient humidity – Operation – Storage/transport | 20 to 85 % rH (at 25 °C, non-condensing) Max. 50 % rH (at 60 °C, non-condensing) |
| Cable length sensor | Max. 100 m, min. 0.75 mm ² (fine wire) |
| Cable length LON | Max. 1200 m, 0.6 mm ² , twisted cable (bus topology), terminator on both sides 120 ohm |
| eBus cable length | Max. 50 m, min. 0.5 mm ² (fine wire) |
| Relay breaking capacity | 6.0 (2.0) A |
| Total breaking capacity | 6.0 A |
| Weight | 0.60 kg |
| CE conformity | 2014/35/EU "Low Voltage Directive" 2014/30/EU "EMC Directive" 2011/65/EU "RoHS Directive" |
| Safety | EN 60730-1, EN 60730-2-9 |
| Protection class | I acc. to EN 60730 |
| Degree of protection | IP 20 (EN 60529) if installed correctly |
| Leakage path and clearance | Overvoltage category II Degree of pollution 2 |
| EMC immunity | EN 61000-6-2 |
| EMC emission | EN 61000-6-3 |

19. Technical data for calculating the flue gas system acc. to EN 13384-1

| BioWIN 2 Touch pellet boiler | Formula symbols | Unit | BioWIN 102 | | BioWIN 152 | | BioWIN 212 | | BioWIN 262 | | BioWIN 332 | |
|---|-----------------------------|-----------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | | | Partial load | Nominal load | Partial load | Nominal load | Partial load | Nominal load | Partial load | Nominal load | Partial load | Nominal load |
| Nominal thermal output | Q_{min} / Q_N | kBTU (kW) | 10.2 (3) | 33.8 (9.9) | 14.7 (4.3) | 51.2 (15.0) | 21.5 (6.3) | 71.7 (21.0) | 25.9 (7.6) | 88.4 (25.9) | 33.4 (9.8) | 110.9 (32.5) |
| Nominal heat load (firing thermal output) | Q_B | kBTU (kW) | 11.3 (3.3) | 35.8 (10.5) | 16.0 (4.7) | 54.6 (16.0) | 27.3 (6.8) | 76.5 (22.4) | 27.6 (8.1) | 94.2 (27.6) | 35.2 (10.3) | 118.4 (34.7) |
| Volume concentration of CO ₂ | σ (CO ₂) | % | 9.7 | 13.4 | 10.1 | 14.2 | 11.3 | 14.2 | 12.1 | 14.2 | 12.3 | 14.6 |
| Flue gas mass flow rate at nominal output | \dot{m} | kg/s | 0.0025 | 0.0058 | 0.0034 | 0.0085 | 0.0044 | 0.0118 | 0.0049 | 0.0146 | 0.006 | 0.018 |
| Flue gas temperature at nominal output ¹ | T_w | °F (°C) | 172.4 (78) | 208.4 (98) | 179.6 (82) | 246.2 (119) | 188.6 (87) | 260.6 (127) | 194 (90) | 273.2 (134) | 197.6 (92) | 280.4 (138) |
| Necessary feed pressure at the flue gas connection | P_w | Pa | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 |
| Flue gas connection diameter | \emptyset | in (mm) | 5.12 (130) | | | | | | | | | |

¹ Values in practical operation (average between two cleaning intervals)

20. Technical data – General

| BioWIN 2 Touch | Unit | | BioWIN 102 | BioWIN 152 | BioWIN 212 | BioWIN 262 | BioWIN 332 |
|--|------------|---|---|----------------------|---|----------------------|-----------------------|
| Boiler class according to EN 303-5 | | | 5 | | | | |
| Mode of operation of the boiler | | | Negative pressure boiler; non-condensing; induced draught fan | | | | |
| Nominal thermal output | kBTU (kW) | | 33.8 (9.9) | 51.2 (15) | 71.7 (21) | 88.4 (25.9) | 110.9 (32.5) |
| Nominal thermal output range | kBTU (kW) | 158/122 °F (70/50 °C) | 10.2–33.8 (3.0–9.9) | 15.3–51.2 (4.5–15.0) | 21.5–71.7 (6.3–21.0) | 26.6–88.4 (7.8–25.9) | 33.4–110.9 (9.8–32.5) |
| Feed pressure at the flue gas connection | Pa | Partial load Nominal load | -20 (negative pressure) to 0 (positive pressure) -20 (negative pressure) to +5 (positive pressure) | | -20 (negative pressure) to 0 (positive pressure) -20 (negative pressure) to +5 (positive pressure) | | |
| Boiler water volume | l | | 39 | | 47 | | |
| Water-side resistance | psi (mbar) | $\Delta T = 20 \text{ °K}$ | 0.0145038 (1.0) | 0.0304579 (2.1) | 0.0565647 (3.9) | 0.0841219 (5.8) | 0.124732 (8.6) |
| | psi (mbar) | $\Delta T = 10 \text{ °K}$ | 0.0522136 (3.6) | 0.110229 (7.6) | 0.207404 (14.3) | 0.3118311 (21.5) | 0.4510674 (31.1) |
| Boiler temperature control range | °F (°C) | | 140–167 (185) ² 60–75 (85) ² | | | | |
| Return temperature | °F (°C) | min. | 68 ³ 20 ³ | | | | |
| Electrical fuse, supply cable | A | | 25 (slow-blow) | | | | |
| Medium sound pressure level $L_{p,A}$ at distance of 3.28 ft (1 m) | dB | Nominal load of boiler | 45.3 | 45.7 | 46.1 | 46.5 | 47.6 |
| Content of pellet fuel hopper | lb (kg) | Klassik/Exklusiv-S Klassik-L/Exklusiv-SL Premium/Exklusiv | 236 (107) 441 (200) max. 157 (max. 71) | | | | |
| Total net weight | lb (kg) | Klassik/Klassik-L Premium Exklusiv/Exklusiv-S/Exklusiv-SL | 545/661 (247/300) 575 (261) 630/600/717 (286/272/325) | | 593/710 (269/322) 624 (283) 679/650/767 (308/295/348) | | |
| Dimensions W x D x H | in (mm) | Klassik/Exklusiv-S Premium/Exklusiv Klassik-L/Exklusiv-SL | 42x28x57 (1075x710x1453) 42x28x67 (1075x710x1705) 56x28x58 (1422x710x1470) | | 42x31x57 (1075x780x1453) 42x31x67 (1075x780x1705) 56x31x58 (1422x780x1470) | | |
| For further dimensions and weights, see sections 8 and 11.2 | | | | | | | |
| Values for BioWIN 102, 152, 212, 262 from type test; testing office TÜV SÜD Munich report no.: C1–C3 1358-00/13 from 15.11.2013 | | | | | | | |
| Values for BioWIN 332 from type test; testing office TÜV SÜD Munich report no.: C4 1358-00/16 from 04.08.2016 | | | | | | | |
| Combustion efficiency h_f (100- q_A - q_U - q_F) | % | Partial load/nominal load | 97.3/96.9 | 97.0/95.9 | 97.1/95.4 | 97.2/95.1 | 97.3/95.3 |
| Boiler efficiency η_w | % | Nominal load | 94.4 | 93.8 | 93.9 | 93.9 | 94.8 |
| Flue gas temperature | °F (°C) | Partial load/nominal load | 136/172 (58/78) | 144/210 (62/99) | 153/235 (67/113) | 158/237 (70/114) | 153/239 (67/115) |
| Electrical power consumption of pellet boiler: | | | | | | | |
| Maximum for igniting | W | | 1054 | | | | |
| Ignition process | Wh | | 128 | | | | |
| Auxiliary energy Q_{min}/Q_N | W | Partial load/nominal load | 16 / 28 | 18 / 33 | 20 / 41 | 21 / 48 | 31 / 77 |
| Idle operation (standby) | W | | 6 | | | | |

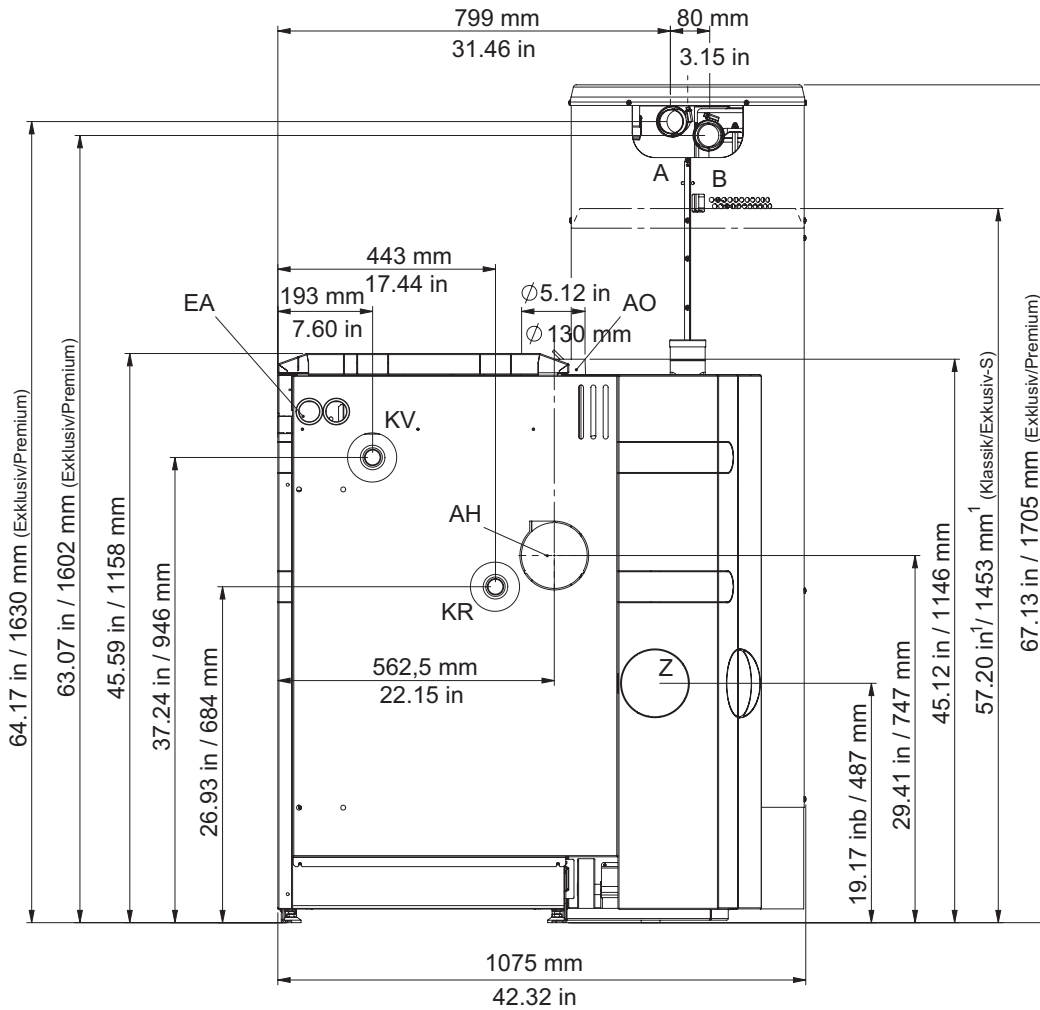
¹ See operating manual, Fuels section

² Only with buffer operation

³ In heating-up mode min. return temperature of 59 °F (15 °C) (setback mode/heating mode)

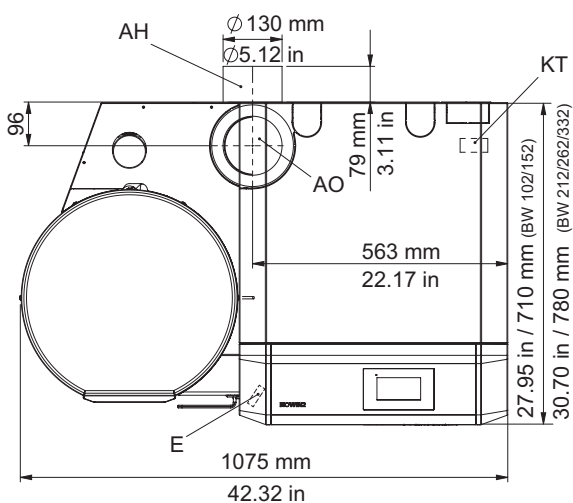
21. Dimensional drawings

BioWIN 2 Touch Exklusiv/Premium/Exklusiv-S/Klassik:



¹ Height when the pellet integral fuel hopper filling cover is open: 70.9 in (1800 mm)

Fig. 125 BioWIN 2 Touch Exklusiv/Premium/Exklusiv-S/Klassik – view from rear

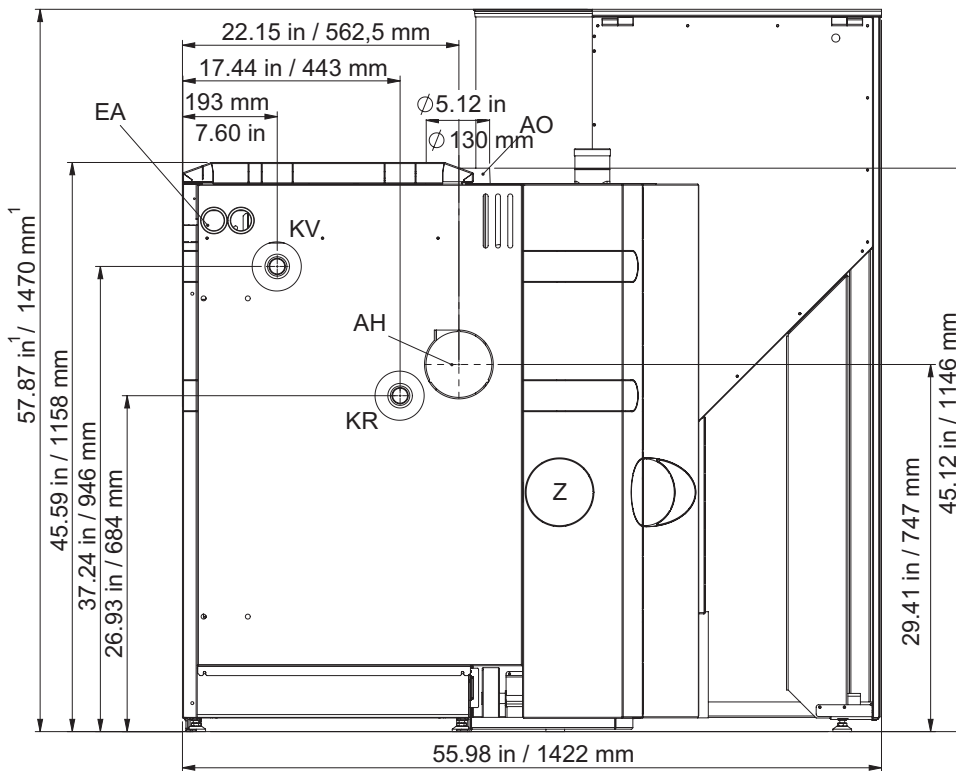


- KV Boiler flow (1" pipe)
- KR Boiler return (1" pipe)
- E Discharge
- A Pellet feed (Ø 1.97 in/50 mm pipe)
- B Return air flow (Ø 1.97 in/50 mm pipe)
- KT Boiler temperature sensor
- AO Flue connection top (Ø 5.12 in/130 mm)
- AH Flue connection rear (Ø 5.12 in/130 mm)
- EA Electrical connections
- Z External combustion air (Ø 3.94 in/100 mm)

Fig. 126 BioWIN 2 Touch Exklusiv/Premium/Exklusiv-S/Klassik – view from top

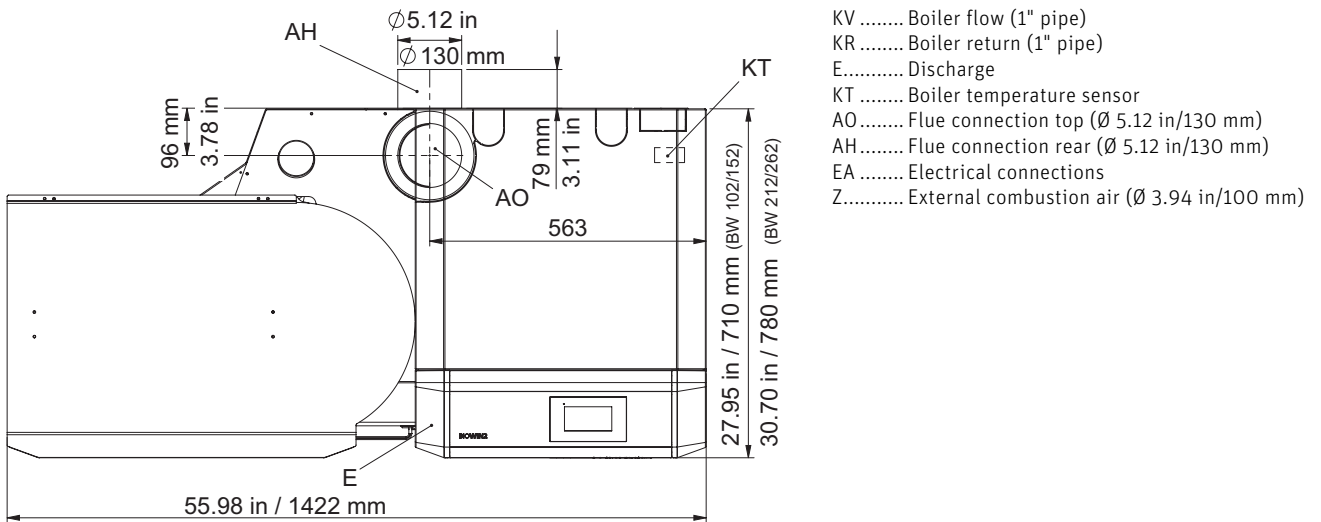
Technical data

BioWIN 2 Touch Exklusiv-SL/Klassik-L:



¹ Height when the pellet integral fuel hopper filling cover is open: 72.8 in (1850 mm)

Fig.127 BioWIN 2 Touch Exklusiv-SL/Klassik-L – view from rear



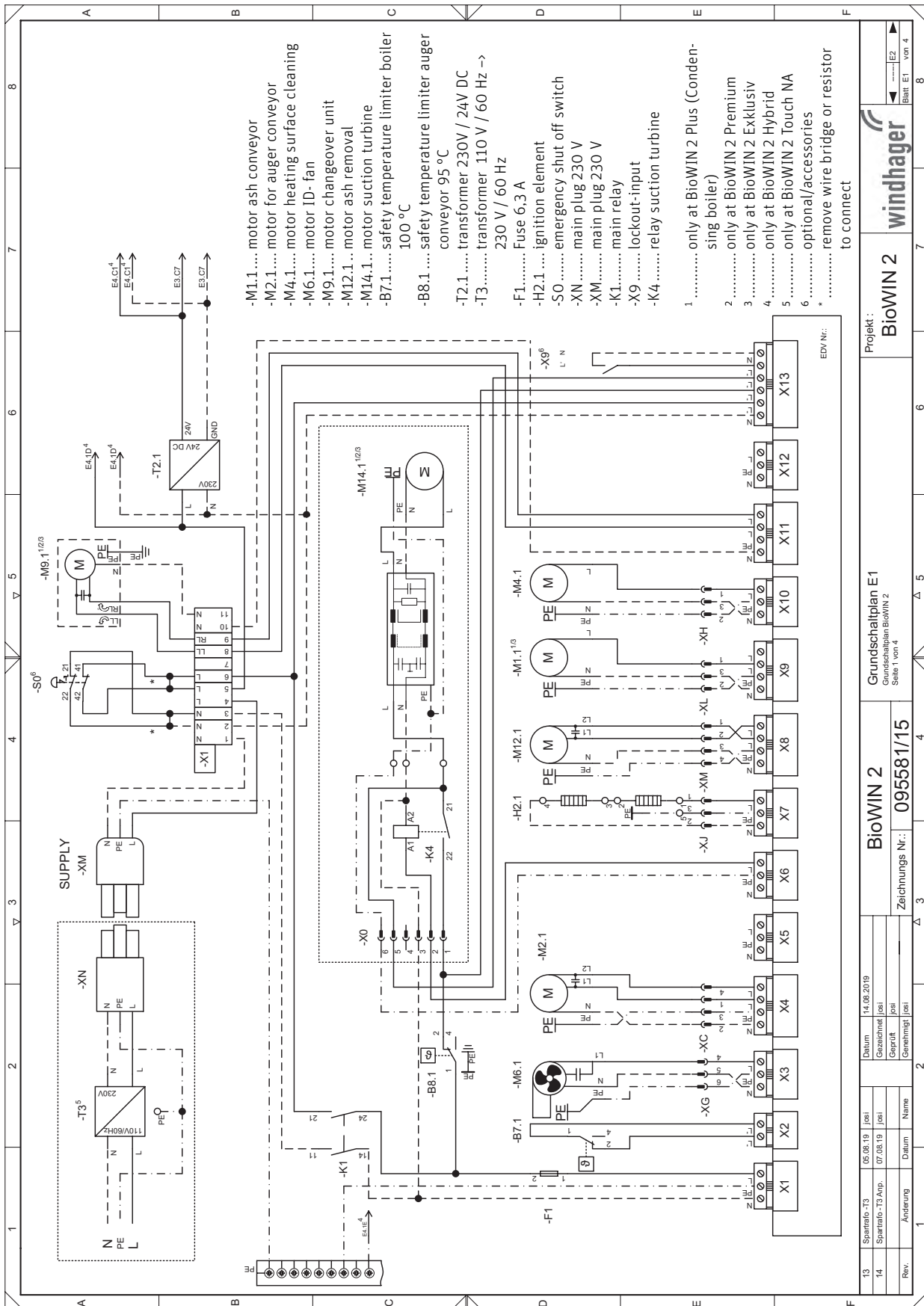
- KV Boiler flow (1" pipe)
- KR Boiler return (1" pipe)
- E Discharge
- KT Boiler temperature sensor
- AO Flue connection top (Ø 5.12 in/130 mm)
- AH Flue connection rear (Ø 5.12 in/130 mm)
- EA Electrical connections
- Z External combustion air (Ø 3.94 in/100 mm)

Fig.128 BioWIN 2 Touch Exklusiv-SL/Klassik-L – view from top

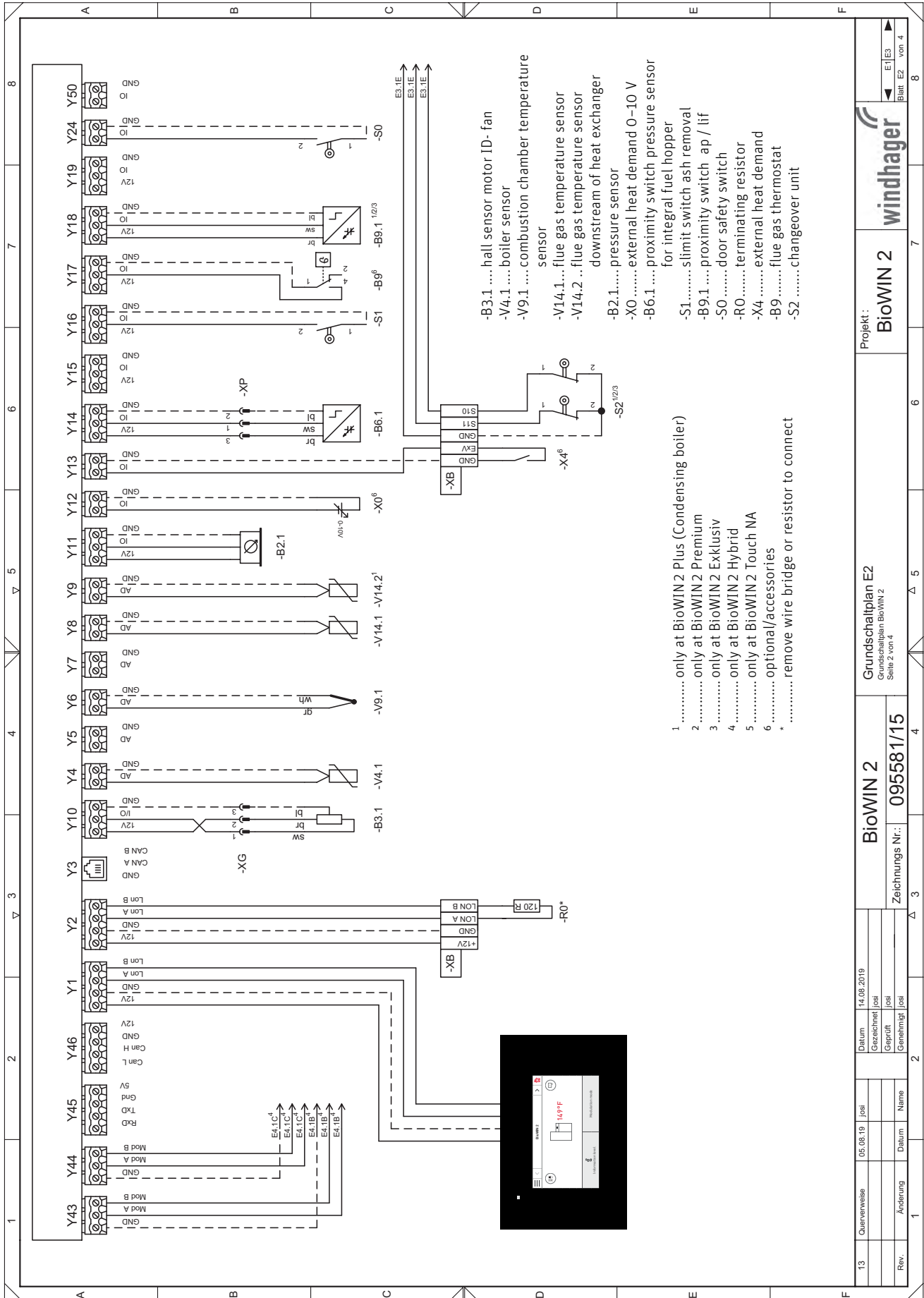
ELECTRIC CIRCUIT DIAGRAMS

22. Basic circuitry – BioWIN 2 Touch

22.1 Plan E1

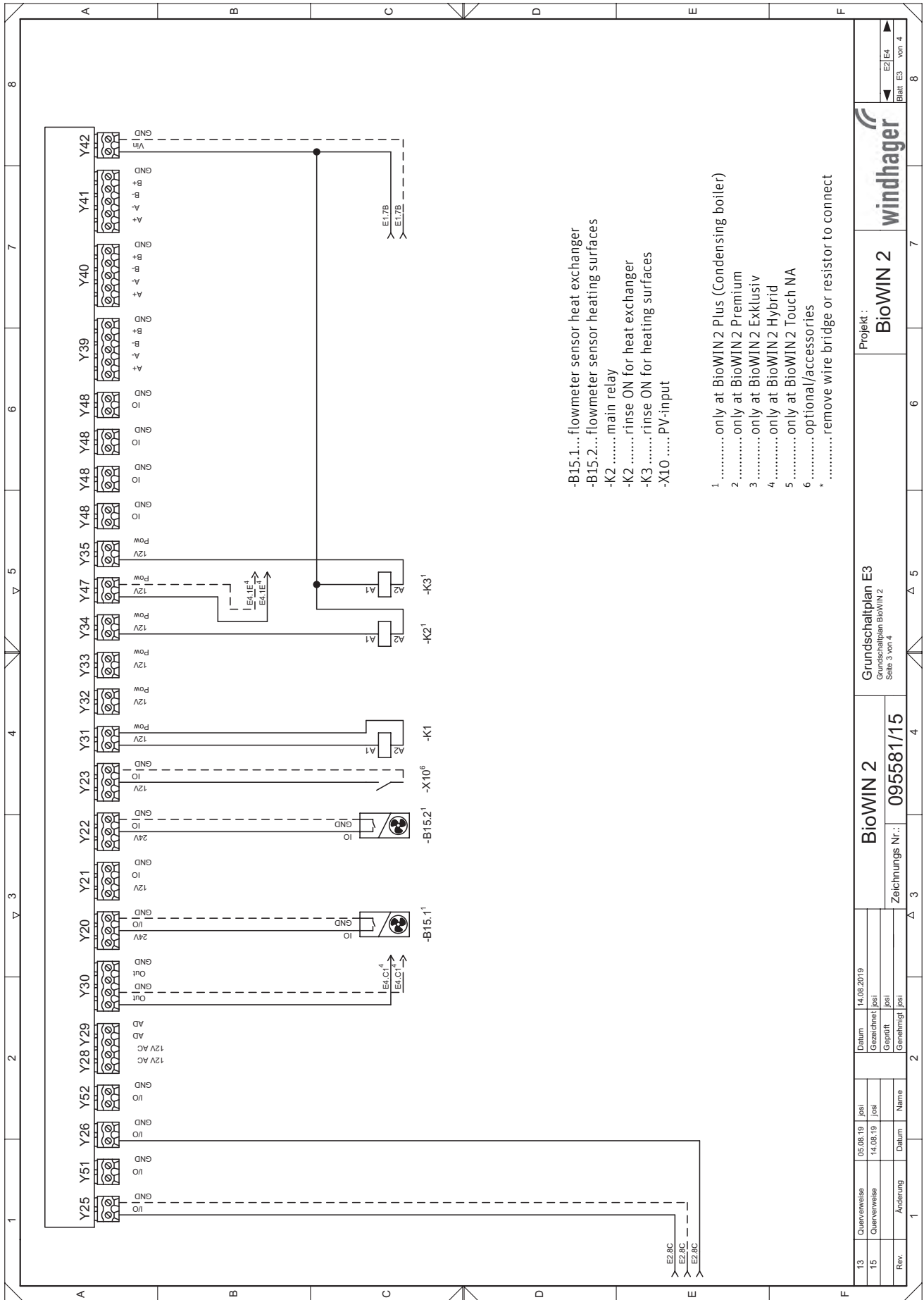


22.2 Plan E2



| | | | | | | | | | | | |
|----|-------------|----------|-------|------------|------------|--------------------------|--|--------------------------|--|-----------|--|
| 13 | Quervorname | 05.08.19 | josl | Datum | 14.09.2019 | Projekt: | | BioWIN 2 | | windhager | |
| | Gezeichnet | josl | | Gezeichnet | josl | Grundschaltplan BioWIN 2 | | Blatt E2 | | von 4 | |
| | Geprüft | josl | | Geprüft | josl | Seite 2 von 4 | | Blatt E2 | | von 4 | |
| | Genehmigt | josl | | Genehmigt | josl | Zeichnungs Nr.: | | 095581/15 | | 8 | |
| | Rev. | Änderung | Datum | Name | | BioWIN 2 | | Grundschaltplan E2 | | 7 | |
| | | | | | | Seite 2 von 4 | | Grundschaltplan BioWIN 2 | | 6 | |
| | | | | | | Seite 2 von 4 | | Grundschaltplan BioWIN 2 | | 5 | |
| | | | | | | Seite 2 von 4 | | Grundschaltplan BioWIN 2 | | 4 | |
| | | | | | | Seite 2 von 4 | | Grundschaltplan BioWIN 2 | | 3 | |
| | | | | | | Seite 2 von 4 | | Grundschaltplan BioWIN 2 | | 2 | |
| | | | | | | Seite 2 von 4 | | Grundschaltplan BioWIN 2 | | 1 | |

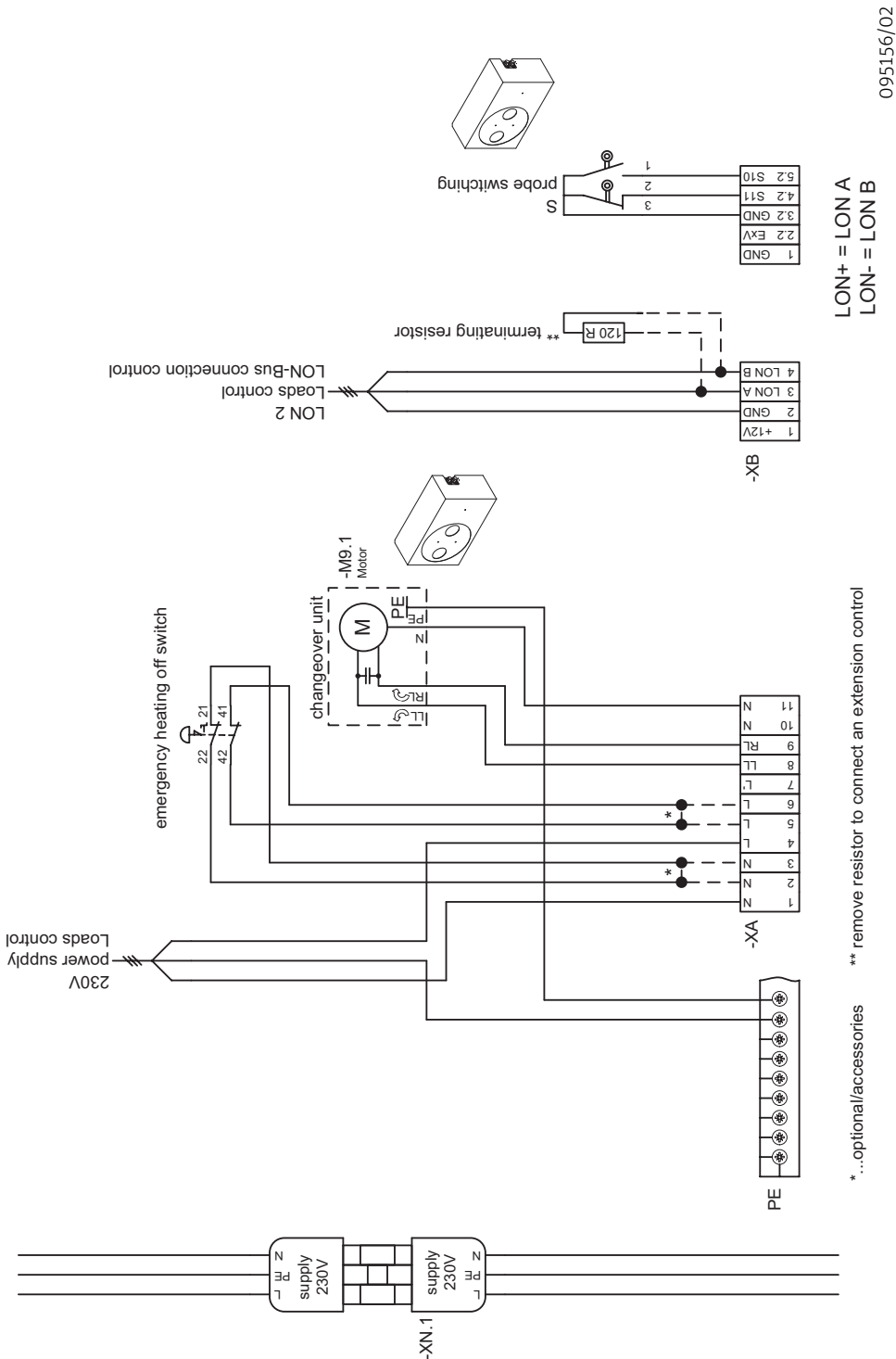
22.3 Plan E3



23. Connection diagram – BioWIN 2 Touch

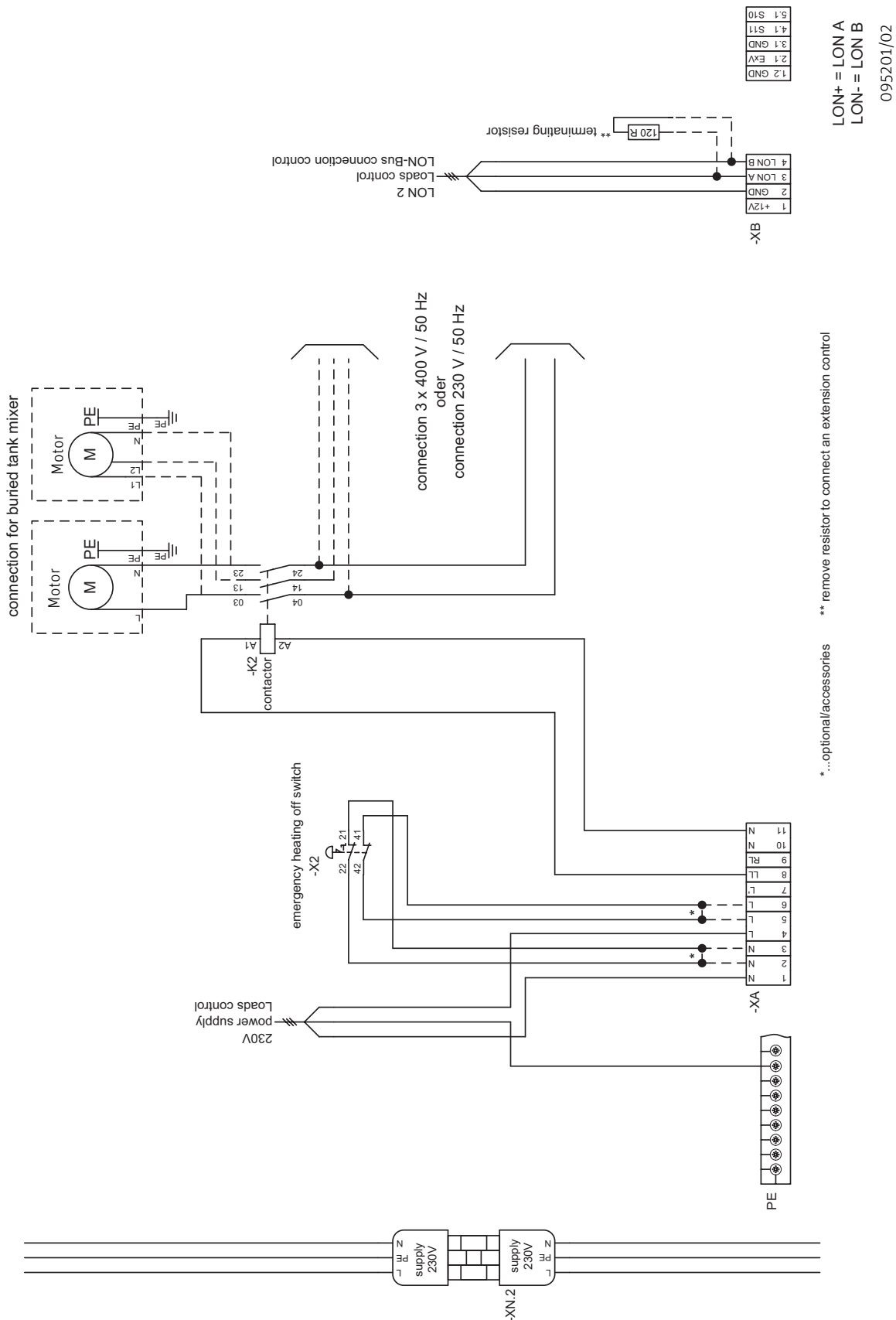
Two separate cables are needed to connect the changeover unit.

- For the limit switches, a 12 V DC cable: min. 3 x AWG 17 (no ground). We recommend using a shielded cable if the cable is longer than 16.4 ft / 5 m
- For the motor, a 110–230 V AC cable: 4 x AWG 15
- ▶ Operation with a pellet feed system must be set in the service level – see the InfoWIN Touch operating manual; service level → settings → Type of fuel feed system.
- ▶



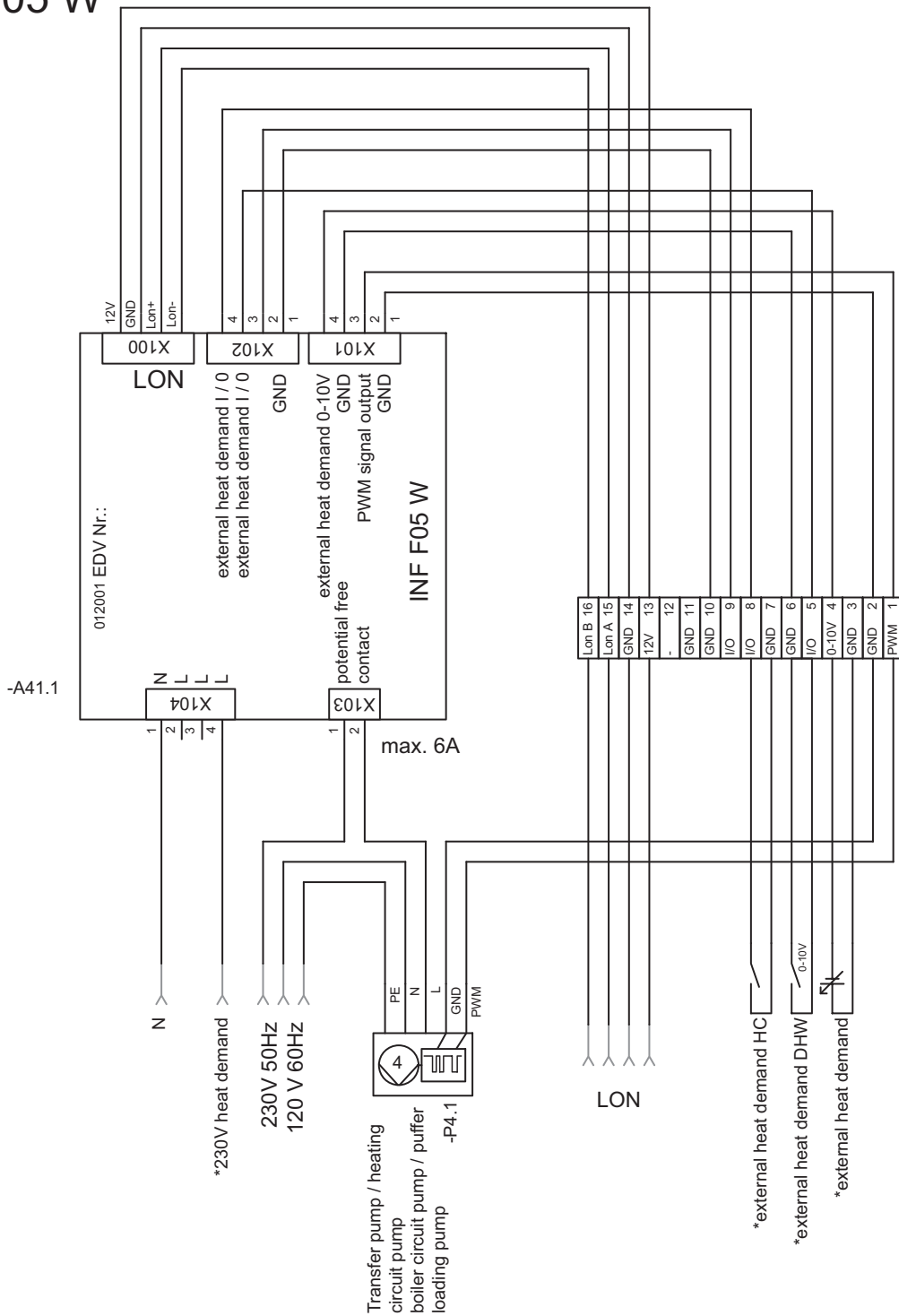
24. Connection diagram for pellet feed with buried tank mixer

- ▶ Operation with a mixer must be set in the service level – see the InfoWIN Touch operating manual; service level → settings → Type of fuel feed system → Suction turb. with mixer (for buried tank with mixer and for single probe).



25. Connection diagram function module INF F05 W

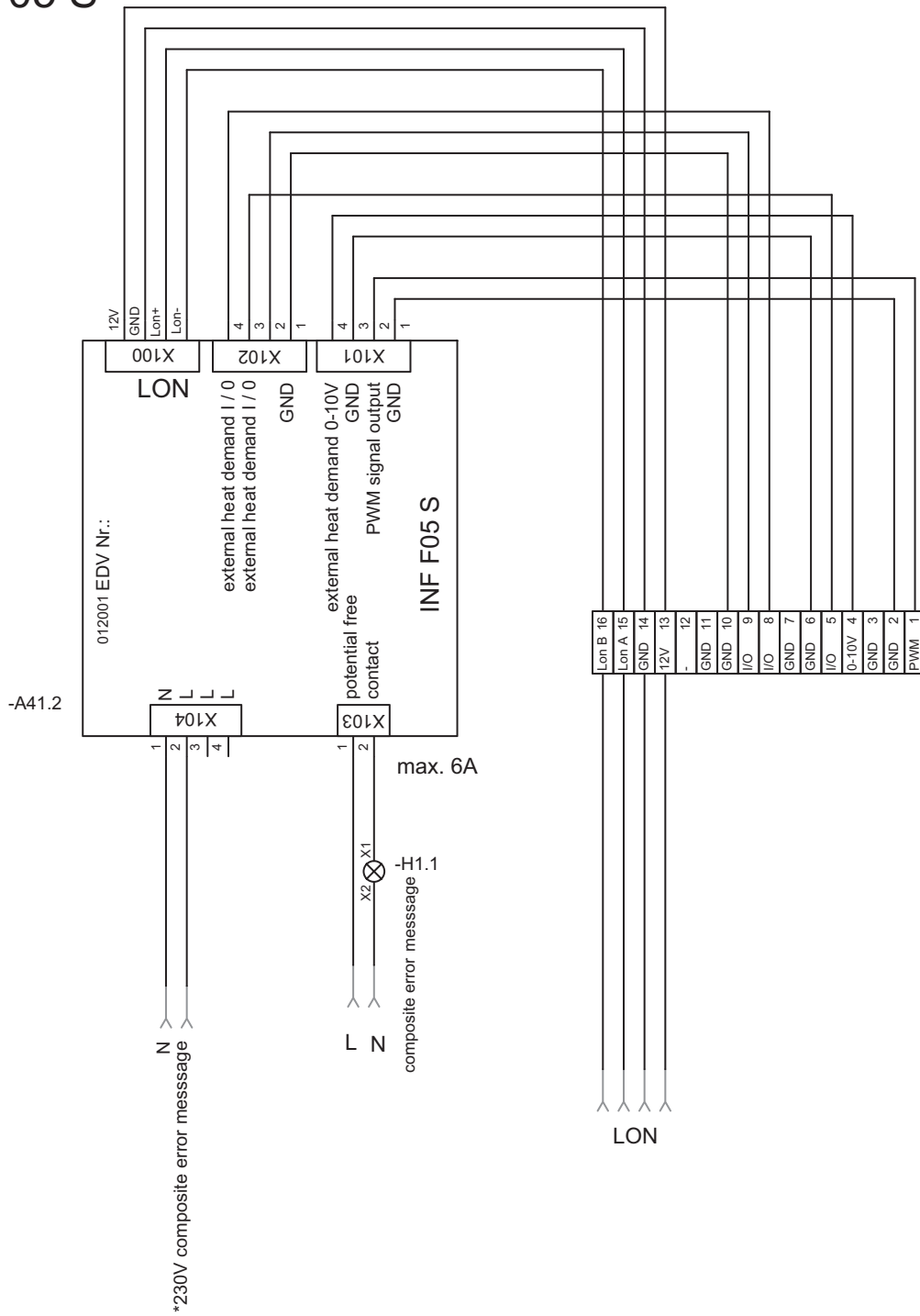
INF F05 W



095260/00

26. Connection diagram function module INF F05 S

INF F05 S



095260/00

27. Connection diagram

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windhager
SINCE 1921 
HEAT WITH VISION

Appendix 15

Conditioning data

| date | time | boiler temp [°C] | boiler output [%] | flue gas temp [°C] | fuel consumed [kg] | hours of operation |
|-------------|-------------|-------------------------|--------------------------|---------------------------|---------------------------|---------------------------|
| 20.08.2019 | 13:46:44 | 25,5 | 100 | 28,3 | 0,1 | 0,5 |
| 20.08.2019 | 14:16:44 | 63 | 100 | 102,4 | 3,7 | 1,0 |
| 20.08.2019 | 14:46:43 | 72,1 | 95 | 118,8 | 7,4 | 1,5 |
| 20.08.2019 | 15:16:43 | 74,4 | 94 | 119,1 | 10,8 | 2,0 |
| 20.08.2019 | 15:46:44 | 74,7 | 96 | 120,4 | 14,2 | 2,5 |
| 20.08.2019 | 16:16:44 | 74,9 | 95 | 121,3 | 17,7 | 3,0 |
| 20.08.2019 | 16:46:44 | 75 | 91 | 121,4 | 21,0 | 3,5 |
| 20.08.2019 | 17:16:43 | 75,1 | 93 | 122,3 | 24,4 | 4,0 |
| 20.08.2019 | 17:46:44 | 74,7 | 98 | 124,1 | 27,9 | 4,5 |
| 20.08.2019 | 18:16:44 | 75,6 | 93 | 124,8 | 31,4 | 5,0 |
| 20.08.2019 | 18:46:43 | 75,1 | 91 | 124 | 34,8 | 5,5 |
| 20.08.2019 | 19:16:44 | 52,2 | 100 | 61,3 | 38,0 | 6,0 |
| 20.08.2019 | 19:46:43 | 73 | 81 | 113,8 | 41,3 | 6,5 |
| 20.08.2019 | 20:16:43 | 74,2 | 85 | 117,7 | 44,3 | 7,0 |
| 20.08.2019 | 20:46:43 | 74,3 | 91 | 120,8 | 47,4 | 7,5 |
| 20.08.2019 | 21:16:44 | 74,6 | 93 | 123,5 | 50,7 | 8,0 |
| 20.08.2019 | 21:46:44 | 75,1 | 91 | 125,5 | 54,1 | 8,5 |
| 20.08.2019 | 22:16:43 | 75,1 | 89 | 125,1 | 57,4 | 9,0 |
| 20.08.2019 | 22:46:43 | 75,1 | 87 | 124,5 | 60,6 | 9,5 |
| 20.08.2019 | 23:16:43 | 75,4 | 89 | 126,4 | 63,9 | 10,0 |
| 20.08.2019 | 23:46:44 | 75,2 | 89 | 125,8 | 67,3 | 10,5 |
| 21.08.2019 | 00:16:43 | 75 | 87 | 124,8 | 70,4 | 11,0 |
| 21.08.2019 | 00:46:44 | 75,9 | 86 | 125,9 | 73,6 | 11,5 |
| 21.08.2019 | 01:16:43 | 74,8 | 88 | 124,9 | 76,7 | 12,0 |
| 21.08.2019 | 01:46:44 | 54,7 | 100 | 58,5 | 79,9 | 12,5 |
| 21.08.2019 | 02:16:43 | 73,2 | 85 | 117,9 | 83,0 | 13,0 |
| 21.08.2019 | 02:46:44 | 74,4 | 87 | 122,3 | 86,2 | 13,5 |
| 21.08.2019 | 03:16:43 | 75,1 | 85 | 124,5 | 89,3 | 14,0 |
| 21.08.2019 | 03:46:44 | 75,1 | 86 | 125,7 | 92,5 | 14,5 |
| 21.08.2019 | 04:16:44 | 74,3 | 93 | 126,2 | 95,6 | 15,0 |
| 21.08.2019 | 04:46:43 | 74,5 | 94 | 127,9 | 98,8 | 15,5 |
| 21.08.2019 | 05:16:13 | 75,1 | 87 | 127,3 | 101,9 | 16,0 |
| 21.08.2019 | 05:46:43 | 75,2 | 85 | 127,2 | 105,1 | 16,5 |
| 21.08.2019 | 06:16:43 | 75 | 87 | 128,4 | 108,2 | 17,0 |
| 21.08.2019 | 06:46:44 | 75,1 | 88 | 128,7 | 111,4 | 17,5 |
| 21.08.2019 | 07:16:43 | 75,1 | 87 | 128,3 | 114,5 | 18,0 |
| 21.08.2019 | 07:46:44 | 56,5 | 60 | 82,7 | 117,7 | 18,5 |
| 21.08.2019 | 08:16:44 | 72 | 86 | 120,4 | 120,8 | 19 |
| 21.08.2019 | 08:46:43 | 74,2 | 85 | 123,9 | 124,0 | 19,5 |
| 21.08.2019 | 09:16:43 | 74,9 | 85 | 127,4 | 127,1 | 20,0 |
| 21.08.2019 | 09:46:43 | 74,6 | 91 | 128,8 | 130,3 | 20,5 |
| 21.08.2019 | 10:16:43 | 74,6 | 92 | 129,1 | 133,4 | 21,0 |
| 21.08.2019 | 10:46:44 | 75,2 | 86 | 129,6 | 136,6 | 21,5 |
| 21.08.2019 | 11:16:43 | 74,6 | 90 | 128,8 | 139,7 | 22,0 |
| 21.08.2019 | 11:46:44 | 74,8 | 88 | 127,9 | 142,9 | 22,5 |
| 21.08.2019 | 12:16:44 | 75,2 | 86 | 129 | 146,0 | 23,0 |
| 21.08.2019 | 12:46:13 | 75,2 | 86 | 128,9 | 149,1 | 23,5 |
| 21.08.2019 | 13:16:14 | 57,7 | 100 | 86,2 | 152,3 | 24,0 |

| | | | | | | |
|------------|----------|------|-----|-------|-------|------|
| 21.08.2019 | 13:46:43 | 71,3 | 91 | 122,4 | 155,5 | 24,5 |
| 21.08.2019 | 14:16:43 | 74,3 | 84 | 125,9 | 158,6 | 25,0 |
| 21.08.2019 | 14:46:43 | 75 | 85 | 130,1 | 161,8 | 25,5 |
| 21.08.2019 | 15:16:44 | 74,8 | 87 | 129,3 | 164,9 | 26,0 |
| 21.08.2019 | 15:46:44 | 75,2 | 85 | 128,7 | 168,1 | 26,5 |
| 21.08.2019 | 16:16:44 | 75,5 | 79 | 125 | 171,2 | 27,0 |
| 21.08.2019 | 16:46:43 | 75,1 | 77 | 122,6 | 174,4 | 27,5 |
| 21.08.2019 | 17:16:43 | 74,8 | 81 | 123,8 | 177,5 | 28,0 |
| 21.08.2019 | 17:46:44 | 75,3 | 76 | 123,4 | 180,7 | 28,5 |
| 21.08.2019 | 18:16:43 | 75 | 79 | 125,6 | 183,8 | 29,0 |
| 21.08.2019 | 18:46:44 | 74,8 | 82 | 126,5 | 187,0 | 29,5 |
| 21.08.2019 | 19:16:43 | 74,7 | 86 | 129 | 190,1 | 30,0 |
| 21.08.2019 | 19:46:44 | 56 | 75 | 73,9 | 193,3 | 30,5 |
| 21.08.2019 | 20:16:44 | 73 | 76 | 119,6 | 196,4 | 31,0 |
| 21.08.2019 | 20:46:44 | 74,4 | 77 | 122,7 | 199,6 | 31,5 |
| 21.08.2019 | 21:16:43 | 74,7 | 79 | 125,5 | 202,7 | 32,0 |
| 21.08.2019 | 21:46:43 | 75,1 | 80 | 127,6 | 205,9 | 32,5 |
| 21.08.2019 | 22:16:43 | 75,2 | 80 | 126,8 | 209,0 | 33,0 |
| 21.08.2019 | 22:46:43 | 74,8 | 82 | 127,6 | 212,2 | 33,5 |
| 21.08.2019 | 23:16:44 | 75,2 | 81 | 128,4 | 215,3 | 34,0 |
| 21.08.2019 | 23:46:43 | 75,1 | 77 | 126,6 | 218,5 | 34,5 |
| 22.08.2019 | 00:16:44 | 74,7 | 82 | 128,7 | 221,4 | 35,0 |
| 22.08.2019 | 00:46:43 | 74,8 | 82 | 129,4 | 224,3 | 35,5 |
| 22.08.2019 | 01:16:13 | 75,1 | 81 | 130 | 227,1 | 36,0 |
| 22.08.2019 | 01:46:44 | 75,4 | 79 | 129,4 | 230,1 | 36,5 |
| 22.08.2019 | 02:16:14 | 54,3 | 100 | 67,6 | 233,0 | 37,0 |
| 22.08.2019 | 02:46:43 | 73,2 | 78 | 121,6 | 235,9 | 37,5 |
| 22.08.2019 | 03:16:44 | 74,7 | 77 | 125,7 | 238,8 | 38,0 |
| 22.08.2019 | 03:46:14 | 74,9 | 80 | 127,3 | 241,6 | 38,5 |
| 22.08.2019 | 04:16:43 | 75,4 | 78 | 127,5 | 244,6 | 39,0 |
| 22.08.2019 | 04:46:44 | 74,7 | 81 | 127,8 | 247,5 | 39,5 |
| 22.08.2019 | 05:16:44 | 75,1 | 79 | 127,8 | 250,4 | 40,0 |
| 22.08.2019 | 05:46:43 | 75,1 | 80 | 128,9 | 253,3 | 40,5 |
| 22.08.2019 | 06:16:43 | 74,9 | 82 | 130,9 | 256,2 | 41,0 |
| 22.08.2019 | 06:46:43 | 75,4 | 82 | 131,8 | 259,1 | 41,5 |
| 22.08.2019 | 07:16:43 | 74,9 | 78 | 128,2 | 262,0 | 42,0 |
| 22.08.2019 | 07:46:44 | 75,3 | 77 | 127,8 | 264,9 | 42,5 |
| 22.08.2019 | 08:16:43 | 55,8 | 30 | 61,8 | 267,8 | 43,0 |
| 22.08.2019 | 08:46:44 | 55 | 100 | 50,7 | 270,7 | 43,5 |
| 22.08.2019 | 09:16:44 | 73,4 | 78 | 124 | 273,6 | 44,0 |
| 22.08.2019 | 09:46:43 | 74,5 | 80 | 127,9 | 276,5 | 44,5 |
| 22.08.2019 | 10:16:44 | 75,5 | 81 | 130,1 | 279,4 | 45,0 |
| 22.08.2019 | 10:46:44 | 77,7 | 42 | 103,6 | 282,3 | 45,5 |
| 22.08.2019 | 11:16:43 | 76,3 | 30 | 86,3 | 285,2 | 46,0 |
| 22.08.2019 | 11:46:43 | 76,1 | 30 | 85,7 | 288,1 | 46,5 |
| 22.08.2019 | 12:16:43 | 76,2 | 30 | 85,8 | 291,0 | 47,0 |
| 22.08.2019 | 12:46:44 | 76,2 | 30 | 85,8 | 293,9 | 47,5 |
| 22.08.2019 | 13:16:44 | 76 | 30 | 85,7 | 296,8 | 48,0 |
| 22.08.2019 | 13:46:44 | 76 | 30 | 85,8 | 299,7 | 48,5 |
| 22.08.2019 | 14:16:43 | 76 | 30 | 85,7 | 302,6 | 49,0 |
| 22.08.2019 | 14:46:43 | 75,8 | 30 | 85,6 | 305,5 | 49,5 |
| 22.08.2019 | 15:16:44 | 69,4 | 30 | 66,6 | 308,4 | 50,0 |

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