AUSTRALIAN SOLID FUEL TESTING
ASFT

3 Garden Street, Morwell Vic 3840
ABN: 46 610 154 768

Prepared for
PADesigns Pty Ltd

PARTICULATE EMISSIONS, POWER OUTPUT AND THERMAL EFFICIENCY TESTING OF THE PADESIGNS 1200 GUILLOTINE FREE-STANDING SOLID FUEL APPLIANCE

Report No: ASFT22082-PRELIMINARY REPORT

Issue Date: 15 November 2022

CONFIDENTIAL - CLIENT USE ONLY

by

Steve Marland

Report Distribution

PADesigns Pty Ltd
Level 7, 474 Williams Street
MELBOURNE VIC 3000

Mr Paul Agnew

ASFT Report Archive

Revision Details

Revision	Date	Comments
0	15/11/2022	Preliminary Issue – pending payment of invoice and engineering drawings

EXECUTIVE SUMMARY

The PADesigns 1200 Guillotine Free-standing solid fuel appliance was tested for particulate emissions power output and efficiency according to the requirements of the joint Australian/New Zealand Standard AS/NZS 4012/4013 (2014).

Below is a summary of the appliance results;

Primary Air Settings	**Average Power (kW)**	**Average Peak Power (kW)**	**Efficiency (%)**	**Average Dry Fuel Consumption Rate (kg/hr)**	**Average Burn Time (mins)**	**Particulate Emission Factor (g/kg) Oven Dry Wood**
High	20.0	23.9 @ 10% fuel load	61	6.1	171	0.6
Medium	17.5		65	5.0	207	1.0
Low	15.4		68	4.2	243	1.4

The appliance particulate emissions factor was 1.0g/kg of hardwood that complies to AS/NZS 4014.1, and the average efficiency of the appliance for all burn rates was 65%.

The PADesigns 1200 Guillotine Free-standing solid fuel appliance complies with the requirements of AS/NZS 4012/4013 (2014).

Signed	
Name	Steve Marland
Title	*Managing Director – Australian Solid Fuel Testing*
Date	15 November 2022

1 INTRODUCTION

Testing of the PADesigns 1200 Guillotine took place from November 2 to 9, 2022 at the Australian Solid Fuel Testing Laboratory located at 3 Garden Street, Morwell, Victoria. The testing was performed by Mr S. Marland and Mr G. Mooney.

Particulate emissions, power output and thermal efficiency testing of the appliance was performed according to the requirements of the joint Australian/New Zealand Standard AS/NZS 4012/4013 (2014).

The appliance was tested using hardwood as the test fuel. This test fuel was used after conforming to the requirements of the joint AS/NZS 4014.1 (1999).

2 INSTALLATION OF THE APPLIANCE

The appliance firebox was measured according to the method described in the joint standard AS/NZS 4012. The appliance fuel load, fuel length and number of wood pieces were then calculated as per section 5 of AS/NZS4012.

Prior to testing, the appliance was burnt for a minimum of 16 hours (two × 8 hours) as per section 6.1.2 of AS/NZS4012:2014.

Testing was conducted according to the manufacturer's verbal or written instructions (joint AS/NZS 4013 Paragraph 8.20[c]).

3 PROCEDURE

The appliance firebox was measured according to the method described in the joint standard AS/NZS 4012. The appliance fuel load, fuel length and number of wood pieces were then calculated as per section 5 of AS/NZS4012. The test fuel was loaded according to the manufacturer's instructions.

Appendix 1 shows photographs of the appliance under test and a typical fuel load and loading geometry.

3.1 Power Output and Thermal Efficiency (AS/NZS4012)

Australian Solid Fuel Testing uses a calorimetry room which is an insulated room (75 mm thick polystyrene lined on walls, floor and ceiling) of internal dimensions 3.0 m × 3.0 m × 2.4 m high.

Air flow into the room is via a 300 mm diameter duct from a manually controlled variable speed fan. Air flow out of the room is via a 300 mm diameter duct also connected to a variable speed fan. The outlet duct air pressure is kept at 57Pa (recorded on Dywer digital 607D-11 manometer) while the inlet air fan speed is adjusted via the variable speed drive to keep the calorimeter room at atmospheric pressure. (by use of a Dwyer digital DP 607D-02 manometer)

Air flow temperatures are measured by three type K thermocouples (batch calibrated by ECE Fast report 14705) in both the inlet and outlet ducts. The Appliance being tested sits on a 0 –600 kg digital

platform scales (Ohaus VE1500RA). The flue system consists of an insulated silicone oil bath that isolates the weight of the appliance from the remainder of the flue. The flue, where it exits from the room, passes into an insulated flue casing. Total flue length above the top of the scales is set at 4.6±0.1 m.

Temperatures and transducer signals are fed to a National Instruments DAQMX that is connected to a computer. A digital signal from the scales is also sent to the computer. The ASFT Labview/SQL designed computer program records all data and desplys realtime results as they are collected.

The calorimeter room heat losses through the walls have been measured and accounted for by calibration from a electrical resistance heater of known output (NATA certified kWhr meter).

3.2 Particulate Emissions (AS/NZS4013)

The emissions equipment consists of a dilution tunnel, collection hood, pitot tube and NATA certified digital manometer (Dwyer digital DP 607D-02) for air flow measurement and sampling train/probe.

The sampling train/probe consists of a sample probe, double filter assembly, including thermocouple, a gas drier, vacuum pump and NATA certified gas meter (Landis & Gyr).

Grade 333, forty-seven millimetre glass fibre filters are pre-weighed (by way of Ohaus PA114C balance)and are mounted in the filter assembly.

Data from thermocouples, manometer and dry gas meter is fed to a National Instruments DAQMX and ASFT's labview/SQL designed computer program. The particulate emissions information is collected at the same time as data from the calorimeter room.

At the completion of a burn cycle, the filters are removed from the filter holders and placed in a desiccator for drying. Condensed and entrapped emissions from the sample probe are washed with acetone into a glass beaker. A rifle cleaning rod is used to clean the inside of the sampling probe. The cleaning rod is then washed with acetone (into the glass beaker). The acetone washing is allowed to vaporise to dryness and the residue weight determined. The two dried filters are re-weighed.

Emission weight is then determined by totalling the filter weight increases from the two filters and the residue from acetone washings.

4 DETAILS OF APPLIANCE

The test results reported directly relate to the appliance provided by the manufacturer for testing. The details of the appliance given in this section include features which may affect the particulate emissions, power output and thermal efficiency. Any change in the design/construction of this appliance may invalidate this report. Engineering diagrams were sighted and checked by Australian Solid Fuel Testing against test appliance measurements recorded in the table below. (joint AS/NZS 4013 Paragraph 8.2 [d]).

Appliance Model Name: **1200 Guillotine Unit**		Serial No: **000025/2022**
Manufacturer: **PA Designs**		
Overall Height: **1582mm**	Overall Depth: **612mm**	Overall Width: **1470mm**
Top Plate Width: **1272mm**	Top Plate Depth: **335-453mm**	Top Plate Thickness: **4mm**
Appliance Leg Height: **210mm**	Depth: **70mm**	Width: **70mm**
Appliance Feet Height: **Adjustable to 55mm**	Diameter: **50mm**	
Usable Firebox Height: **410mm**	Width: **1178mm**	Depth: **397mm**
Usable Firebox Volume: **203.4 Litres**		
Firebox Material Type/Seam Fully Welded: **3.5mm steel fully welded**		
Firebrick Type: **Fully lined 25mm ceramic**		
Main Door Opening Height: **335mm**	Width: **1115mm**	
Door Height: **435mm**	Width: **1205mm**	Depth: **35mm**
Door glass Height: **400mm**	Width: **1203mm**	
Primary Air Location: **Under grate**		
Dimension of Primary Air: **1 hole @ 80mm diameter Butterfly control**		**Zero when fully closed**
Area of Primary (mm^2): **2,147.2mm^2**		
Secondary/Tertiary Air Location: **1 Tube running left to right at top and in the centre of the firebox**		
Dimension of Secondary/Tertiary Air: **16×6mm holes facing towards front, 16×6mm holes facing towards rear and 15×6mm holes downward**		
Area of Secondary/Tertiary Air (mm^2): **1,329.1mm^2**		
Baffle Plate size: **2 @ 1210×172×30mm ceramic. 1 front and 1 rear of secondary air tube**		
Flue Dimensions: **177.8mm**		
Spigot Dimensions:	OD: **196mm**	ID: **179mm**
Spigot to Rear of Appliance: **108mm**		
Rear Internal to External Heat Shield: **N/A**		
Firebox to Side External Heat Shield: **N/A**		
Heat Shield Material Type: **N/A**		
Water Heater Fitted: **No**		
Fan Location/Speeds: **No**		
Catalytic Combustor fitted: **No**		
Grate: **Yes**		

NOTE: Accuracy of measurement is ±5% of the measured value

4.1 Test Fuel

The appliance was fired using the fuel type specified in the table below;

Fuel Type	Hardwood
Common Name	Greybox
Scientific name	Eucalyptus Microcarpa
Average Fuel load	20.1kg (10% firebox volume fuel load as per AS/NZS4012,4013 section 5.3.1)
Average moisture content	15.6%
Dry density	0.89kg/L
Fuel length	308mm
No. of pieces	12
Method of loading (fuel placement)	Front to Rear, 5 on 7
Calorific Value (Gross Dry)	19.6MJ/kg
Ash Content	0.6% db

5 RESULTS

5.1 High Burn Cycles

The appliance was fully fired in accordance with Section 6.3(a) of the joint AS/NZS 4012. Below is a table of the appliance setting for the high burn cycles;

Primary air setting	Average Fuel load	Fan Setting
Primary air set @ 40% (~1288mm²) Secondary air set @ 50% (~794mm²)	20.2kg	N/A

5.2 Low Burn Cycles

The appliance was fired in accordance with Section 6.3(b) of the joint AS/NZS 4012. Below is a table of the appliance setting for the Low burn cycles;

Primary air setting for first 20% fuel reduction	Primary air setting after 20% fuel reduction	Average Fuel load	Fan Setting
Primary air set @ 40% (~1288mm²) Secondary air set @ 50% (~794mm²)	Primary air fully closed (0mm²) Secondary air set @ 25% (~397mm²)	20.0kg	N/A

5.3 Medium Burn Cycles

The appliance was fired in accordance with Section 6.3(c) of the joint AS/NZS 4012. Below is a table of the appliance setting for the Medium burn cycles;

Primary air setting for first 20% fuel reduction	Primary air setting after 20% fuel reduction	Average Fuel load	Fan Setting
Primary air set @ 40% (~1288mm²) Secondary air set @ 50% (~794mm²)	Primary air fully closed (0mm²) Secondary air set @ 50% (~794mm²)	20.2kg	N/A

5.4 Leak Test Results

The appliance passed the post-conditioning air flow test with a flue velocity of 0.87m^3/min at 25 Pa (<1 m^3/min required in Standard).

The appliance passed the post-burn air flow test with a flue velocity of 0.94m^3/min at 25 Pa (<1 m^3/min required in Standard).

The appliance conforms with clause 6.10 of AS/NZS 4012 (2014).

5.5 Particulate Emissions Factor

The table below shows the particulate emissions values for each burn cycle and the resultant appliance particulate emission factor.

Primary Air Setting	Total Emission Weight (mg)	Sample Dilution Tunnel Ratio	Particulate Emission Factor (g/kg) Oven Dry Wood
High No 1	9.4	1108.4	0.6
High No 2	5.0	1397.8	0.4
High No 3	10.9	1457.5	0.9
Average			0.6
Medium No 1	14.6	1135.8	0.9
Medium No 2	16.0	1149.1	1.0
Medium No 3	18.7	1117.4	1.2
Average			1.0
Low No 1	17.5	1112.3	1.1
Low No 2	19.2	1166.6	1.3
Low No 3	25.6	1128.1	1.7
Average			1.4

The Appliance Particulate Emissions Factor is 1.0g/kg of hardwood that complies to AS/NZS 4014.1.

5.6 Efficiency/Power Results

The tables below shows the summary of the appliance average power, dry fuel consumption rate and burn time for each burn cycle.

Primary Air Settings	Average Power (kW)	Average Peak Power (kW)	Efficiency (%)	Average Dry Fuel Consumption Rate (kg/hr)	Average Burn Time (mins)
High	20.0	23.9 @ 10% fuel load	61	6.1	171
Medium	17.5		65	5.0	207
Low	15.4		68	4.2	243

Appliance Combined Efficiency is 65% when tested with hardwood that complies to AS/NZS 4014.1.

Primary Air Setting	Commencement Date and Time	Cycle Time (mins)	Average Power (kW)	Wet Wood Mass (kg)	Wood Moisture Content (wt%)	Power Efficiency (%)	Peak Power (kW)	Dry Fuel Consumption Rate (kg/hr)
High No 1	03/11/2022 16:44	197	18.50	20.20	15.7	65.6	23.44	5.18
High No 2	04/11/2022 10:50	146	22.11	20.25	15.7	57.9	24.87	7.01
High No 3	04/11/2022 13:33	170	19.50	20.20	15.0	59.1	23.44	6.06
Medium No 1	07/11/2022 09:54	203	16.42	20.25	15.4	59.5		5.07
Medium No 2	07/11/2022 13:20	209	17.28	20.10	15.4	64.9		4.89
Medium No 3	07/11/2022 16:51	208	18.92	20.15	15.8	71.1		4.89
Low No 1	06/11/2022 09:35	235	15.85	20.00	15.8	67.7		4.30
Low No 2	06/11/2022 13:48	262	14.12	20.05	15.5	66.8		3.88
Low No 3	06/11/2022 21:53	231	16.19	19.90	15.7	68.3		4.35

5.7 Uncertainty of Measurement Statement

a) The uncertainty of temperature measurement during the entire test period was ± 1.5°C (at the 95% confidence level).

b) The uncertainty of power measurement was ± 5%.

c) The uncertainty of the outlet air pressure was ± 0.6 Pa.

d) The uncertainty of the dilution tunnel pressure was ± 1 Pa.

e) The uncertainty of particulate emission weights was ± 0.4 mg.

g) The uncertainty of the test fuel mass was ± 50 gm (on appliance balance).

6 CONCLUSION

The PADesigns 1200 Guillotine Free-standing solid fuel burning appliance produced an appliance particulate emissions factor of 1.0g/kg and an average efficiency of 65% for all burn rates, using hardwood that complies to AS/NZS 4014.1, when tested according to joint AS/NZS 4012, AS/NZS 4013 (2014).

The PADesigns 1200 Guillotine Free-standing solid fuel burning appliance complies with the requirement of a combined effieiency of not less than 60% and a particulate emissions factor of not greater than 1.5g/kg of hardwood that complies to AS/NZS4014.

APPENDIX 1

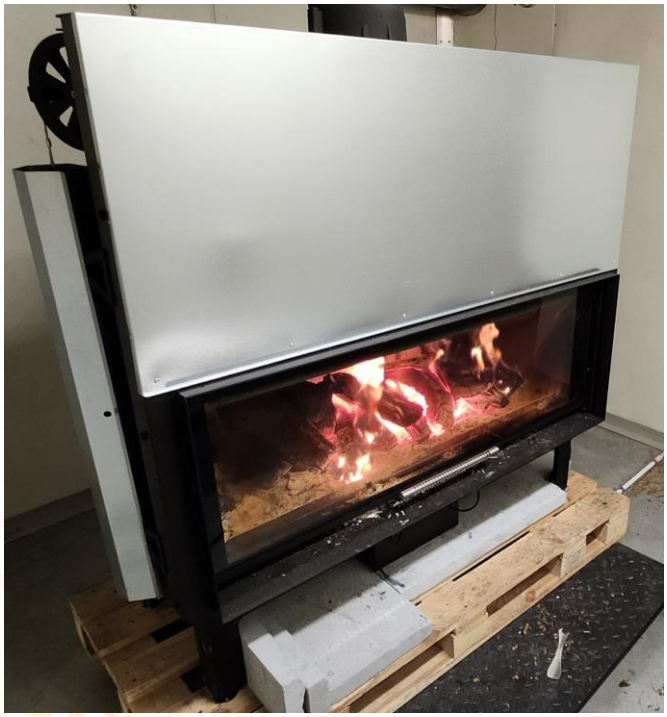

Figure 1: Appliance during testing.

Figure 2: Test fuel load.