
Innovative Hearth Products, LLC

Project # 18-428

Model: GV230GL

AKA: ML230GL

Type: Residential Non-catalytic Wood
Fired Heater

October 19, 2018

EPA Test Method 28R for Certification and Auditing of Wood Heaters

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Affidavit

PFS-TECO was contracted by Innovative Hearth Products, LLC (IHP) to provide testing services for the GV230GL Non-Catalytic Wood-Fired Room Heater per EPA Method 28R, *Certification and Auditing of Wood Heaters*. All testing and associated procedures were conducted at PFS-TECO's Portland Laboratory beginning on 9/12/2018 and ending on 8/25/2018. PFS-TECO's Portland Laboratory is located at 11785 SE Highway 212 – Suite 305, Clackamas, Oregon 97015. Testing procedures followed EPA Method 28R and ASTM E2780, *Standard Test Method for Determining Particulate Matter Emissions from Wood Heaters*. Particulate sampling was performed per ASTM E2515, *Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel*.

PFS-TECO is accredited by the U.S. Environmental Protection Agency for the certification and auditing of wood heaters pursuant to subpart AAA of 40 CFR Part 60, New Source Performance Standards for Residential Wood Heaters and subpart QQQQ of 40 CFR Part 60, Standards of Performance for New Hydronic Heaters and Forced Air Furnaces, Methods 28R, 28WHH, 28 WHH-PTS, and all methods listed in Sections 60.534 and 60.5476. PFS-TECO holds EPA Accreditation Certificate Numbers 4 and 4M (mobile). PFS-TECO is accredited by IAS to ISO 17020:2012 "Criteria for Bodies Performing Inspections, By A2LA to ISO 17025:2005 "Requirements for Testing Laboratories", and by Standards Council of Canada to ISO 17065:2012 "Requirements for Bodies Operating Product Certification Systems".

The following people were associated with the testing, analysis and report writing associated with this project.



Sebastian Button, Laboratory Supervisor

Introduction

Innovative Hearth Products of Auburn, WA, contracted with PFS-TECO to perform EPA certification testing on GV230GL Non-Catalytic Wood-Fired Room Heater. All testing was performed at PFS-TECO's Portland Laboratory. Testing was performed by Mr. Sebastian Button.

Notes

- Prior to start of testing, 50 hours of conditioning was performed per ASTM E2780.
- Prior to start of testing, the dilution tunnel was cleaned with a steel brush.
- Front filters were changed on sample train A at one hour for all 6 test runs.
- A total of 6 test runs were performed in accordance with EPA Method 28R, 1 at the maximum burn rate category, 1 at the medium high burn rate category, 3 at the medium low burn rate category, two of which was meets the 1.00 kg/hr or less requirement for stoves operating at minimum air setting, and 1 fan confirmation test, all 6 test runs met validity requirements, and all but the fan confirmation test and one of the category 2 tests (on a 2-for-1 basis) are included in the weighted average. See Run Narrative section for further detail on each run.

Wood Heater Identification and Testing

- Appliance Tested: **GV230GL**
- Serial Number: **Un-serialized Prototype – PFS Tracking Number 0008**
- Manufacturer: **Innovative Hearth Products, LLC**
- Catalyst: **No**
- Heat exchange blower: **Optional**
- Type: **Wood Stove**
- Style: **Free Standing**
- Date Received: **Monday, September 10, 2018**
- Wood Heater Aging: **August 27, 2018 - September 7, 2018**
- Testing Period – Start: **Wednesday, September 12, 2018** Finish: **Tuesday, September 25, 2018**
- Test Location: **PFS-TECO Portland Laboratory, 11785 SE HWY 212 - Suite 305, Clackamas, OR 97015**
- Elevation: **≈131 Feet above sea level**
- Test Technician(s): **Sebastian Button**
- Observers: **Bob Wayman of IHP**

Test Procedures and Equipment

All Sampling and analytical procedures were performed by Sebastian Button. All procedures used are directly from ASTM E2780 and ASTM E2515. See the list below for equipment used. See Appendix C submitted with this report for calibration data.

Equipment List:

Equipment ID#	Equipment Description
040	Delmhorst J-2000 Wood Moisture Meter
041	Rice Lake 3'x3' floor scale w/digital weight indicator
050	Digiweigh DWP12i Platform Scale
053	APEX XC-60 Digital Emissions Sampling Box A
054	APEX XC-60 Digital Emissions Sampling Box B
055	APEX Ambient sampling box
057	California Analytical ZRE CO2/CO/O2 IR ANALYZER
109A/B	Troemner 100mg/200mg Audit Weights
107	Sartorius Analytical Balance
051	10 lb audit weight
064	Digital Barometer
090	Dewalt Tape Measure
092	Digital Calipers
095	Anemometer
111	Microtector
CC144992	Gas Analyzer Calibration Span Gas
CC332147	Gas Analyzer Calibration Mid Gas

Results

A total of 6 test runs were performed on the GV230GL. Run #4 was excluded from the weighted average on a 2-for-1 basis (see Runs 1 & 5). Run #6, a fan confirmation test was not used in any weighted average results calculations. The weighted average emissions rate for the 4 run test series was measured to be **1.7 g/hr** with a Higher Heating Value efficiency of **73.7%**. The average CO emission rate for the 4 tests was **1.7 g/min.** The IHP GV230GL Non-Catalytic Wood-Fired Room Heater meets the 2020 crib wood PM emission standard of ≤ 2.0 g/hr per CFR 40 part 60, §60.532 (b).

Detailed individual run data can be found in Appendix A submitted with this report.

Summary Table

	Cat. 2 ≤ 1.00 kg/hr.	Cat. 2 0.80 - 1.25 kg/hr.	Cat. 2 0.80 - 1.25 kg/hr. ¹	Cat. 3 1.25 - 1.90 kg/hr.	Cat. 4 Max Burn Rate	Fan Confirmation (Cat. 2) ²
Date	9/12/2018	9/17/2018	9/14/2018	9/13/2018	9/13/2018	9/25/2018
Run Number	1	5	4	3	2	6
Emission Rate (g/hr).	1.89	1.01	2.87	2.14	2.02	2.28
Burn Rate (kg/hr)	0.91	0.95	1.23	1.86	2.58	1.23
Heat Output (Btu/hr)	12,631	13,279	16,625	25,183	33,911	16,509
Overall Efficiency (% HHV)	74.1	75.2	73.0	72.7	71.0	72.5
CO Emissions (g/MJ Output)	7.45	5.60	7.23	4.51	3.14	6.98
CO Emissions (g/kg Dry Fuel)	109.36	83.44	104.52	65.04	44.20	100.28
CO Emissions (g/min)	1.65	1.31	2.11	2.00	1.87	2.03
ASTM E2515 Emissions – First Hour (g/hr)	7.25	3.79	8.54	3.75	2.27	8.06
Weighted particulate emission average of 4 test runs: 1.7 grams per hour.						
Weighted average HHV efficiency of 4 test runs: 73.7%.						

¹Test not included in weighted average calculation on 2-for-1 basis, runs 1 and 5 are also category 2 burn rates.


²Fan Confirmation test not included in weighted average calculations.

Weighted Average Calculation Summary

28R Weighted Average.xlsm

EPA Method 28R Weighted Average Emissions

Client: IHP
 Stove Model: GV230GL
 Test Dates: 9/12/18 - 9/17/18
 Job Number: 18-428

Signature/Date: 

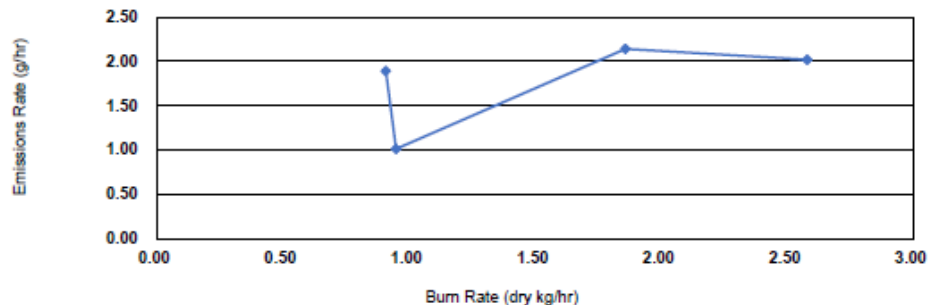
9/24/2018

Weighted Average Particulate Emissions (g/hr):	1.7
Weighted Average HHV Efficiency (%):	73.7%
Weighted Average LHV Efficiency (%):	79.7%
Average CO Emissions (g/min):	1.7

Individual Run Summaries

Run Number: 1	Run Number: 5
Burn Rate (dry kg/hr): 0.91	Burn Rate (dry kg/hr): 0.95
Emissions Rate (g/hr): 1.89	Emissions Rate (g/hr): 1.01
HHV Efficiency (%): 74.1%	HHV Efficiency (%): 75.2%
LHV Efficiency (%): 80.1%	LHV Efficiency (%): 81.3%
Weighting Percentage (%): 19.70%	Weighting Percentage (%): 34.78%
Run Number: 3	Run Number: 2
Burn Rate (dry kg/hr): 1.86	Burn Rate (dry kg/hr): 2.58
Emissions Rate (g/hr): 2.14	Emissions Rate (g/hr): 2.02
HHV Efficiency (%): 72.7%	HHV Efficiency (%): 71.0%
LHV Efficiency (%): 78.6%	LHV Efficiency (%): 78.7%
Weighting Percentage (%): 38.59%	Weighting Percentage (%): 6.93%

Emission Rate vs Burn Rate Plot



Test Run Narrative

Run 1

Run 1 was performed on 9/12/2018 as a category 2 test, per EPA Method 28R. The total test time was 390 minutes. The particulate emissions rate for the test was 1.89 g/hr, the burn rate was 0.91 kg/hr with an HHV efficiency of 74.1%. The Train A front filter was changed at 1 hr to determine 1st hour emissions. All test results were appropriate and valid. There were no anomalies and all test criteria were met.

This test meets the burn rate requirements described in EPA Method 28 Section 8.1.1.3.2 as a category 2 test with a burn rate of 1.00 kg/hr or less for wood stoves that cannot be operated at burn rates less than 0.8 kg/hr. This test was performed with the air control set to its lowest setting, it is not possible to operate the stove at a lower air setting. Therefore, this test will be used in lieu of a category 1 test.

Run 2

Run 2 was performed on 9/13/2018 as a category 4 test, per EPA Method 28R. The total test time was 140 minutes. The particulate emissions rate for the test was 2.02 g/hr, the burn rate was 2.58 kg/hr with an HHV efficiency of 71.0%. The Train A front filter was changed at 1 hr to determine 1st hour emissions. All test results were appropriate and valid. There were no anomalies and all test criteria were met.

Run 3

Run 3 was performed on 9/13/2018 as a category 3 test, per EPA Method 28R. The total test time was 190 minutes. The particulate emissions rate for the test was 2.14 g/hr, the burn rate was 1.86 kg/hr with an HHV efficiency of 72.7%. The Train A front filter was changed at 1 hr to determine 1st hour emissions. All test results were appropriate and valid. There were no anomalies and all test criteria were met.

Run 4

Run 4 was performed on 9/14/2018 as a category 2 test, per EPA Method 28R. The total test time was 290 minutes. The particulate emissions rate for the test was 2.87 g/hr, the burn rate was 1.23 kg/hr with an HHV efficiency of 73.0%. The Train A front filter was changed at 1 hr to determine 1st hour emissions. All test results were appropriate and valid. There were no anomalies and all test criteria were met. This test was excluded from the weighted average calculation on accordance with ASTM E2780 Section 9.5.13, "If more than one test run is conducted at a specified burn rate, the results from at least two thirds of the test runs in that burn rate category shall be used in calculating the weighted average emissions rate." Test runs 1 and 5 were used in calculating the weighted average in lieu of this test run.

Run 5

Run 5 was performed on 9/17/2018 as a category 2 test, per EPA Method 28R. The total test time was 400 minutes. The particulate emissions rate for the test was 1.01 g/hr, the burn rate was 0.95 kg/hr with an HHV efficiency of 75.2%. The Train A front filter was changed at 1 hr to determine 1st hour emissions. All test results were appropriate and valid. There were no anomalies and all test criteria were met.

Run 6

Run 6 was performed on 9/25/2018 as a category 2 fan confirmation test, per EPA Method 28R. The total test time was 320 minutes. The particulate emissions rate for the test was 2.28 g/hr with a burn rate of 1.23 kg/hr. All test results were appropriate and valid. There were no anomalies and all test criteria were met. Since the particulate emissions rate is within 1.0 g/hr of another category 2 test (run 1, 1.89 g/hr) the blower is determined not to have a significant impact on emissions performance and may therefore be approved as an optional accessory. This test run is not included in the weighted average calculations presented in the results summary.

Test Conditions Summary

Testing conditions for all runs fell within allowable specifications of ASTM E2780 and ASTM E2515. A summary of facility conditions, fuel burned, and run times is listed below.

Runs	Ambient (°F)		Relative Humidity (%)		Average Barometric Pressure (In. Hg.)	Preburn Fuel Weight (lbs)	Test Fuel Weight (lbs)	Test Fuel Moisture (%DB)	Test Run Time (Min)
	Pre	Post	Pre	Post					
1	73	75	47.8	37.9	29.92	15.6	15.56	20.0	390
2	69	71	51.5	42.3	30.00	19.5	15.68	20.1	140
3	74	72	40.4	33.4	29.97	15.2	15.4	19.7	190
4	71	77	46.8	31.5	29.95	15.5	15.54	20.1	290
5	71	76	44.5	31.9	30.04	14.88	16.45	19.5	400
6	71	77	37.2	26.3	30.12	15.56	17	19.3	320

Appliance Operation and Test Settings

The appliance was operated according to procedures as described in the Operations Manual, found in Appendix B submitted with this report. Detailed run information can be found in Appendix A submitted with this report.

Settings & Run Notes

	Pre-Burn Air Setting	Test Run Air and Fan Settings ¹
Run 1	Adjustable Primary Air Control (PAC) fully closed.	Adjustable PAC fully closed, fan turned on to low setting 25 minutes after loading, per manufacturer's instructions
Run 2	Adjustable PAC fully open	Adjustable PAC fully open, fan turned on to high setting 5 minutes after loading, per manufacturer's instructions.
Run 3	Adjustable PAC open 0.85" from bottom of channel to bottom of control rod	Adjustable PAC open 0.85", fan turned on to high setting 15 minutes after loading, per manufacturer's instructions.
Run 4	Adjustable PAC open 0.43" from bottom of channel to bottom of control rod	Adjustable PAC open 0.43", fan turned on to low setting 25 minutes after loading, per manufacturer's instructions.
Run 5	Adjustable PAC fully closed	Adjustable PAC fully closed, fan turned on to low setting 25 minutes after loading, per manufacturer's instructions.
Run 6	Adjustable PAC fully closed	Adjustable PAC fully closed, fan off for duration of test, fan confirmation test.

Appliance Description

Model(s): GV230GL

Additional Models Discussion: In addition to the GV230GL, the manufacturer also offers the model ML230GL, which is identical in firebox construction and air intake/control. The difference between the two models is that the GV230GL is a free-standing appliance, while the ML230GL is designed to be a fireplace insert. The difference between the two models is not expected to cause the appliance to exceed the required emissions limit.

Appliance Type: Non-Catalytic Wood-Fired Room Heater

Firebox Volume: 2.28 ft³

Air Introduction System: Primary Air enters the firebox from the rear bottom of the appliance and is channeled up the sides of the appliance and down through the air wash. Primary air is controlled via a damper arm located on the side of the stove, which moves up (open) to down (closed). In addition to the primary air the stove utilizes a startup air system in which, upon opening of the door, a bypass flapper allows additional air into the primary air stream adjacent to the control damper, a mechanical timer slowly closes the bypass damper over a period of approximately 25 minutes. Secondary air is pulled through a fixed opening in the rear bottom of the appliance and channeled up through 4 secondary air tubes. Dimensions on all these features can be found in Appendix D.

Baffles: A pair of mating 7.14" x 17.93" x 0.625" magnaflow board panels mate together to form a baffle which rests on top of the secondary air tubes.

Refractory Insulation: The firebox is lined with 1" thick firebrick.

Flue Outlet: 6-inch exhaust outlet located on the top of the appliance.

Catalytic Combustor: N/A

Fan: The appliance is optionally offered with a convection fan that attached to the rear of the appliance.

Gasketing: 3/4" fiberglass rope gasket seals the door against the firebox, 1" x 1/8" "u" channel gasket is used to seal the 5mm ceramic glass against the door frame.

Appliance Dimensions

GV230GL Unit Dimensions

Height	Width	Depth	Firebox Volume	Weight
35"	25.125"	23.75"	2.28 ft ³	385 lbs

Appliance design drawings can be found in Appendix D submitted with the CBI copy of this report.

Appliance Front



Appliance Left



Appliance Right



Appliance Rear



Test Fuel Properties

Test fuel used was dimensional Doug fir lumber, air-dried to the specified moisture content range. Typical fuel loads are pictured below:

Typical Test Fuel Load Configuration



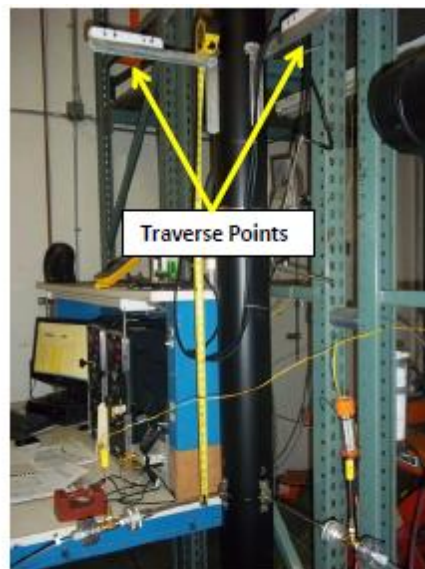
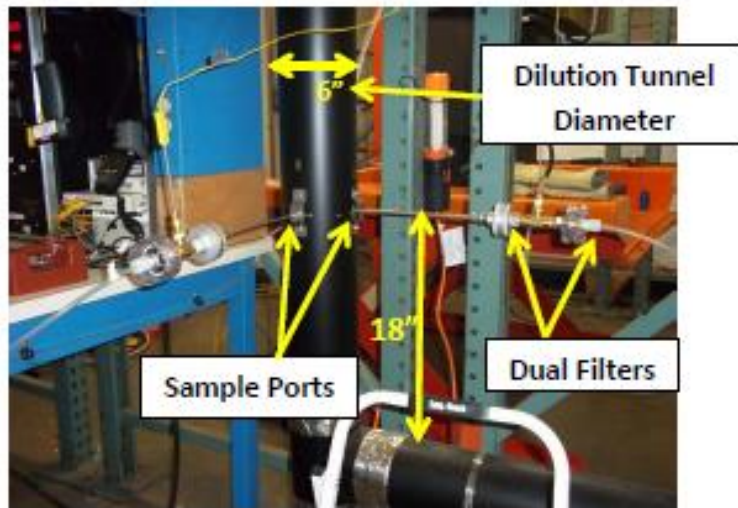
Typical Test Fuel Loaded in Test Stove



Sampling Locations and Descriptions

Sample ports are located 16.5 feet downstream from any disturbances and 1 foot upstream from any disturbances. Flow rate traverse data was collected 12 feet downstream from any disturbances and 5.5 feet upstream from any disturbances. (See below).

Sample Points



Sampling Methods

ASTM E2515 was used in collecting particulate samples. The dilution tunnel is 6 inches in diameter. All sampling conditions per ASTM E2515 were followed. No alternate procedures were used, and no sampling intervals fell outside of proportional rates of +/- 10%.

Analytical Methods Description

All sample recovery and analysis procedures followed ASTM E2515 procedures. At the end of each test run, filters, O-Rings and probes were removed from their housings, dessicated for a minimum of 24 hours, and then weighed at 6 hour intervals to a constant weight per ASTM E2515-11 Section 10.

Calibration, Quality Control and Assurances

Calibration procedures and results were conducted per EPA Method 28R, ASTM E2515-11 and ASTM E2780. Test method quality control procedures (leak checks, volume meter checks, stratification checks, proportionality results) followed the procedures outlined.

Appliance Sealing and Storage

Upon completion of testing, the appliance was secured with metal strapping and the seal below was applied, the appliance was then returned to the manufacturer's location at: 1502 14th St. NW Auburn, WA 98001, for archival.

Sealing Label

ATTENTION:

THIS SEAL IS NOT TO BE BROKEN WITHOUT PRIOR AUTHORIZATION FROM THE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY.

THIS APPLIANCE HAS BEEN SEALED INACCORDANCE WITH REQUIREMNTS OF 40CFR
PART 60 SUBPART AAA §60.535 (a)(2)(vii)

REPORT # _____

DATE SEALED _____

MANUFACTURER _____

MODEL # _____

Sealed Unit



List of Appendices

The following appendices have been submitted electronically in conjunction with this report:

Appendix A – Test Run Data, Technician Notes, Sample Analysis, and Photos

Appendix B – Labels and Manuals

Appendix C –Equipment Calibration Records

Appendix D – Design Drawings (CBI Report Only)

Appendix E – Manufacturer QAP (CBI Report Only)

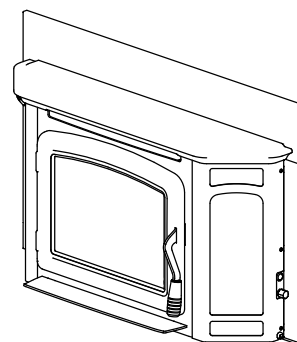


INSTALLATION AND OPERATION MANUAL

EPA Certified Wood-Burning Fireplace Inserts

Save These Instructions
For Future Reference

P/N 900937-00, Rev. NC, 10/2018



Montlake™ 230GL



ML230 - Report # 14-182

Wood-Burning Fireplace Inserts Model Montlake™ ML230GL

With Innovative Thermal Fin Technology (TFT™)

A French manual is available upon request. Order P/N 900937-01.

Ce manuel d'installation est disponible en français, simplement en faire la demande. Numéro de la pièce 900937-01.

This appliance must be properly installed and operated in order to prevent the possibility of a house fire. Please read this entire installation and operation manual before installing and using your wood fireplace insert. Failure to follow these instructions could result in property damage, bodily injury or even death. Contact your local building or fire officials to obtain a permit and information on any installation requirements and inspection requirements in your area.



	⚠ WARNING <ul style="list-style-type: none">• Hot! Do not touch! The glass and surfaces of this appliance will be hot during operation and will retain heat for a while after shutting off the appliance. Severe burns may result.• Carefully supervise children in the same room as appliance.
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CONGRATULATIONS!

When you purchased your new wood-burning fireplace insert, you joined the ranks of thousands of individuals whose answer to their home heating needs reflects their concern for aesthetics, efficiency and our environment. We extend our continued support to help you achieve the maximum benefit and enjoyment available from your new wood-burning fireplace insert.

Thank you for selecting an Innovative Hearth Products, LLC (IHP) wood-burning fireplace insert as the answer to your home heating needs.

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USING THIS MANUAL

Please read and carefully follow all of the instructions found in this manual. Please pay special attention to the safety instructions provided in this manual.

PRODUCT IS SUBJECT TO CHANGE WITHOUT NOTICE

IMPORTANT SAFETY AND WARNING INFORMATION

READ THIS MANUAL IN ITS ENTIRETY AND UNDERSTAND THESE RULES TO FOLLOW FOR SAFETY.

1. When this room heater is not properly installed, a house fire may result. To reduce the risk of fire, follow the installation instructions. Contact local building or fire officials about restrictions and installation inspection requirements in your area.
2. Wear gloves during installation to avoid injury from sharp edges on the insert and/or its parts.
3. This unit is designed and engineered to burn only dry, well-seasoned wood. Burning wet wood will greatly reduce your inserts efficiency, produce excessive amounts of smoke and can cause dangerous chimney fires due to creosote build-up.
4. Before opening the door, the draft control must be fully open to avoid possible combustion flash (ignition of hot volatile gases as the door is opened).
5. Never use gasoline, gasoline-type lantern fuel, kerosene, charcoal lighter fluid, or similar liquids to start or 'freshen up' a fire in this heater. Keep all such liquids well away from the heater while it is in use. **DO NOT USE CHEMICALS OR FLUIDS TO START THE FIRE.**
6. While burning, fuel utilizes oxygen from the air in the room. Be sure to allow an adequate amount of fresh air into the room where the insert is burning.
7. The outside surface of the insert will be hot while burning properly and can set items like clothing and curtains on fire. Keep furnishings and other combustible materials away from the insert. Using the heat from the insert to dry wet clothing can be hazardous if clothes are placed too near the surface of the insert.
8. **HOT WHILE IN OPERATION. KEEP CHILDREN, CLOTHING FURNISHINGS AND COMBUSTIBLE MATERIAL A CONSIDERABLE DISTANCE AWAY. CONTACT MAY CAUSE SKIN BURNS.** Do not allow children to play near the appliance without close supervision. Do not touch the appliance while it is burning. Use extreme caution while the unit is in use. Surface temperatures become dangerously hot and can cause serious burns.
9. Do not allow anyone to operate the insert who is not familiar with the operating instructions.
10. Attempts to achieve heat output rates that exceed insert design specifications can result in permanent damage to the insert. Never leave your insert unattended on high burn rates. This may cause overfiring. Overfiring the insert may cause a house fire. If the insert glows, you are overfiring.
11. Keep a water hose or hand-operated fire extinguisher close for safety.
12. **Smoke Detectors** - Since there are always several potential sources of fire in any home, we recommend installing smoke detectors. If possible, install the smoke detector in a hallway adjacent to the room (to reduce the possibility of occasional false activation from the heat produced by the insert). If your local code requires a smoke detector be installed within the same room, you must follow the requirements of your local code. Check with your local building department for requirements in your area.
13. Inspect your chimney at least once a month during the burning season to check for soot and creosote accumulations. Any accumulations over 1/8" thick should be removed by a professional chimney sweep. Do not attempt to burn out heavy creosote accumulations with a hot fire. If large accumulations are occurring, review your burning procedures.
14. If a creosote fire should develop, the fire department should be called immediately and then attempts should be made to control the fire until assistance arrives. If a "runaway" fire should develop causing over-heating of the insert, the door and draft regulators should be closed immediately. The fire should die down once deprived of oxygen. After a severe chimney fire, the complete chimney system should be checked before further use.
15. **Do Not Use Grate Or Elevate Fire - Build Wood Fire Directly On Hearth (firebrick).** Do not use andirons or other methods of supporting the fuel.
16. Please read this entire manual before you install and use your new room heater. Failure to follow instructions may result in property damage, bodily injury, or even death.
17. Check all local building and safety codes before installation. The installation instructions and appropriate code requirements must be followed exactly and without compromise. In the absence of local codes the following standards and codes must be followed.
18. In the U.S.A, install in accordance with the National Fire Protection Association's Code, NFPA 211, Standards for Chimneys, Fireplaces, Vents and Solid-Fuel-Burning Appliances, or similar regulations, may apply to the installation of a Solid-Fuel-Burning appliance in your area. In Canada, the guideline is established by the CSA Standard, CAN/CSA-B365-M93, Installation Code for Solid-Fuel-Burning Appliances and Equipment.
19. **DO NOT CONNECT TO OR USE IN CONJUNCTION WITH ANY AIR DISTRIBUTION DUCTWORK UNLESS SPECIFICALLY APPROVED FOR SUCH INSTALLATIONS.**
20. **WARNING: BURNING IMPROPER FUEL (I.E. CHARCOAL) CAN RESULT IN CARBON MONOXIDE POISONING, WHICH MAY LEAD TO DEATH!**
21. **Carbon Monoxide Poisoning** – early signs of carbon monoxide poisoning resemble the flu with headaches, dizziness, or nausea. If you have these signs, get fresh air at once! Have the heater inspected by a qualified service technician. Some people are more affected by carbon monoxide than others. These include pregnant women, people with heart or lung disease or anemia, those under the influence of alcohol, and those at high altitudes.
22. Failure to use manufacturer provided parts, variations in techniques and construction materials or practices other than those described in this manual may create a fire hazard and void the limited warranty.
23. Do not make any make-shift compromises during installation. Any modification or alteration may result in damage to the appliance or dwelling and will void the warranty, certification and listings of this unit.
24. These appliances are designed as supplemental heaters. Therefore, it is advisable to have an alternate heat source when installed in a dwelling.
25. **Do Not Overfire** – If Heater or Chimney Connector Glows, You Are Overfiring.
26. **DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE.**
27. **DO NOT BURN GARBAGE OR FLAMMABLE FLUIDS SUCH AS GASOLINE, NAPHTHA OR ENGINE OIL.**

WARNING

This product can expose you to chemicals including Carbon Black, which is known to the State of California to cause cancer, and Carbon Monoxide, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

WARNING

This wood heater 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.

TESTING INFORMATION

This manual describes the installation and operation of the Montlake™ 230GL non-catalytic wood heaters. These heaters meet the U.S. Environmental Protection Agency's emissions limits, and are compliant with 2020 EPA NSPS particulate emission standards. This heater has been developed, tested and constructed in accordance with the requirements of UL 1482, ULC S628 and HUD standards and is listed by PFS Corporation. It has been approved for residential installations.

Model	Emission Rate	EPA Test Range BTU/hr	Max. Output BTU/hr	EPA Default Efficiency
ML230	1.7 g/hr	12,600 - 33,900	76,000	63% *
ML300	3.1 g/hr	10,249 - 29,181	100,000	63% *

* Default - Category rating as assigned by the EPA. The estimated efficiency is as follows: 63% (non-catalyst equipped), 72% (catalyst-equipped), and 78% (wood pellets). See § 60.536(i)(3) at www.epa.gov.

DRAFT REQUIREMENTS

Your wood fireplace insert is dependent upon a properly functioning chimney for optimum performance. It is a high efficiency appliance that loses much less heat up the chimney than older appliances and fireplaces. For this reason it is important to match the fireplace insert to the chimney. The chimney has two functions:

1. It draws combustion air into the appliance (without air, no fuel will burn) and
2. It exhausts combustion by-products. Your new appliance is what is known as a "natural draft" appliance.

The appliance depends solely on the natural draft of the chimney system to draw combustion air into the unit. Draft is the force that moves air from the appliance up into the chimney. The amount of draft in your chimney depends on the length of the chimney, local geography, nearby obstructions and other factors. Too much draft may cause excessive temperatures in the appliance (overfiring). Slow or inadequate draft equals poor combustion

and possible smoking problems. The following are some conditions that may contribute to poor chimney draft:

1. A chimney too large for your appliance.
2. A chimney with not enough height to produce adequate draft.
3. A chimney with excessive height (this may allow exhaust to cool too much before exiting, which will stall the rate the exhaust exits).
4. Offsets in the venting system are too restrictive (see *Chimney Guidelines*).

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

Excessive draft may cause an uncontrollable burn or a glowing red fireplace insert or chimney part.

Overfiring Damage - If the heater or chimney connector glows, you are overfiring. Other symptoms may include: Cracking, warping or burning out of components, plated accessories may turn color, stove or insert glass may develop a haze, which will not come off with cleaning.

Overfiring of a stove or fireplace insert is a condition where excessive temperatures are reached, beyond the design capabilities of the appliance. The damage that occurs from overfiring is not covered under the manufacturer's limited warranty.

Also see *Troubleshooting* on **Page 25**.

SELECTING THE PROPER VENTING SYSTEM

The appliance is merely one component of a larger system. The other equally important component is the venting system. This is necessary for achieving the required flow of combustion air to the fire chamber and for safely removing unwanted combustion by-products from the appliance. If the venting system's design does not promote these ends, the system may not function properly. Poorly functioning venting systems may create performance problems as well as be a safety hazard. **A draft test should read greater than .04" W.C. (inches water column) and less than .08" W.C.** As per NFPA-211 standard (see paragraph below), the installer must take into account all variables within the installation and install the appliance in such a manner that satisfies the draft requirements of the appliance. See *Chimney Guidelines* below to assist you in selecting the proper venting system for your installation.

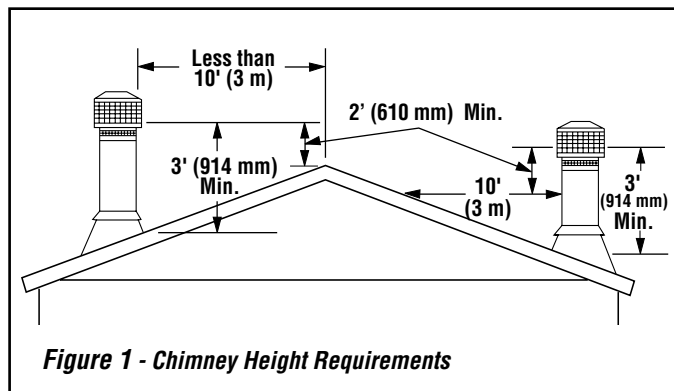
American National Standards Institute ANSI/NFPA 211, Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances - See Draft Section: A chimney or vent shall be so designed and constructed to develop a flow sufficient to completely remove all flue and vent gases to the outside atmosphere. The venting system shall satisfy the draft requirements of the connected appliance in accordance with the manufacturer's instructions.

Chimney Guidelines:

- This appliance requires approximately 12 feet minimum of "effective draw" provided by the venting system. As a rule of thumb, every 90 degree total direction change in the venting will result in a loss of approximately 5 feet of "effective draw." Example: If two 45 degree offsets are used, subtract 5 feet from the actual vertical vent height to determine your "effective draw." In this case if you had 14 feet of vertical vent, the effective draw would only be approximately 9 feet (14 ft. - 5 ft. = 9 ft.), therefore it may be necessary to add additional height to the venting system.
- In well insulated and weather tight homes, it may be difficult to establish a good draft up your chimney. The poor draft is caused by a shortage of air in the house (see *Negative Pressure Warning* on **Page 5**).

CHIMNEY HEIGHT REQUIREMENTS

The chimney must extend 3' (.92m) above the level of roof penetration and a minimum of 2' (.61m) higher than any roof surface within 10' (3m) (see below). Check with your local building officials for additional requirements for your area.



To pass inspection in nearly any jurisdiction, the chimney must meet both safety and exhaust flow requirements. The (3' by) 2' by 10' rule applies to both masonry and factory-built chimneys.

*** Ref. USA - National Standard, NFPA 211-latest edition and Canada National Standard CSA B365-01-latest edition. Vents installed with a listed cap shall terminate in accordance with the terms of the cap's listings.**

NEGATIVE PRESSURE WARNING

This appliance is not designed to be operated in a negative pressure. In very airtight homes with large kitchen exhaust fans, furnace cold air returns, fresh air exchange systems and any other air system in close proximity to the heating appliance may create a negative pressure in the same room as the heating appliance. This can create dangerous back drafting of the fireplace insert and chimney joints, drawing combustion by-products into the home. Be sure your home has adequate makeup air to eliminate negative pressures caused by the above-mentioned sources. IHP accepts no liability for damages resulting from negative pressures described above.

Ventilation Requirements - Provide adequate air for combustion. The fresh air requirements of this appliance must be met within the space where it will be installed. Ventilation is essential when using a Solid-Fuel-Burning heater. In well insulated and weather tight homes, it may be difficult to establish a good draft up the chimney (caused by a shortage of air in the home). The lack of air is caused by many common household appliances which exhaust air from the home (such as a furnace, heat pump, air conditioner, clothes dryer, exhaust fans, fireplaces, and other fuel burning appliances). Also, the combustion process of this heater uses oxygen from inside the dwelling. If the available fresh air delivery in the dwelling is insufficient to support the demands of these appliances, problems can result (i.e. excessive negative pressure can develop in the dwelling which will affect the rate at which this appliance can draft thus resulting in performance problems. To correct this problem it may help to open a window (preferably on the windward side of the house).

Montlake™ ML230GL

WARNING: BE ABSOLUTELY SURE THE DISTANCE BETWEEN THE HEATER AND THE SURFACE OF ANY COMBUSTIBLE CONSTRUCTION IS NOT LESS THAN SHOWN ON THIS PAGE.

Model	A*(3)	B*	C*	D*	E(1)
ML230GL	USA-15" CAN-381mm	USA-13" CAN-330mm	4" 102mm	1" 25mm	USA-8" CAN-203mm
Model	F (1)	G	H	J(2)	M
ML230GL	USA-16" CAN-450mm	15-1/2" 394mm	21-1/4" 540mm	5-3/8" 137mm	36-3/4" 934mm

Table 1 - Clearances

* Reduced clearances may be available for A, B, C and D dimensions per NFPA 211 - latest edition, Standard for Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances (in Canada CSA B365 - latest edition). See section on "Reduction of Appliance Clearance with Specified Forms of Protection."

- (1) (USA) 16" minimum hearth extension on all stoves and inserts as measured from the door opening of the unit. (Canada) 18" (450 mm) minimum hearth extension on all stoves and inserts as measured from the door opening of the unit. Minimum distance of floor protection to the side = 8" (200 mm). This is measured from the sides of the door opening in the USA and from the sides of the insert in Canada.
- (2) J = Maximum lintel depth without flue offset or smoke deflector.
- (3) If the mantel projection is 8" or less, the 'A' mantel clearance may be reduced to 14".

NOTES:

- Facing material that projects more than 3/4" (19 mm) from the wall is considered a mantel or side wall.

Montlake™ 230GL		ZC Fireplace UL 127	Masonry Fireplace UBC Chapter 37
G	Depth Min.	15-1/2" (374mm)	15-1/2" (374mm)
H	Height Min.	21-1/2" (546mm)	21-1/2" (546mm)
J	Lintel Max. Depth ①	5-3/8" (137mm)	5-3/8" (137mm)
K	Front Width Min.	36" (914mm)	25" (635mm)
L	Rear Width Min.	22-1/2" (572mm)	22-1/2" (572mm)

① Without use of adjustable offset box or smoke deflector

Table 2 - Fireplace Sizing

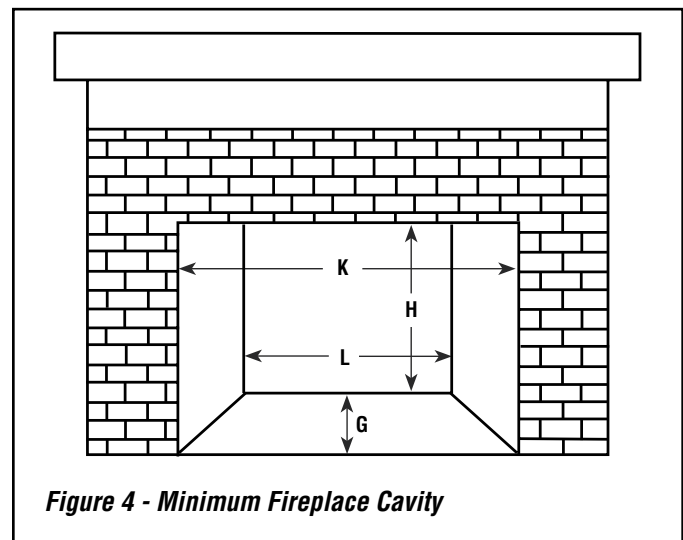
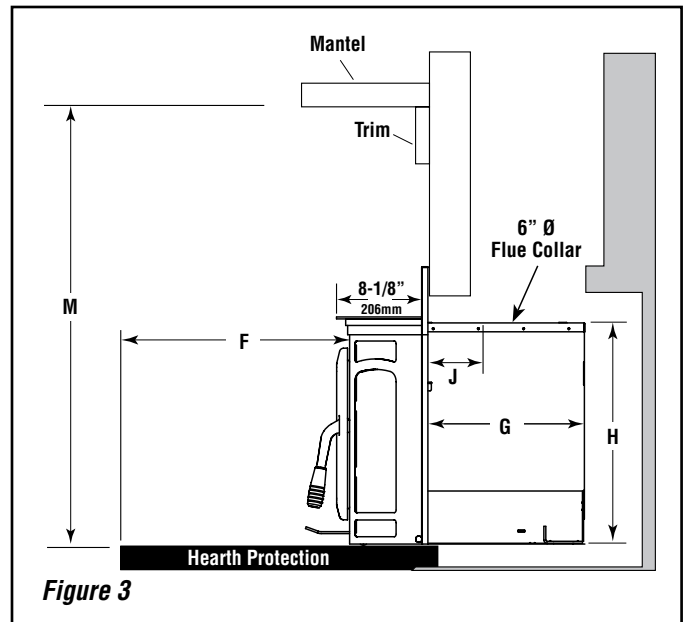
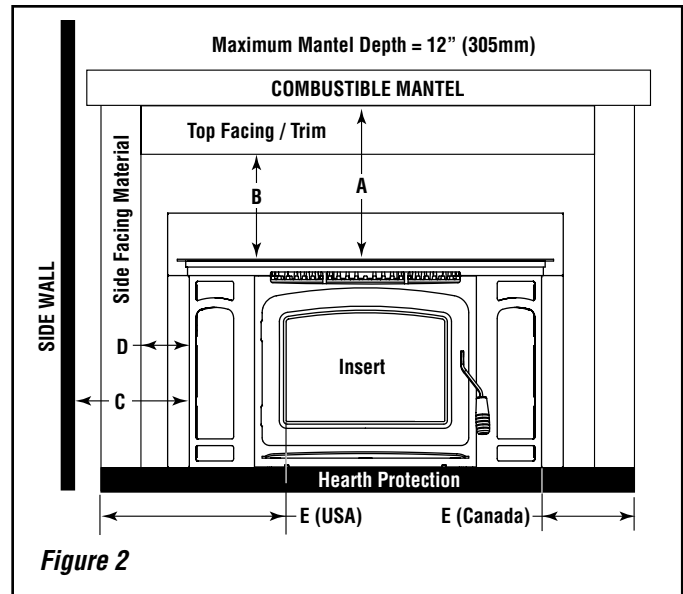
Also see appliance dimensional views on **Page 7** (see **Figure 8**).

Bottom Clearance	Thermal Protection Thickness	Hearth Extension Depth	
		USA	Canada
0" (0mm)	1-1/2" (38mm)	16" (406mm)	18" (450mm)
4-1/2" (114mm)	1/2" (13mm)	18" (450mm)	18" (450mm)
7-1/2" (191mm)	0" (0mm)	16" (406mm)	18" (450mm)

Table 3 - Hearth Extension / Thermal Protection Requirements

*Distance between hearth and the bottom of the appliance

REQUIRED CLEARANCES



NOTE: DIAGRAMS & ILLUSTRATIONS ARE NOT TO SCALE.

Montlake™ ML230GL

Product Reference Information			
Cat. No.	Description	Ship. Weight	Ship. Volume
TBD	Montlake 230GL Wood-Burning Insert	390 lb.	26.6 cu. ft.

NOTES:

- Dimensions shown are approximations only (+/- 1/4")
- Diagrams, illustrations and photographs are not to scale – consult installation instructions. Product designs, materials, dimensions, specifications, colors and prices are subject to change or discontinuance without notice.
- Approved for residential and manufactured home -installations.
- Optional Kits Available:
Door Trim Kit

❶ Square-foot heating capacities and burn times are approximations only. Actual performance may vary depending upon home design and insulation, ceiling heights, climate, condition and type of wood used, appliance location, burn rate, accessories chosen, chimney installation and how the appliance is operated.


SPECIFICATIONS

Flue Size	6" (152 mm)
Log Length	16" W x 18" D Max. (406mm W x 457mm D Max.)
Firebox	17" W x 19" D x 12-1/2" H Max. (432mm W x 483mm D x 318mm H Max.) Volume = 2.3 cu. ft.
Glass Viewing Area	16-1/2" W x 11-5/16" H (419mm W x 287mm H)
EPA Test Load: Cord Wood: ❶	28,200 BTUs/hr. 76,000 BTUs/hr.
Maximum Burn Times ❶	12 hours
Heating Capacity ❶	1200 to 2200 sq. ft.
EPA Grams Per Hour	1.7 gr/hr

EPA Phase II and Washington State Approved

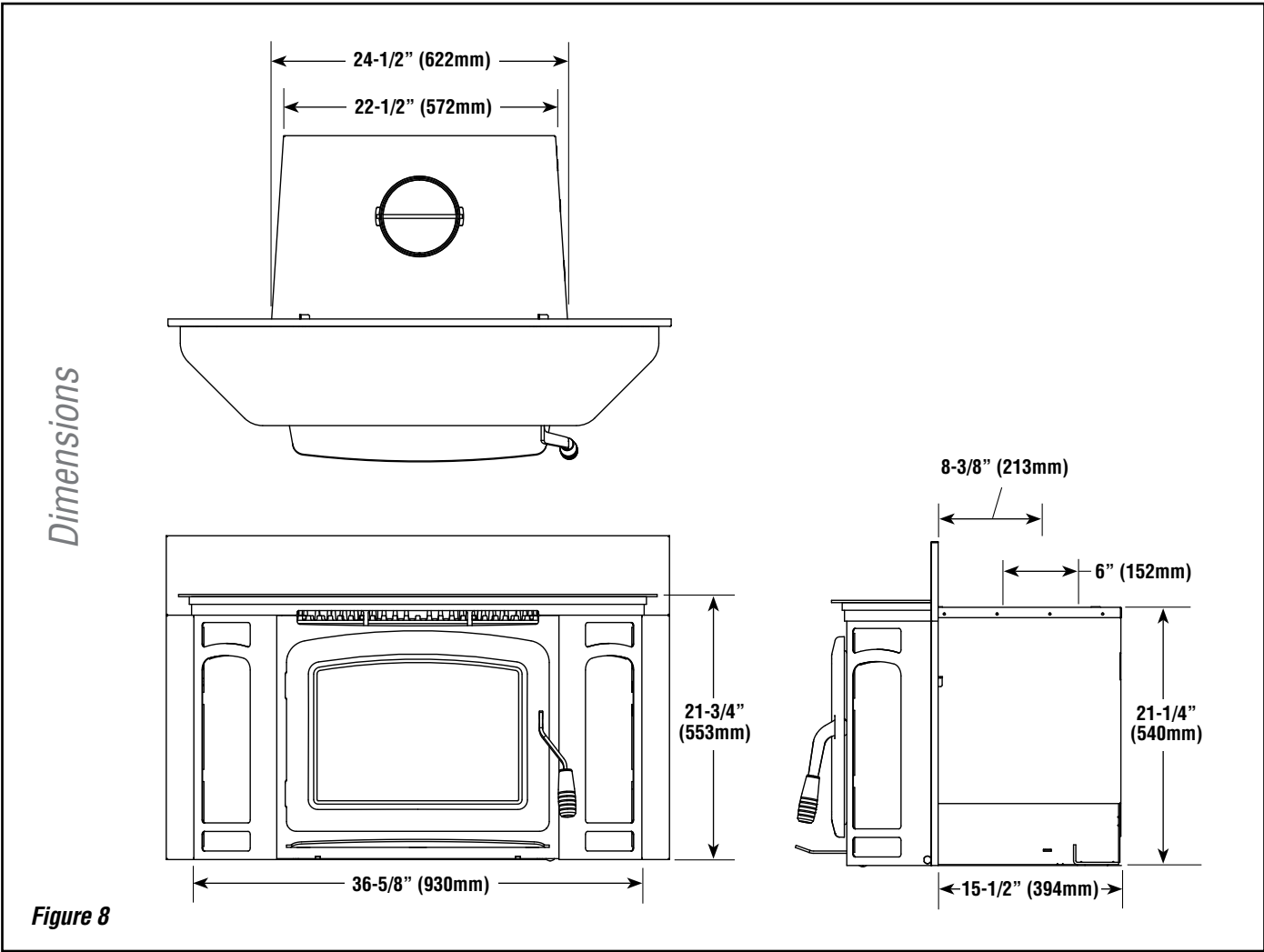
The Montlake™ Model ML230 wood-burning fireplace insert is safety listed with the following agency:

- PFS Corporation, Tested to UL 1482, ULC S628



Report # 14-182

Specifications
Listing



NOTE: DIAGRAMS & ILLUSTRATIONS ARE NOT TO SCALE.

Montlake™ ML230GL

The hearth/floor protection must be a thermally rated type II UL 1618 listed floor protection with a minimum R value of 3.12, or 2.08 per inch with a minimum thickness of 1-1/2" (38mm). The covering must extend to the front, a minimum of 16" (406mm) in the USA and 18" (450mm) in Canada. It must extend to the sides a minimum of 8" (200mm) in the USA and Canada (measured from the door opening in the USA and measured from the side of the unit in Canada).

To calculate the minimum thickness required for alternate material use either the **k formula** or **r formula** shown below.

Reference information

k_M = k value per inch of **alternate** material
 r_M = r value per inch of **alternate** material
 T_M = minimum thickness required for **alternate** material
 T_s = standard thickness of the **alternate** material

k_L = k value per inch of **listed** material
 r_L = r value per inch of **listed** material
 T_L = minimum thickness of **listed** material

NOTE: An asterisk "*" in formula below indicates it is a value taken from **Table 7**.

k formula:

Example using k formula: If Micore 160 Mineral Fiber Board is to be used for the floor protection, what is the minimum thickness required?

Minimum thickness of alternate material (T_M)	=	$\frac{k\text{-value (per Inch) of alternate material } (k_M)}{k\text{-value (per inch) of listed material } (k_L)}$	x	Specified min. thickness of listed material (T_L)
T_M (inches)	=	$\frac{* k_M}{* k_L}$	x	* T_L
T_M (inches)	=	$\frac{* .35}{* .48}$	x	* 1.5"
1.092 (inches)	=	.728	x	* 1.5"

Answer - The minimum required thickness of the Micore 160 is 1.094" therefore round up to nearest standard thickness available which is 1.125" (1-1/8")

r formula:

Example using r formula: If Micore 160 Mineral Fiber Board is to be used for the floor protection, what is the minimum thickness required?

Minimum thickness of alternate material (T_M)	=	$\frac{r\text{-value (per Inch) of listed material } (r_L)}{r\text{-value (per inch) of alternate material } (r_M)}$	x	Specified min. thickness of listed material (T_L)
T_M (inches)	=	$\frac{* r_L}{* r_M}$	x	* T_L
T_M (inches)	=	$\frac{* 2.08}{* 2.86}$	x	* 1.5"
1.092 (inches)	=	.728	x	* 1.5"

Answer - The minimum required thickness of the Micore 160 is 1.094" therefore round up to nearest standard thickness available which is 1.125" (1-1/8")

HEARTH PROTECTION

Listed Material				
	k (per inch)	r (per inch)	Listed Min. Thickness	R-Value
Listed Material	.48 k_L	2.08 r_L	1.5" (1-1/2") T_L	3.12
* Approved Alternate Materials for Floor/Hearth Protection				
Alternative Materials	Thermal Values		Minimum Thickness (rounded to nearest 1/8 inch)	
	k (per inch) k_M	r (per inch) r_M	Min. Thickness T_M	
Kaowool M Board	.48	2.08	1.5" (1-1/2")	
Micore 160™ U.S. Gypsum	.35	2.86	1.094" (1-1/8")	

Table 7

INSERT INSTALLATION

NOTE: IHP RECOMMENDS PROFESSIONAL INSTALLATION BY A LICENSED AND BONDED INSTALLER. SEE YOUR DEALER FOR RECOMMENDATIONS. IMPROPER INSTALLATION OR MIS-USE WILL VOID YOUR WARRANTY AND CREATE A SERIOUS SAFETY HAZARD.

This appliance is approved for use in a masonry fireplace built to UBC Chapter 37 or equivalent with a minimum 25" (635mm) opening at the front of the fireplace.

In residential applications, this appliance may be installed in a bedroom in the United States.

These heaters are designed to be installed into an existing masonry fireplace (built to UBC 37 or ULC S628 standards) or factory-built, solid-fuel and wood-burning fireplaces (listed to UL 127 or ULC S610) only.

Approved with or without positive flue connection. Approved with minimum 6" (152 mm) diameter stainless steel listed reline system. IronStrike® wood-burning inserts are tested to UL 1482 / ULC S628 and listed by PFS Corporation.

MASONRY FIREPLACE PRE-INSTALLATION PREPARATION

Remove any doors or screen materials from the fireplace opening. Remove the damper mechanism completely. Also remove grates or ember catches inside the fireplace hearth. If your fireplace is equipped with a smoke shelf or baffle and if it interferes with the installation it may be removed. Do not remove brick or mortar from masonry fireplace to accommodate insert.

Check all clearances for the flue connection prior to starting the install to ensure proper alignment. If there is an alignment problem, connection can be made using a short piece of stainless flex or a stainless steel offset box (available from your dealer). Before installing the liner, make any attachment brackets or drill any holes in the liner, offset box, or insert. Once installed, it may be difficult or impossible to drill additional holes.

FACTORY-BUILT ZERO CLEARANCE FIREPLACES – INSTALLATION PREPARATION

Fireplace and Chimney Requirements

This appliance must only be installed in a zero clearance factory-built fireplace using 6" (152mm) stainless steel pipe extending from the insert's flue into the chimney of the fireplace. For optimum safety and performance we recommend a full length stainless steel liner directly connected to the insert's flue outlet. This appliance must only be installed in a zero clearance factory-built fireplace that is structurally sound. Fireboxes or chimneys that have flaws, burn-outs, or warping must be replaced or repaired prior to installation. Check with your fireplace manufacturer if any problems exist. All convection vents and louvers must be left unmodified and unobstructed.

This appliance can only be installed in the factory-built fireplaces listed to UL 127 or CSA S610.

See **Page 6** (ML230) for the minimum fireplace cavity size requirements. Installations into other brands of the same size is permissible only with approval from local building officials.

Modifications allowed to the factory-built fireplace are as follows:

- Remove the damper
- Remove the smoke shelf or smoke baffle
- Remove ember catches
- Remove viewing screen/curtain
- Remove side and rear bricks
- Remove the fire grate
- Remove doors

The factory built chimney must be listed per UL 127 (US), and meet type HT requirements of UL 103 (US). Factory built fireplace chimneys tested to UL 127-1998 (or later), may be at the fireplace manufacturer's option, tested to the same criteria as UL 103HT requirements. If the chimney is not listed as meeting HT requirements, or if the factory built fireplace was tested prior to 1998, a full height listed chimney liner must be installed from the appliance flue collar to the chimney top. The liner must meet type HT requirements (2100°F) per UL 1777 (US). The liner must be securely attached to the insert flue collar and the chimney top. To prevent room air passage to the chimney cavity of the fireplace, seal either the damper area around the chimney liner with high temperature sealant or the fireplace with fiberglass batting.

FACTORY BUILT FIREPLACE WARNING TAG

The fireplace must not be altered, except for the exceptions listed above. The permanent metal warning label provided must be attached to the back of the fireplace, stating that the fireplace may have been altered to accommodate the insert, and must be returned to original condition for use as a conventional fireplace.

NOTE: Secure the tag using screws or nails to the fireplace

This fireplace has been altered to accommodate a fireplace insert and should be inspected by a qualified person prior to re-use as a conventional fireplace.

Figure 10 - Fireplace Warning Label

CHIMNEY LINER INSTALLATION

IMPORTANT NOTE: See Draft Requirements and Selecting a Proper Venting System on **Page 4** to assist you in choosing the proper venting system for your installation.

WARNING: CHIMNEY CONNECTOR MUST BE IN GOOD CONDITION AND KEPT CLEAN. DO NOT INSTALL DAMAGED PARTS.

Remove the existing chimney cap and install a stainless steel liner into the chimney (if a special section has been used or drilled to attach to the insert, it must be the bottom piece). The next piece should be a dripless slip joint, followed by the rest of the chimney liner. Fasten the chimney at the top when it is positioned so that the slip joint will allow the lowest piece to slide up enough to clear the insert during installation. Insulate the top four to six feet between the liner and the chimney to prevent heat loss. Install the cap and flash if necessary to prevent water or creosote from entering the chimney's venting system.

From inside the fireplace firebox, attach any adaptors or flue offsets and slide the liner up as far as necessary for the bottom piece to clear the insert during installation.

In Canada, This fireplace insert must be installed with a continuous chimney liner of 6" diameter extending from the fireplace insert to the top of the chimney. The chimney liner must conform to the Class 3 requirements of CAN/ULC-S635, Standard for Lining Systems for Existing Masonry or Factory-Built Chimneys and Vents, or CAN/ULC S640, Standard for Lining Systems for New Masonry Chimneys.

POSITIVE FLUE CONNECTION (REQUIRED IN CANADA)

A positive flue connection is providing a seal between the vent pipe or liner and the existing fireplace chimney for the purpose of preventing room air passage to the chimney cavity of the fireplace. There are different approved methods to achieve this. See *Direct Connect Positive Flue Connection* on this page.

Direct Connect Positive Flue Connection

See the following instructions for approved methods of achieving a positive flue connection - See **Figure 12**.

A qualified installer should evaluate the existing fireplace to determine the best method for achieving a positive flue connection between the vent pipe or liner and the existing fireplace chimney. The most common method for achieving a positive flue connection in masonry fireplaces is to secure a seal-off plate (i.e. 22-gage sheet steel) in the fireplace throat using masonry screws. Other acceptable methods include packing noncombustible material (i.e. high temp fiberglass or ceramic insulation) around the vent pipe or using a flue adaptor. Whatever "seal off" method is used, it must effectively seal the area to prevent room air passage to the chimney cavity of the fireplace.

Alternate Flue Liner Attachment Method (for short fireplace installations)

For shorter fireplace firebox installations, where it may be difficult to attach the liner to the flue collar on top of the insert, you can complete the final liner attachment from within the insert firebox as follows:

1. Remove the screw, bracket and inner collar as shown below.
2. Using 3 screws, secure the liner to the inner collar.
3. From within the insert firebox, pull down the inner collar (with liner attached).
4. Reassemble the components as shown below.

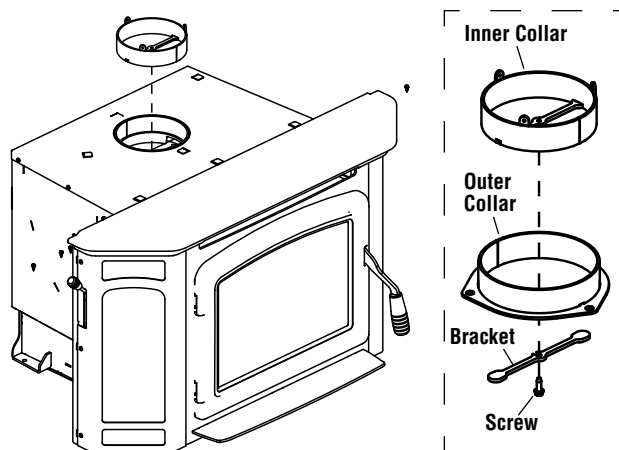
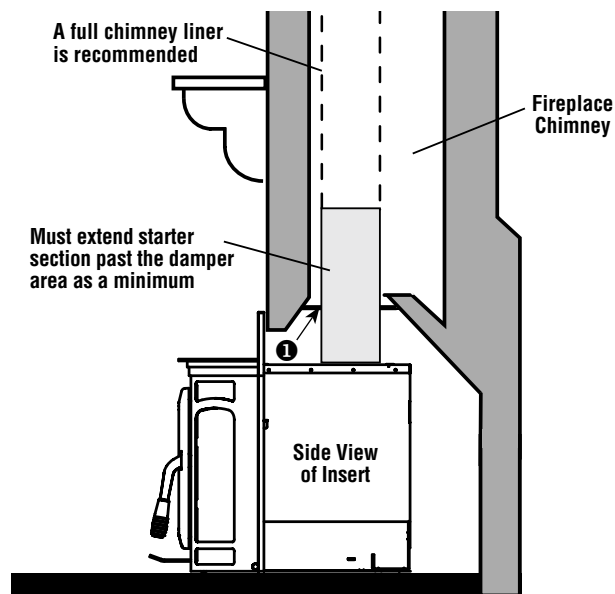


Figure 11

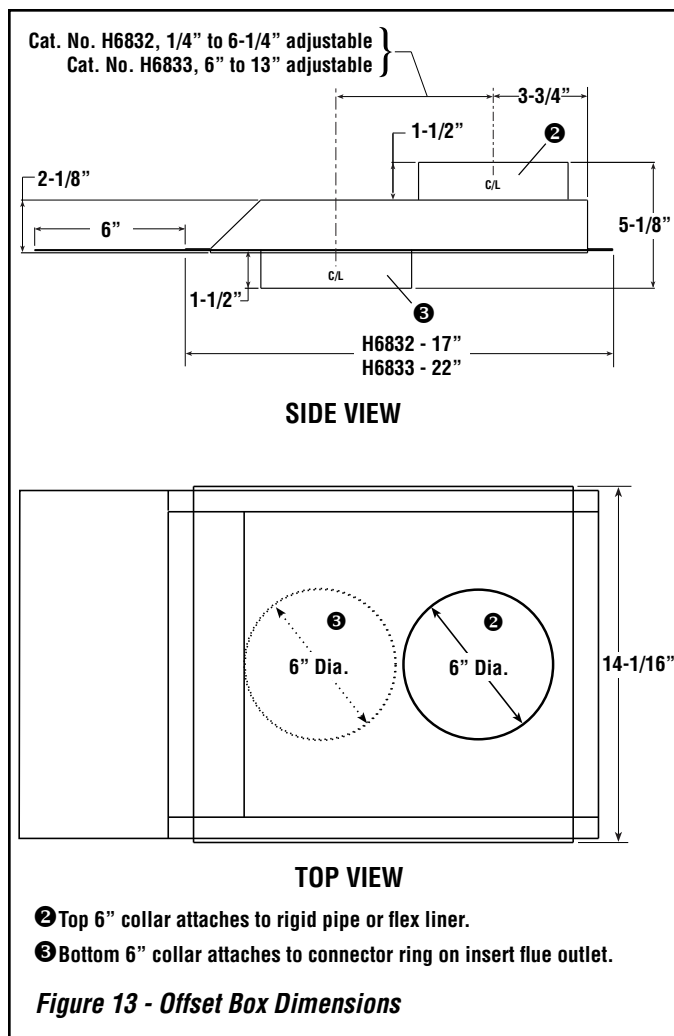


① A non-combustible seal is required at the damper area (to prevent dilution air from entering the chimney). See *Direct Connect Positive Flue Connection* on this page. A seal-off plate method is shown here.

Figure 12 - Positive Flue Connection

Offset Boxes

Offsets can be handled using an offset box (it aligns flue outlet of insert with the fireplace flue (see **Figures 12 and 13**). Care should be used to ensure that this adjustable offset box is oriented so it does not angle down when positioned on the insert flue outlet (level or slightly up at the outbound end is recommended).



INSTALLATION PROCEDURE FOR MASONRY AND FACTORY-BUILT FIREPLACES

READ THE ENTIRE INSTALLATION INSTRUCTIONS AND CHECK ALL REQUIRED CLEARANCES PRIOR TO INSTALLING THIS APPLIANCE.

WEAR GLOVES DURING INSTALLATION IN CASE OF SHARP EDGES ON THE FIREPLACE.

CAUTION



SHARP EDGES - WATCH YOUR FINGERS

Wear gloves to guard against any sharp metal edges.

Position Insert and Connect Venting

Place the insert into the fireplace, making sure to center it side to side. Slide the insert in until the surround mounts are approximately 1/2" (13 mm) from the face of the fireplace where the surround panels cover. Lower the chimney and make attachment to the insert.

Leveling the Insert in the Fireplace

The leveling leg access holes are accessible from inside the firebox. Break away both cover plates and insert the leveling bolts (provided in manual pack). Level the fireplace insert by using a 9/16" socket to adjust the bolts. The leveling bolts are 1" in length and combined with minimal clearance in the firebox, only allows for 1/2" adjustment. If more adjustment is needed, longer 3/8-16 UNC bolts can be used at the appropriate lengths. For installs where the fireplace bottom is sloped down toward the back, refractory brick can be used to first level the fireplace floor prior to installing the insert.

Installing Surround Panels and Insert Top

Once the insert is in place and the venting has been connected, install a surround panel kit to cover the exposed fireplace opening. For factory-built fireplace installations, you must leave 1/4" space between the surround panels and the fireplace front. After installing the surround panels, install the insert top warming surface.

Installing Front Support

If front support is necessary, use a front support kit (Part# H8675 for model ML230GL) to support the front of the insert and fill the space between the hearth and the insert bottom. Leveling legs can be used to support the front of the insert and can be inserted into two 3/8-16 holes located under the front of the firebox.

NOTES:

- Although not required, a full-length stainless steel liner is recommended for optimum safety and performance. If a full-length liner is not used and a consistent draft cannot be maintained during operation, it may be necessary to use a full-length liner. See your IHP dealer for details.
- When installing Your appliance with a positive flue connection into a factory-built fireplace, be sure to leave the insulation off the surround panels (flanges) and leave a 1/4" (6 mm) airspace insulation off the surround panels and the facing of your fireplace.
- This appliance may be vented into a code-approved masonry chimney with flue liner.
- It is necessary to permanently seal any opening between the masonry of the fireplace and the facing masonry.

MANUFACTURED HOME INSTALLATIONS (ML230GL ONLY)

This appliance is approved for installation into a manufactured (mobile) home. Installation should be in accordance with the Mobile Home Construction and Safety Standard, Title 24 CFR, Part 3280 (in Canada CAN/CSA Z240 MH), or, when such a standard is not applicable, the Standard for Mobile Home Installations, ANSI A225.1.

The appliance must be secured to the floor of the fireplace and grounded to the chassis of the mobile home.

WARNING: DO NOT INSTALL IN SLEEPING ROOM OF A MOBILE HOME.

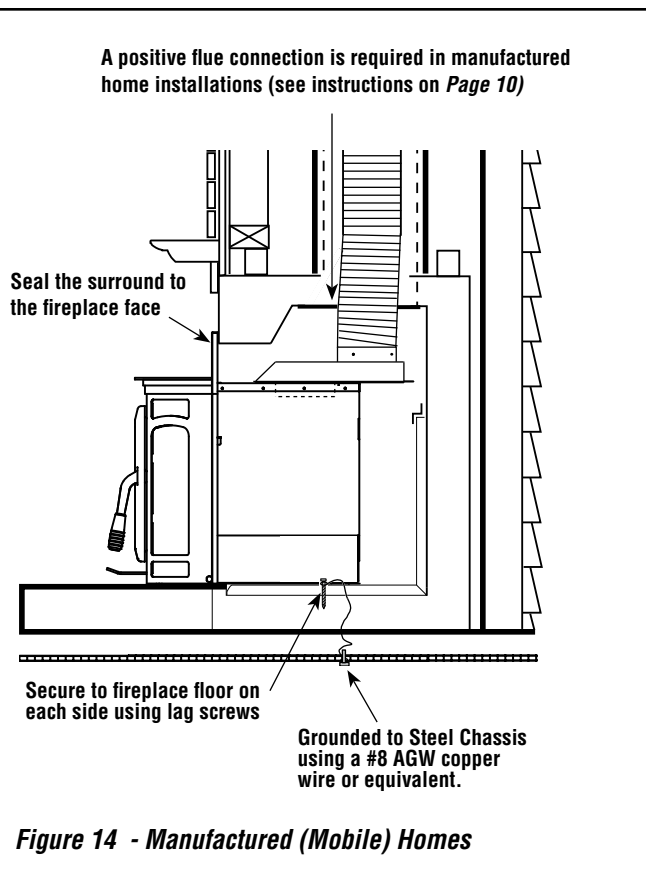
CAUTION: THE STRUCTURAL INTEGRITY OF THE MOBILE HOME FLOOR, WALL AND CEILING/ROOF MUST BE MAINTAINED.

Approved Chimney Liner - Flexible or Rigid 6" Stainless Steel 2100°F HT Liner listed to UL-1777 (US) or ULC-S635 (Canada).

YOUR CHIMNEY LINER INSTALLATION MUST COMPLY WITH LOCAL BUILDING AND FIRE CODES.

Outside Combustion Air

In Manufactured (mobile) Home installations, outside combustion air is required. This can be achieved by sealing the surround assembly to the fireplace face (and anywhere else that room air may enter the firebox of the fireplace). A positive flue connection is also required (see instructions on **Page 10**). This will ensure combustion air is drawn through the existing fireplace air duct from outside the house and into the air intake on the lower back of the appliance.



Factory Built (ZC) Fireplace
Built to UL-127 (US) or ULC-S610 (Canada) Standards

Requires a minimum of a positive flue connection (*Figure 12*) in the USA. In Canada, a full length stainless steel flue liner is required.

Approved Liner -
6" - 2100°F HT Liner listed to
UL-1777 (US) or ULC-S635
(Canada)

Flexible or Rigid 6"
Stainless Steel
Liner

Remove Fireplace
Damper Or
Secure Open

Secure liner to flue
outlet using three
sheet metal screws

Shown with offset
box installed (see
Offset Boxes on
Page 11)

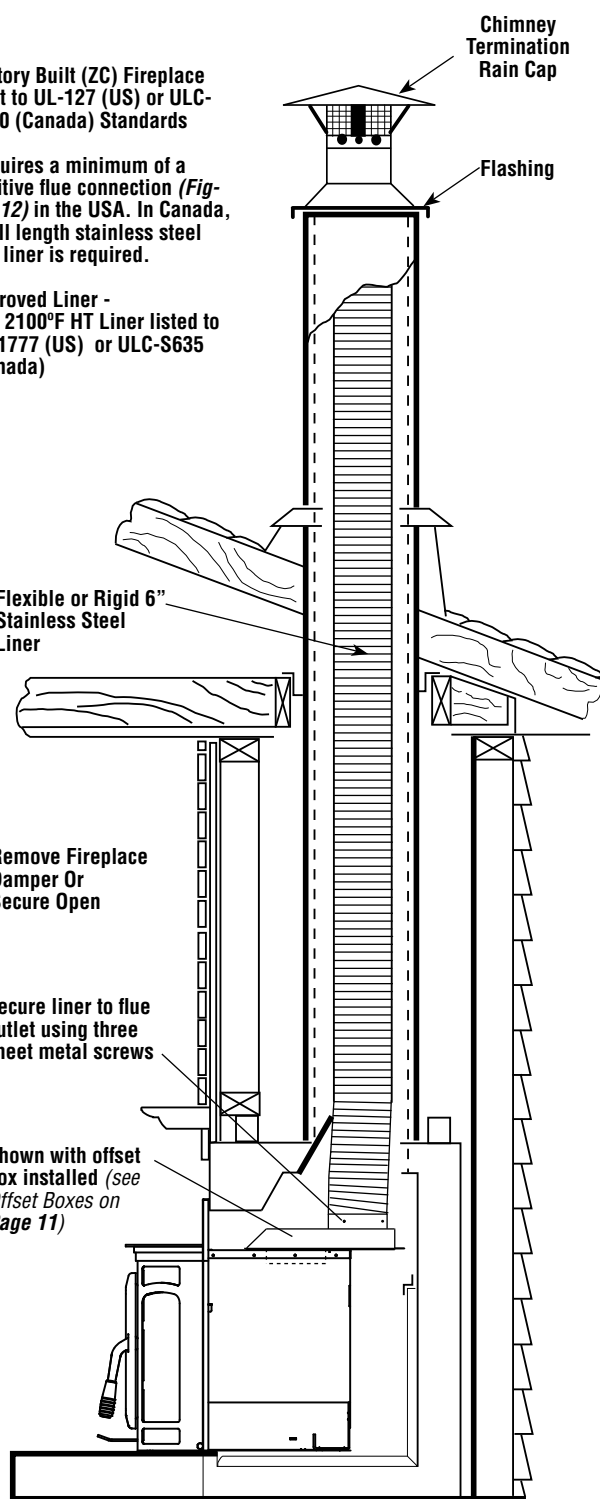


Figure 15 - Typical Installation - Factory Built Fireplace

Masonry Fireplace -
Built to UBC Chapter 37
Standards

Requires a minimum of a positive flue connection (*Figure 12*) in the USA. In Canada, a full length stainless steel flue liner is required.

Approved Liner -
6" - 2100°F HT Liner listed to
UL 1777 (US) or ULC S635
(Canada)

Flexible or Rigid 6"
Stainless Steel
Liner

Remove Fireplace
Damper Or
Secure Open

Secure liner to flue
outlet using three
sheet metal screws

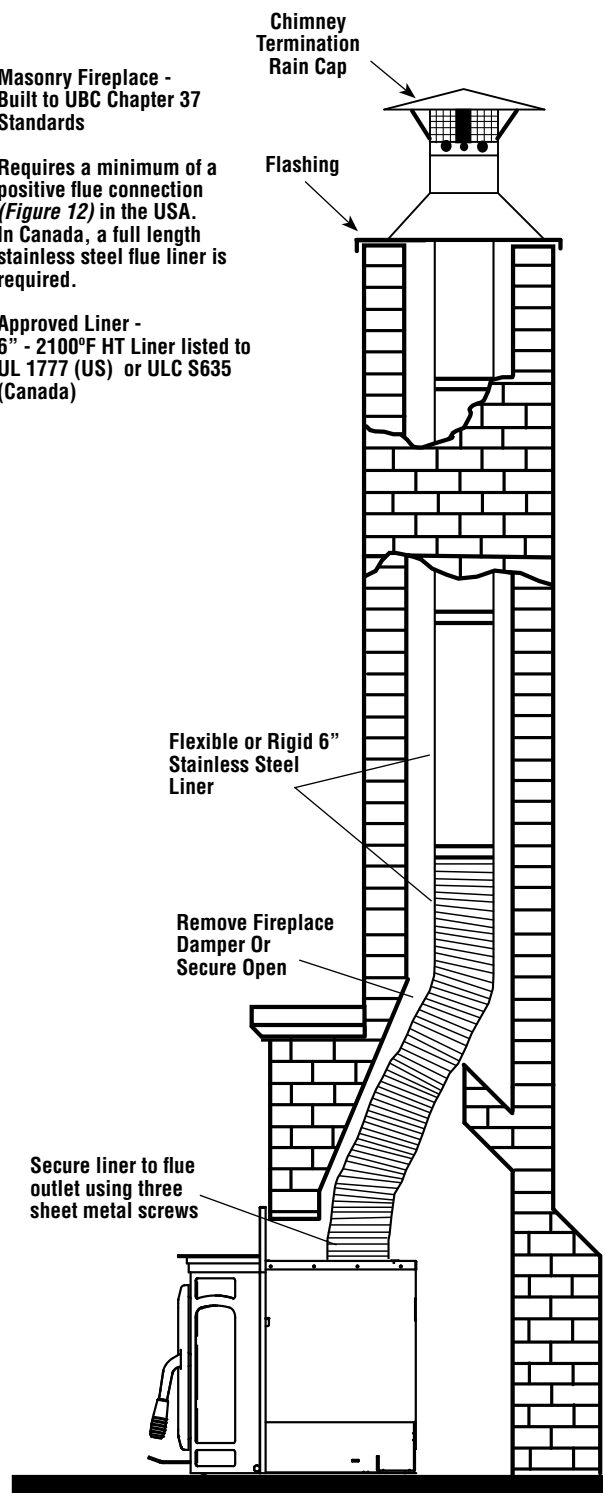


Figure 16 - Typical Installation - Masonry Fireplace

**YOUR CHIMNEY INSTALLATION MUST COMPLY WITH LOCAL BUILDING AND FIRE CODES.
INSTALL VENTING SYSTEM PER VENT MANUFACTURERS INSTRUCTIONS!**

Montlake™ ML230GL

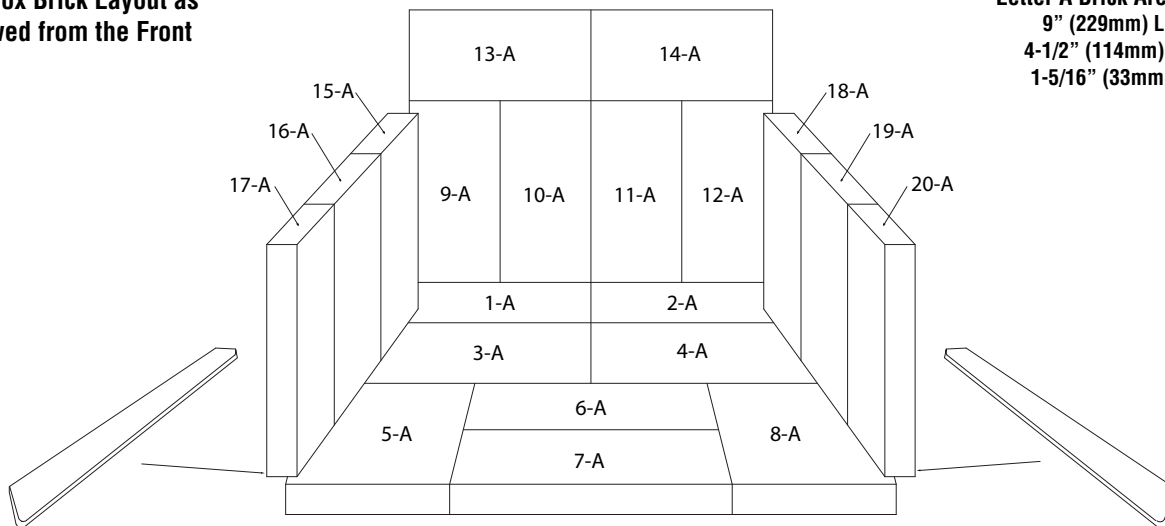
BRICK AND BAFFLE INSTALLATION

CAUTION: Wear gloves during brick installation in case of sharp edges inside the stove or insert.

WARNING: IF THE BRICKS ARE NOT INSTALLED EXACTLY AS SHOWN BELOW, THEY COULD FALL OUT OF PLACE DURING REFUELING OR BURNING OF THE STOVE OR INSERT CAUSING SERIOUS INJURY.

1. Install firebox bottom brick spacers on both the left and right side of firebox. The brick spacers are located in the package with the manual. Assure that brick spacers are pushed to each side until they are in full contact with the firebox side on each side.
NOTE: Your brick spacers may already be welded in place.
2. Install brick #1-20 in the numbered sequence shown in **Figure 17**.
3. Brick's 13 and 14 will be located between the steel firebox and rear baffle board (already installed).
4. Once all bricks are installed confirm that the already installed baffle boards are in there correct location and resting on the secondary burn tubes.

Firebox Brick Layout as Viewed from the Front



Letter A Brick Are Full Size
9" (229mm) Long x
4-1/2" (114mm) Wide x
1-5/16" (33mm) Thick

Figure 17 - Brick

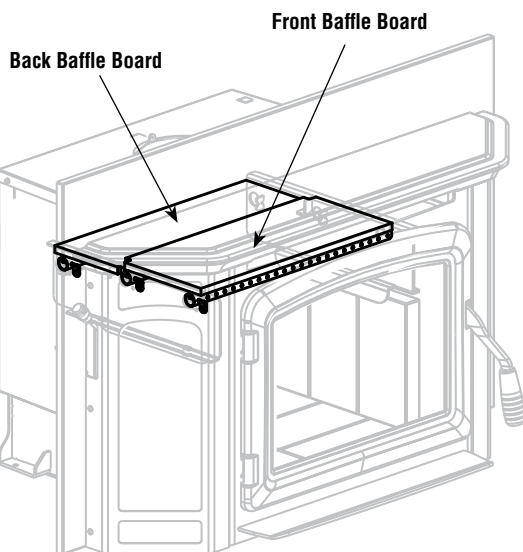


Figure 18 - Baffle Boards Installed

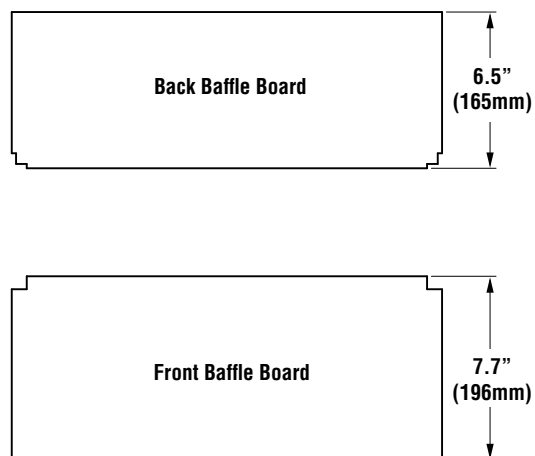


Figure 19 - Baffle Boards

NOTE: DIAGRAMS & ILLUSTRATIONS ARE NOT TO SCALE.

SECONDARY TUBE AND BAFFLE BOARD REPLACEMENT

- Gently lift front baffle board upward and place on rear baffle board.
- Starting front to rear, locate secondary tube retaining pin and rotate counter clockwise; pull pin toward front of stove, allowing capturing end to slide through retaining pin notches as shown.
- Slide secondary tube to the right, releasing it from the left side. Angle left side upward, and slide left to release from right side. Remove tube from stove
- Repeat process for secondary tube number two
- Gently lift top baffle board and slide forward; tilt left side up and left slightly, allowing the right side to drop into the firebox area for removal. Repeat process for rear baffle board
- Secondary tubes three and four can now be removed in same fashion as tubes one and two
- Reinstall baffle boards and secondary tubes in reverse order. *Note- Secondary tube number one has larger holes, as the remainder of the tubes are the same.

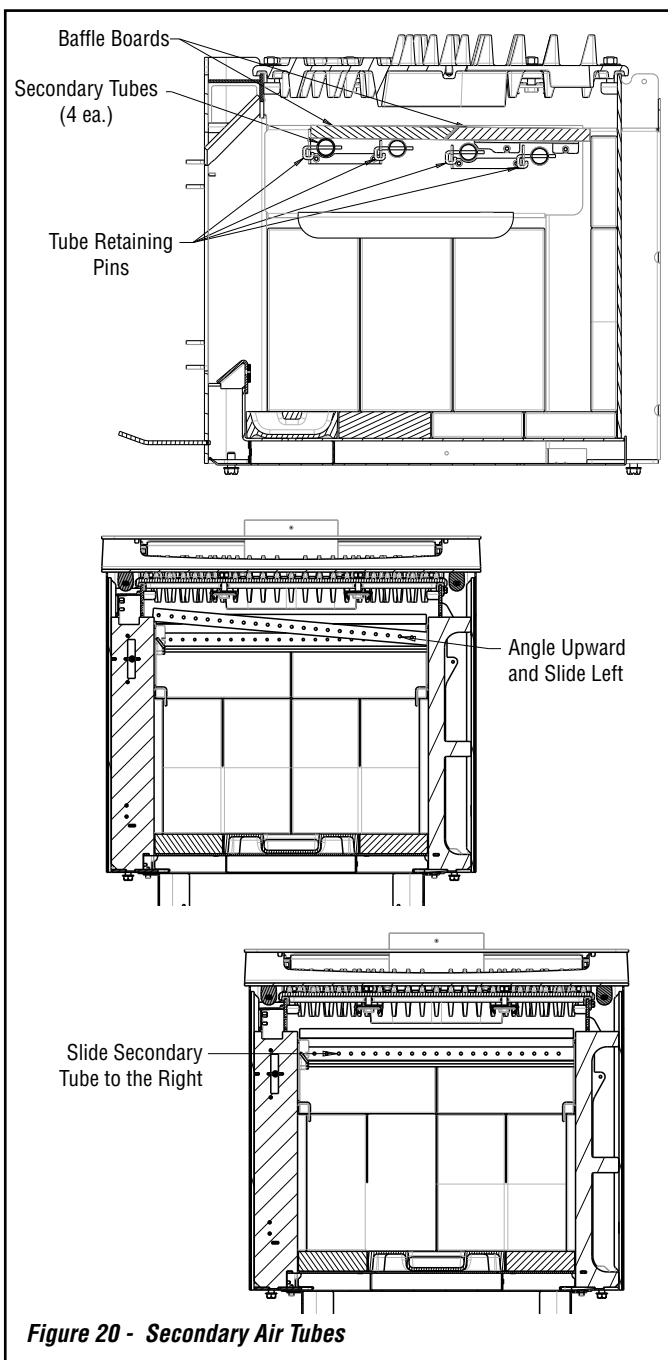


Figure 20 - Secondary Air Tubes

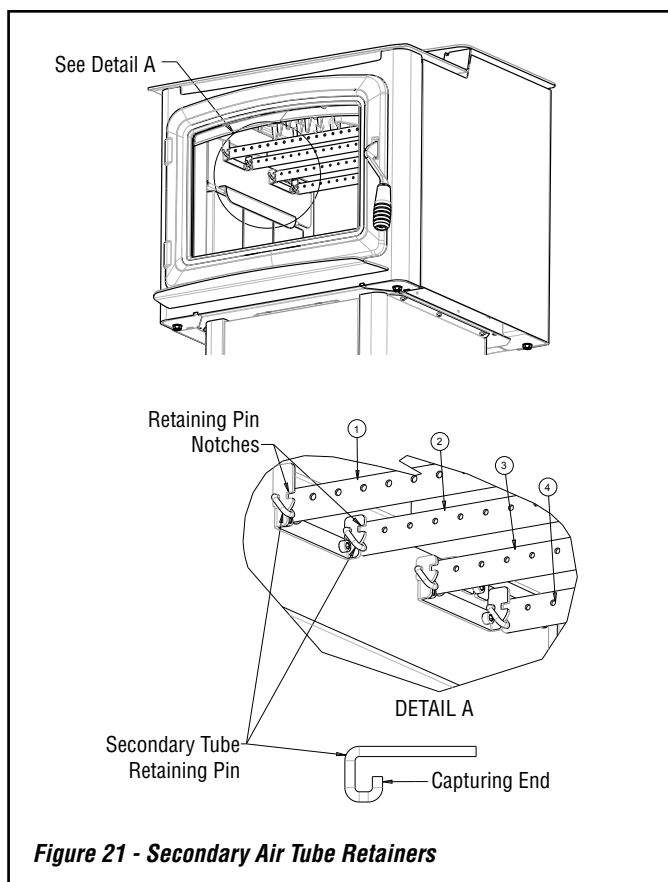


Figure 21 - Secondary Air Tube Retainers

TIMER REPLACEMENT:

- Turn damper lever counter clockwise and remove from stove
- Remove thermostat bracket (if equipped) by removing the two mounting screws and sliding rearward through the opening; set aside
- Loosen the top and bottom left heat shield mounting screws, leaving loose but in place; fully remove center mounting screw
- Lift left heat shield upward, while pulling rearward to release heat shield from rear mounting screws and front capturing tabs; set aside
- Lift upward on vertical timer link to engage timer and gain access to vertical timer link mounting screw; remove screw
- Remove timer mounting screws and timer
- Replacement timer will come equipped with timer engagement link
- Reinstall timer in reverse order; it may be necessary to rotate timer engagement link slightly to properly mount timer and align with vertical timer link (do not rotate more than 180 degrees)
- To reattach timer engagement link, lift upward slightly to align mounting hole with vertical timer link mounting hole. Tighten screw until tight and loosen slightly so timer linkage can operate freely.

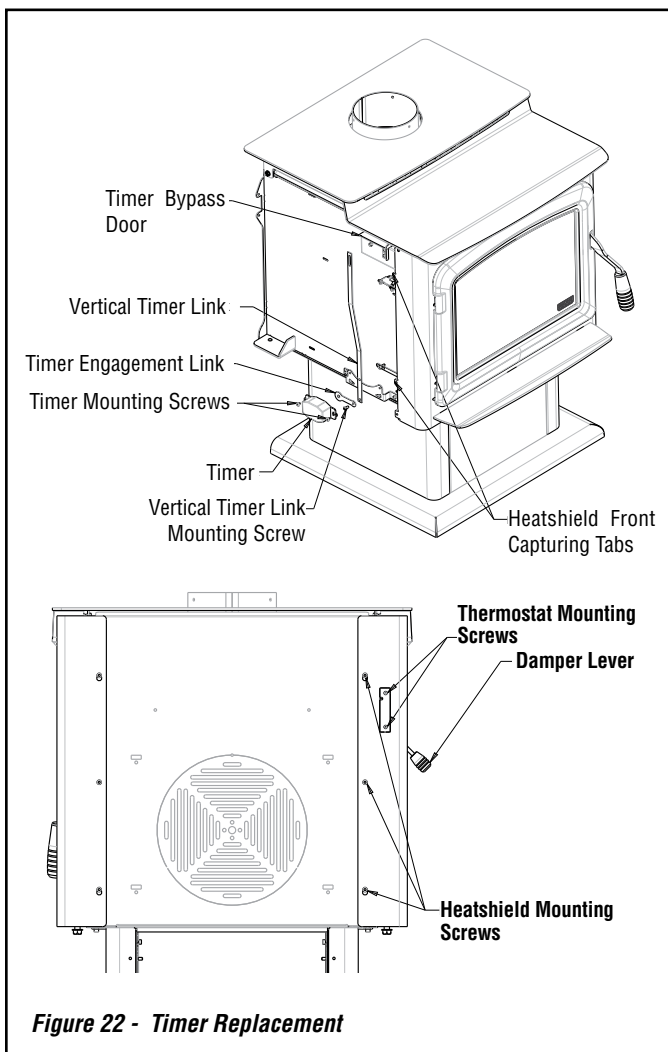


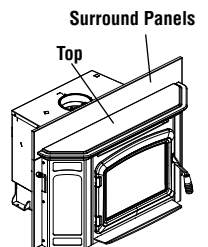
Figure 22 - Timer Replacement

CHECK:

- Inspect timer linkage to ensure it can move freely and is not binding. Vertical timer link can be lifted in an upward and downward motion (manually engaging and disengaging timer), which will open and close the timer bypass door near the top of the unit. This should operate freely with only slight tension from the torque of the timer. Now manually slide vertical timer link downward, disengaging timer. Open door; timer should reengage, lifting timer bypass door, which will then close in approx. 25-30 minutes. If functioning properly, proceed to reassemble stove. If timer is not functioning properly, check all mounting points within linkage to ensure they are moving freely. A small amount of antisieze or high temp lithium grease may be applied to moving linkage parts for lubrication.
- Reinstall left heat shield in reverse order, ensuring slots on front edge of heat shield slots are captured on the front capturing tabs.
- Reinstall thermostat in reverse order
- Reinstall damper lever; if damper lever is misaligned with slot and/or mounting point, the heat shield is not captured properly on the front capturing tabs. Loosen rear mounting screws and ensure proper alignment.

POST INSTALLATION CHECKS

- ☐ Check that one of the required surround kits is properly installed per the instructions provided in kit (Instr. # 506033-76). See Page 28 for ordering information.
- ☐ Check that one of the required top warming surface kits is properly installed per the instructions provided in kit (Instr. # 506033-75). See Page 28 for ordering information.
- ☐ Check that all chimney pipe joints are secured and installed according to the manufacturers instruction.
- ☐ Be sure all roof flashings are watertight (if applicable).
- ☐ Ensure baffle and brick are properly installed (see Page 14).



FOR YOUR OWN PROTECTION AND INSURANCE PURPOSES, HAVE YOUR CHIMNEY AND CONNECTOR PIPE INSTALLATION INSPECTED BY YOUR LOCAL BUILDING CODE AUTHORITY OR FIRE MARSHAL BEFORE STARTING A FIRE IN YOUR STOVE OR INSERT. NOTIFY YOUR INSURANCE COMPANY.

ATTACHING CONTROL LABELS

Once the surround panels are in place, apply the included control labels as shown in **Figure 23**.

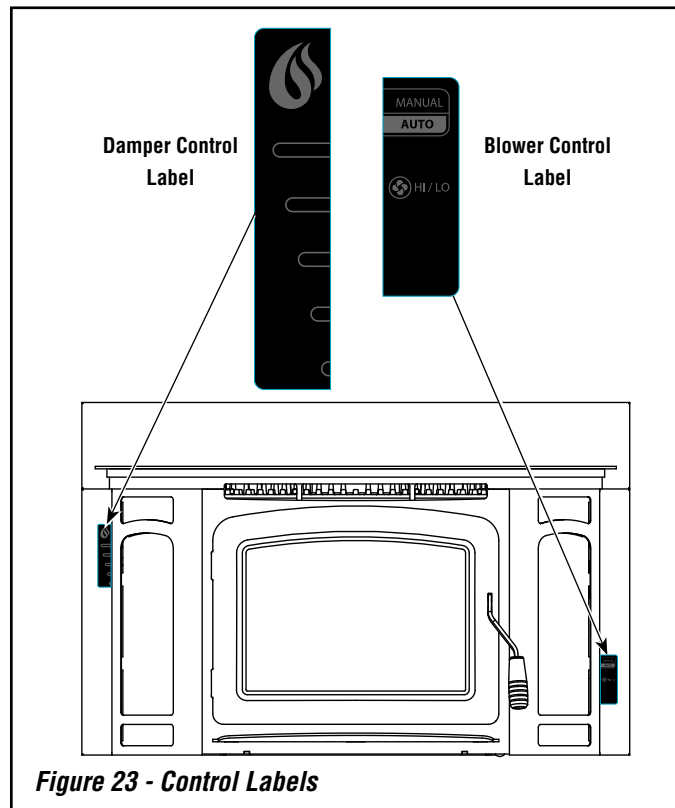


Figure 23 - Control Labels

PAINT CURING

If your appliance has plated accessories, be sure to clean it with a household type glass cleaner and a very soft cloth to remove any fingerprints and residues prior to the first fire and before any fire if the plated accessory has been handled or soiled. Do not close the door tightly during the "Burn-In Period." Also, open the door frequently (every 5-10 minutes) to keep the gasket from adhering to the curing paint. Ventilate the house well during these first firings as the paint gives off carbon dioxide and unpleasant odors. It is recommended that persons sensitive to an imbalance in the indoor air quality avoid the appliance during the curing process.

Your new appliance is painted with a high temperature paint that cures during the first few firings. We recommend that you put your stove or fireplace insert through a regimen of three burns. The first two should last for 20 minutes each at 250 degrees (the appliance should be allowed to cool completely between each burn). The third should be a burn of at least 450 degrees F. for 45-60 minutes. The paint will become soft, gummy and emit non-toxic smoke during these burns. During these first burns, open the appliance door frequently to help prevent the door gasket from adhering to the appliance. After the appliance cools down for the third time, the paint will harden. **DO NOT BUILD A LARGE ROARING FIRE UNTIL THIS CURING EFFECT IS COMPLETE OR YOU MAY DAMAGE THE FINISH OF YOUR STOVE OR INSERT.** Spray can touch-ups should be done only with a high temperature stove paint (cat. no. H8159), available from all IHP dealers.

BURN-IN PERIOD

Please be patient with the heat output of your appliance for the first few weeks. The steel will go through a curing process that eliminates mois-

ture, which is deep in the steel and firebrick. This moisture will reduce initial heat output of your appliance and may make it difficult to start. **(DO NOT OVERFIRE THE STOVE OR INSERT DURING THIS PROCESS. IF THE STOVE OR INSERT OR CHIMNEY BECOMES RED, REDUCE THE AMOUNT OF AIR ENTERING THE STOVE OR INSERT IMMEDIATELY).**

OPERATING HINTS

1. Burn only dry, well-seasoned cord wood. In some states it is illegal to burn wet wood or anything other than clean, dry wood products.
2. Your stove or fireplace insert is designed to operate with the door closed! Operate only with the door shut tightly at all times except when loading wood and possibly on start up to establish a draft. Never leave the unit unattended while the front door is opened.
3. **DO NOT** hit or move the baffle board while loading wood. Occasionally check the baffle. Loading oversized logs may dislodge the baffle boards.
4. **CAUTION: THE DRAFT CONTROL MUST BE FULLY OPEN BEFORE OPENING THE DOOR TO AVOID POSSIBLE COMBUSTION FLASH!!** (Ignition of hot volatile gases as the door is opened).
5. Feeding excessive amounts of fuel to the appliance should be avoided. It is important to supply it with sufficient draft and fuel to maintain a moderately hot fire. If, during overnight burns, heavy creosote deposits develop inside your stove or fireplace insert and on the door, the draft is set too low - review your burning habits!

DOOR OPERATION

Do not operate the appliance with the door open or ajar other than possibly during start up to create a draft (Do not leave the unit unattended while the front door is slightly open during start up). Operating the appliance with the door open other than in initial start up if needed will produce extreme temperatures within the appliance. Damage caused from over-firing is not covered under the manufacturers limited warranty.

WARNING

Be careful not to abuse door assembly by striking or slamming it. If the door assembly or glass is broken or damaged, they must be replaced with factory original parts before heater can be safely operated. Use only components provided by the manufacturer as replacement parts.

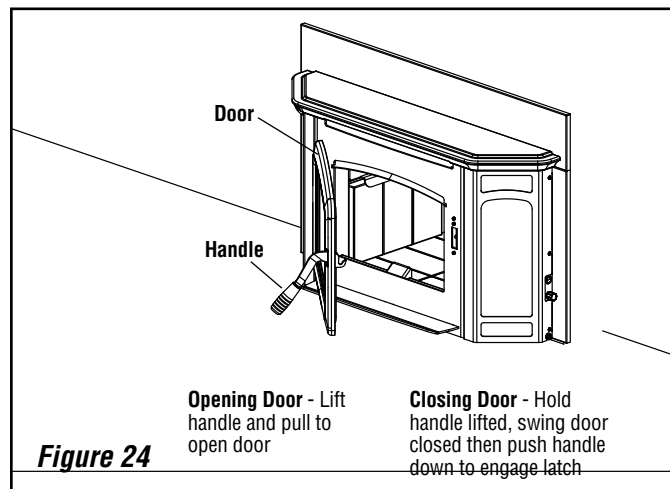


Figure 24

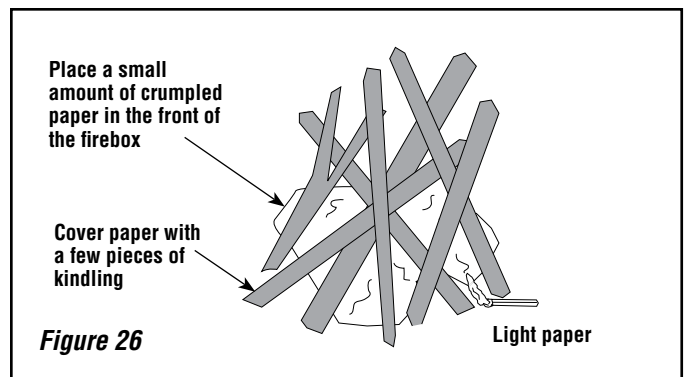
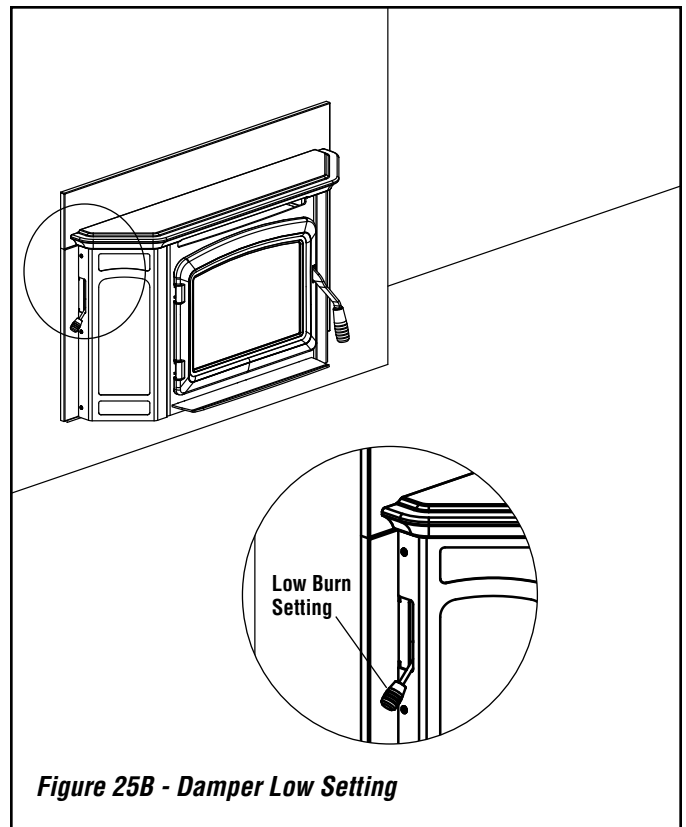
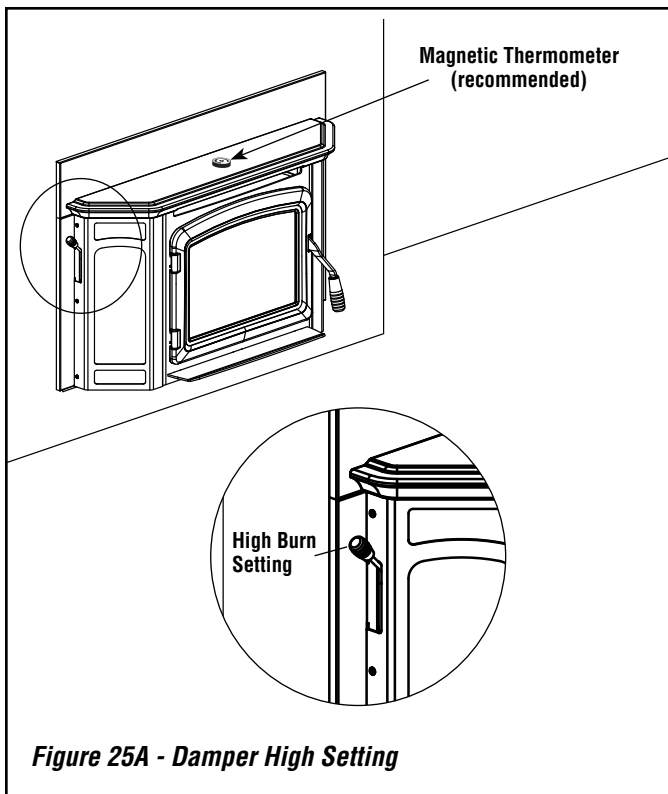
STARTING AND MAINTAINING A FIRE

1. **NEVER USE FLAMMABLE LIQUIDS TO START OR REKINDLE A SOLID FUEL FIRE!!**
2. Fully open the primary draft control by placing draft control (wood handle located on left side of the stove) in the highest position. This control determines the amount of air entering the stove. Lowering this control reduces the burn rate of the stove. For your convenience, the control is marked with five positions to assist you in obtaining repeatable burn rates.
3. Place a small amount of crumpled paper in the front of the firebox and cover it with a few pieces of kindling.
4. Light the paper and allow sufficient time for the kindling to become fully engulfed in flames. You will now close the wood units front door. Your wood units front door may or may not need to be left slightly open during this start up process, this depends on the appliance model and the amount of draft present.
5. When operating any wood burning appliance, it is important to become familiar with how the damper control affects heat output and the overall temperature of the appliance. A stove thermometer can be a helpful tool to help ensure you are not over-firing your appliance and it will also ensure you are burning fuel at a rate that is most efficient. Place a stove thermometer on the top of the appliance as shown in **Figure 25A**. Monitor the temperature every 15 minutes or so until you become more familiar with your appliance. Close the damper all the way down if you begin to reach 400 degrees, as this is a sign that you are operating your appliance at too high a temperature.

DO NOT LEAVE THE APPLIANCE UNATTENDED WHILE THE FRONT DOOR IS SLIGHTLY OPEN.

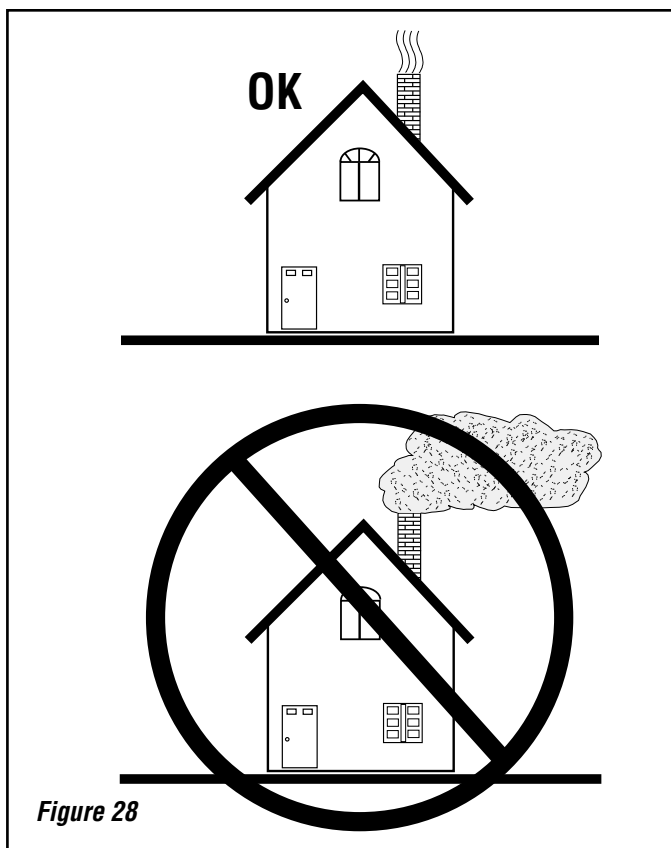
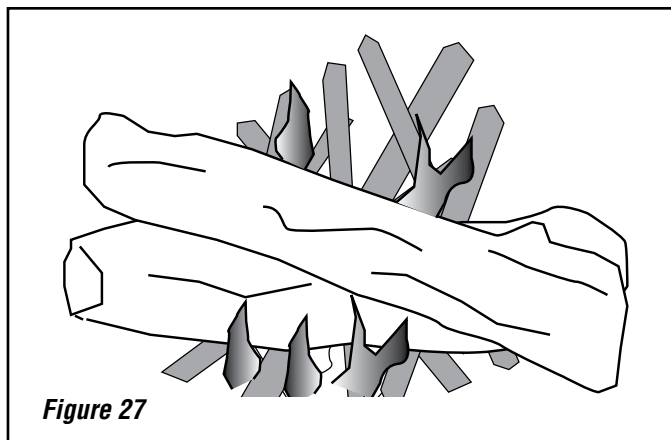
CAUTION: Do Not alter the adjustment range of the draft control for increased firing for any reason.

Operate only with fuel door closed. Maintain all seals in good condition. Do not operate with broken glass.



SEE MAINTENANCE SECTION FOR GLASS CLEANING GUIDELINES AND TIPS FOR KEEPING THE GLASS CLEAN (Page 24).

6. Once kindling is burning well, larger pieces of wood may be added, then the door should be fully closed if there was the need to keep it slightly open during start up.
7. For best results, use smaller pieces of wood to get the appliance temperature very high before loading larger wood for sustained burns. If necessary, crack the door to allow ignition of the fuel charge. Do not leave the unit unattended while the front door is slightly open. Now you can add larger pieces of wood and after several minutes of high burn, set the left control for the desired heat output. Check the exhaust in about 15 to 20 minutes (see **Figure 27**). Large amounts of smoke indicate an improper burn setting (either too high or too low). Adjust and recheck in 5 to 10 minutes.



FUEL

This appliance is designed to burn dry seasoned natural wood only (see Page 22 for a list of prohibited fuels). Failure to burn proper fuels only will void the certification and the warranty of the appliance.

Dry, seasoned wood is that which has been cut, split and allowed to dry under a covered area where air is free to flow and circulate under and around the wood (not under a tarp or plastic). Make sure wood is not stacked directly on the ground, it may absorb moisture from the ground. It should be allowed to dry in these conditions for a minimum of six months, preferably one year or more. **IT MUST BE UNDERSTOOD THAT WOOD CANNOT BE LEFT IN ANY KIND OF WET OR DAMP AREA OR IT WILL NEVER BECOME COMPLETELY SEASONED.**

Do Not store fuel within space heater installation clearances or within the space required for refueling and ash removal.

DO NOT OVERFIRE THIS HEATER

Attempts to achieve heat output rates that exceed heater design specifications can result in permanent damage to the heater.

What does "Well-Seasoned" mean?

When a tree is cut down, the wood is green, full of sap and moisture. This moisture content can exceed 80%, which must be reduced to less than 20%. Wood properly seasoned is then capable of generating the heat the stove or insert was designed to provide.

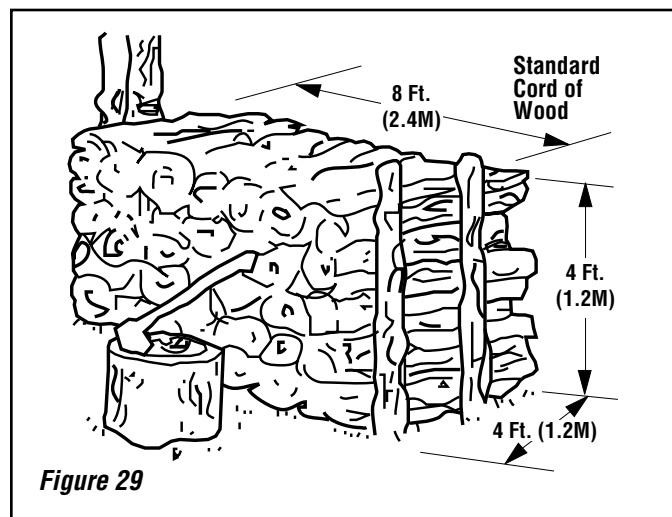
Green wood does not burn easily. Attempting to burn green wood often results in a lot of smoke and very little fire. Time is the most important factor in seasoning wood. Ideally the moisture content should be reduced to 11-20%. **NOTE: The use of a firewood moisture meter is recommended to ensure the firewood contains less than 20% moisture.**

Seasoning Guide

Softwoods – 6 months to 18 months

Hardwoods – 12 months to 24 months

Logs that are 5" diameter across or larger should be split in half, three pieces if over 8 inches, and four pieces when over a foot across. If a tree has been dead for 2 – 4 years it still needs to be cut, split, and seasoned for 6 to 24 months depending on the wood.



GETTING THE MOST OUT OF YOUR APPLIANCE

Recent developments in wood-burning technology have made wood-burning a cleaner and more convenient way to heat your home. Overall efficiency in a wood-burning appliance is a combination of combustion efficiency and heat transfer efficiency. Whether heating your entire home or just a room or two, your understanding of how to best operate your stove or insert will enhance its overall efficiency and performance. What this can mean to you is longer, cleaner burns, less wood use and more heat.

The following sections will outline techniques you can use to “get the most out of your stove or insert.” Please read them carefully.

MAXIMIZING YOUR APPLIANCE'S OVERALL EFFICIENCY

It is important to know that for high, combustion efficient, clean burns, you will need to have sufficient temperatures inside the firebox for thorough combustion. The best method for determining if you have sufficient temperatures is to watch the brick lining in your firebox. When you first light your stove or fireplace insert, the firebrick will turn a dark brown or black. After 20 to 30 minutes of a hot fire, most of the bricks should return to near their original beige color. This means the firebrick have reached a high enough temperature for your appliance to achieve high combustion efficiency and you are ready to adjust the draft control to a lower setting.

Second and just as important, is achieving a high level of heat transfer efficiency. Slowing the rate of flow through the stove or insert enhances heat transfer, thus allowing more time for heat to be transferred into your home. To do this, be sure to thoroughly preheat your stove or insert and then reduce the amount of primary air by closing the draft control down to a lower setting. (More air may produce a slightly greater amount of heat, but will greatly increase wood consumption).

To get the most out of your appliance, you will need to combine good combustion efficiency with good heat transfer practices. The following are some tips on how to operate your appliance to achieve the highest overall efficiency.

1. Thoroughly preheat your appliance before slowing the burn rate by closing the draft control.
2. When loading wood into a preheated stove or fireplace insert, allow a vigorous fire to build before lowering the draft control.
3. Operate your stove or fireplace insert as much as possible in the low to medium burn ranges.
4. Do not lower the draft setting so low as to completely extinguish the flames in the firebox. Check for at least some small flames twenty minutes after setting the draft control.
5. Do not continually operate your stove or fireplace insert in the high (wide open) setting. This wastes wood by carrying a great deal of heat up the chimney and can damage your stove or fireplace insert and chimney.
6. Go outside and check your chimney. More than a very small amount of smoke indicates wasted heat, creosote build up and pollution (*see Figure 28*).

ACHIEVING CLEAN, LONG BURNS

To achieve long burn times, after having thoroughly preheated the appliance, let the appliance top cool down to 250 to 325 degrees. Now load the firebox and set the draft control. At this point, you may need to burn the fireplace insert with the draft open for a few minutes to ignite the wood. All IHP stoves and inserts are EPA tested for emissions at low burn with the air control completely closed. Whether or not you should burn Your appliance with the air control completely closed will depend on the following factors:

- How you load your wood
- Your chimney type, height and draft
- Your wood type and its moisture content
- The temperature of the appliance or fireplace insert
- Which model stove or insert you have

In order to maximize the burn time of your stove or insert you may need to experiment to get the right balance of starting temperature, wood type, and draft control setting for your particular venting configuration. Do not reload the stove or insert for long burns when the stainless secondary tubes or baffles are glowing red, or when the stove or insert is uncomfortably hot to load. This indicates the stove or insert is too hot to load for a long burn.

BLOWER OPERATION

Blower Operation - The blower can be operated manually or automatically (blower will turn on when the stove or insert is hot and turn off when the stove or insert is cool).

The rocker switch on the control panel allows you to select between manual operation or automatic operation as follows (see **Figure 30**):

MANUAL OPERATION: Turn rocker switch to the manual position (up) and adjust rheostat knob to the desired speed. The blower will have to be manually turned "OFF" by rotating the rheostat knob counterclockwise until it clicks.

AUTO OPERATION: Turn rocker switch to the "AUTO" position and the rheostat to the ON position (rotate rheostat knob clockwise until it clicks). When the stove or insert warms up, the blower will automatically turn on (adjust rheostat knob to the desired speed setting). When the stove or insert cools down, the blower will automatically turn off.

Rheostat Operation - The highest blower speed is obtained by turning the rheostat knob clockwise until it clicks "ON", then rotate towards "HIGH" to increase blower speed. Rotate the knob clockwise for a lower speed. To turn off, continue to rotate the knob counterclockwise until it clicks "OFF."

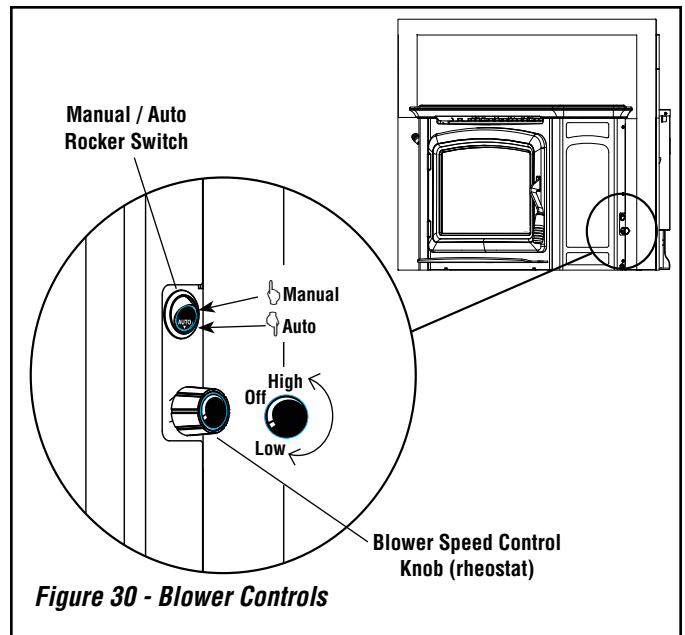


Figure 30 - Blower Controls

Blower Operation Guidelines

While in auto operation mode, the blower will turn off and on based on the temperature of the appliance. Auto operation ensures there is sufficient heat build-up to warm the air being moved by the blower before the blower is turned on. Likewise, when the appliance cools off, the blower is turned off to prevent circulating cool air. Depending on the size and intensity of the fire it may be necessary to adjust the blower speed accordingly to ensure uninterrupted blower operation. For example a small fire may require a slower blower speed to keep the heat output by the blower consistent. If the blower is operated in manual mode, it may be necessary to adjust the blower speed as the fire begins to burn down and the appliance is no longer hot enough to effectively heat the air moved by the blower. If the air coming from the blower feels cool, one should either decrease the blower speed or stoke the fire to build up more heat.

NOTE: Turn blower off before opening the door to load the fuel.

WARNING

The blower must be plugged directly into a properly grounded three-prong receptacle, 120 VAC, 60 Hz, single phase. Do not cut or remove the grounding prong from this plug. Do not route power cord under or in front of appliance.

Installation must be in accordance with National Electrical Code, ANSI/NFPA 70 - latest edition. In Canada, the current CSA C22.1 Canadian Electrical Code - latest edition.

DANGER: Disconnect power before servicing blower.

NOTE: SWITCH CONDITIONS
GIVEN AT ROOM TEMPERATURE

N/C = NORMALLY CLOSED
N/O = NORMALLY OPEN

— = FEMALE DISCONNECT
—> = MALE DISCONNECT
—○— = STUD CONNECTION

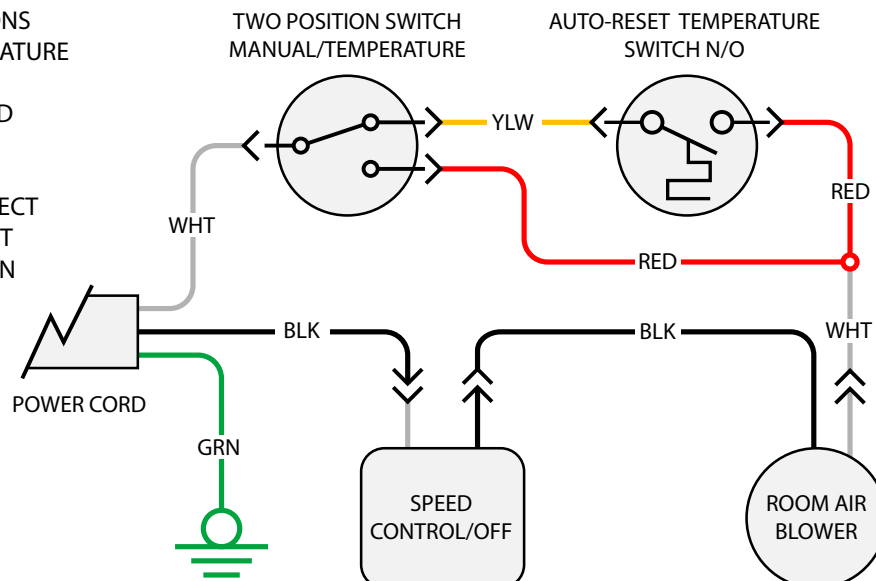


Figure 31 - ML230 Blower Wiring Schematic

DO'S AND DON'TS

- DO NOT:** Install or operate the appliance before reading this manual.
- DO NOT:** Close the draft beyond the point at which the flames are completely extinguished.
- DO NOT:** Open the appliance door without fully opening the draft first.
- DO NOT:** Burn driftwood or wood that has been in salt water. This includes mill ends and scrap lumber that has been floated in salt water on the way to the mill. (This will void your warranty).
- DO NOT:** Handle the Nickel Door Trim unnecessarily. Do not push or pull the stove door by any other means other than the handle.
- DO NOT:** Force oversized logs into the firebox as this may dislodge the baffle assembly.
- DO NOT:** Close the door tightly during Burn-In period.
- DO:** Be sure to clean any fingerprints from optional accessories that have plated surfaces before burning the appliance. Clean the plated surfaces only with household type glass cleaner and a very soft cloth.
- DO:** Consult local building department if other than recommended clearances are desired.
- DO:** Read instructions for the baffle boards occasionally to ensure you have not bumped or moved them out of place when loading wood.
- DO:** Check the chimney and baffle monthly to make sure they are clean.
- DO:** Burn seasoned, dry wood only! (RAIN = WET WOOD)
- DO:** Open the door frequently during Burn-In period to keep gasket from adhering to the curing paint.
- DO:** Enjoy the warm feeling of your new IHP appliance.

Smoke Detector Recommended

Since there are always several potential sources of fire in any home, we recommend installing smoke detectors. If possible, install the smoke detector in a hallway adjacent to the room (to reduce the possibility of occasional false activation from the heat produced by these appliances). If your local code requires a smoke detector be installed within the same room, you must follow the requirements of your local code. Check with your local building department for requirements in your area.

Carbon Monoxide Monitor Recommended

Carbon Monoxide Poisoning: Early signs of carbon monoxide poisoning are similar to the flu with headaches, dizziness and/or nausea. If you have these signs, obtain fresh air immediately. Some people are more affected by carbon monoxide than others, including pregnant women, people with heart or lung disease or anemia, those under the influence of alcohol, and those at high altitudes.

It is against federal regulations to operate wood heaters in a manner inconsistent with operating instructions in the manual.

PROHIBITED FUELS

This heater is designed to burn natural wood only. Higher efficiencies and lower emissions generally result when burning air dried seasoned hardwoods, as compared to softwoods or to green or freshly cut hardwoods. **DO NOT BURN:**

- Garbage;
- Lawn clippings or yard waste;
- Materials containing rubber, including tires;
- Materials containing plastic;
- Waste petroleum products, paints or paint thinners, or asphalt products;
- Materials containing asbestos;
- Construction or demolition debris;
- Railroad ties or pressure-treated wood;
- Manure or animal remains;
- Salt water driftwood or other previously salt water saturated materials;
- Unseasoned wood;
- Christmas tree branches;
- Paper products, colored paper, cardboard, plywood, or particleboard;
- gasoline;
- naphtha;
- engine oil;
- flammable liquids;
- solvents;
- grease; or
- coal

The prohibition against burning these materials does not prohibit the use of fire starters made from paper, cardboard, saw dust, wax and similar substances for the purpose of starting a fire in an affected wood heater.

Burning these materials may result in release of toxic fumes or render the heater ineffective and cause smoke. Intense firing with these materials may overheat the fireplace, causing damage to the unit, a fire or even possibly igniting a chimney fire if the chimney is creosoted. Burning unapproved fuel, resulting in excessive pollutants being emitted, may be prohibited and subject to a fine or other penalty by the authority having jurisdiction in your area.

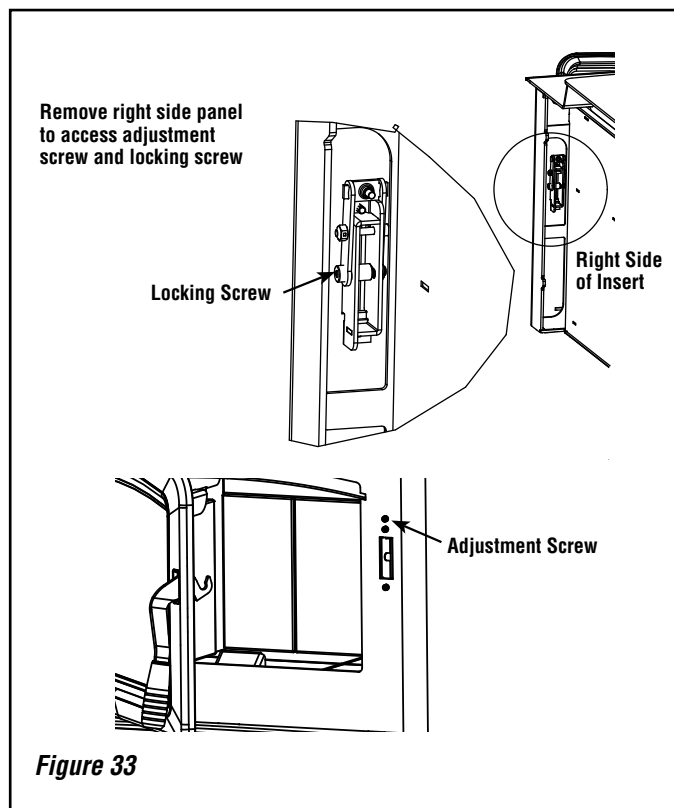
MAINTENANCE

Have your product inspected at least once a year by a qualified service technician to ensure gaskets, air tubes, baffles, and venting are in good repair to ensure proper performance. Have degraded items replaced by a qualified service technician.

THIS WOOD HEATER NEEDS PERIODIC INSPECTION AND REPAIR FOR PROPER OPERATION. IT IS AGAINST FEDERAL REGULATIONS TO OPERATE THIS WOOD HEATER IN A MANNER INCONSISTENT WITH OPERATING INSTRUCTIONS IN THIS MANUAL.

DOOR HINGES: If door hinges need lubricating, use an anti-seize compound (never use oil) available from your IHP dealer.

DOOR LATCH: Adjustment Instructions - Remove the right side heat shield by loosening the 3 screws located on the side of the insert. Using a "L" shaped 5/32" allen wrench, loosen the locking screw in the latch assembly as shown in **Figure 33**. With the locking screw loosened, adjust the top 5/32" allen screw (**Figure 33**) in the front of the insert to adjust the door tension. Turning the screw to the right will tighten the door, turning the screw to the left will loosen the door. When you loosen the door it will be easiest to pull the roller pin to the full forward position and make slight adjustments to tighten to the desired tension. Assure that the tension on the front door creates a good seal between the gasket on the front door and the firebox front. After adjusting the door tension, re-tighten the lock screw and replace the side panel.



DOOR GASKET: Periodically check gasket to make sure it is not over-compressed. If compressed, replace with a special woven door rope. (Don't try substituting rope, only use special IHP door rope).

PLATED ACCESSORIES: Clean only with a household type glass cleaner and a very soft cotton cloth. Other products may damage plated finish, paint and gaskets.

BAFFLE BOARDS: Your baffle boards should be inspected during every chimney cleaning. If either board is damaged then replace baffle boards.

CREOSOTE FORMATION AND NEED FOR REMOVAL

When wood is burned slowly, it produces tar and other organic vapors, which combine with expelled moisture to form creosote. The creosote vapors condense in the relatively cool chimney flue of a slow-burning fire. As a result, creosote residue accumulates on the flue lining. When ignited, this creosote makes an extremely hot fire. The chimney and chimney connector should be inspected at least once monthly during the heating season to determine if a creosote buildup has occurred. If creosote has accumulated (1/8" [3mm] or more), it should be removed to reduce the risk of a chimney fire.

Establish a routine for the fuel, wood burner and firing technique. Check daily for creosote build-up until experience shows how often you need to clean to be safe. Be aware that the hotter the fire the less creosote is deposited, and weekly cleaning may be necessary in mild weather even though monthly cleaning may be enough in the coldest months. Contact your local municipal or provincial fire authority for information on how to handle a chimney fire. Have a clearly understood plan to handle a chimney fire.

DISPOSAL OF ASHES

Whenever ashes get 3 to 4 inches deep in your firebox, and when the fire has burned down and cooled, remove excess ashes. Leave an ash bed approximately 1 inch deep on the firebox bottom to help maintain a hot charcoal bed.

Ashes should be scooped out of a cool stove or fireplace insert with a small metal shovel. Ashes should be placed in a steel container with a tight fitting lid and moved outdoors immediately. Other waste shall not be placed in this container. The closed container of ashes should be placed on a non-combustible floor or on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all the cinders have thoroughly cooled. Ashes can ignite up to 72 hours after removal from the fireplace insert.

WARNING

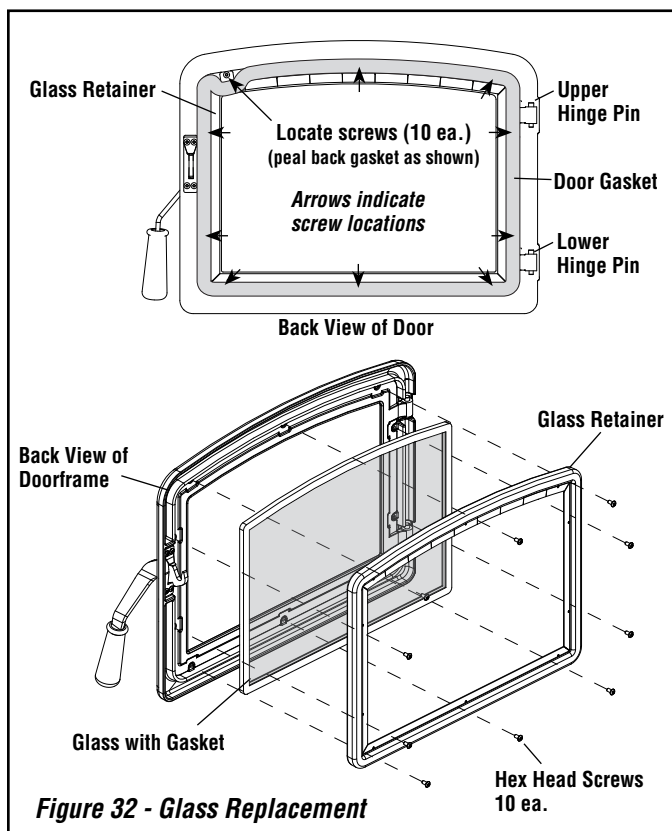
Inspect and clean chimney and connector frequently. Under certain conditions of use, creosote buildup may occur rapidly.

MAINTENANCE

GLASS REPLACEMENT INSTRUCTIONS

(Refer to *Figure 32*)

- Step 1. Remove Door Assembly** - Remove the upper and lower hinge pins by pressing the bottom of each hinge pin up, then pull out from the top. Lift off door and place face down on a soft surface.
- Step 2. Remove Glass Retainer Screws (10 ea.)** - Using an 1/8" allen wrench remove the ten glass retainer screws. To locate screws, peel back the door gasket as necessary. The screws are located by the holes in the stainless steel glass retainer strips.
- Step 3. Remove Glass** - Carefully remove broken glass one piece at a time (protective leather gloves are recommended).
- Step 4. Clean Door Frame** - Clean the area of the door frame where the new glass with gasket will be installed.
- Step 5. Install New Glass Assembly** - Install the new glass with gasket (use only factory supplied 5mm ceramic glass with gasket. **Do not substitute**).
- Step 6. Reinstall Retainer and Screws** - Carefully reinstall the glass retainer and screws. Be very careful not to overtighten the screws (this could result in glass breakage when the stove or insert is hot).
- Step 7. Reinstall Door** - Align hinges on door frame with corresponding hinge holes on the face of stove or insert. Reinstall the upper and lower hinge pins from the top.



GLASS CLEANING GUIDELINES

WARNING: DO NOT CLEAN GLASS WHEN APPLIANCE IS HOT!

Glass on any wood stove or fireplace insert will not stay perfectly clean. Here are some guidelines for cleaning and caring for the glass:

- Ensure the appliance is cold prior to cleaning glass.
- This appliance is designed to provide a flow of air over the inside of the glass, where along with high heat helps inhibit build-up on the glass. When build-up occurs, a commercial glass cleaner designed for stoves is recommended. Regular household glass cleaners will not clean creosote.
- Do not use abrasives such as steel pads, steel wool or oven cleaner as they will scratch the glass. Never scrape glass with a razor blade as this may pit the glass and make it impossible to clean in the future.
- Do not use chemical glass cleaners as they may damage the gaskets or painted surfaces.

TIPS FOR KEEPING THE GLASS CLEAN

- Burn only dry seasoned cord wood. Wet wood = Dirty glass.
- A short, hot fire (15 - 20 minutes) may help to clean off some of the normal buildup. Lower burns = more build-up. Higher burns = less build-up.
- Keep freshly loaded wood away from the glass.
- After reloading, allow all the wood to catch flame before dampering down the appliance.

Removal of the fireplace insert for the purpose of inspecting the fireplace insert and fireplace - See Page 11, Reverse installation instructions.

CAUTION

Cleaning Glass: Ensure appliance is cold prior to cleaning glass. A commercial glass cleaner designed for stoves is recommended. Do not use abrasive cleaners. Do not clean with any materials, which may scratch or otherwise damage the glass. Scratches on the glass can develop into cracks or break. Inspect the glass regularly. If you detect a crack, extinguish the fire and contact your dealer for a replacement.

TROUBLESHOOTING

Problem	Solution
POOR DRAFT:	Extend chimney in length or have the chimney realigned to the proper size flue. Oversized chimneys normally have poor drafts. Remember, the appliances' draft depends solely on the natural draft of the chimney (See Draft Requirements on Page 4). If your stove or fireplace insert is not drafting properly, your chimney is the problem. All stoves and fireplace inserts are thoroughly tested to ensure proper draft with the correct size chimney flue.
EXCESSIVE DRAFT:	With better chimneys being more common, excessive draft can be an issue. Alleviate excessive draft by slowing the burn rate of the appliance once it has reached proper operating temperature (See Maximizing Your appliances Overall Efficiency on Page 20).
DIRTY GLASS:	<ol style="list-style-type: none"> 1) Burn smaller, hotter fires and check to make sure you are not setting the draft down too far with the draft control. 2) Make sure your wood is well seasoned and dry (not open to rain - see Creosote (Page 23) and Fuel (Page 22) sections. 3) See Poor Draft section (above) and Clean Glass (above).
SMOKES WHEN DOOR IS OPEN:	<ol style="list-style-type: none"> 1) If smoke is entering the room, check to make sure your baffle boards are properly installed. 2) Check the chimney for blockage due to creosote (see Creosote section on Page 23). 3) Check draft (See POOR DRAFT section above).
WOOD BURNS TOO FAST:	<ol style="list-style-type: none"> 1) The draft control must be closed further. 2) Add fuel at lower firebox temperatures. 3) Load wood side to side and reduce the flow of air under wood. 4) The door seal may need replacing, check for leakage. 5) See "Excessive Draft."
POOR HEAT OUTPUT:	<ol style="list-style-type: none"> 1) Check your wood. Wet, moist, unseasoned wood will not produce heat. 2) Your stove or fireplace insert needs to be seasoned (moisture removed from the steel and brick). Continue to burn a fire. It normally takes from one to three weeks of burning to season your stove or fireplace insert (See Burn-In Period on Page 17). 3) See Excessive Draft section above.
PAINT GIVES OFF ODOR (smoke):	Paint is tempering-in. Burn only moderately hot for the first few days until paint is fully cured. Then burn a very hot fire to cure any paint that may not easily cure. Open windows or door to ventilate (See Burn-In Period on Page 17).

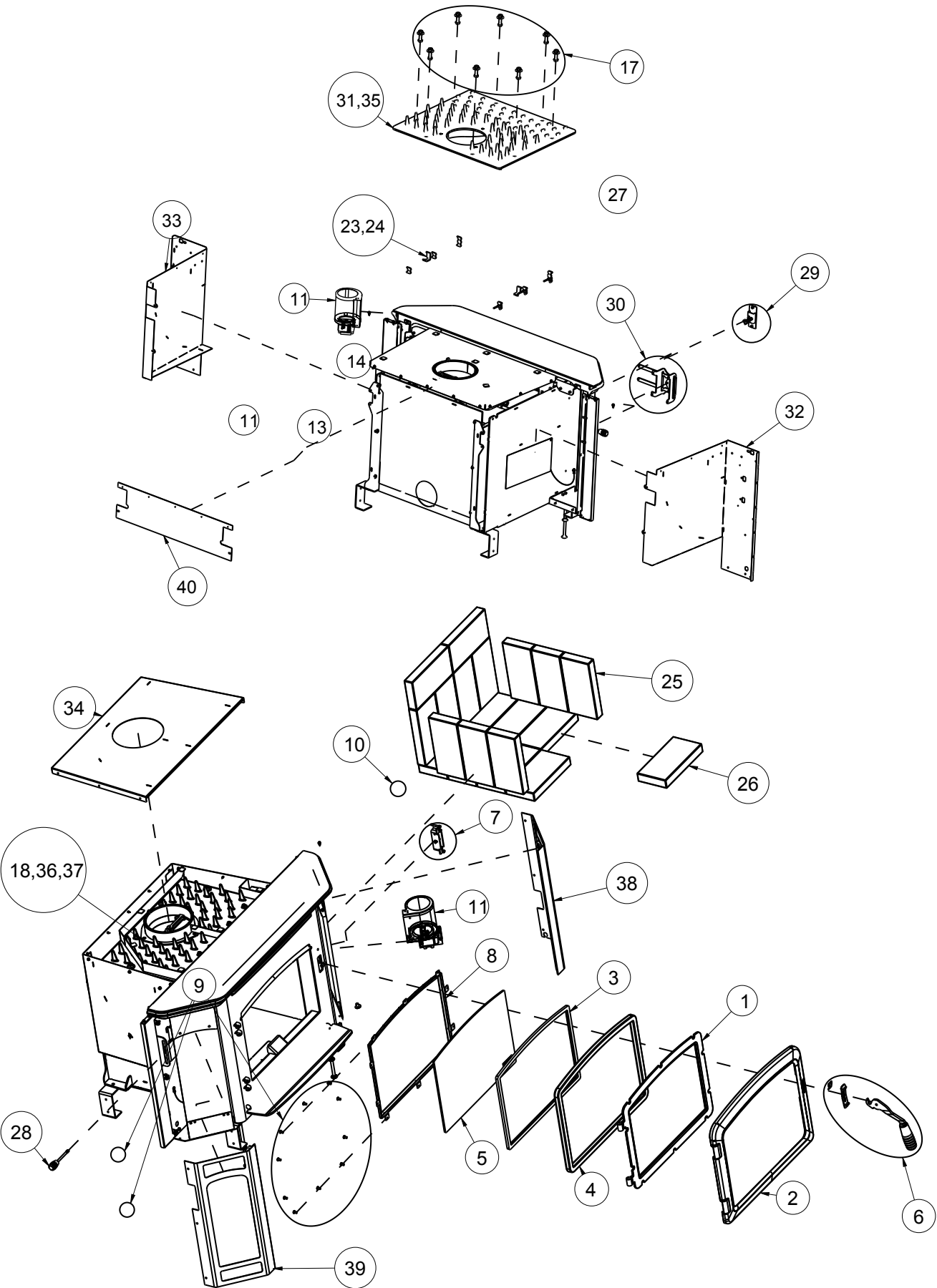
REPLACEMENT PARTS - MODEL MONTLAKE™ 230GL

Contact an IHP dealer to obtain any of these parts. Never use substitute materials. Use of non-approved parts can result in poor performance and safety hazards.

FRONT DOOR PARTS LIST		
Item #	Description	ML230GL
1	Inner Door Frame, Cast Iron	H8365
2	Outer Door Frame, Cast Iron	H8366
3	Glass Gasket 1"	H8380
4	Door Gasket 7/8"	H5639
5	Ceramic Glass With Gasket	H8392
6	Door Handle Kit	H8395
7	Door Latch Assembly (4 button head screws and latch)	H8397
8	Glass, Retainer Kit	H8394
9	Door Hardware Kit (includes 2 pins, door roller and 10 button head screws and door set screw)	H8398
BLOWER PARTS		
10	Snap switch	H8682
11	Blower Kits	F3222
---	Wire Harness	H8684
13	Rheostat	H5742
14	Toggle Switch	H8066
MISCELLANEOUS PARTS		
---	Dry Graphite (apply to door handle bushing)	71052
---	Anti Seize, 2 Gram Pouch	H5633
17	Heat Exchanger Bolt Kit	H8387
18	Flue Ring Bolt Kit	H8388

MISCELLANEOUS PARTS (continued)		
Item #	Description	ML230GL
---	Taplite Qty 8 (34055)	H8390
---	Button Head Screw Qty 8 (34027)	H8391
---	Control Labels	H8685
FIREBOX AND TIMER PARTS		
---	Replacement Secondary Air Tube Kit GV/ML GL	TBD
---	Baffle Board Kit GV/ML 230GL	TBD
---	Timer Assembly GV/ML GL	TBD
---	Linkage Assembly GV/ML 230GL	TBD
22	Secondary Tube Retainer Clips (4 required)	H8367
25	Complete Firebrick Kit (GV230 - 20 bricks included, GV300 - 26 bricks included)	H8378
26	Firebrick 4-1/2" X 9", Each	H5612
27	Baffle Board Kit	H8379
BODY PARTS		
28	Damper Rod	H8393
29	Damper Assembly	H8396
30	Damper Assembly Linkage	H8686
31	Cast Iron Heat Exchanger (hardware included)	H8369
32	Left Side Heat Shield Assy (hardware included)	H8687
33	Right Side Heat Shield Assy (hardware included)	H8688
34	Top Heat Shield (hardware included)	H8689
35	Heat Exchanger Gasket	H8377
36	Flue collar base (hardware included)	H8690
37	Flue collar insert (hardware included)	H8691
38	Right side front panel	H8692
39	Left side front panel	H8693
40	Rear Heat Shield (hardware included)	H8725

REPLACEMENT PARTS - MODEL MONTLAKE™ 230GL



NOTE: DIAGRAMS & ILLUSTRATIONS ARE NOT TO SCALE.

ACCESSORIES - MODEL MONTLAKE™ 230GL

Model	Description	ML230
TOP WARMING SURFACE KITS (ONE REQUIRED)		
TOP-STEEL-ML230	Steel Top - Montlake™ 230GL	H8673
TOP-CASTIRON-ML230	Cast Top - Montlake 230GL	H8674
DOOR TRIM KITS		
DRTRM-ML230-NKL	Door Trim, Nickel	H8346
DRTRM-ML230-BRNKL	Door Trim, Brushed Nickel	H8347
SURROUND KITS (ONE REQUIRED)		
ML230-FP2641	Surround Kit, 26-1/2" X 41" Black - Montlake 230GL	H8677
ML230-FP2648	Surround Kit, 26-1/2" X 48" Black - Montlake 230GL	H8678
ML230-FP3141	Surround Kit, 31" X 41" Black - Montlake 230GL	H8679
ML230-FP3148	Surround Kit, 31" X 48" Black - Montlake 230GL	H8680
ML230-FPTRIM3348	Surround Kit, 33" X 48" Black Trimmable - Montlake 230GL	H8681
MISC.		
ZC-SUPPRT-ML230	ZC Support - Montlake 230GL	H8675
TSPK-B	Touch-up Spray Paint Kit, Black	H8159



**CONTACT YOUR LOCAL BUILDING OR FIRE OFFICIALS ABOUT
RESTRICTIONS AND INSTALLATION INSPECTION IN YOUR AREA**

Listed Factory-built or Masonry Fireplace Accessory/Insert



Manufactured By / Fabriqué Par:
INNOVATIVE HEARTH PRODUCTS
1502 14th Street NW
Auburn, WA 98001 USA



"PREVENT HOUSE FIRES"

Report No./Numéro de Rapport: 14-182

Install and use only in accordance with manufacturer's installation instructions and your local building codes. Do not connect this unit to a chimney flue serving another appliance.

Serial No.
Numéro de série **ML230GL-**

Blower Electrical Rating: 120V, 60 Hz, .8 Amp

Model / Modèle: **Montlake™ 230GL**

Do not route power cord under or in front of appliance.

Tested to/Testé à: UL 1482, ULC S628
Room Heater, Solid Fuel Type, Also For Use In
Mobile Homes.

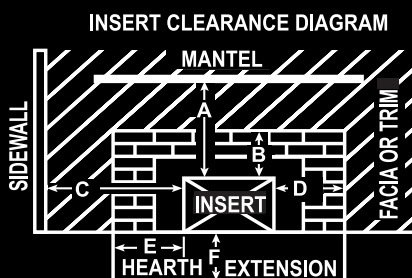
Replace glass only with 5mm ceramic.

Operate only with doors closed.

This wood heater needs periodic inspection and repair for proper operation. Consult the owner's manual for further information. It is against federal regulations to operate this wood heater in a manner inconsistent with the operating instructions in the owner's manual.

Certified to comply with 2020 particulate emission standards using crib wood - Emissions: 1.7 grams/hr

Minimum Clearance to Combustible Materials - Inches (millimeters)



- (A) Clearance from Insert top to Mantel = USA-15", CAN-15" (381mm). Maximum mantel depth = 12"
- (B) Clearance from insert top to combustibles = USA -13" CAN-13" (330mm)
- (C) Minimum clearance to combustibles sidewall = 4" (102mm)
- (D) Minimum clearance to combustibles side trim = 1" (25mm)
- (E) Minimum distance of floor protection to the side = 8" (203mm). This is measured from the sides of the door opening in the USA and from the sides of the insert in Canada.
- (F) Minimum distance from front of insert to combustibles = USA-16", CAN-18" (450mm)

The hearth and/or floor protection must be a thermally rated non-combustible hearth/floor protector meeting or exceeding a thermal rating of k=48 or equivalent with a listed thickness of 1-1/2" (38mm) minimum in USA (1-1/2" - 38mm minimum in Canada).

Install only in a masonry fireplace, built to UBC Chapter 37 or approved factory-built fireplace (USA only - see owner's manual). Do not remove brick or mortar from masonry fireplace to accommodate insert. Approved with minimum 6" (152mm) diameter stainless steel listed reline system. Remove and clean behind unit frequently, as creosote build up may occur rapidly. See owner's manual for reductions on mantel, trim and floor protection.

HEARTH EXTENSION			
Height	Thermal Protection Thickness	Hearth Extension Depth	
		USA	Canada
0"	1-1/2"	16"	18"
4-1/2"	1/2"	18"	18"
7-1/2"	0"	16"	18"



CAUTION - HOT WHILE IN OPERATION. DO NOT TOUCH. KEEP CHILDREN, CLOTHING, FURNISHINGS AND COMBUSTIBLE MATERIAL A CONSIDERABLE DISTANCE AWAY. CONTACT MAY CAUSE SKIN BURNS. SEE NAMEPLATE AND INSTRUCTIONS. DO NOT OVERFIRE. IF HEATER OR CHIMNEY CONNECTOR GLOWS, YOU ARE OVERFIRING. INSPECT AND CLEAN CHIMNEY AND CONNECTOR FREQUENTLY. UNDER CERTAIN CONDITIONS OF USE, CREOSOTE BUILDUP MAY OCCUR RAPIDLY. DO NOT USE GRATE OR ELEVATE FIRE - BUILD WOOD FIRE DIRECTLY ON HEARTH. FEED DOOR MUST BE CLOSED DURING FIRING EXCEPT WHEN ADDING FUEL. KEEP ASH DOOR CLOSED TO AVOID EXCESS HEAT. DANGER: RISK OF ELECTRICAL SHOCK. DISCONNECT POWER BEFORE SERVICING UNIT.
TYPE OF FUEL: SOLID WOOD ONLY.

Date of Manufacture / Date De Fabrication

2018	2019	2020	JAN. JANV	FEB. FEVR	MAR. MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC
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U.S. ENVIRONMENTAL PROTECTION AGENCY

Certified to comply with 2020 particulate emission standards using crib wood

Part No./ No. pièce #900939-00 Rev. 0, 10/2018 DO NOT REMOVE THIS LABEL Made in U.S.A.

NOTES

[illegible]

Innovative Hearth Products IronStrike® Brand Wood Burning Stove and Insert Limited Lifetime Warranty

THE WARRANTY

Innovative Hearth Products ("IHP") Limited Lifetime Warranty warrants your IronStrike® Brand Wood Burning Stove or Insert ("Product") to be free from defects in materials and workmanship at the time of manufacture. The Product body, firebox and ceramic glass carry the Limited Lifetime Warranty. Ceramic glass carries the Limited Lifetime Warranty against thermal breakage only. After installation, if covered components manufactured by IHP are found to be defective in materials or workmanship during the Limited Lifetime Warranty period and while the Product remains at the site of the original installation, IHP will, at its option, repair or replace the covered components. If repair or replacement is not commercially practical, IHP will, at its option, refund the purchase price or wholesale price of the IHP product, whichever is applicable. IHP will also pay IHP prevailing labor rates, as determined in its sole discretion, incurred in repairing or replacing such components for up to five years. THERE ARE EXCLUSIONS AND LIMITATIONS to this Limited Lifetime Warranty as described herein.

COVERAGE COMMENCEMENT DATE

Warranty coverage begins on the date of purchase. In the case of new home construction, warranty coverage begins on the date of first occupancy of the dwelling or six months after the sale of the Product by an independent IHP dealer/distributor, whichever occurs earlier. The warranty shall commence no later than 24 months following the date of product shipment from IHP, regardless of the installation or occupancy date.

EXCLUSIONS AND LIMITATIONS

This Limited Lifetime Warranty applies only if the Product is installed in the United States or Canada and only if operated and maintained in accordance with the printed instructions accompanying the Product and in compliance with all applicable installation and building codes and good trade practices.

This warranty is non-transferable and extends to the original owner only. The Product must be purchased through a listed supplier of IHP and proof of purchase must be provided. The Product body and firebox carry the Limited Lifetime Warranty from the date of installation. Vent components, trim components and paint are excluded from this Limited Lifetime Warranty. The following do not carry a Limited Lifetime Warranty but are warranted as follows:

Cast Iron Heat Exchanger – Replacement for five years from the date of installation

Cast iron parts – Replacement for one year from the date of installation

Catalyst – Carries a separate warranty. Refer to the warranty certificate provided for that part

Electrical components – Repair or replacement for one year from date of installation

Gaskets – Replacement for one year from the date of installation.

Gold & nickel plating – Replacement for two years from date of installation. Excludes tarnishing

Refractory & screens – Replacement for two years from date of installation. Excludes hairline cracks

Removable air tubes – Repair or replacement for seven years from date of installation. IHP prevailing labor rates for years one through five.

Labor coverage – Prevailing IHP labor rates apply for the warranty period of the component, unless otherwise noted

Parts not otherwise listed carry a 90 day warranty from the date of installation.

Whenever practicable, IHP will provide replacement parts, if available, for a period of 10 years from the last date of manufacture of the Product.

IHP will not be responsible for: (a) damages caused by normal wear and tear, accident, riot, fire, flood or acts of God; (b) damages caused by abuse, negligence, misuse, or unauthorized alteration or repair of the Product affecting its stability or performance. (The Product must be subject to normal use with approved fuels listed in the Operation Manual provided with the product. Fuel products with abnormal burning characteristics, including but not limited to fuel such as driftwood, coal or plywood and wood products using a binder may burn at excessive temperatures and may cause damage to the Product or may cause it to function improperly; IHP stoves, inserts and high efficiency EPA fireplaces are approved for burning dry seasoned wood only.); (c) damages caused by failing to provide proper maintenance and service in accordance with the instructions provided with the Product; (d) damages, repairs or inefficiency resulting from faulty installation or application of the Product.

Coverage of this Limited Lifetime Warranty is conditional upon the appliance being operated without the use of grates, irons or any other method to elevate the fire.

IHP is not responsible for inadequate system draft caused by air conditioning and heating systems, mechanical ventilation systems, or general construction conditions which may generate negative air pressure in the room in which the appliance is installed. Additionally IHP assumes no responsibility for smoking conditions caused by inadequate chimney height, adjoining trees or buildings, adverse wind conditions or unusual environmental factors and conditions. Certain IHP Products are listed for use with Security Chimneys International, Ltd. chimney systems only. Use of chimney components other than that specified in the Product manual will void the Product warranty.

This Limited Lifetime Warranty covers only parts and labor as provided herein. In no case shall IHP be responsible for materials, components or construction which are not manufactured or supplied by IHP or for the labor necessary to install, repair or remove such materials, components or construction. Additional utility bills incurred due to any malfunction or defect in equipment are not covered by this Limited Lifetime Warranty. All replacement or repair components will be shipped F.O.B. from the nearest stocking IHP factory.

LIMITATION ON LIABILITY

It is expressly agreed and understood that IHP's sole obligation and the purchaser's exclusive remedy under this warranty, under any other warranty, expressed or implied, or in contract, tort or otherwise, shall be limited to replacement, repair, or refund, as specified herein.

In no event shall IHP be liable for any incidental or consequential damages caused by defects in the Product, whether such damage occurs or is discovered before or after replacement or repair, and whether such damage is caused by IHP's negligence. IHP has not made and does not make any representation or warranty of fitness for a particular use or purpose, and there is no implied condition of fitness for a particular use or purpose.

IHP makes no expressed warranties except as stated in this Limited Lifetime Warranty. The duration of any implied warranty is limited to the duration of this expressed warranty.

No one is authorized to change this Limited Lifetime Warranty or to create for IHP any other obligation or liability in connection with the Product. Some states and provinces do not allow the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. The provisions of this Limited Lifetime Warranty are in addition to and not a modification of or subtraction from any statutory warranties and other rights and remedies provided by law.

INVESTIGATION OF CLAIMS AGAINST WARRANTY

IHP reserves the right to investigate any and all claims against this Limited Lifetime Warranty and to decide, in its sole discretion, upon the method of settlement.

To receive the benefits and advantages described in this Limited Lifetime Warranty, the appliance must be installed and repaired by a licensed contractor approved by IHP.

Contact IHP at the address provided herein to obtain a listing of approved dealers/distributors. **IHP shall in no event be responsible for any warranty work done by a contractor that is not approved without first obtaining IHP's prior written consent.**

HOW TO REGISTER A CLAIM AGAINST WARRANTY

In order for any claim under this warranty to be valid, you must contact the IHP dealer/distributor from which you purchased the product. If you cannot locate the dealer/distributor, then you must notify IHP in writing. IHP must be notified of the claimed defect in writing within 90 days of the date of failure. Notices should be directed to the IHP Warranty Department at 1508 Elm Hill Pike, Suite 108; Nashville, TN 37210 or visit our website at WWW.IRONSTRIKE.US.COM.

WARRANTY

Your wood appliance is covered by a limited warranty (provided with the appliance). Please read the warranty to be familiar with its coverage.

Retain this manual. File it with your other documents for future reference.

REPLACEMENT PARTS

See **Pages 26-27** for a complete replacement parts list. Use only parts supplied from the manufacturer.

Normally, all parts should be ordered through your IHP distributor or dealer. Parts will be shipped at prevailing prices at time of order.

When ordering repair parts, always give the following information:

1. The model number of the appliance.
2. The Serial Number of the appliance.

3. The part number.
4. The description of the part.
5. The quantity required.
6. The installation date of the appliance.

If you encounter any problems or have any questions concerning the installation or application of this system, please contact your dealer.

Innovative Hearth Products, LLC (IHP)
1769 East Lawrence Street
Russellville, AL 35654
IronStrike.us.com

PRODUCT REFERENCE INFORMATION

We recommend that you record the following important information about your appliance. If you did not purchase your appliance directly from an IHP dealer, then contact us at IronStrike.us.com to find your nearest IHP dealer who will answer your questions or address your concerns.

Model Number _____
Serial Number _____
Date Installed _____
Your Dealer's Name _____



Innovative Hearth Products (IHP) reserves the right to make changes at any time, without notice, in design, materials, specifications, and prices, and also to discontinue colors, styles, and products. Consult your local distributor for fireplace code information.





**CONTACT YOUR LOCAL BUILDING OR FIRE OFFICIALS ABOUT
RESTRICTIONS AND INSTALLATION INSPECTION IN YOUR AREA**

Listed Factory-built or Masonry Fireplace Accessory/Insert



Manufactured By / Fabriqué Par:
INNOVATIVE HEARTH PRODUCTS
1502 14th Street NW
Auburn, WA 98001 USA



"PREVENT HOUSE FIRES"

Report No./Numéro de Rapport: 14-182

Install and use only in accordance with manufacturer's installation instructions and your local building codes. Do not connect this unit to a chimney flue serving another appliance.

Serial No.
Numéro de série **ML230GL-**

Blower Electrical Rating: 120V, 60 Hz, .8 Amp

Model / Modèle: **Montlake™ 230GL**

Do not route power cord under or in front of appliance.

Tested to/Testé à: UL 1482, ULC S628
Room Heater, Solid Fuel Type, Also For Use In
Mobile Homes.

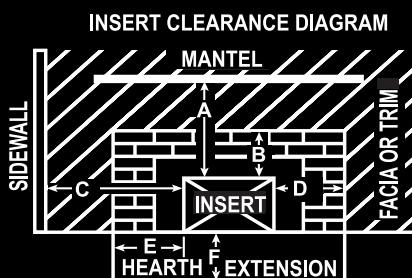
Replace glass only with 5mm ceramic.

Operate only with doors closed.

This wood heater needs periodic inspection and repair for proper operation. Consult the owner's manual for further information. It is against federal regulations to operate this wood heater in a manner inconsistent with the operating instructions in the owner's manual.

Certified to comply with 2020 particulate emission standards using crib wood - Emissions: 1.7 grams/hr

Minimum Clearance to Combustible Materials - Inches (millimeters)



- (A) Clearance from Insert top to Mantel = USA-15", CAN-15" (381mm). Maximum mantel depth = 12"
(B) Clearance from insert top to combustibles = USA -13" CAN-13" (330mm)
(C) Minimum clearance to combustibles sidewall = 4" (102mm)
(D) Minimum clearance to combustibles side trim = 1" (25mm)
(E) Minimum distance of floor protection to the side = 8" (203mm). This is measured from the sides of the door opening in the USA and from the sides of the insert in Canada.
(F) Minimum distance from front of insert to combustibles = USA-16", CAN-18" (450mm)

The hearth and/or floor protection must be a thermally rated non-combustible hearth/floor protector meeting or exceeding a thermal rating of k=.48 or equivalent with a listed thickness of 1-1/2" (38mm) minimum in USA (1-1/2" - 38mm minimum in Canada).

Install only in a masonry fireplace, built to UBC Chapter 37 or approved factory-built fireplace (USA only - see owner's manual). Do not remove brick or mortar from masonry fireplace to accommodate insert. Approved with minimum 6" (152mm) diameter stainless steel listed reline system. Remove and clean behind unit frequently, as creosote build up may occur rapidly. See owner's manual for reductions on mantel, trim and floor protection.

HEARTH EXTENSION			
Height	Thermal Protection Thickness	Hearth Extension Depth	
		USA	Canada
0"	1-1/2"	16"	18"
4-1/2"	1/2"	18"	18"
7-1/2"	0"	16"	18"



CAUTION - HOT WHILE IN OPERATION. DO NOT TOUCH. KEEP CHILDREN, CLOTHING, FURNISHINGS AND COMBUSTIBLE MATERIAL A CONSIDERABLE DISTANCE AWAY. CONTACT MAY CAUSE SKIN BURNS. SEE NAMEPLATE AND INSTRUCTIONS. DO NOT OVERFIRE. IF HEATER OR CHIMNEY CONNECTOR GLOWS, YOU ARE OVERFIRING. INSPECT AND CLEAN CHIMNEY AND CONNECTOR FREQUENTLY. UNDER CERTAIN CONDITIONS OF USE, CREOSOTE BUILDUP MAY OCCUR RAPIDLY. DO NOT USE GRATE OR ELEVATE FIRE - BUILD WOOD FIRE DIRECTLY ON HEARTH. FEED DOOR MUST BE CLOSED DURING FIRING EXCEPT WHEN ADDING FUEL. KEEP ASH DOOR CLOSED TO AVOID EXCESS HEAT. DANGER: RISK OF ELECTRICAL SHOCK. DISCONNECT POWER BEFORE SERVICING UNIT.
TYPE OF FUEL: SOLID WOOD ONLY.

Date of Manufacture / Date De Fabrication

2018	2019	2020	JAN. JANV	FEB. FEVR	MAR. MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC

U.S. ENVIRONMENTAL PROTECTION AGENCY

Certified to comply with 2020 particulate emission standards using crib wood

Part No./ No. pièce #900939-00 Rev. 0, 10/2018 DO NOT REMOVE THIS LABEL Made in U.S.A.

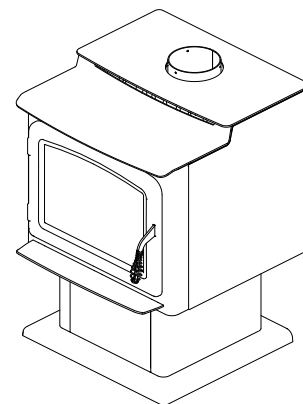


INSTALLATION AND OPERATION MANUAL

Free-Standing EPA Certified Wood-Burning Stoves

Save These Instructions
For Future Reference

P/N 900936-00, Rev. NC, 10/2018



Wood-Burning Stoves Model Grandview™ GV230GL

With Innovative Thermal Fin Technology (TFT™)




GV230GL - Report # 14-182

A French manual is available upon request. Order P/N 900936-01.

Ce manuel d'installation est disponible en français, simplement en faire la demande. Numéro de la pièce 900936-01.

This appliance must be properly installed and operated in order to prevent the possibility of a house fire. Please read this entire installation and operation manual before installing and using your wood stove. Failure to follow these instructions could result in property damage, bodily injury or even death. Contact your local building or fire officials to obtain a permit and information on any installation requirements and inspection requirements in your area.



	<p>! WARNING</p> <ul style="list-style-type: none">• Hot! Do not touch! The glass and surfaces of this appliance will be hot during operation and will retain heat for a while after shutting off the appliance. Severe burns may result.• Carefully supervise children in the same room as appliance.
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CONGRATULATIONS!

When you purchased your new wood stove, you joined the ranks of thousands of individuals whose answer to their home heating needs reflects their concern for aesthetics, efficiency and our environment. We extend our continued support to help you achieve the maximum benefit and enjoyment available from your new wood stove.

Thank you for selecting an Innovative Hearth Products, LLC (IHP) wood stove as the answer to your home supplemental heating needs.

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USING THIS MANUAL

Please read and carefully follow all of the instructions found in this manual. Please pay special attention to the safety instructions provided in this manual.

PRODUCT IS SUBJECT TO CHANGE WITHOUT NOTICE

IMPORTANT SAFETY AND WARNING INFORMATION

READ THIS MANUAL IN ITS ENTIRETY AND UNDERSTAND THESE RULES TO FOLLOW FOR SAFETY.

1. When this room heater is not properly installed, a house fire may result. To reduce the risk of fire, follow the installation instructions. Contact local building or fire officials about restrictions and installation inspection requirements in your area.
2. Wear gloves during installation to avoid injury from sharp edges on the stove and/or its parts.
3. This unit is designed and engineered to burn only dry, well-seasoned wood. Burning wet wood will greatly reduce the stove's efficiency, produce excessive amounts of smoke and can cause dangerous chimney fires due to creosote build-up.
4. Before opening the door, the draft control must be fully open to avoid possible combustion flash (ignition of hot volatile gases as the door is opened).
5. Never use gasoline, gasoline-type lantern fuel, kerosene, charcoal lighter fluid, or similar liquids to start or 'freshen up' a fire in this heater. Keep all such liquids well away from the heater while it is in use. **DO NOT USE CHEMICALS OR FLUIDS TO START THE FIRE.**
6. While burning, fuel utilizes oxygen from the air in the room. Be sure to allow an adequate amount of fresh air into the room where the stove is burning.
7. The outside surface of the stove will be hot while burning properly and can set items like clothing and curtains on fire. Keep furnishings and other combustible materials away from the stove. Using the heat from the stove to dry wet clothing can be hazardous if clothes are placed too near the surface of the stove.
8. **HOT WHILE IN OPERATION. KEEP CHILDREN, CLOTHING, FURNISHINGS AND COMBUSTIBLE MATERIAL A CONSIDERABLE DISTANCE AWAY. CONTACT MAY CAUSE SKIN BURNS.** Do not allow children to play near the stove without close supervision. Do not touch the stove while it is burning. Use extreme caution while the unit is in use. Surface temperatures become dangerously hot and can cause serious burns.
9. Do not allow anyone to operate the stove who is not familiar with the operating instructions.
10. Attempts to achieve heat output rates that exceed stove design specifications can result in permanent damage to the stove. Never leave your stove unattended on high burn rates. This may cause overfiring. Overfiring the stove may cause a house fire. If the stove glows, you are overfiring.
11. Keep a water hose or hand-operated fire extinguisher close for safety.
12. **Smoke Detectors** - Since there are always several potential sources of fire in any home, we recommend installing smoke detectors. If possible, install the smoke detector in a hallway adjacent to the room (to reduce the possibility of occasional false activation from the heat produced by the stove). If your local code requires a smoke detector be installed within the same room, you must follow the requirements of your local code. Check with your local building department for requirements in your area.
13. Inspect your chimney at least once a month during the burning season to check for soot and creosote accumulations. Any accumulations over 1/8" thick should be removed by a professional chimney sweep. Do not attempt to burn out heavy creosote accumulations with a hot fire. If large accumulations are occurring, review your burning procedures.
14. If a creosote fire should develop, the fire department should be called immediately and then attempts should be made to control the fire until assistance arrives. If a "runaway" fire should develop causing over-heating of the stove, the door and draft regulators should be closed immediately. The fire should die down once deprived of oxygen. After a severe chimney fire, the complete chimney system should be checked before further use.
15. **Do Not Use Grate Or Elevate Fire - Build Wood Fire Directly On Hearth (firebrick).** Do not use andirons or other methods of supporting the fuel.
16. Please read this entire manual before you install and use your new room heater. Failure to follow instructions may result in property damage, bodily injury, or even death.
17. Check all local building and safety codes before installation. The installation instructions and appropriate code requirements must be followed exactly and without compromise. In the absence of local codes the following standards and codes must be followed.
18. In the U.S.A, install in accordance with the National Fire Protection Association's Code, NFPA 211, Standards for Chimneys, Fireplaces, Vents and Solid-Fuel-Burning Appliances, or similar regulations, may apply to the installation of a Solid-Fuel-Burning appliance in your area. In Canada, the guideline is established by the CSA Standard, CAN/CSA-B365-M93, Installation Code for Solid-Fuel-Burning Appliances and Equipment.
19. **DO NOT CONNECT TO OR USE IN CONJUNCTION WITH ANY AIR DISTRIBUTION DUCTWORK UNLESS SPECIFICALLY APPROVED FOR SUCH INSTALLATIONS.**
20. **WARNING: BURNING IMPROPER FUEL (I.E. CHARCOAL) CAN RESULT IN CARBON MONOXIDE POISONING, WHICH MAY LEAD TO DEATH!**
21. **Carbon Monoxide Poisoning** - Early signs of carbon monoxide poisoning resemble the flu with headaches, dizziness, or nausea. If you have these signs, get fresh air at once! Have the heater inspected by a qualified service technician. Some people are more affected by carbon monoxide than others. These include pregnant women, people with heart or lung disease or anemia, those under the influence of alcohol, and those at high altitudes.
22. Failure to use manufacturer provided parts, variations in techniques and construction materials or practices other than those described in this manual may create a fire hazard and void the limited warranty.
23. Do not make any make-shift compromises during installation. Any modification or alteration may result in damage to the appliance or dwelling and will void the warranty, certification and listings of this unit.
24. These appliances are designed as supplemental heaters. Therefore, it is advisable to have an alternate heat source when installed in a dwelling.
25. **Do Not Overfire** - If Heater or Chimney Connector Glows, You Are Overfiring.
26. **DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVING ANOTHER APPLIANCE.**
27. **DO NOT BURN GARBAGE OR FLAMMABLE FLUIDS SUCH AS GASOLINE, NAPHTHA OR ENGINE OIL.**

WARNING

This product can expose you to chemicals including Carbon Black, which is known to the State of California to cause cancer, and Carbon Monoxide, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

WARNING

This wood heater 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.

TESTING INFORMATION

This manual describes the installation and operation of the Grandview™ 230GL non-catalytic wood heaters. These heaters meet the U.S. Environmental Protection Agency's emissions limits, and are compliant with 2020 EPA NSPS particulate emission standards. These heaters have been developed, tested and constructed in accordance with the requirements of UL 1482, ULC S627 and HUD standards and are listed by PFS Corporation. These heaters have been approved for residential, mobile home and alcove installations.

Model	Emission Rate	EPA BTU/hr Test Range	Max. Output BTU/hr	EPA Default Efficiency
GV230GL	1.7 g/hr	12,600 - 33,900	76,000	63% *

* Default - Category rating as assigned by the EPA. The estimated efficiency is as follows: 63% (non-catalyst equipped), 72% (catalyst-equipped), and 78% (wood pellets). See § 60.536(i)(3) at www.epa.gov.

DRAFT REQUIREMENTS

This appliance is dependent upon a properly functioning chimney for optimum performance. It is a high efficiency appliance that loses much less heat up the chimney than older appliances and fireplaces. For this reason it is important to match the stove to the chimney. The chimney has two functions:

1. It draws combustion air into the appliance (without air, no fuel will burn) and
2. It exhausts combustion by-products. Your new stove is what is known as a "natural draft" appliance.

The appliance depends solely on the natural draft of the chimney system to draw combustion air into the unit. Draft is the force that moves air from the appliance up into the chimney. The amount of draft in your chimney depends on the length of the chimney, local geography, nearby obstructions and other factors. Too much draft may cause excessive temperatures in the appliance (overfiring). Slow or inadequate draft

equals poor combustion and possible smoking problems. The following are some conditions that may contribute to poor chimney draft:

1. A chimney too large for your appliance.
2. A chimney with not enough height to produce adequate draft.
3. A chimney with excessive height (this may allow exhaust to cool too much before exiting, which will stall the rate the exhaust exits).
4. Offsets in the venting system are too restrictive (see *Chimney Guidelines*). Inadequate draft will cause the appliance to leak smoke into the room through the stove and the chimney connector joints. Excessive draft may cause an uncontrollable burn or a glowing red stove or chimney part.

Overfiring Damage - If the heater or chimney connector glows, you are overfiring. Other symptoms may include: Cracking, warping or burning out of components, plated accessories may turn color, stove glass may develop a haze, which will not come off with cleaning.

Overfiring of a stove is a condition where excessive temperatures are reached, beyond the design capabilities of the appliance. The damage that occurs from overfiring is not covered under the manufacturer's limited warranty.

Also see *Troubleshooting* on **Page 27**.

SELECTING THE PROPER VENTING SYSTEM

The appliance is merely one component of a larger system. The other equally important component is the venting system. This is necessary for achieving the required flow of combustion air to the fire chamber and for safely removing unwanted combustion by-products from the appliance. If the venting system's design does not promote these ends, the system may not function properly. Poorly functioning venting systems may create performance problems as well as be a safety hazard. **A draft test should read greater than .04" W.C. (inches water column) and less than .08" W.C.** As per NFPA-211 standard (see paragraph below), the installer must take into account all variables within the installation and install the appliance in such a manner that satisfies the draft requirements of the appliance. See *Chimney Guidelines* below to assist you in selecting the proper venting system for your installation.

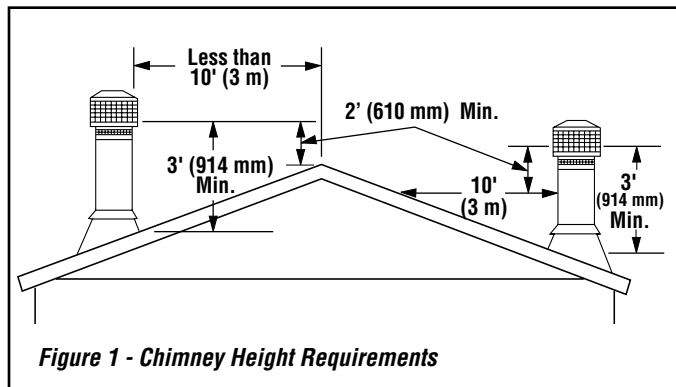
American National Standards Institute ANSI/NFPA 211, Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances - See Draft Section: A chimney or vent shall be so designed and constructed to develop a flow sufficient to completely remove all flue and vent gases to the outside atmosphere. The venting system shall satisfy the draft requirements of the connected appliance in accordance with the manufacturer's instructions.

Chimney Guidelines:

- This appliance requires approximately 12 feet minimum of "effective draw" provided by the venting system. As a rule of thumb, every 90 degree total direction change in the venting will result in a loss of approximately 5 feet of "effective draw." Example: If two 45 degree offsets are used, subtract 5 feet from the actual vertical vent height to determine your "effective draw." In this case if you had 14 feet of vertical vent, the effective draw would only be approximately 9 feet (14 ft. - 5 ft. = 9 ft.), therefore it may be necessary to add additional height to the venting system.
- Do not install an offset within the first two feet above the flue outlet on the appliance.
- In well insulated and weather tight homes, it may be difficult to establish a good draft up your chimney. The poor draft is caused by a shortage of air in the house. In this situation an Outside Air Kit may need to be installed (See *Negative Pressure Warning* on **Page 5** and *Outside Combustion Air* on **Page 15**).

CHIMNEY HEIGHT REQUIREMENTS

The chimney must extend 3' (.92m) above the level of roof penetration and a minimum of 2' (.61m) higher than any roof surface within 10' (3m) (see below). Check with your local building officials for additional requirements for your area.



To pass inspection in nearly any jurisdiction, the chimney must meet both safety and exhaust flow requirements. The (3' by) 2' by 10' rule applies to both masonry and factory-built chimneys.

*** Ref. USA - National Standard, NFPA 211-latest edition and Canada National Standard CSA B365-01-latest edition. Vents installed with a listed cap shall terminate in accordance with the terms of the cap's listings.**

NEGATIVE PRESSURE WARNING

This appliance is not designed to be operated in a negative pressure. In very airtight homes with large kitchen exhaust fans, furnace cold air returns, fresh air exchange systems and any other air system in close proximity to the heating appliance may create a negative pressure in the same room as the heating appliance. This can create dangerous back drafting of the stove and chimney joints, drawing combustion by-products into the home. Be sure your home has adequate makeup air to eliminate negative pressures caused by the above-mentioned sources. Outside air connected to the appliance probably will not resolve such a problem as the appliance is not the source of negative pressure. IHP accepts no liability for damages resulting from negative pressures described here.

Ventilation Requirements - Provide adequate air for combustion. The fresh air requirements of this appliance must be met within the space where it will be installed. Ventilation is essential when using a Solid-Fuel-Burning heater. In well insulated and weather tight homes, it may be difficult to establish a good draft up the chimney (caused by a shortage of air in the home). The lack of air is caused by many common household appliances which exhaust air from the home (such as a furnace, heat pump, air conditioner, clothes dryer, exhaust fans, fireplaces, and other fuel burning appliances). Also, the combustion process of this heater uses oxygen from inside the dwelling. If the available fresh air delivery in the dwelling is insufficient to support the demands of these appliances, problems can result (e.g. excessive negative pressure can develop in the dwelling which will affect the rate at which this appliance can draft thus resulting in performance problems). To correct this problem it may help to open a window (preferably on the windward side of the house) or install an optional outside air kit.

CLEARANCES TO COMBUSTIBLES

WARNING: BE ABSOLUTELY SURE THE DISTANCE BETWEEN THE HEATER AND THE SURFACE OF ANY COMBUSTIBLE CONSTRUCTION IS NOT LESS THAN SHOWN IN THE FIGURES ON Page 7 FOR MODEL GV230 WOODSTOVE.

Floor Protection

USA - The floor in front and under the heater must be protected with noncombustible material. The covering must extend 16" in front of the door opening of the heater and 8" to either side of the door opening.

Canada - The floor in front and under the heater must be protected with noncombustible material. The covering must extend 450 mm in front of the door opening of the heater and 200 mm to either side of the stove body and 200 mm to the rear or to the wall, whichever is smaller.

USA and Canada - A chimney connector / venting extends horizontally over the floor, protection must also cover the floor under the connector / venting and at least 2" (51 mm) to either side.

Alcove Installations USA and Canada - The floor protection must be a thermally rated non-combustible floor protector. See **Page 8** for GV230GL stoves.

Alcove Installation

Clearances - In alcove installations, only 6" double wall connector pipe can be used (single wall or single wall pipe with shield is not allowed).

Minimum alcove width between combustible materials:
GV230GL - 52" (1321 mm)

Maximum alcove depth:
GV230GL - 48" (1219 mm)

Minimum alcove height:
GV230GL - 72" (1829 mm)

Thermal Floor Protection

GV230GL - Thermal floor protection is only required where the stove is installed into an alcove.

Chimney and Connector

Minimum 6" diameter, minimum 24 MSG black steel connector pipe with UL103HT listed factory-built chimney suitable for use with solid fuels or masonry chimney. Horizontal connection not tested, refer to local building codes for installation. See installation instructions for details. Restrictions apply! Read instructions before installing.

Residential chimney systems must be from the same brands as listed for mobile homes but connector pipe may be double wall, single wall, or single wall with shield as listed.

This appliance may be vented into a code-approved masonry chimney with flue liner.

WARNING: CHIMNEY CONNECTOR MUST BE IN GOOD CONDITION AND KEPT CLEAN. DO NOT INSTALL DAMAGED PARTS.

All of the stove connector pipe used must be of the same brand. The chimney that the stove pipe transitions into may be a different brand. Other than the transition of the stove pipe into the chimney, do Not mix different brand vent components. Install all vent components per vent manufacturer's instructions.

The chimney connector shall not pass through an attic or roof space, closet or similar concealed space, or a floor, or ceiling. Where passage through a wall, or partition of combustible construction is desired, the installation shall conform to CAN/CSA-B365, Installation Code for Solid-Fuel-Burning Appliances and Equipment.

There must be an effective vapor barrier at the location where the chimney or other component penetrates to the exterior of the structure. Follow the vent manufacturer's detailed instructions.

IMPORTANT NOTE: See *Draft Requirements* and *Selecting a Proper Venting System* on **Page 4** to assist you in choosing the proper venting system for your installation.

Clearance dimensions are to flue collar. If a single wall connector pipe with shield is used, a 1 inch air space is needed between pipe and shield. Shield attaches to rear of stove pipe and must run from stove top to ceiling. Pipe shield shall be UL listed.

Components Required For Installations

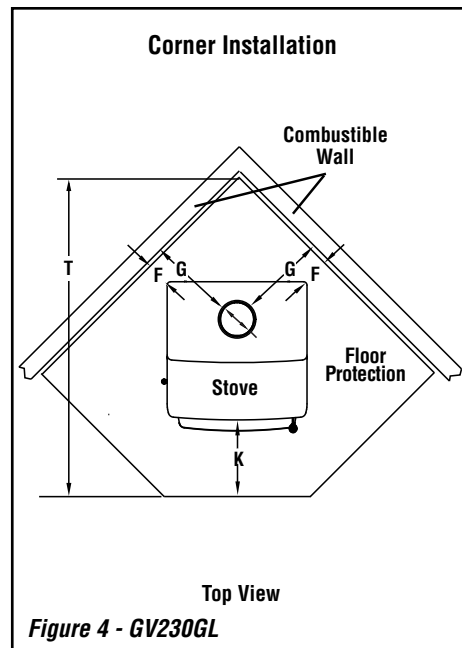
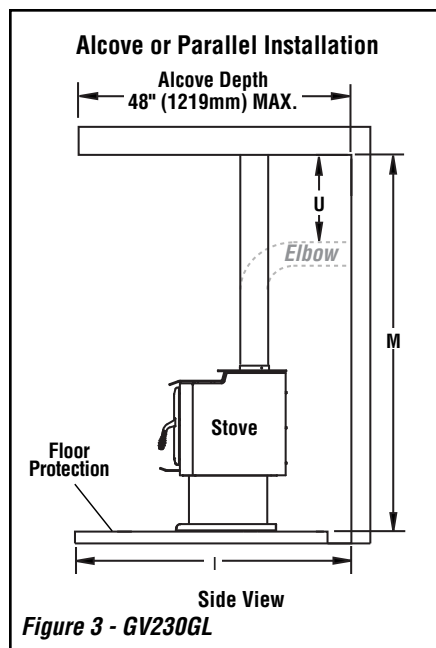
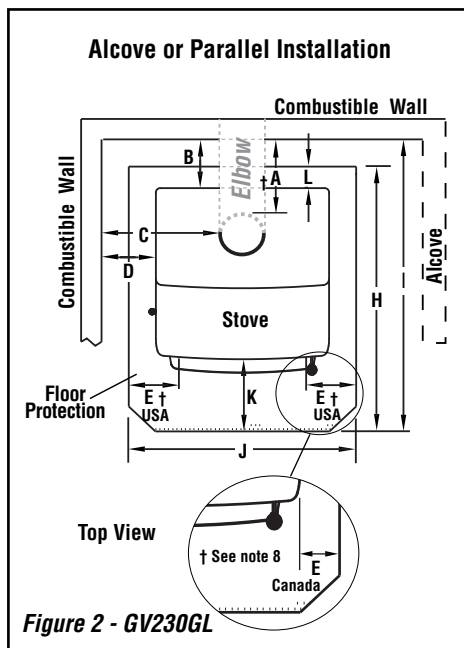
Legs OR Pedestal Assembly.

Use all required components specified for this appliance. Do not substitute.

WARNING: In the event that you remove the blower for any reason, make sure a cover plate (available from IHP) is installed before using the heater. *Note: The cover plate is not necessary if a blower has never been installed because a knock-out will be in place to act as the cover.*

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INSTALLATION CLEARANCES - REFER TO FIGURES 2, 3 AND 4



USA - inches (millimeters)



PIPE	INSTALLATION	A (3)	B (1)	C (3)	D (1)	E (8)	F (1,4)	G(3,4)	H (2)	I (6)	J (2)	K (7)	L (5)	M	T (6)	U
Single Wall	Residential-Vertical Vent	16 (406)	12-3/8 (314)	22 (559)	12-1/2 (318)	8 (200)	5-3/4 (146)	16 (406)	38-5/8 (981)	51 (1295)	33 (838)	16 (406)	0 (0)	84 (2134)	58-7/8 (1495)	N/A N/A
Single Wall	Residential-With Elbow	19 (483)	15-3/8 (391)	23 (584)	13-1/2 (343)	8 (200)	5-3/4 (146)	16 (406)	38-5/8 (981)	54 (1372)	33 (838)	16 (406)	0 (0)	84 (2134)	58-7/8 (1495)	19 N/A
Double Wall	Residential or Mobile Home-Vertical Vent	10 (254)	6-3/8 (162)	20 (508)	10-1/2 (267)	8 (200)	4-3/4 (121)	15 (381)	38-5/8 (981)	45 (1143)	33 (838)	16 (406)	0 (0)	84 (2134)	57-1/2 (1461)	N/A N/A
Double Wall	Residential or Mobile Home-With Elbow	10 (254)	6-3/8 (162)	21 (533)	11-1/2 (292)	8 (200)	4-3/4 (121)	15 (381)	38-5/8 (981)	45 (1143)	33 (838)	16 (406)	0 (0)	84 (2134)	57-1/2 (1461)	10 N/A
Double Wall	Alcove-Vertical Vent	13 (330)	9-3/8 (238)	22-1/2 (572)	13 (330)	8 (200)	N/A N/A	N/A N/A	38-5/8 (981)	48 (1219)	33 (838)	16 (406)	0 (0)	72 (1829)	N/A N/A	N/A N/A

CANADA - inches (millimeters)



PIPE	INSTALLATION	A (3)	B (1)	C (3)	D (1)	E (8)	F (1,4)	G(3,4)	H (2)	I (6)	J (2)	K (7)	L (5)	M	T (6)	U
Single Wall	Residential-Vertical Vent	16 (406)	12-3/8 (314)	22 (559)	12-1/2 (318)	8 (200)	5-3/4 (146)	16 (406)	49 (1235)	53 (1346)	41-1/8 (1045)	18 (450)	8 (200)	84 (2134)	58-7/8 (1495)	N/A N/A
Single Wall	Residential-With Elbow	19 (483)	15-3/8 (391)	23 (584)	13-1/2 (343)	8 (200)	5-3/4 (146)	16 (406)	49 (1235)	56 (1422)	41-1/8 (1045)	18 (450)	8 (200)	84 (2134)	58-7/8 (1495)	19 (483)
Double Wall	Residential or Mobile Home-Vertical Vent	10 (254)	6-5/16 (160)	20 (508)	10-1/2 (267)	8 (200)	4-3/4 (121)	15 (381)	47 (1193)	47 (1193)	41-1/8 (1045)	18 (450)	8 (200)	84 (2134)	57-1/2 (1461)	N/A N/A
Double Wall	Residential or Mobile Home-With Elbow	10 (254)	6-5/16 (160)	21 (533)	11-9/16 (293)	8 (200)	4-3/4 (121)	15 (381)	47 (1193)	47 (1193)	41-1/8 (1045)	18 (450)	8 (200)	84 (2134)	57-1/2 (1461)	10 (254)
Double Wall	Alcove-Vertical Vent	13 (330)	9-3/8 (238)	22-1/2 (572)	13-1/16 (331)	8 (200)	N/A N/A	N/A N/A	49 (1235)	50 (1270)	41-1/8 (1045)	18 (450)	8 (200)	72 (1829)	N/A N/A	N/A N/A

Footnotes:

- These dimensions to the stove body are for reference only. Actual distances should be measured from the stove's flue collar.
- Minimum noncombustible hearth pad dimensions.
- Clearances to connector pipe shall be measured from the flue collar of the stove.
- Not applicable to alcove installations.

- In corner applications, when installed at minimum back wall clearances, the required floor protection is dimensioned off the back plane of the stove, therefore the floor protection required off the back corners (at a 45 degree angle) only needs to extend to the wall. This situation will only occur in CANADA installations.

- Reference dimension only, to assist in planning the installation.
- Measured from front of floor protection to the front of firebox.
- USA=8" (200mm) from door opening, Canada=8" (200mm) from sides and back of unit.

Grandview™ GV230GL

ALCOVE INSTALLATIONS - FLOOR PROTECTION

When the Grandview™ 230 is installed in an Alcove, the floor protection must be a thermally rated non-combustible floor protector meeting or exceeding a thermal rating of $k=.47$ or equivalent with a listed thickness of 1/2" (12.7 mm) minimum in the USA and Canada. The thermal protection must extend 16" in front of the heater and 8" to each side (measured from the door opening).

Using Alternate Material As Floor Protection

The floor protection or alternate material used as a floor protector must be constructed of a durable noncombustible material having an equal or better thermal conductivity value (lower k value) of $k=.47$ BTU/IN FT² HR °F or a thermal resistance that equals or exceeds $r = 2.13$ HR °F FT² IN/BTU with a minimum thickness of 1/2". With these values, determine the minimum thickness of the alternate material required using the formula(s) and shown in **Table 1**.

Note: Any noncombustible material having a minimum thickness of 1/2" (12.7mm) whose k value is less than .47 or whose r value is more than 2.13 is acceptable. If the alternate material used has a higher k value or lower r value will require a greater thickness of the material used. In some cases, if the k value is less or the r value higher, a thinner material may be used.

Methods of determining floor protection equivalents:

To determine the thickness required for the alternate material when either the " k " value or " r " value is known, use either the **k formula** or **r formula**.

Example: If Micore 160 Mineral Fiber Board is to be used for the floor protection, how thick must this material be?

k_M = k value per inch of **alternate** material

r_M = r value per inch of **alternate** material

T_M = minimum thickness required for **alternate** material

T_S = standard thickness of the **alternate** material

k_L = k value per inch of **listed** material

r_L = r value per inch of **listed** material

T_L = minimum thickness of **listed** material

Note: An asterisk "*" indicates, it is a value taken from **Table 1**.

Using the k formula:

Minimum thickness of alternate material (T_M) = $\frac{k\text{-value (per Inch) of alternate material } (k_M)}{k\text{-value (per inch) of listed material } (k_L)} \times \text{Specified min. thickness of listed material } (T_L)$

$$T_M \text{ (inches)} = \frac{k_M}{*.47} \times T_L$$

$$T_M \text{ (inches)} = \frac{*.35}{*.47} \times .50"$$

$$.312 \text{ (inches)} = .745 \times .50"$$

Answer - The minimum required thickness of the Micore 160 is .372" therefore round up to nearest standard thickness available which is 3/8" (.375")

Using the r formula:

Minimum thickness of alternate material = $\frac{r\text{-value (per Inch) of listed material } (r_L)}{r\text{-value (per inch) of alternate material } (r_M)} \times \text{Specified min. thickness of listed material } (T_L)$

$$T_M \text{ (inches)} = \frac{r_L}{r_M} \times T_L$$

$$T_M \text{ (inches)} = \frac{2.13}{2.86} \times .50"$$

$$.312 \text{ (inches)} = .745 \times .50"$$

Answer - The minimum required thickness of the Micore 160 is .372" therefore round up to nearest standard thickness available which is 3/8" (.375")

Listed Material			
	k (per inch)	r (per inch)	Listed Min. Thickness
Listed Material	.47 k_L	2.13 r_L	1/2" (.50") T_L
** Approved Alternate Materials for Floor/Hearth Protection			
Alternative Materials	Thermal Values		Minimum Thickness (rounded to nearest 1/8 inch)
	k (per inch) k_M	r (per inch) r_M	Min. Thickness T_M
Kaowool M Board	.47	2.13	.5" (1/2")
Micore 160™ U.S. Gypsum	.35	2.86	.37" (3/8")
Micore 300™ U.S. Gypsum	.46	2.17	.49" (1/2")
Durock™ Cement Board U.S. Gypsum	1.92	.52	2.04" (2-1/8")
Hardibacker™	1.95	.51	2.07" (2-1/8")
Hardibacker 500™	2.30	.43	2.45" (2-1/2")
Cultured Stone Hearth-stone™	2.82	.35	3" (3")
Wonderboard	3.23	.31	3.44" (3-1/2")
Super Firetemp M Johns-Manville	.61	1.64	.65" (3/4")
Super Firetemp L Johns-Manville	.54	1.85	.57" (5/8")
Face brick	9.00	.111	9.57" (9-5/8")
Common brick	5.00	.20	5.32" (5-3/8")
Cement mortar	5.00	.20	5.32" (5-3/8")
Ceramic tile	12.5	.08	13.30" (13-3/8")
Marble	~11	~.09	11.70" (11-3/4")

Table 1 - USA AND CANADA REQUIREMENTS - GV230GL

**** If the hearth extension material(s) that is intended to be used is NOT listed on Table 1, the material can still be used if the material(s) is non-combustible. However, the manufacturer of the material must provide either the listed k -value per inch or r -value per inch with listed thickness so that the minimum thickness required for the hearth can be calculated (per instructions here or as specified in the NFI Certification Manuals).**

Note: Also see NFI (National Fireplace Institute) Certification Manuals showing other acceptable calculation methods and acceptable alternate materials which can be used.

SPECIFICATIONS - GV230GL

GV230GL Specifications

Stove Pipe Diameter

Single Wall or

Double Wall 6" (152 mm)

Log Length

16" W x 18" D Max.
(406mm W x 457mm D Max.)

Firebox

17" W x 19" D x 12-1/2" H Max.
(432mm W x 483mm D x

318mm

H Max.) Volume = 2.3 cu. ft.

Glass Viewing Area

16-1/2" W x 11-5/16" H
(419mm W x 287mm H)

EPA Test Load:

28,200 BTUs/hr.

Cord Wood: ①

76,000 BTUs/hr.

Maximum Burn Times ① 12 hours

Heating Capacity ① 1200 to 2200 sq. ft.

EPA Grams Per Hour 1.7 gr/hr

EPA Phase II and Washington State Approved

Product Reference Information

Cat. No.	Description	Ship. Wt.	Ship. Volume
TBD	Grandview 230GL	385 lb.	20.09 cu. ft.

NOTES

- Dimensions shown are approximations only (+/- 1/4")
- Diagrams, illustrations and photographs are not to scale - consult installation instructions. Product designs, materials, dimensions, specifications, colors and prices are subject to change or discontinuance without notice.
- Approved for residential, manufactured home (GV230GL only), and alcove installations.
- Optional Kits Available:
Door Trim Kit
Blower
Outside Air Kit
Louvers
Legs (choice of three styles)
Pedestal
Ash Drawer for legs or for pedestal

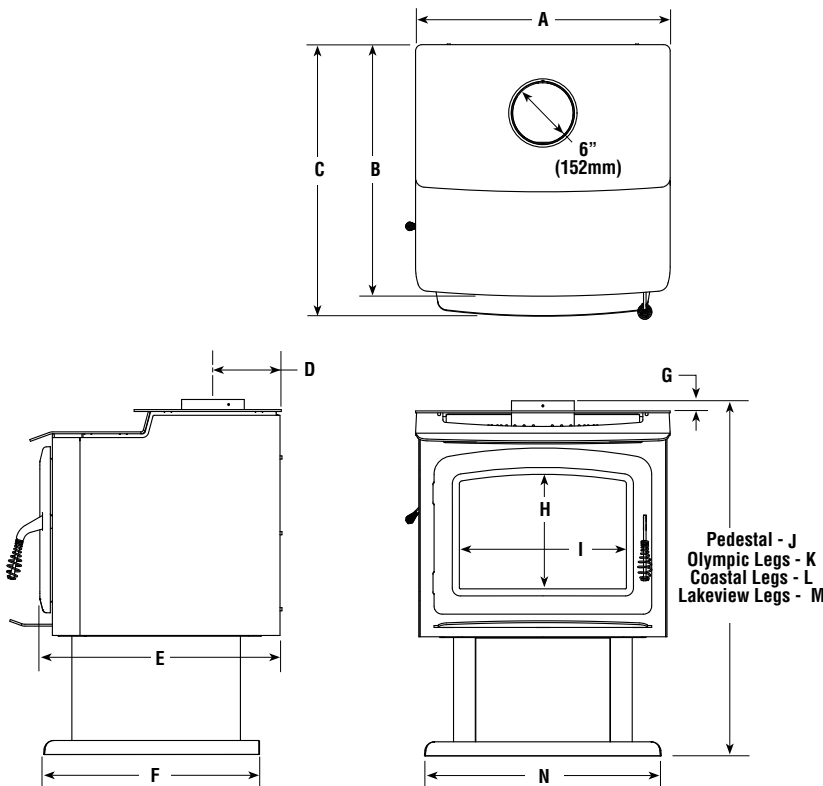
- ① Square-foot heating capacities and burn times are approximations only. Actual performance may vary depending upon home design and insulation, ceiling heights, climate, condition and type of wood used, appliance location, burn rate, accessories chosen, chimney installation and how the appliance is operated.

The Grandview™ Model GV230GL woodstoves are safety listed with the following agency:

- PFS Corporation, Tested to UL 1482, ULC S627



GV230GL - Report # 14-182



Model	A	B	C	D	E	F	G
GV230GL	25-1/8" (638mm)	24-3/4" (629mm)	26-5/8" (676mm)	6-9/16" (167mm)	23-3/4" (603mm)	21-5/16" (541mm)	1" (25mm)

Model	H	I	J	K	L	M	N
GV230GL	11-5/16" (287mm)	16-1/2" (419mm)	35" (889mm)	33-1/2" (851mm)	32-1/2" (826mm)	32-13/16" (833mm)	23-1/8" (587mm)

Figure 8 - Dimensions

Single Wall Pipe
Using 6" Diameter Single Wall Connector Pipe

INSTALL VENTING SYSTEM PER VENT MANUFACTURERS INSTRUCTIONS!

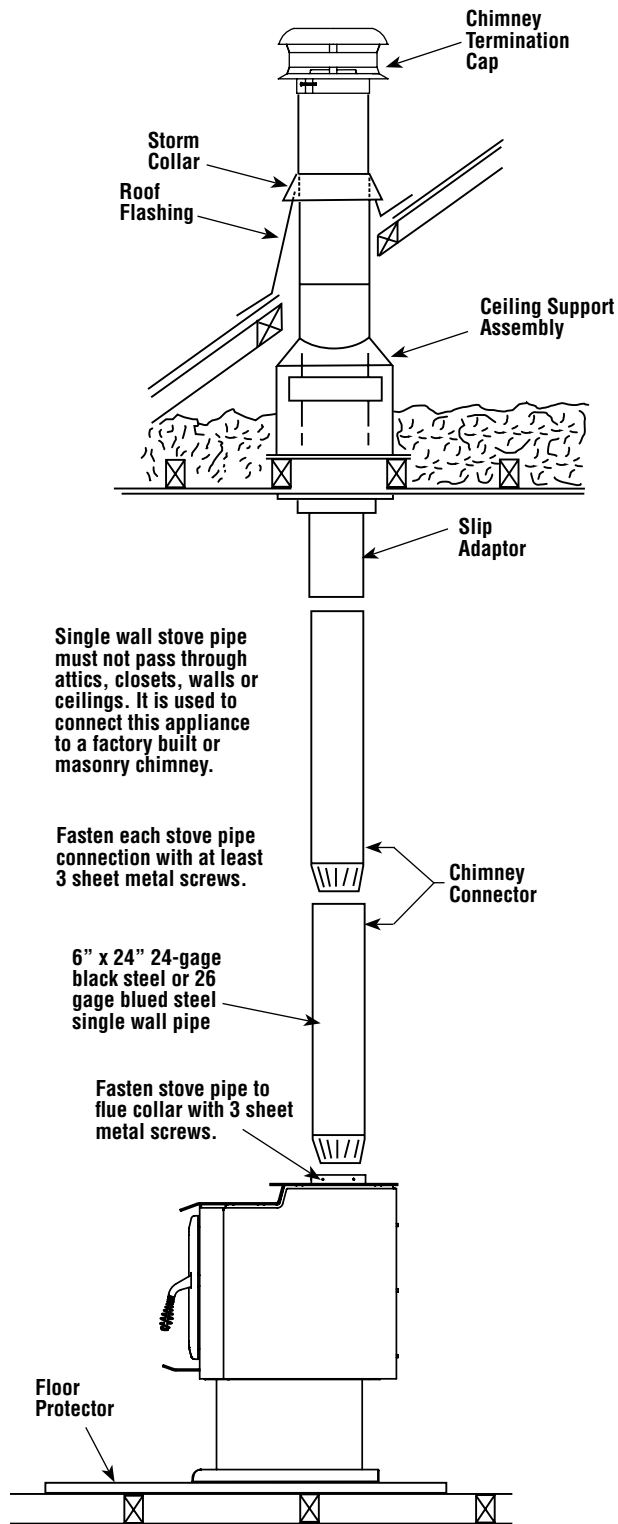


Figure 9 - Typical Installation

STAINLESS STEEL LINER
Using 6" Diameter Rigid Stainless Steel Liner

INSTALL VENTING SYSTEM PER VENT MANUFACTURERS INSTRUCTIONS!

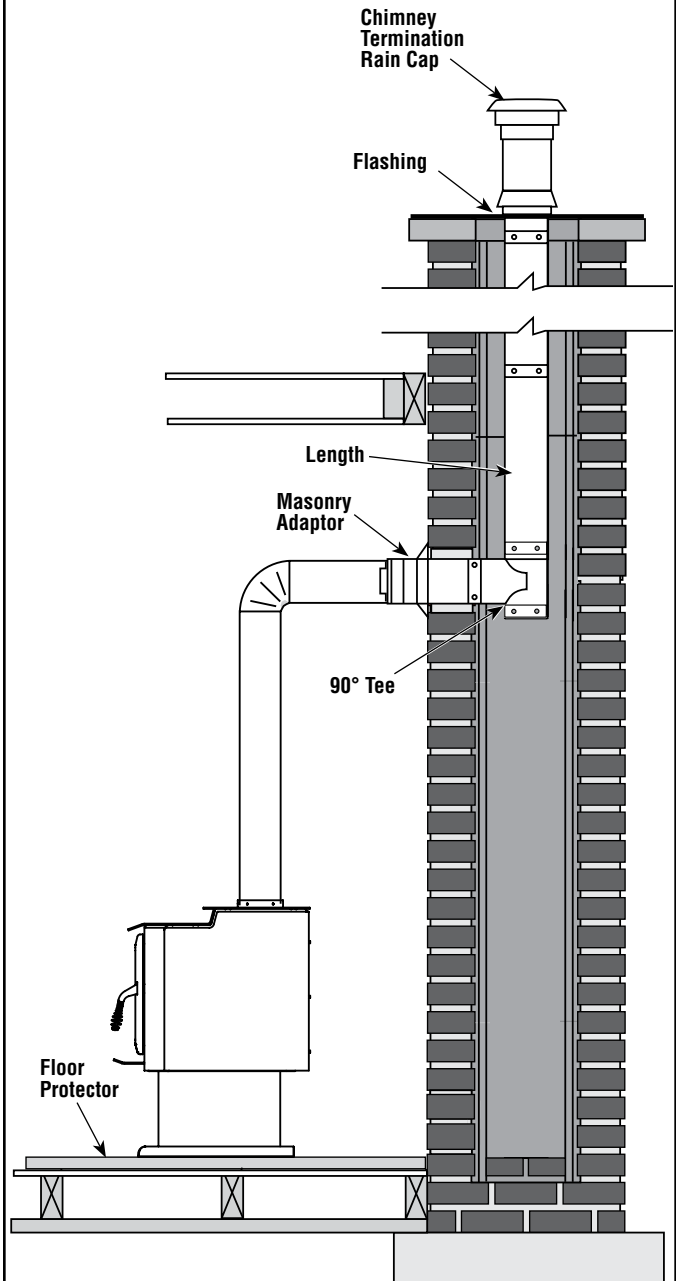


Figure 10 - Connected to a Masonry Chimney

YOUR CHIMNEY INSTALLATION MUST COMPLY WITH LOCAL BUILDING AND FIRE CODES.

CHIMNEY INSTALLATION

- Install chimney as per manufacturer's instructions. Some brands of pipe may require removal of the spacer ring in the flue collar.
- All horizontal runs of pipe should be as short as possible and are required by NFPA No. 211 to have an upward pitch or rise in the same direction the smoke travels of no less than 1/4" to the linear foot. The connector pipe must meet minimum clearances in any direction to walls or other combustible materials. It must attach to a listed double wall metal chimney at least 6" in diameter or to a masonry chimney with a flue passage of at least 48 square inches.
- It is required that a chimney connector pipe not extend further than the inner wall of the flue when it is connected to a masonry chimney and that it either be cemented to the masonry or be installed without cement in a thimble connected to the masonry wall. When the connector is inserted into a thimble, the joint must be tight enough so that it will not be dislodged in normal use. Install connector at no less than the minimum clearances from the ceiling when using a 90-degree elbow to pass through combustible constructions.
- Chimney connector pipes should never pass through a floor, ceiling, fire wall, partition, or combustible construction of any type unless certain precautions are taken. The best method is to use a listed thimble and a listed chimney in accordance with the manufacturer's directions. NFPA No. 211 gives approved methods for passing a flue pipe through combustible constructions (see **Page 12**).

Manufactured Home Installations (GV230GL ONLY) (ref. **Figure 11**)

Model GV230GL woodstove is approved for installation into a manufactured (mobile) home.

Installation should be in accordance with the **Mobile Home Construction and Safety Standard, Title 24 CFR, Part 3280** (in Canada **CAN/CSA Z240 MH**), or, when such a standard is not applicable, the **Standard for Mobile Home Installations, ANSI A225.1**.

All mobile home installations require an outside air kit (see **Page 30** for ordering information). The stove must be secured to the floor and grounded to the chassis of the mobile home.

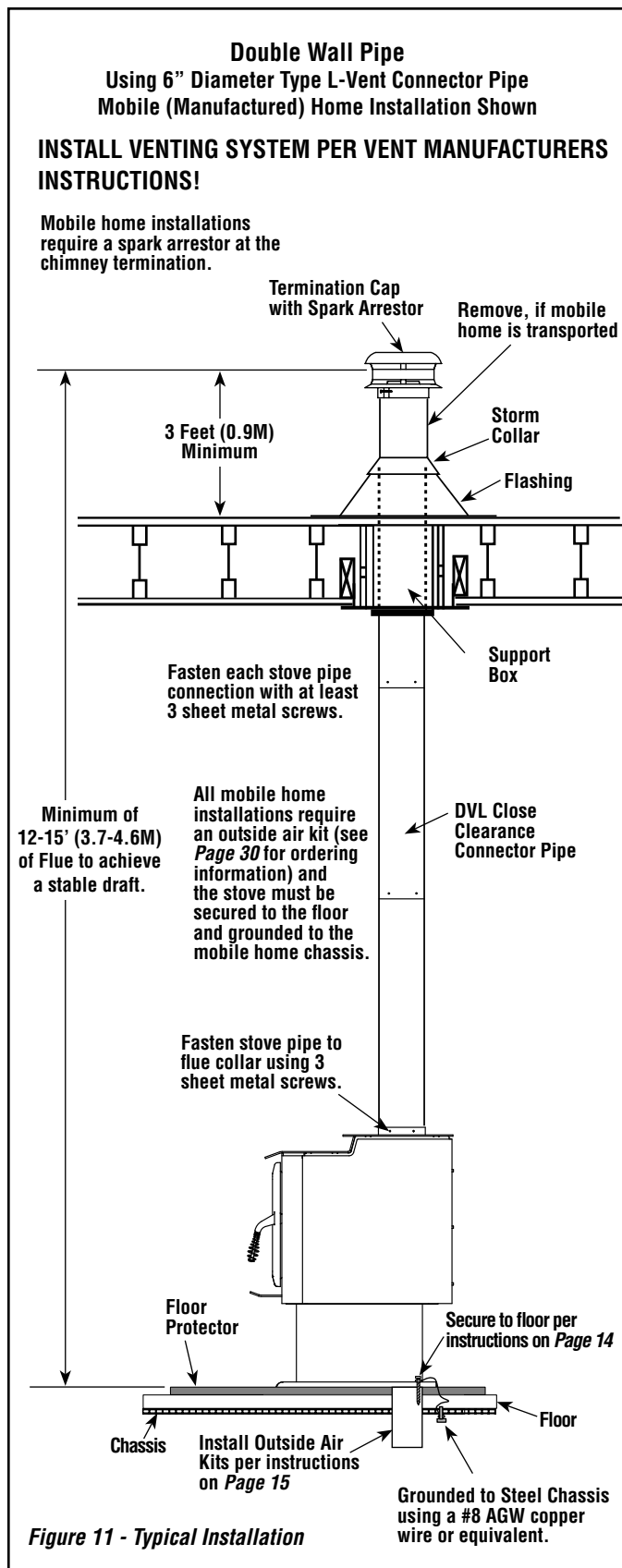
WARNING: DO NOT INSTALL IN SLEEPING ROOM OF A MOBILE HOME.

CAUTION: THE STRUCTURAL INTEGRITY OF THE MOBILE HOME FLOOR, WALL AND CEILING/ROOF MUST BE MAINTAINED.

Approved Chimney* - Your stove is approved for use with Class A, UL 103 HT (U.S.) / ULC-S629 (Canada) Listed Residential Type and Building Heating Appliance Chimney (HT chimney - 2100° Fahrenheit) and double wall connector pipe. Approved chimney brands are Security Chimneys™, Jakes Evans/GSW, Dura-Vent, Metal Fab, Ameri-Tec, Metalbestos and Industrial Chimney (ICC).

Clearances to connector shall be measured from 6" flue collar. Restrictions apply! Read instructions before installing.

YOUR CHIMNEY INSTALLATION MUST COMPLY WITH LOCAL BUILDING AND FIRE CODES.



Chimney Connector Systems and Clearances from Combustible Walls for Residential Heating Appliances (NFPA 211) Refer to Figure 12.

System A. Minimum 3.5 in. (90 mm) thick brick masonry wall framed into combustible wall with a minimum of 12 in. (305 mm) brick separation from clay liner to combustibles. Fireclay liner (ASTM C 315, Standard Specification for Clay Flue Linings, or equivalent), minimum 5/8 in. (16 mm) wall thickness, shall run from outer surface of brick wall to, but not beyond, the inner surface of chimney flue liner and shall be firmly cemented in place.

Clearance: 12 in. (305 mm)

System B. Solid-insulated, listed factory-built chimney length of the same inside diameter as the chimney connector and having 1 in. (25.4 mm) or more of insulation with a minimum 9 in. (229 mm) air space between the outer wall of the chimney length and combustibles.

The inner end of the chimney length shall be flush with the inside of the masonry chimney flue and shall be sealed to the flue and to the brick masonry penetration with non-water-soluble refractory cement. Supports shall be securely fastened to wall surfaces on all sides.

Fasteners between supports and the chimney length shall not penetrate the chimney liner.

Clearance: 9 in. (229 mm)

System C. Sheet steel chimney connector, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness, with a ventilated thimble, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness, having two 1 in. (25.4 mm) air channels, separated from combustibles by a minimum of 6 in. (152 mm) of glass fiber insulation. Opening shall be covered, and thimble supported with a sheet steel support, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness.

Supports shall be securely fastened to wall surfaces on all sides and shall be sized to fit and hold chimney section. Fasteners used to secure chimney section shall not penetrate chimney flue liner.

Clearance: 6 in. (152 mm)

System D. Solid-insulated, listed factory-built chimney length with an inside diameter 2 in. (51 mm) larger than the chimney connector and having 1 in. (25.4 mm) or more of insulation, serving as a pass-through for a single wall sheet steel chimney connector of minimum 24 gauge [0.024 in. (0.61 mm)] thickness, with a minimum 2 in. (51 mm) air space between the outer wall of chimney section and combustibles. Minimum length of chimney section shall be 12 in. (305 mm). Chimney section concentric with and spaced 1 in. (25.4 mm) away from connector by means of sheet steel support plates on both ends of chimney section. Opening shall be covered, and chimney section supported on both sides with sheet steel supports of minimum 24 gauge [0.024 in. (0.61 mm)] thickness.

Supports shall be securely fastened to wall surfaces on all sides and shall be sized to fit and hold chimney section. Fasteners used to secure chimney section shall not penetrate chimney flue liner.

Clearance: 2 in. (51 mm)

Additional requirements:

1. Insulation material used as part of wall pass-through system shall be of noncombustible material and shall have a thermal conductivity of 1.0 Btu-in./hr-ft² - °F (4.88 kg-cal/hr-m² - °C) or less.
2. All clearances and thicknesses are minimums; larger clearances and thicknesses shall be permitted.
3. Any material used to close up an opening for the connector shall be of noncombustible material.
4. A connector to a masonry chimney, except for System B, shall extend in one continuous piece through the wall pass-through system and the chimney wall to the inner face of the flue liner, but not beyond.

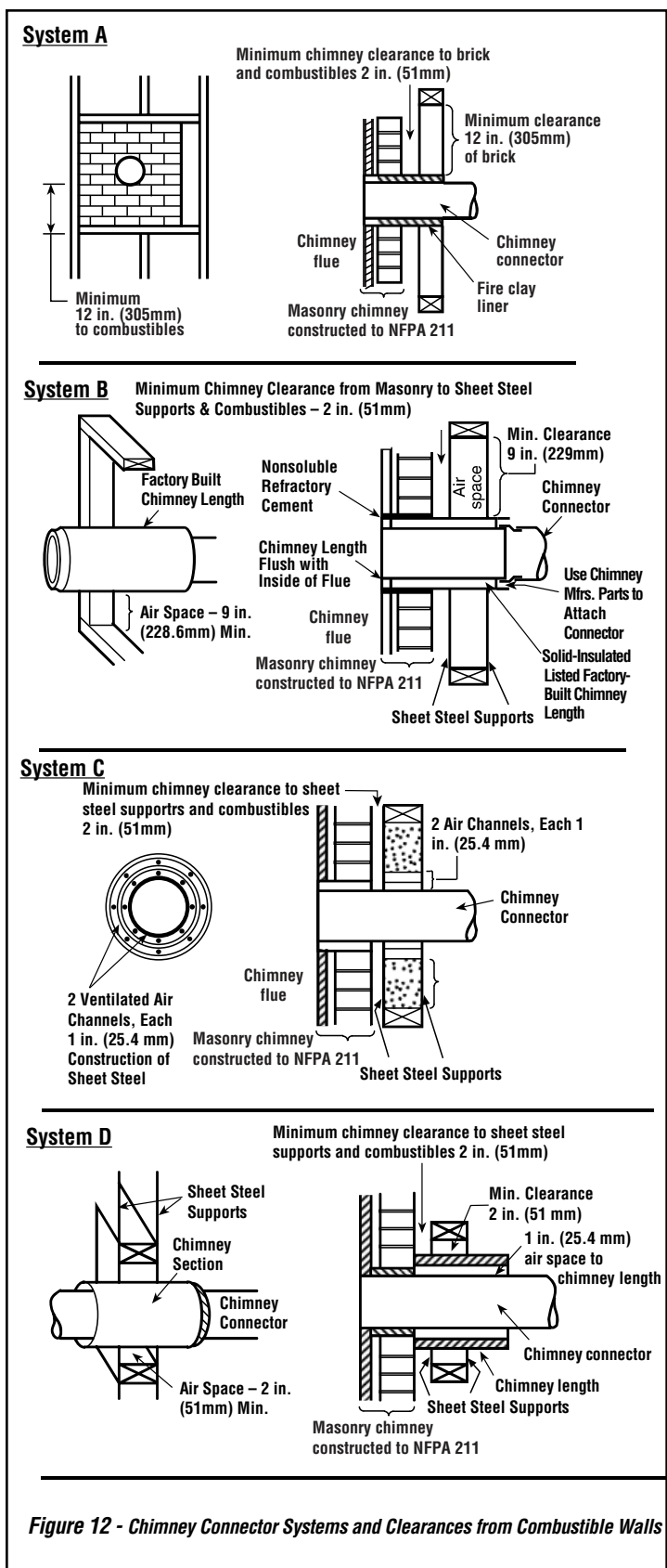


Figure 12 - Chimney Connector Systems and Clearances from Combustible Walls

LEG INSTALLATION

Residential and Mobile Homes

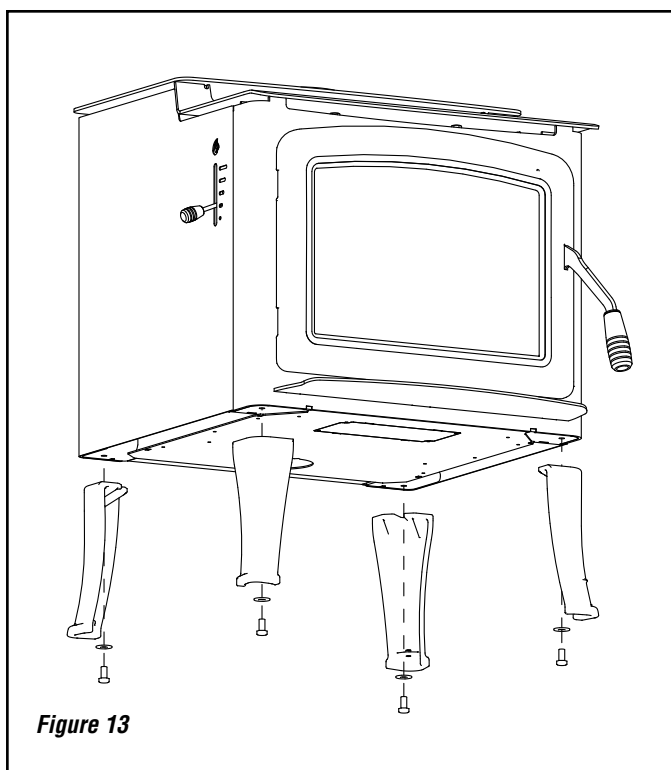
(Tying down and grounding are required only in mobile homes)

Open all cartons, if any and remove the contents upon receipt and check for any damaged or missing parts. If there is hidden damage, notify your freight company or IHP dealer immediately.

CAUTION: Wear gloves during installation in case of sharp edges on the stove.

Leg Installation

1. Carefully place stove on it's back. Be careful not to scratch the stove, use a piece of cardboard or carpet to protect the back of the stove.
2. Using a 9/16" wrench or socket remove the bolt in each of the four corners along with the attached shipping brackets.
3. Remove legs from the packaging and using the bolts and washers that come with the legs install each leg in each corner with one bolt and one washer.
4. Before the legs are fully tightened down make sure that they are aligned correctly to match the front and side planes of the stove.
5. The stove can now be set up on the legs making sure that all baffle boards and bricks are set back in place. These items may have shifted when the stove was placed on it's back.
6. If it is necessary to level, secure, or ground your stove, use the holes in the bottom of the leg for those applications. To level the stove use leg leveling kit (P/N H8407). Level by adjusting the bolt or leveling pad down on each leg that is not in full contact with the hearth or surface below that the stove is located on.



PEDESTAL INSTALLATION

Residential and Mobile Homes

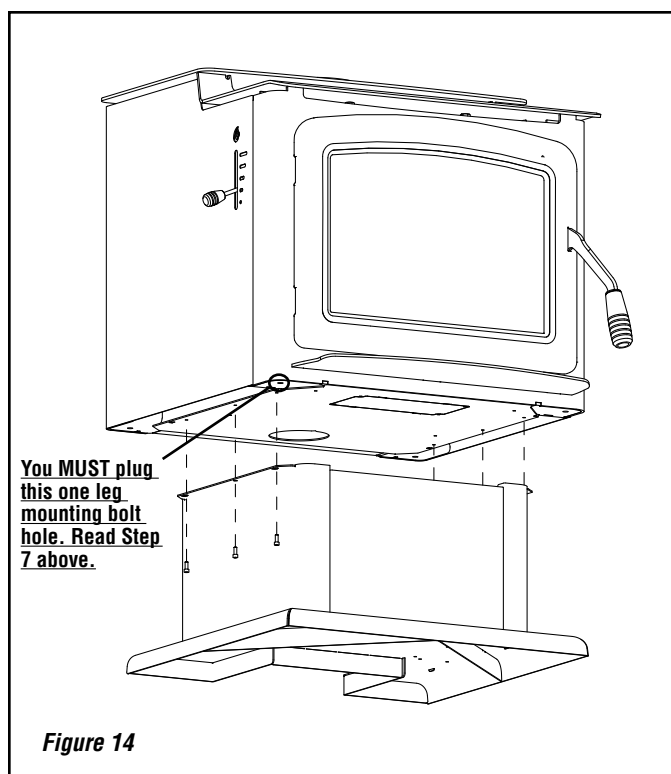
(Tying down and grounding are required only in mobile homes)

Open all cartons, if any and remove the contents upon receipt and check for any damaged or missing parts. If there is hidden damage, notify your freight company or IHP dealer immediately.

CAUTION: Wear gloves during installation in case of sharp edges on the stove.

Pedestal Installation

1. Remove the heater from the carton, if packaged, upon receipt and check for any damaged or missing parts.
2. Install the 10-24 screws included with the pedestal kit to the bottom of the stove as seen in **Figure 14**. You will need a 5/32" allen wrench to complete this.
3. Carefully place stove on it's back. Be careful not to scratch the stove, use a piece of cardboard or carpet to protect the back of the stove.
4. The pedestal will have key hole slots that line up with the screws that were placed in the bottom of the stove. Carefully install pedestal on the installed screws with the open end of the pedestal towards the rear of the stove.
5. Assuring that the pedestal is placed correctly in slots then tighten all six screws.
6. The stove can now be set up on the pedestal making sure that all baffle boards and bricks are set back in place. These items may have shifted when the stove was placed on it's back.
7. When installing a pedestal on this stove you **MUST** plug the one leg mounting bolt hole, located on the bottom of the stove in the front left corner, with the bolt that was used to mount the shipping legs. **FAILURE TO INSTALL THIS BOLT PROPERLY WILL RESULT IN REDUCED CONTROL OF THE STOVE'S COMBUSTION SYSTEM!**



ATTACHING STOVE TO MANUFACTURED HOME FLOOR - GV230GL WOODSTOVE ONLY

Leg Tie Down Kits (Manufactured [mobile] Homes)

Order:

H7665 Leg Tie Down Kit, Coastal and Lakeview Legs

H5308 Leg Tie Down Kit, Olympic Legs

ATTACHING STOVE TO MANUFACTURED HOME FLOOR

THE STOVE MUST BE ATTACHED TO THE FLOOR AT NO LESS THAN TWO POINTS

Pedestal

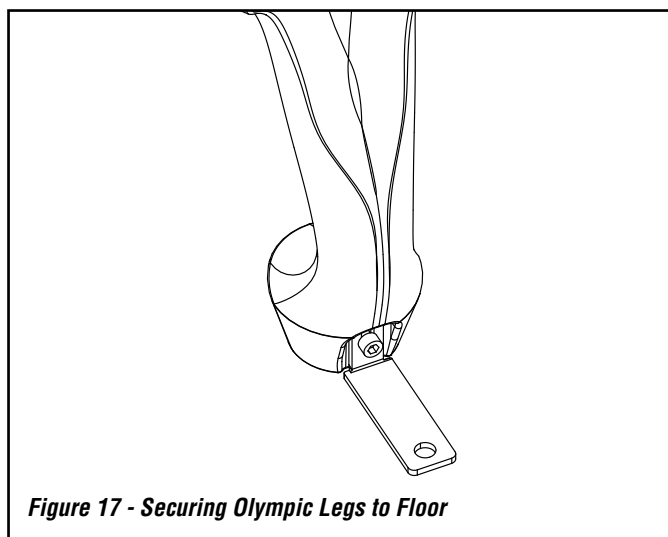
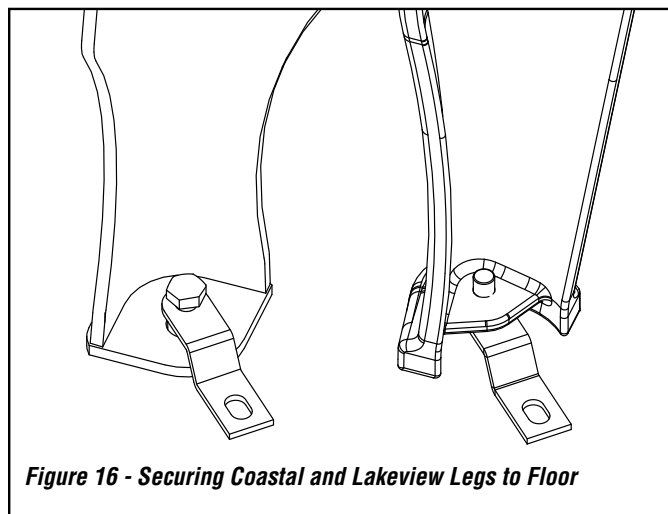
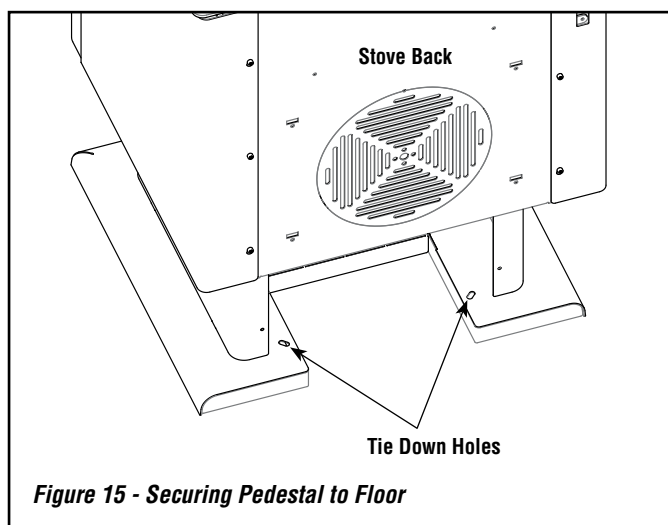
Locate the two holes on the back of the pedestal (**Figure 15**). Secure the pedestal to the floor using two field provided 1/4" screws.

Lakeview and Coastal Legs

Connect the bolt down bracket to each leg using kit (P/N H7665) screw as shown in **Figure 16**. Secure the leg bracket to the floor using one field provided 1/4" bolt.

Olympic Legs

Connect the bolt down bracket to each leg using kit (P/N H5308) screw as shown in **Figure 17**. Secure the leg bracket to the floor using one field provided 1/4" screw.



OUTSIDE COMBUSTION AIR KIT INSTALLATION - GV230GL

Outside Air Kits

Order:

1 ea. P/N UZIAD Outside Air Coupler Kit (connects outside air ducting, UZI, to stove)

AND

1 ea. P/N UZI Outside Air Ducting Kit (includes 4" insulated flex x 10' long)

An outside air kit is required in Manufactured (mobile) Home installations. For residential installations, check with local authorities having jurisdiction in your area, it may be mandatory.

Outside Air Kit Coupler

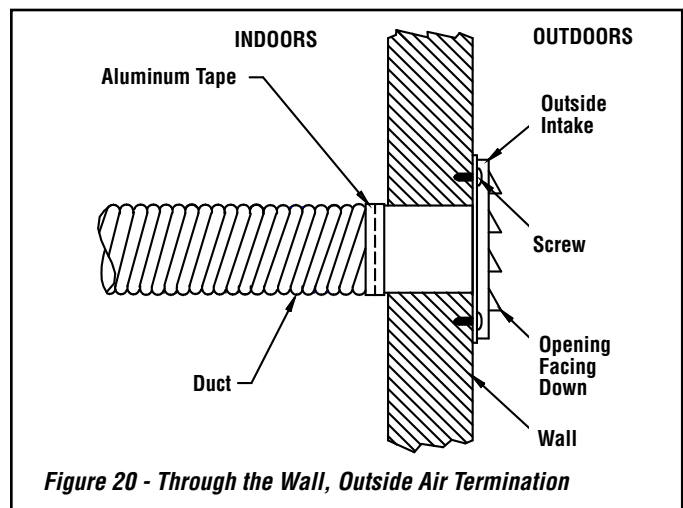
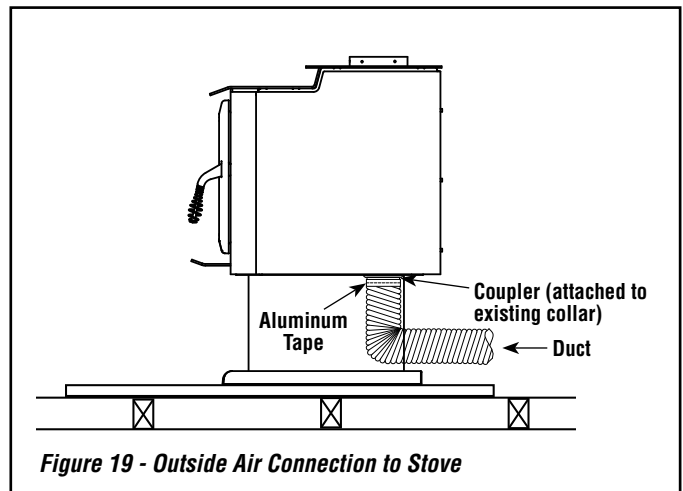
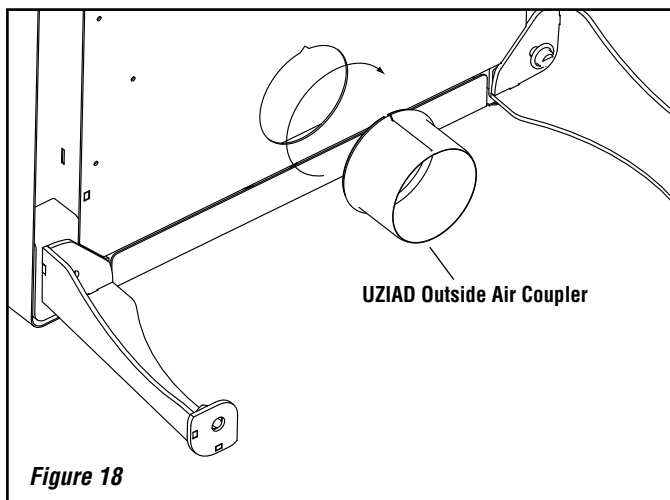
To install the outside air kit coupler onto the stove, line up the "V" notch in the coupler with the "V" notch in the open on the bottom of the stove. Push and twist so the rolled edge catches the bottom of the stove and continue turning full 360° to lock the coupler in place.

Through the Wall Outside Air Kit Installation (refer to Figures 18, 19 and 20)

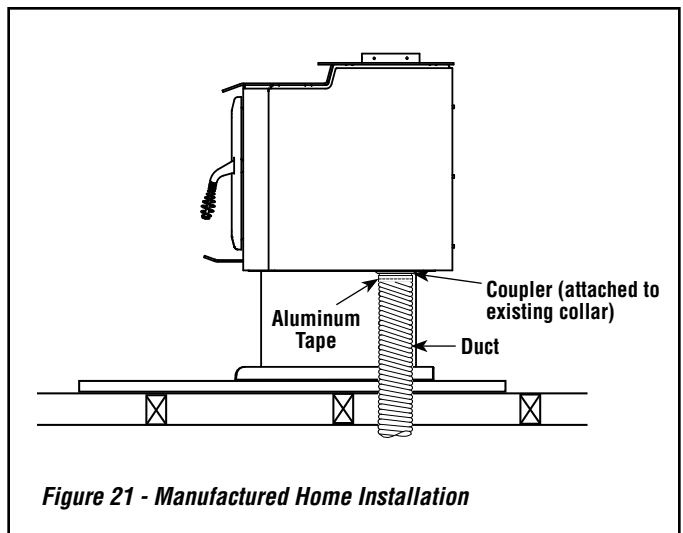
The outside air assembly may be installed according to the following requirements:

- A) Duct length should be kept to a minimum.
- B) The air intake register must not be installed more than ten (10) feet (3050 mm) above the base of the stove.
- C) The fresh air must come from outside the house. The air intake must not draw air from the attic, from the basement or garage.
- D) The air intake should be installed where it is not likely to be blocked by snow or exposed to extreme wind and away from automobile exhaust fumes, gas meters and other vents.
- E) The duct and register may be installed above or below floor level.

- Make a 4-1/4" (110 mm) hole in the outside wall of the house at the chosen location. From outside, place the outside air register in the hole (open side down) and fasten the register to the wall, with screws as shown (see **Figure 20**).
- Install the coupler onto the existing collar on stove (see **Figure 18**).
- Attach the duct to the coupler on stove (see **Figure 19**). Using the aluminium tape provided, wrap the tape around the joint between the flexible duct and the air inlet.



Manufactured Home Through the Floor Outside Air Kit Installation (refer to Figure 21) - Model GV230GL woodstoves only.



Grandview™ GV230GL

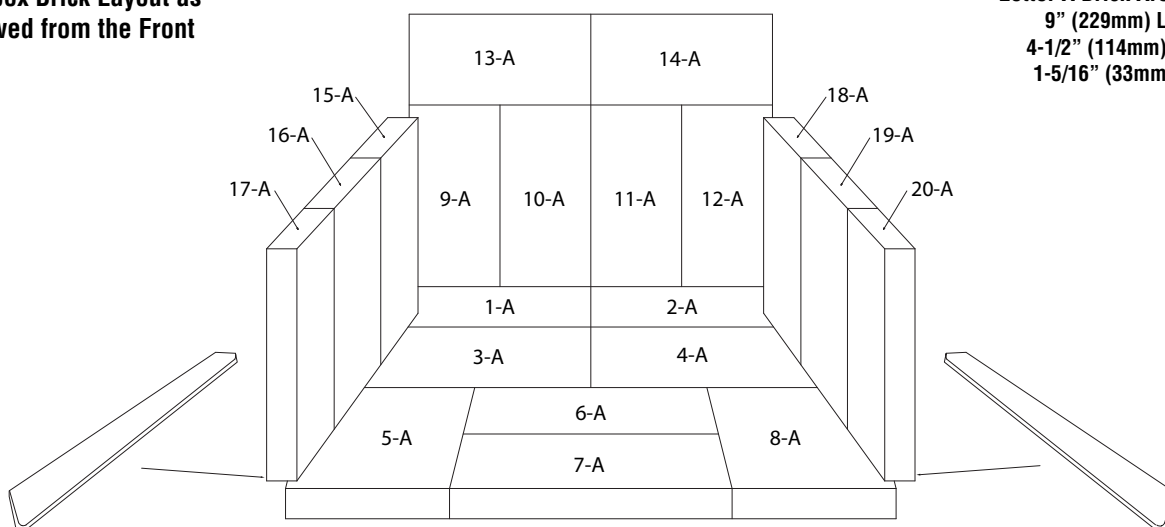
BRICK AND BAFFLE INSTALLATION

CAUTION: Wear gloves during brick installation in case of sharp edges inside the stove.

WARNING: IF THE BRICKS ARE NOT INSTALLED EXACTLY AS SHOWN BELOW, THEY COULD FALL OUT OF PLACE DURING REFUELING OR BURNING OF THE STOVE CAUSING SERIOUS INJURY.

1. Install firebox bottom brick spacers on both the left and right side of firebox. The brick spacers are located in the package with the manual. Assure that brick spacers are pushed to each side until they are in full contact with the firebox side on each side.
NOTE: Your brick spacers may already be welded in place.
2. Install brick #1-20 in the numbered sequence shown in **Figure 22**.
3. Brick's 13 and 14 will be located between the steel firebox and rear baffle board (already installed).
4. Once all bricks are installed confirm that the already installed baffle boards are in their correct location and resting on the secondary burn tubes.

Firebox Brick Layout as Viewed from the Front



Letter A Brick Are Full Size
9" (229mm) Long x
4-1/2" (114mm) Wide x
1-5/16" (33mm) Thick

Figure 22 - Brick Diagram

Back Baffle Board Front Baffle Board

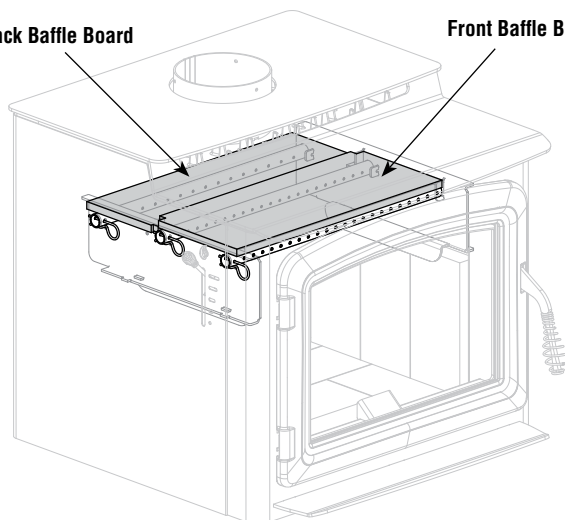


Figure 23 - Baffle Boards Installed

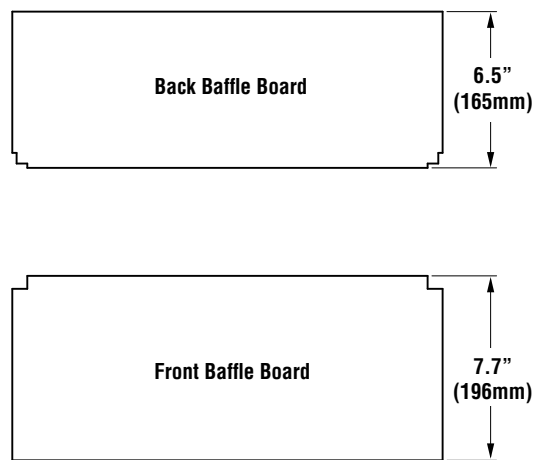


Figure 24 - Baffle Boards

SECONDARY TUBE AND BAFFLE BOARD REPLACEMENT

- Gently lift front baffle board upward and place on rear baffle board.
- Starting front to rear, locate secondary tube retaining pin and rotate counter clockwise; pull pin toward front of stove, allowing capturing end to slide through retaining pin notches as shown.
- Slide secondary tube to the right, releasing it from the left side. Angle left side upward, and slide left to release from right side. Remove tube from stove
- Repeat process for secondary tube number two
- Gently lift top baffle board and slide forward; tilt left side up and left slightly, allowing the right side to drop into the firebox area for removal. Repeat process for rear baffle board
- Secondary tubes three and four can now be removed in same fashion as tubes one and two
- Reinstall baffle boards and secondary tubes in reverse order. *Note- Secondary tube number one has larger holes, as the remainder of the tubes are the same.

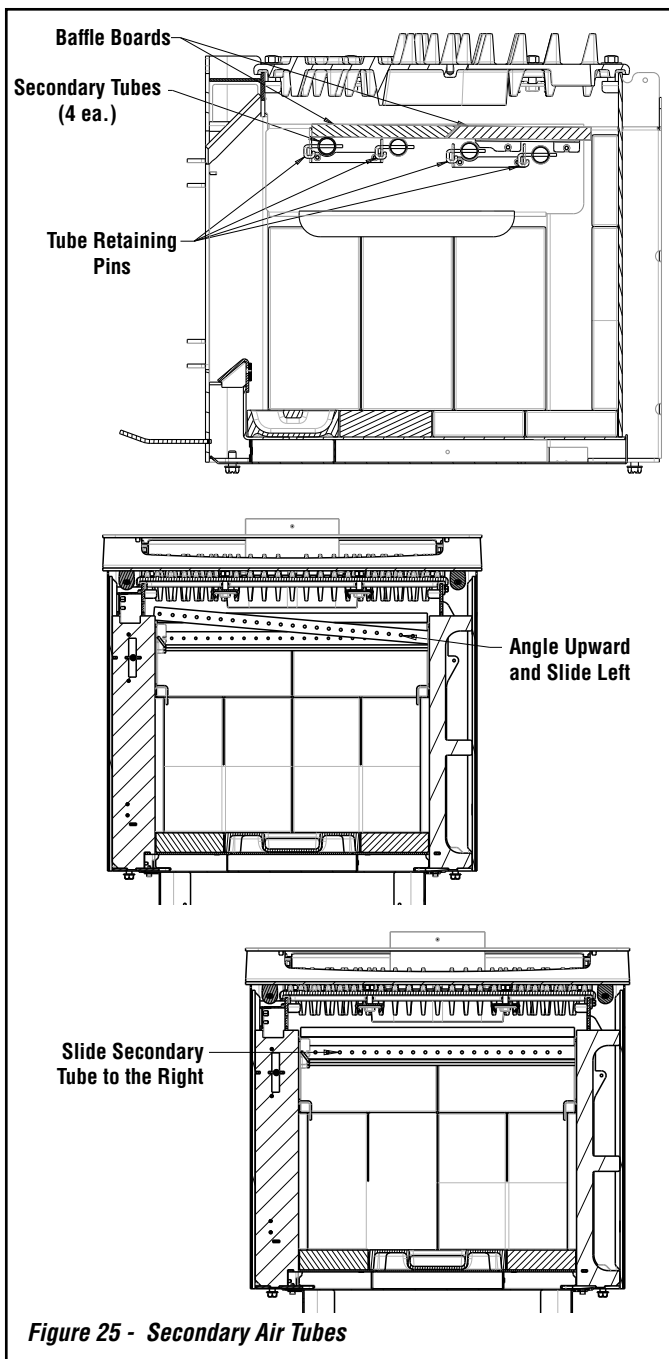


Figure 25 - Secondary Air Tubes

See Detail A

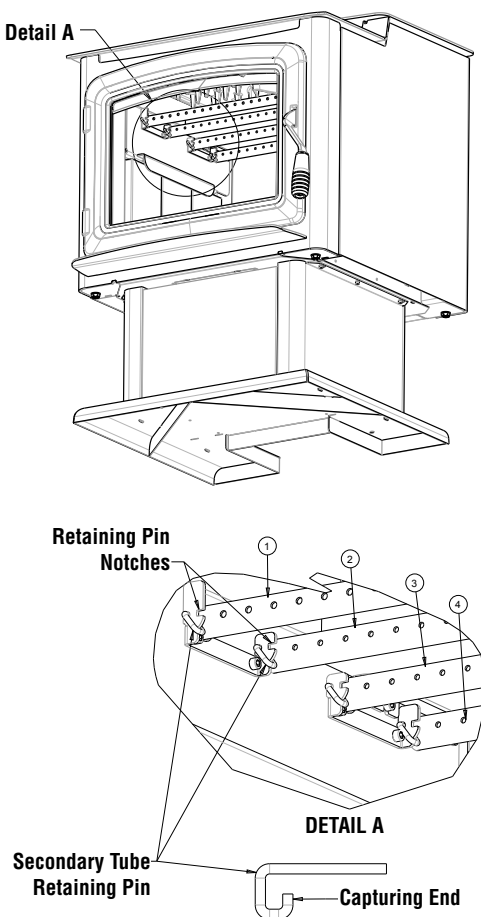


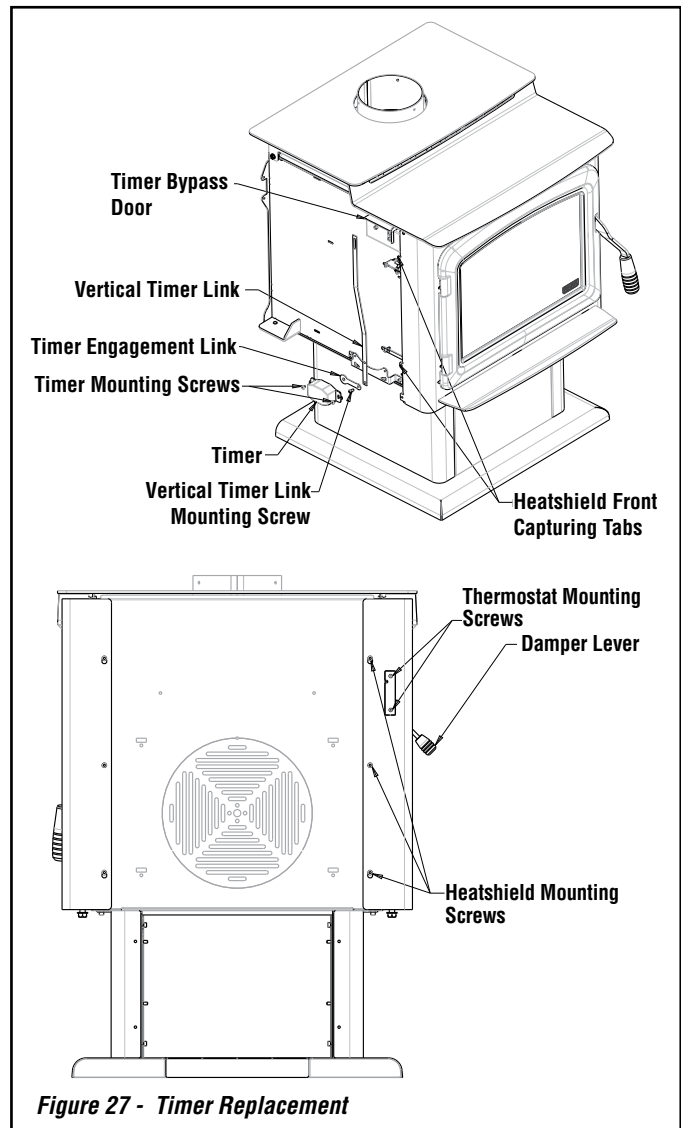
Figure 26 - Secondary Air Tube Retainers

TIMER REPLACEMENT:

- Turn damper lever counter clockwise and remove from stove
- Remove thermostat bracket (if equipped) by removing the two mounting screws and sliding rearward through the opening; set aside
- Loosen the top and bottom left heat shield mounting screws, leaving loose but in place; fully remove center mounting screw
- Lift left heat shield upward, while pulling rearward to release heat shield from rear mounting screws and front capturing tabs; set aside
- Lift upward on vertical timer link to engage timer and gain access to vertical timer link mounting screw; remove screw
- Remove timer mounting screws and timer
- Replacement timer will come equipped with timer engagement link
- Reinstall timer in reverse order; it may be necessary to rotate timer engagement link slightly to properly mount timer and align with vertical timer link (do not rotate more than 180 degrees)
- To reattach timer engagement link, lift upward slightly to align mounting hole with vertical timer link mounting hole. Tighten screw until tight and loosen slightly so timer linkage can operate freely.

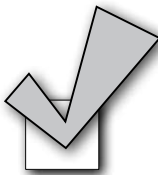
CHECK:

- Inspect timer linkage to ensure it can move freely and is not binding. Vertical timer link can be lifted in an upward and downward motion (manually engaging and disengaging timer), which will open and close the timer bypass door near the top of the unit. This should operate freely with only slight tension from the torque of the timer. Now manually slide vertical timer link downward, disengaging timer. Open door; timer should reengage, lifting timer bypass door, which will then close in approx. 25-30 minutes. If functioning properly, proceed to reassemble stove. If timer is not functioning properly, check all mounting points within linkage to ensure they are moving freely. A small amount of antisieze or high temp lithium grease may be applied to moving linkage parts for lubrication.
- Reinstall left heat shield in reverse order, ensuring slots on front edge of heat shield slots are captured on the front capturing tabs.
- Reinstall thermostat in reverse order
- Reinstall damper lever; if damper lever is misaligned with slot and/or mounting point, the heat shield is not captured properly on the front capturing tabs. Loosen rear mounting screws and ensure proper alignment.



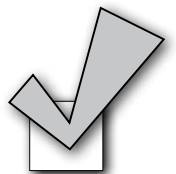
FOR MOBILE HOME INSTALLS

- ☐ Be sure the stove is properly grounded
- ☐ Be sure the stove is properly securely fastened to the floor
- ☐ Be sure the outside air vent is free of obstructions and has a mesh screen in place



POST INSTALLATION CHECKS

- ☐ Check that all chimney pipe joints are secured and installed according to the manufacturers instruction.
- ☐ If used, make sure the outside air kit is properly installed and unobstructed.
- ☐ Make sure the legs or pedestal are securely fastened to the stove.
- ☐ Double check all stove clearances.
- ☐ Be sure bricks and baffle boards are properly installed.
- ☐ If plated accessories are used, be sure surfaces are clean prior to firing the stove. See Page 20



FOR YOUR OWN PROTECTION AND INSURANCE PURPOSES, HAVE YOUR CHIMNEY AND CONNECTOR PIPE INSTALLATION INSPECTED BY YOUR LOCAL BUILDING CODE AUTHORITY OR FIRE MARSHAL BEFORE STARTING A FIRE IN YOUR STOVE. NOTIFY YOUR INSURANCE COMPANY.

NOTE: DIAGRAMS & ILLUSTRATIONS ARE NOT TO SCALE.

PAINT CURING

If your stove has plated accessories, be sure to clean it with a household type glass cleaner and a very soft cloth to remove any fingerprints and residues prior to the first fire and before any fire if the plated surfaces have been handled or soiled. Do not close the door tightly during the "Burn-In Period." Also, open the door frequently (every 5-10 minutes) to keep the gasket from adhering to the curing paint. Ventilate the house well during these first firings as the paint gives off carbon dioxide and unpleasant odors. It is recommended that persons sensitive to an imbalance in the indoor air quality avoid the appliance during the curing process.

Your new stove is painted with a high temperature paint that cures during the first few firings. We recommend that you put your stove or fireplace insert through a regimen of three burns. The first two should last for 20 minutes each at 250 degrees (the appliance should be allowed to cool completely between each burn). The third should be a burn of at least 450 degrees F. for 45-60 minutes. The paint will become soft, gummy and emit non-toxic smoke during these burns. During these first burns, open the appliance door frequently to help prevent the door gasket from adhering to the appliance. After the appliance cools down for the third time, the paint will harden. **DO NOT BUILD A LARGE ROARING FIRE UNTIL THIS CURING EFFECT IS COMPLETE OR YOU MAY DAMAGE THE FINISH OF YOUR STOVE.** Spray can touch-ups should be done only with a high temperature stove paint (cat. no. H8159), available from all IHP dealers.

BURN-IN PERIOD

Please be patient with the heat output of your appliance for the first few weeks. The steel will go through a curing process that eliminates moisture, which is deep in the steel and firebrick. This moisture will reduce initial heat output of your appliance and may make it difficult to start. **(DO NOT OVERFIRE THE STOVE DURING THIS PROCESS. IF THE STOVE OR CHIMNEY BECOMES RED, REDUCE THE AMOUNT OF AIR ENTERING THE STOVE IMMEDIATELY).**

OPERATING HINTS

1. Burn only dry, well-seasoned cord wood. In some states it is illegal to burn wet wood or anything other than clean, dry wood products.
2. Your stove or fireplace insert is designed to operate with the door closed! Operate only with the door shut tightly at all times except when loading wood and possibly on start up to establish a draft. Never leave the unit unattended while the front door is opened.
3. **DO NOT** contact or move the baffle boards while loading wood. Occasionally check the baffle to assure that the boards are in their correct location.

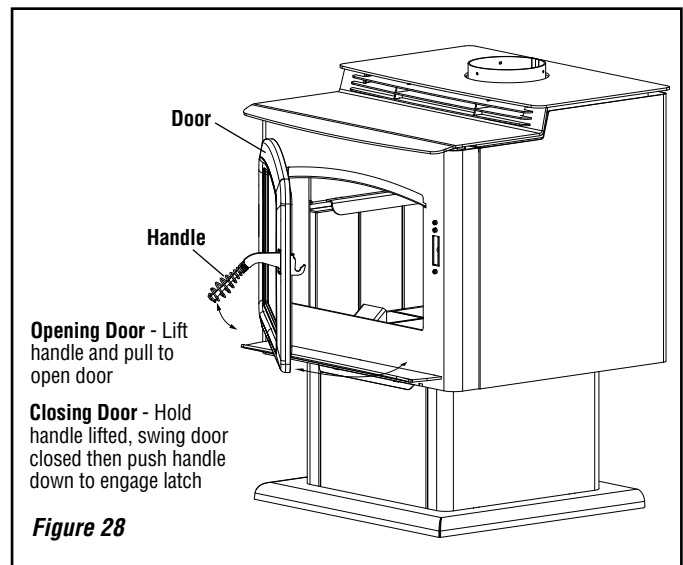
4. **CAUTION: THE DRAFT CONTROL MUST BE FULLY OPEN BEFORE OPENING THE DOOR TO AVOID POSSIBLE COMBUSTION FLASH!!** (Ignition of hot volatile gases as the door is opened).
5. Feeding excessive amounts of fuel to the appliance should be avoided. It is important to supply it with sufficient draft and fuel to maintain a moderately hot fire. If, during overnight burns, heavy creosote deposits develop inside your stove and on the door, the draft is set too low - review your burning habits!

DOOR OPERATION

Do not operate the appliance with the door open or ajar other than possibly during start up to create a draft (Do not leave the unit unattended while the front door is slightly open during start up). Operating the appliance with the door open other than in initial start up if needed will produce extreme temperatures within the appliance. Damage caused from over-firing is not covered under the manufacturers limited warranty.

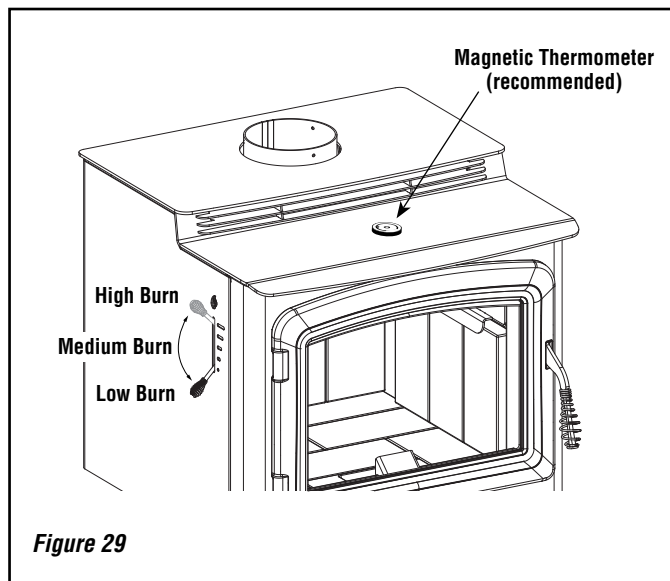
WARNING

Be careful not to abuse door assembly by striking or slamming it. If the door assembly or glass is broken or damaged, they must be replaced with factory original parts before heater can be safely operated. Use only components provided by the manufacturer as replacement parts.



STARTING AND MAINTAINING A FIRE

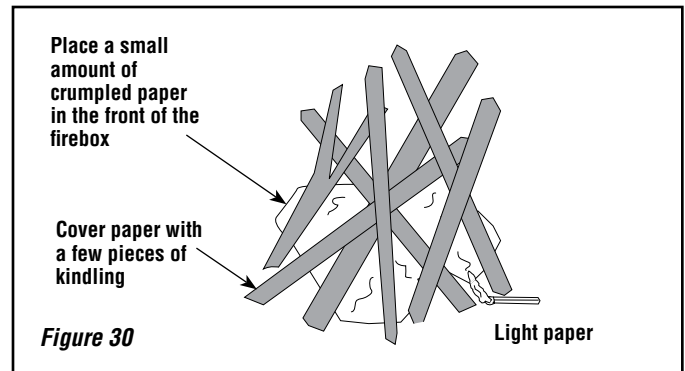
1. **NEVER USE FLAMMABLE LIQUIDS TO START OR REKINDLE A SOLID FUEL FIRE!!**
2. Fully open the primary draft control by placing draft control (wood handle located on left side of the stove) in the highest position. This control determines the amount of air entering the stove. Lowering this control reduces the burn rate of the stove. For your convenience, the control is marked with five positions to assist you in obtaining repeatable burn rates.
3. Place a small amount of crumpled paper in the front of the firebox and cover it with a few pieces of kindling.
4. Light the paper and allow sufficient time for the kindling to become fully engulfed in flames. You will now close the wood units front door. Your wood units front door may or may not need to be left slightly open during this start up process, this depends on the stove model and the amount of draft present.
5. **When operating any wood burning appliance, it is important to become familiar with how the damper control affects heat output and the overall temperature of the appliance. A stove thermometer can be a helpful tool to help ensure you are not over-firing your appliance and it will also ensure you are burning fuel at a rate that is most efficient. Place a stove thermometer on the top of the appliance as shown in *Figure 29*. Monitor the temperature every 15 minutes or so until you become more familiar with your appliance. Close the damper all the way down if you begin to reach 500 degrees, as this is a sign that you are operating your appliance at too high a temperature.**



DO NOT LEAVE THE STOVE UNATTENDED WHILE THE FRONT DOOR IS SLIGHTLY OPEN.

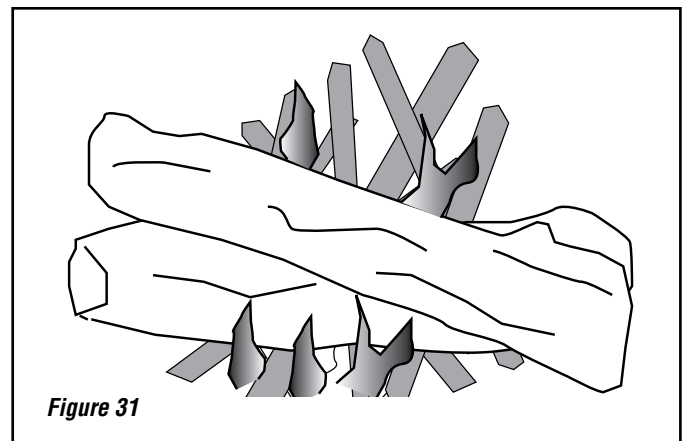
CAUTION: Do Not alter the adjustment range of the draft control for increased firing for any reason.

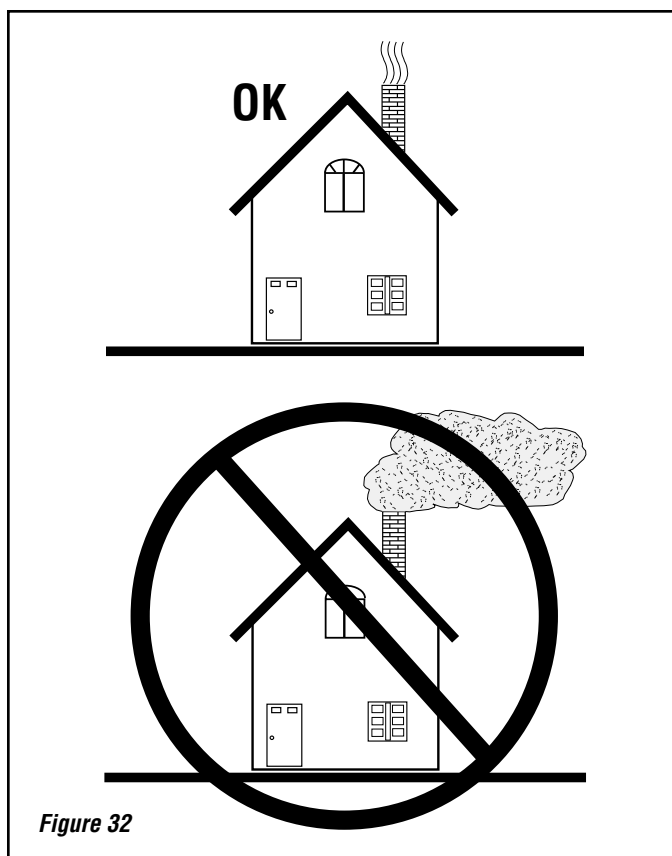
Operate only with fuel door and ash drawer closed. Maintain all seals in good condition. Do not operate with broken glass.



SEE MAINTENANCE SECTION FOR GLASS CLEANING GUIDELINES AND TIPS FOR KEEPING THE GLASS CLEAN (*Page 33*).

6. Once kindling is burning well, larger pieces of wood may be added, then the door should be fully closed if there was the need to keep it slightly open during start up.
7. For best results, use smaller pieces of wood to get the appliance temperature very high before loading larger wood for sustained burns. If necessary, crack the door to allow ignition of the fuel charge. Now you can add larger pieces of wood and after several minutes of high burn, set the left control for the desired heat output. Check the exhaust in about 15 to 20 minutes (*see Figure 32*). Large amounts of smoke indicate an improper burn setting (either too high or too low). Adjust and recheck in 5 to 10 minutes.





FUEL

This appliance is designed to burn dry seasoned natural wood only (see Page 26 for a list of prohibited fuels). Failure to burn proper fuels only will void the certification and the warranty of the appliance.

Dry, seasoned wood is that which has been cut, split and allowed to dry under a covered area where air is free to flow and circulate under and around the wood (not under a tarp or plastic). Make sure wood is not stacked directly on the ground, it may absorb moisture from the ground. It should be allowed to dry in these conditions for a minimum of six months, preferably one year or more. **IT MUST BE UNDERSTOOD THAT WOOD CANNOT BE LEFT IN ANY KIND OF WET OR DAMP AREA OR IT WILL NEVER BECOME COMPLETELY SEASONED.**

Do Not store fuel within space heater installation clearances or within the space required for refueling and ash removal.

DO NOT OVERFIRE THIS HEATER

Attempts to achieve heat output rates that exceed heater design specifications can result in permanent damage to the heater.

What does “Well-Seasoned” mean?

When a tree is cut down, the wood is green, full of sap and moisture. This moisture content can exceed 80%, which must be reduced to less than 20%. Wood properly seasoned is then capable of generating the heat the stove was designed to provide.

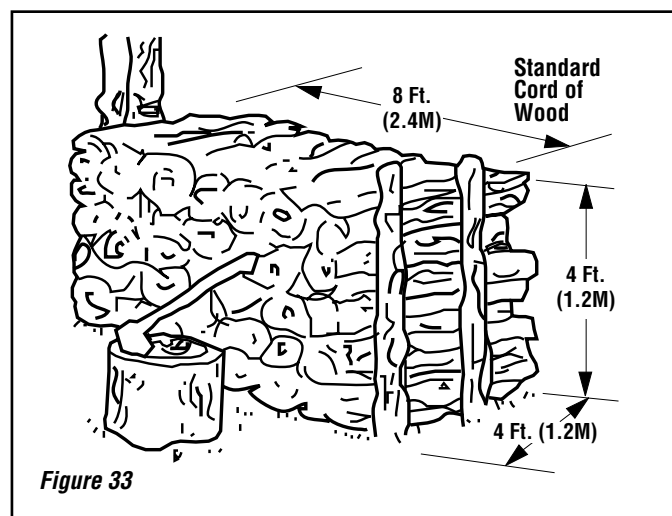
Green wood does not burn easily. Attempting to burn green wood often results in a lot of smoke and very little fire. Time is the most important factor in seasoning wood. Ideally the moisture content should be reduced to 11-20%. **NOTE: The use of a firewood moisture meter is recommended to ensure the firewood contains less than 20% moisture.**

Seasoning Guide

Softwoods - 6 months to 18 months

Hardwoods - 12 months to 24 months

Logs that are 5” diameter across or larger should be split in half, three pieces if over 8 inches, and four pieces when over a foot across. If a tree has been dead for 2 - 4 years it still needs to be cut, split, and seasoned for 6 to 24 months depending on the wood.



GETTING THE MOST OUT OF YOUR STOVE

Recent developments in wood-burning technology have made wood-burning a cleaner and more convenient way to heat your home. Overall efficiency in a wood-burning appliance is a combination of combustion efficiency and heat transfer efficiency. Whether heating your entire home or just a room or two, your understanding of how to best operate your stove or insert will enhance its overall efficiency and performance. What this can mean to you is longer, cleaner burns, less wood use and more heat.

The following sections will outline techniques you can use to “get the most out of your stove.” Please read them carefully.

MAXIMIZING YOUR STOVE’S OVERALL EFFICIENCY

It is important to know that for clean highly efficient burns you will need to have sufficient temperatures inside the firebox for thorough combustion. The best method for determining if you have sufficient temperatures is to watch the brick lining in your firebox. When you first light your stove or fireplace insert, the firebrick will turn a dark brown or black. After 20 to 30 minutes of a hot fire, most of the bricks should return to near their original beige color. This means the firebrick have reached a high enough temperature for your stove to achieve high combustion efficiency and you are ready to adjust the draft control to a lower setting.

Second and just as important, is achieving a high level of heat transfer efficiency. Slowing the rate of flow through the stove or insert enhances heat transfer, thus allowing more time for heat to be transferred into your home. To do this, be sure to thoroughly preheat your stove and then reduce the amount of primary air by closing the draft control down to a lower setting. (More air may produce a slightly greater amount of heat, but will greatly increase wood consumption).

To get the most out of your appliance, you will need to combine good combustion efficiency with good heat transfer practices. The following are some tips on how to operate your stove to achieve the highest overall efficiency.

1. Thoroughly preheat your stove before slowing the burn rate by closing the draft control.
2. When loading wood into a preheated stove or fireplace insert, allow a vigorous fire to build before lowering the draft control.
3. Operate your stove as much as possible in the low to medium burn ranges.
4. Do not lower the draft setting so low as to completely extinguish the flames in the firebox. Check for at least some small flames twenty minutes after setting the draft control.
5. Do not continually operate your stove or fireplace insert in the high (wide open) setting. This wastes wood by carrying a great deal of heat up the chimney and can damage your stove or fireplace insert and chimney.
6. Go outside and check your chimney. More than a very small amount of smoke indicates wasted heat, creosote build up and pollution (*see Figure 32*).

ACHIEVING CLEAN, LONG BURNS

To achieve long burn times, after having thoroughly preheated the stove, load the firebox without blocking the small air opening found in the center front of the firebox. At this point, you may need to burn the stove with the draft open for a few minutes to ignite the wood. All IHP stoves are EPA tested for emissions at low burn with the air control completely closed. Whether or not you should burn your stove with the air control completely closed will depend on the following factors:

- How you load your wood
- Your chimney type, height and draft
- Your wood type and its moisture content
- The temperature of the appliance
- Which model stove or insert you have

In order to maximize the burn time of your stove you may need to experiment to get the right balance of starting temperature, wood type, and draft control setting for your particular venting configuration. Do not reload the stove for long burns when the stainless secondary tubes or baffles are glowing red, or when the stove is uncomfortably hot to load. This indicates the stove is too hot to load for a long burn.

BLOWER OPERATION (OPTIONAL KIT)

Blower Operation

The blower can be operated in either manual or automatic mode. When operated automatically, the blower will turn on when the stove is hot, and turn off when the stove is cool.

— **MANUAL OPERATION:** Flip blower mode switch to the manual position (up) and adjust blower speed dial to desired setting. To turn blower off, rotate blower speed dial counter clockwise until it clicks “off.”

— **AUTO OPERATION:** Flip blower mode switch to auto position and turn blower speed dial clockwise until it clicks out of the “off” position. When the stove warms up (approx. 15-20 Mins), the blower will automatically turn on (adjust blower speed dial to desired speed setting). When the stove or insert cools down, the blower will automatically turn off.

Blower Operation Guidelines

While in auto operation mode, the blower will turn off and on based on The temperature of the appliance. Auto operation ensures there is sufficient heat build-up to warm the air being moved by the blower before the blower is turned on. Likewise, when the stove cools off, the blower is turned off to prevent circulating cool air. Depending on the size and intensity of the fire it may be necessary to adjust the fan speed accordingly to ensure uninterrupted fan operation. For example a small fire may require a slower fan speed to keep the heat output by the fan consistent. If the blower is operated in manual mode, it may be necessary to adjust the blower speed as the fire begins to burn down and the stove is no longer hot enough to effectively heat the air moved by the blower. If the air coming from the blower feels cool, one should either decrease the blower speed or stoke the fire to build up more heat.

NOTE: Turn blower off before opening the door to load the fuel.

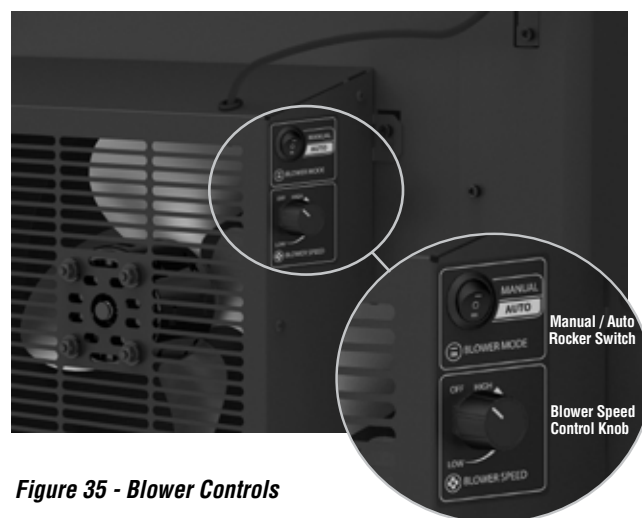


Figure 35 - Blower Controls

⚠ WARNING

The blower must be plugged directly into a properly grounded three-prong receptacle, 120 VAC, 60 Hz, single phase. Do not cut or remove the grounding prong from this plug. Do not route power cord under or in front of appliance.

Installation must be in accordance with National Electrical Code, ANSI/NFPA 70 - latest edition. In Canada, the current CSA C22.1 Canadian Electrical Code - latest edition.

DANGER: Disconnect power before servicing blower.

In the event that you remove the blower for any reason, make sure a cover plate (available from IHP) is installed before using the heater. Excessive rear wall temperatures will result if the stove is burned without the cover plate. The cover plate is not necessary if a blower has never been installed because a knock-out will be in place to act as the cover.

NOTE: SWITCH CONDITIONS
GIVEN AT ROOM TEMPERATURE

N/C = NORMALLY CLOSED
N/O = NORMALLY OPEN

— = FEMALE DISCONNECT
—> = MALE DISCONNECT
—○— = STUD CONNECTION

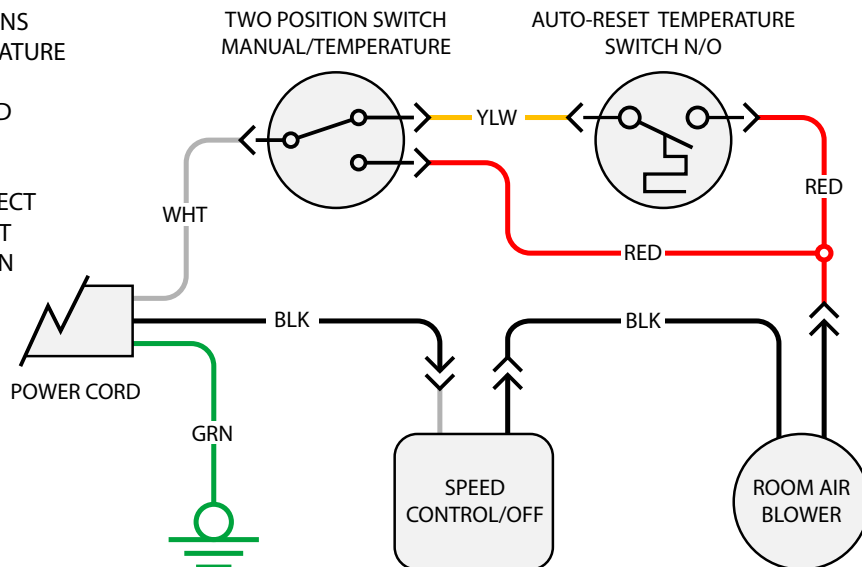


Figure 34 - Blower Wiring Schematic

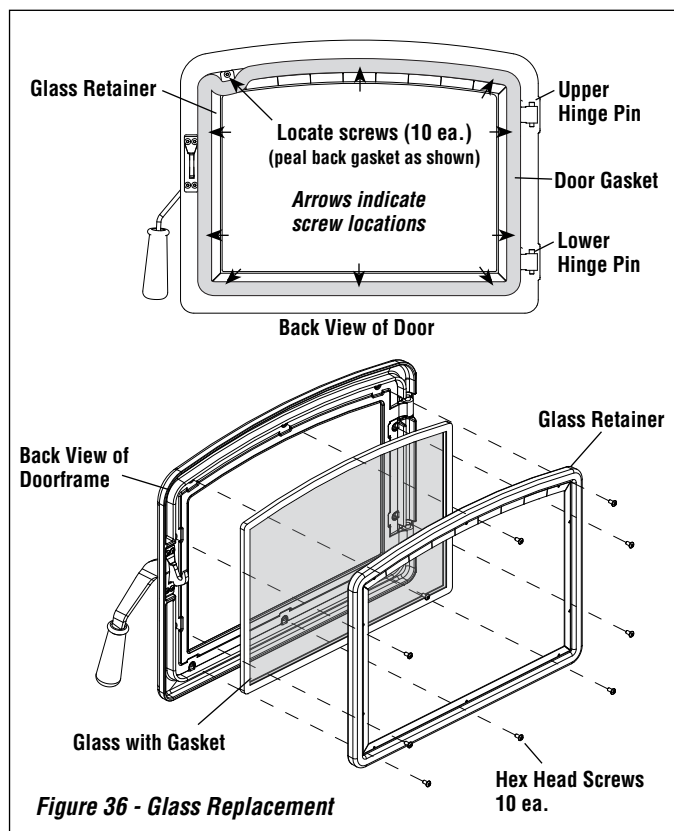
NOTE: DIAGRAMS & ILLUSTRATIONS ARE NOT TO SCALE.

MAINTENANCE

GLASS REPLACEMENT INSTRUCTIONS

(Refer to *Figure 36*)

- Step 1. Remove Door Assembly** - Remove the upper and lower hinge pins by pressing the bottom of each hinge pin up, then pull out from the top. Lift off door and place face down on a soft surface.
- Step 2. Remove Glass Retainer Screws (10 ea.)** - Using an 1/8" allen wrench remove the ten glass retainer screws. To locate screws, peel back the door gasket as necessary. The screws are located by the holes in the stainless steel glass retainer strips.
- Step 3. Remove Glass** - Carefully remove broken glass one piece at a time (protective leather gloves are recommended).
- Step 4. Clean Door Frame** - Clean the area of the door frame where the new glass with gasket will be installed.
- Step 5. Install New Glass Assembly** - Install the new glass with gasket (use only factory supplied 5mm ceramic glass with gasket. **Do not substitute**).
- Step 6. Reinstall Retainer and Screws** - Carefully reinstall the glass retainer and screws. Be very careful not to overtighten the screws (this could result in glass breakage when the stove is hot).
- Step 7. Reinstall Door** - Align hinges on door frame with corresponding hinge holes on the face of stove. Reinstall the upper and lower hinge pins from the top.



GLASS CLEANING GUIDELINES

WARNING: DO NOT CLEAN GLASS WHEN APPLIANCE IS HOT!

Glass on any wood stove will not stay perfectly clean. Here are some guidelines for cleaning and caring for the glass:

- **Ensure the stove is cold prior to cleaning glass.**
- This appliance is designed to provide a flow of air over the inside of the glass, where along with high heat helps inhibit build-up on the glass. When build-up occurs, a commercial glass cleaner designed for stoves is recommended. Regular household glass cleaners will not clean creosote.
- Do not use abrasives such as steel pads, steel wool or oven cleaner as they will scratch the glass. Never scrape glass with a razor blade as this may pit the glass and make it impossible to clean in the future.
- Do not use chemical glass cleaners as they may damage the gaskets or painted surfaces.

TIPS FOR KEEPING THE GLASS CLEAN

- Burn only dry seasoned cord wood. **Wet wood = Dirty glass.**
- A short, hot fire (15 - 20 minutes) may help to clean off some of the normal buildup. **Lower burns = more build-up. Higher burns = less build-up.**
- Keep freshly loaded wood away from the glass.
- After reloading, allow all the wood to catch flame before dampering down the stove.

! CAUTION

Cleaning Glass: Ensure appliance is cold prior to cleaning glass. A commercial glass cleaner designed for stoves is recommended. Do not use abrasive cleaners. Do not clean with any materials, which may scratch or otherwise damage the glass. Scratches on the glass can develop into cracks or break. Inspect the glass regularly. If you detect a crack, extinguish the fire and contact your dealer for a replacement.

MAINTENANCE

Have your product inspected at least once a year by a qualified service technician to ensure gaskets, air tubes, baffles, and venting are in good repair to ensure proper performance. Have degraded items replaced by a qualified service technician.

THIS WOOD HEATER NEEDS PERIODIC INSPECTION AND REPAIR FOR PROPER OPERATION. IT IS AGAINST FEDERAL REGULATIONS TO OPERATE THIS WOOD HEATER IN A MANNER INCONSISTENT WITH OPERATING INSTRUCTIONS IN THIS MANUAL.

DOOR HINGES: If door hinges need lubricating, use an anti-seize compound (never use oil) available from your IHP dealer.

DOOR LATCH: Adjustment Instructions - Remove the right side heat shield by loosening the 3 screws located on the back of the stove. Using a "L" shaped 5/32" allen wrench, loosen the locking screw in the latch assembly as shown in **Figure 37**. With the locking screw loosened, adjust the top 5/32" allen screw (**Figure 37**) in the front of the stove to adjust the door tension. Turning the screw to the right will tighten the door, turning the screw to the left will loosen the door. When you loosen the door it will be easiest to pull the roller pin to the full forward position and make slight adjustments to tighten to the desired tension. Assure that the tension on the front door creates a good seal between the gasket on the front door and the firebox front. After adjusting the door tension, re-tighten the lock screw and replace the heat shield.

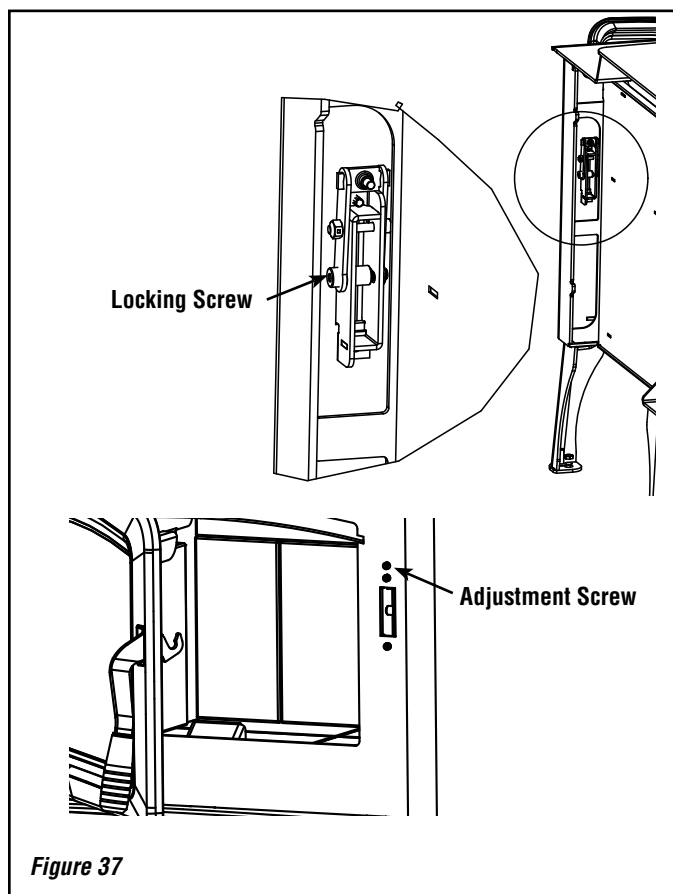


Figure 37

DOOR GASKET: Periodically check gasket to make sure it is not over-compressed. If compressed, replace with a special woven door rope. (Don't try substituting rope, only use IHP door rope).

PLATED ACCESSORIES: Clean only with household type glass cleaner and a very soft cotton cloth. Other products may damage plated finish, paint and gaskets.

BAFFLE BOARDS: Your baffle boards should be inspected during every chimney cleaning. If either board is damaged then replace baffle boards.

CREOSOTE FORMATION AND NEED FOR REMOVAL

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

The chimney and chimney connector should be inspected at least once monthly during the heating season to determine if a creosote buildup has occurred. If creosote has accumulated (1/8" [3 mm] or more), it should be removed to reduce the risk of a chimney fire.

Establish a routine for the fuel, wood burner and firing technique. Check daily for creosote build-up until experience shows how often you need to clean to be safe. Be aware that the hotter the fire the less creosote is deposited, and weekly cleaning may be necessary in mild weather even though monthly cleaning may be enough in the coldest months. Contact your local municipal or provincial fire authority for information on how to handle a chimney fire. Have a clearly understood plan to handle a chimney fire.

DISPOSAL OF ASHES

Whenever ashes get 3 to 4 inches deep in your firebox, and when the fire has burned down and cooled, remove excess ashes. Leave an ash bed approximately 1 inch deep on the firebox bottom to help maintain a hot charcoal bed.

Ashes should be scooped out of a cool stove or fireplace insert with a small metal shovel. Ashes should be placed in a steel container with a tight fitting lid and moved outdoors immediately. Other waste shall not be placed in this container. The closed container of ashes should be placed on a non-combustible floor or on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all the cinders have thoroughly cooled. Ashes can ignite up to 72 hours after removal from the appliance.

WARNING

Inspect and clean chimney and connector frequently. Under certain conditions of use, creosote buildup may occur rapidly.

DO'S AND DON'TS

- DO NOT:** Install or operate the appliance before reading this manual.
- DO NOT:** Close the draft beyond the point at which the flames are completely extinguished.
- DO NOT:** Open the appliance door without **fully opening** the draft first.
- DO NOT:** Burn driftwood or wood that has been in salt water. This includes some mill ends and scrap lumber that has been floated in salt water on the way to the mill. (This will void your warranty).
- DO NOT:** Handle the Nickel Door Trim unnecessarily. Use the door handle only.
- DO NOT:** Force oversized logs into the firebox as this may dislodge the baffle assembly.
- DO NOT:** Close the door tightly during Burn-In Period.

- DO:** Be sure to clean any fingerprints from optional accessories that have plated surfaces before burning the appliance. Clean the plated surfaces only with household type glass cleaner and a very soft cloth.
- DO:** Consult local building department if other than recommended clearances are desired.
- DO:** Read instructions for the baffle boards occasionally to ensure you have not bumped or moved them out of place when loading wood.
- DO:** Check the chimney and baffle monthly to make sure they are clean.
- DO:** Burn seasoned, dry wood only! (RAIN = WET WOOD)
- DO:** Open the door frequently during Burn-In Period to keep gasket from adhering to the curing paint.
- DO:** Enjoy the warm feeling of your new IronStrike® stove.

Smoke Detector Recommended

Since there are always several potential sources of fire in any home, we recommend installing smoke detectors. If possible, install the smoke detector in a hallway adjacent to the room (to reduce the possibility of occasional false activation from the heat produced by these appliances). If your local code requires a smoke detector be installed within the same room, you must follow the requirements of your local code. Check with your local building department for requirements in your area.

Carbon Monoxide Monitor Recommended

Carbon Monoxide Poisoning: Early signs of carbon monoxide poisoning are similar to the flu with headaches, dizziness and/or nausea. If you have these signs, obtain fresh air immediately. Some people are more affected by carbon monoxide than others, including pregnant women, people with heart or lung disease or anemia, those under the influence of alcohol, and those at high altitudes.

It is against federal regulations to operate wood heaters in a manner inconsistent with operating instructions in the manual.

PROHIBITED FUELS

This heater is designed to burn natural wood only. Higher efficiencies and lower emissions generally result when burning air dried seasoned hardwoods, as compared to softwoods or to green or freshly cut hardwoods. **DO NOT BURN:**

- Garbage;
- Lawn clippings or yard waste;
- Materials containing rubber, including tires;
- Materials containing plastic;
- Waste petroleum products, paints or paint thinners, or asphalt products;
- Materials containing asbestos;
- Construction or demolition debris;
- Railroad ties or pressure-treated wood;
- Manure or animal remains;
- Salt water driftwood or other previously salt water saturated materials;
- Unseasoned wood;
- Christmas tree branches;
- Paper products, colored paper, cardboard, plywood, or particle-board;
- gasoline;
- naphtha;
- engine oil;
- flammable liquids;
- solvents;
- grease; or
- coal

The prohibition against burning these materials does not prohibit the use of fire starters made from paper, cardboard, saw dust, wax and similar substances for the purpose of starting a fire in an affected wood heater.

Burning these materials may result in release of toxic fumes or render the heater ineffective and cause smoke. Intense firing with these materials may overheat the fireplace, causing damage to the unit, a fire or even possibly igniting a chimney fire if the chimney is creosoted. Burning unapproved fuel, resulting in excessive pollutants being emitted, may be prohibited and subject to a fine or other penalty by the authority having jurisdiction in your area.

TROUBLESHOOTING

Problem	Solution
POOR DRAFT:	Extend chimney in length or have the chimney realigned to the proper size flue. Oversized chimneys normally have poor drafts. Remember, the appliances' draft depends solely on the natural draft of the chimney (See Draft Requirements on Page 4). If your stove or fireplace insert is not drafting properly, your chimney is the problem. All stoves are thoroughly tested to ensure proper draft with the correct size chimney flue.
EXCESSIVE DRAFT:	With better chimneys being more common, excessive draft can be an issue. Alleviate excessive draft by slowing the burn rate of the appliance once it has reached proper operating temperature (See Maximizing Your Stoves Overall Efficiency on Page 22).
DIRTY GLASS:	<ol style="list-style-type: none"> 1) Burn smaller, hotter fires and check to make sure you are not setting the draft down too far with the draft control. 2) Make sure your wood is well-seasoned and dry (not open to rain - see Creosote [Page 25] and Fuel [Page 21] sections). 3) See Poor Draft section (above) and Cleaning Glass on Page 24.
SMOKES WHEN DOOR IS OPEN:	<ol style="list-style-type: none"> 1) If smoke is entering the room, check to make sure your baffle boards are properly installed. 2) Check the chimney for blockage due to creosote (see Chimney [Page 11] and Creosote [Page 25] sections). 3) Check draft (See POOR DRAFT section above).
WOOD BURNS TOO FAST:	<ol style="list-style-type: none"> 1) The draft control must be closed further. 2) Add fuel at lower firebox temperatures. 3) Load wood side to side and reduce the flow of air under wood. 4) The door seal may need replacing, check for leakage. 5) See "Excessive Draft."
POOR HEAT OUTPUT:	<ol style="list-style-type: none"> 1) Check your wood. Wet, moist, unseasoned wood will not produce heat. 2) Your stove or fireplace insert needs to be seasoned (moisture removed from the steel and brick). Continue to burn a fire. It normally takes from one to three weeks of burning to season your stove (See Burn-In procedures on Page 19). 3) See Excessive Draft section above.
PAINT GIVES OFF ODOR (smoke):	Paint is tempering-in. Burn only moderately hot for the first few days until paint is fully cured. Then burn a very hot fire to cure any paint that may not easily cure. Open windows or door to ventilate (See Burn-In Period on Page 19).

REPLACEMENT PARTS - MODEL GRANDVIEW™ 230GL

Contact an IHP dealer to obtain any of these parts. Never use substitute materials. Use of non-approved parts can result in poor performance and safety hazards.

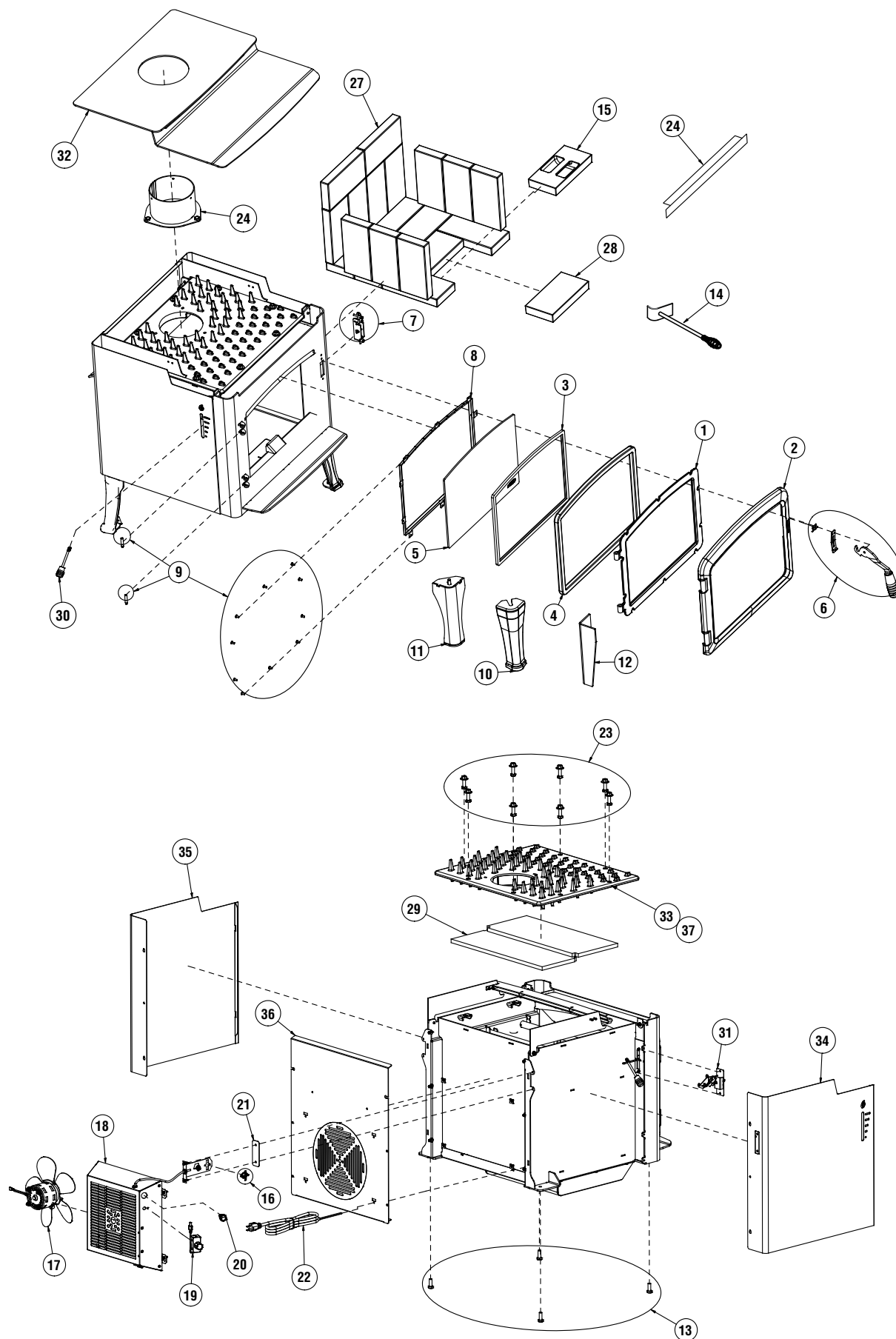
FRONT DOOR PARTS LIST

Item #	Description	GV230GL
1	Inner Door Frame, Cast Iron	H8365
2	Outer Door Frame, Cast Iron	H8366
3	Glass Gasket 1"	H8380
4	Door Gasket 7/8"	H5639
5	Ceramic Glass With Gasket	H8392
6	Door Handle Kit	H8395
7	Door Latch Assembly (4 button head screws and latch)	H8397
8	Glass, Retainer Kit	H8394
9	Door Hardware Kit (includes 2 pins, door roller and 10 button head screws and door set screw)	H8398
LEG PARTS		
10	Coastal Brushed Nickel Leg - single leg	H8383
10	Coastal, Nickel Leg - single leg	H8384
10	Coastal, Black Leg - single leg	H8385
11	Lakeview, Steel Black Leg - single leg	H8386
---	Olympic, Brushed Nickel Cast Leg - single leg	H5619
---	Olympic, Nickel Cast Leg - single leg	H5621
---	Olympic, Black Cast Leg - single leg	H5669
---	Leg, Hardware, Bolt, Kit	H8382
PEDESTAL PARTS		
14	Ash Plug Remover and Rake	H5564
15	Removable Ash Plug	H8381

BLOWER PARTS

Item #	Description	GV230GL
16	Blower Snap Switch	H8374
17	Blower Blade	H8375
18	Blower Cover	H8376
19	Speed Control - High Temperature	H5742
20	Blower Rocker Switch	H8066
---	Blower Opening Cover Plate	H8399
22	Blower Power Cord	H5660
MISCELLANEOUS PARTS		
---	Dry Graphite (apply to door handle bushing)	71052
---	Anti Seize, 2 Gram Pouch	H5633
23	Heat Exchanger Bolt Kit	H8387
---	Flue Ring Bolt Kit	H8388
---	Ash Drawer Hardware Kit	H8389
---	Taptite Qty 8 (34055)	H8390
---	Button Head Screw Qty 8 (34027)	H8391
FIREBOX AND TIMER PARTS		
---	Replacement Secondary Air Tube Kit GV/ML GL	TBD
---	Baffle Board Kit GV/ML 230GL	TBD
---	Timer Assembly GV/ML GL	TBD
---	Linkage Assembly GV/ML 230GL	TBD
---	Secondary Tube Retainer Clips	H8367
24	Back Brick Retainer	---
27	Complete Firebrick Kit (GV230GL - 20 bricks included)	H8378
28	Firebrick 4-1/2" X 9", Each	H5612
29	Baffle Board Kit	H8379
BODY PARTS		
30	Damper Rod	H8393
31	Damper Assembly	H8396
32	Stove Top Replacement	H8368
33	Cast Iron Heat Exchanger (hardware included)	H8369
35	Left Side Heat Shield (hardware included)	H8370
34	Right Side Heat Shield (hardware included)	H8371
36	Rear, Heat, Shield (hardware included)	H8372
37	Heat Exchanger Gasket	H8377

REPLACEMENT PARTS - MODELS GRANDVIEW™ 230GL

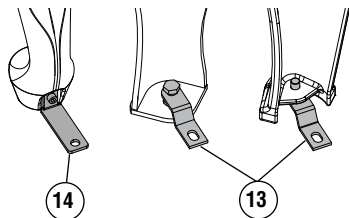
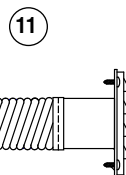
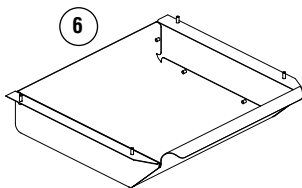
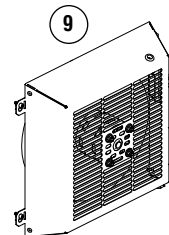
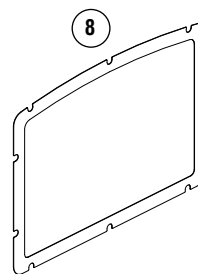
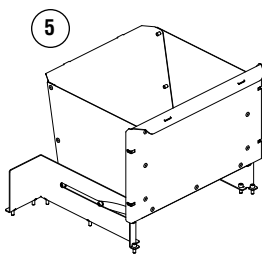
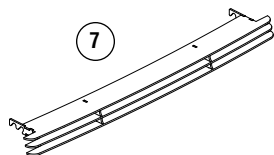
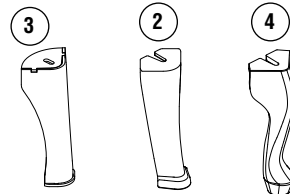
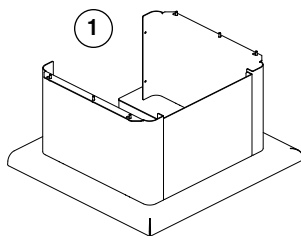
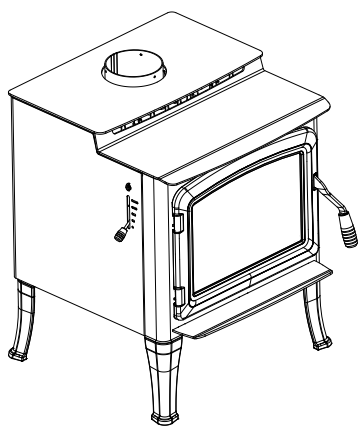


NOTE: DIAGRAMS & ILLUSTRATIONS ARE NOT TO SCALE.

ACCESSORIES - MODEL GRANDVIEW™ 230GL

PEDESTAL (REQUIRED)			
Item #	Model	Description	GV230GL
1	PED-GV	Pedestal, Black	H8343
OR LEGS (REQUIRED)			
2	LEG-COSTL-BLK	Coastal Legs, Black	H8339
2	LEG-COSTL-BRNKL	Coastal Legs, Brushed Nickel	H8340
3	LEG-LKVIEW-BLK	Lakeview Legs, Black	H8342
4	LEG-OLY-B	Olympic Sculptured Black	70000
4	LEG-OLY-N	Olympic Sculptured Nickel	70002
4	LEG-OLY-BRN	Olympic Sculptured Brushed Nickel	70008
ASH DRAWERS			
5	ASHDR-KIT-PED-GV	Pedestal, Ash Drawer Kit	H8344
6	ASHDR-KIT-LEG-GV	Leg, Ash Drawer Kit	H8345
LOUVERS			
7	LVP-GV230-BLK	Louvers, Black	H8348
7	LVR-GV230-BRNKL	Louvers, Brushed Nickel	H8349

DOOR TRIM			
Item #	Model	Description	GV230GL
8	DRTRM-GV230-NKL	Door Trim, Nickel	H8346
8	DRTRM-GV230-BRNKL	Door Trim, Brushed Nickel	H8347
BLOWER			
9	BLWR-GV-700-SS	Blower	H8350
OUTSIDE AIR KITS			
10	UZIAD	Outside Air Coupler for Connection of UZI to Fireplace	UZIAD
11	UZI	Outside Air Kit (4" I.D. x 10 ft. long insulated flex)	UZI
COMMON ACCESSORIES			
12	TSPK-B	Touch-up Spray Paint Kit, Black	H8159
13	WP-LEGF-LBRKT	Leg Tie Down Kit, Coastal & Lakeview Legs, Mobile Homes	H7665
14	W-LEGF-LBRKT	Leg Tie Down Kit, Olympic Legs, Mobile Homes	H5308
----	W-LLK	Leg Leveling Bolt Kit	H8407



This image shows a full page of blank white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, providing a template for writing or drawing. There are no margins, text, or other markings present.

Innovative Hearth Products IronStrike® Brand Wood Burning Stove and Insert Limited Lifetime Warranty

THE WARRANTY

Innovative Hearth Products ("IHP") Limited Lifetime Warranty warrants your IronStrike® Brand Wood Burning Stove or Insert ("Product") to be free from defects in materials and workmanship at the time of manufacture. The Product body, firebox and ceramic glass carry the Limited Lifetime Warranty. Ceramic glass carries the Limited Lifetime Warranty against thermal breakage only. After installation, if covered components manufactured by IHP are found to be defective in materials or workmanship during the Limited Lifetime Warranty period and while the Product remains at the site of the original installation, IHP will, at its option, repair or replace the covered components. If repair or replacement is not commercially practical, IHP will, at its option, refund the purchase price or wholesale price of the IHP product, whichever is applicable. IHP will also pay IHP prevailing labor rates, as determined in its sole discretion, incurred in repairing or replacing such components for up to five years. THERE ARE EXCLUSIONS AND LIMITATIONS to this Limited Lifetime Warranty as described herein.

COVERAGE COMMENCEMENT DATE

Warranty coverage begins on the date of purchase. In the case of new home construction, warranty coverage begins on the date of first occupancy of the dwelling or six months after the sale of the Product by an independent IHP dealer/distributor, whichever occurs earlier. The warranty shall commence no later than 24 months following the date of product shipment from IHP, regardless of the installation or occupancy date.

EXCLUSIONS AND LIMITATIONS

This Limited Lifetime Warranty applies only if the Product is installed in the United States or Canada and only if operated and maintained in accordance with the printed instructions accompanying the Product and in compliance with all applicable installation and building codes and good trade practices.

This warranty is non-transferable and extends to the original owner only. The Product must be purchased through a listed supplier of IHP and proof of purchase must be provided. The Product body and firebox carry the Limited Lifetime Warranty from the date of installation. Vent components, trim components and paint are excluded from this Limited Lifetime Warranty. The following do not carry a Limited Lifetime Warranty but are warranted as follows:

Cast Iron Heat Exchanger – Replacement for five years from the date of installation

Cast iron parts – Replacement for one year from the date of installation

Catalyst – Carries a separate warranty. Refer to the warranty certificate provided for that part

Electrical components – Repair or replacement for one year from date of installation

Gaskets – Replacement for one year from the date of installation.

Gold & nickel plating – Replacement for two years from date of installation. Excludes tarnishing

Refractory & screens – Replacement for two years from date of installation. Excludes hairline cracks

Removable air tubes – Repair or replacement for seven years from date of installation. IHP prevailing labor rates for years one through five.

Labor coverage – Prevailing IHP labor rates apply for the warranty period of the component, unless otherwise noted

Parts not otherwise listed carry a 90 day warranty from the date of installation.

Whenever practicable, IHP will provide replacement parts, if available, for a period of 10 years from the last date of manufacture of the Product.

IHP will not be responsible for: (a) damages caused by normal wear and tear, accident, riot, fire, flood or acts of God; (b) damages caused by abuse, negligence, misuse, or unauthorized alteration or repair of the Product affecting its stability or performance. (The Product must be subject to normal use with approved fuels listed in the Operation Manual provided with the product. Fuel products with abnormal burning characteristics, including but not limited to fuel such as driftwood, coal or plywood and wood products using a binder may burn at excessive temperatures and may cause damage to the Product or may cause it to function improperly; IHP stoves, inserts and high efficiency EPA fireplaces are approved for burning dry seasoned wood only.); (c) damages caused by failing to provide proper maintenance and service in accordance with the instructions provided with the Product; (d) damages, repairs or inefficiency resulting from faulty installation or application of the Product.

Coverage of this Limited Lifetime Warranty is conditional upon the appliance being operated without the use of grates, irons or any other method to elevate the fire.

IHP is not responsible for inadequate system draft caused by air conditioning and heating systems, mechanical ventilation systems, or general construction conditions which may generate negative air pressure in the room in which the appliance is installed. Additionally IHP assumes no responsibility for smoking conditions caused by inadequate chimney height, adjoining trees or buildings, adverse wind conditions or unusual environmental factors and conditions. Certain IHP Products are listed for use with Security Chimneys International, Ltd. chimney systems only. Use of chimney components other than that specified in the Product manual will void the Product warranty.

This Limited Lifetime Warranty covers only parts and labor as provided herein. In no case shall IHP be responsible for materials, components or construction which are not manufactured or supplied by IHP or for the labor necessary to install, repair or remove such materials, components or construction. Additional utility bills incurred due to any malfunction or defect in equipment are not covered by this Limited Lifetime Warranty. All replacement or repair components will be shipped F.O.B. from the nearest stocking IHP factory.

LIMITATION ON LIABILITY

It is expressly agreed and understood that IHP's sole obligation and the purchaser's exclusive remedy under this warranty, under any other warranty, expressed or implied, or in contract, tort or otherwise, shall be limited to replacement, repair, or refund, as specified herein.

In no event shall IHP be liable for any incidental or consequential damages caused by defects in the Product, whether such damage occurs or is discovered before or after replacement or repair, and whether such damage is caused by IHP's negligence. IHP has not made and does not make any representation or warranty of fitness for a particular use or purpose, and there is no implied condition of fitness for a particular use or purpose.

IHP makes no expressed warranties except as stated in this Limited Lifetime Warranty. The duration of any implied warranty is limited to the duration of this expressed warranty.

No one is authorized to change this Limited Lifetime Warranty or to create for IHP any other obligation or liability in connection with the Product. Some states and provinces do not allow the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you. The provisions of this Limited Lifetime Warranty are in addition to and not a modification of or subtraction from any statutory warranties and other rights and remedies provided by law.

INVESTIGATION OF CLAIMS AGAINST WARRANTY

IHP reserves the right to investigate any and all claims against this Limited Lifetime Warranty and to decide, in its sole discretion, upon the method of settlement.

To receive the benefits and advantages described in this Limited Lifetime Warranty, the appliance must be installed and repaired by a licensed contractor approved by IHP.

Contact IHP at the address provided herein to obtain a listing of approved dealers/distributors. **IHP shall in no event be responsible for any warranty work done by a contractor that is not approved without first obtaining IHP's prior written consent.**

HOW TO REGISTER A CLAIM AGAINST WARRANTY

In order for any claim under this warranty to be valid, you must contact the IHP dealer/distributor from which you purchased the product. If you cannot locate the dealer/distributor, then you must notify IHP in writing. IHP must be notified of the claimed defect in writing within 90 days of the date of failure. Notices should be directed to the IHP Warranty Department at 1769 East Lawrence Street; Russellville, AL 35654 or visit our website at WWW.IRONSTRIKE.US.COM.

WARRANTY

Your wood appliance is covered by a limited warranty (provided with the appliance). Please read the warranty to be familiar with its coverage.

Retain this manual. File it with your other documents for future reference.

REPLACEMENT PARTS

See **Pages 28 and 29** for a complete replacement parts list. Use only parts supplied from the manufacturer.

Normally, all parts should be ordered through your IHP distributor or dealer. Parts will be shipped at prevailing prices at time of order.

When ordering repair parts, always give the following information:

1. The model number of the appliance.
2. The Serial Number of the appliance.

3. The part number.
4. The description of the part.
5. The quantity required.
6. The installation date of the appliance.

If you encounter any problems or have any questions concerning the installation or application of this system, please contact your dealer.

Innovative Hearth Products, LLC (IHP)
1769 East Lawrence Street
Russellville, AL 35654
IronStrike.us.com

PRODUCT REFERENCE INFORMATION

We recommend that you record the following important information about your appliance. If you did not purchase your appliance directly from an IHP dealer, then contact us at IronStrike.us.com to find your nearest IHP dealer who will answer your questions or address your concerns.

Model Number _____

Serial Number _____

Date Installed _____

Your Dealer's Name _____



We recommend that our woodburning hearth products be installed and serviced by professionals who are certified in the U.S. by the National Fireplace Institute® (NFI) as NFI Woodburning Specialists or who are certified in Canada by Wood Energy Technical Training (WETT).



Innovative Hearth Products (IHP) reserves the right to make changes at any time, without notice, in design, materials, specifications, and prices, and also to discontinue colors, styles, and products. Consult your local distributor for fireplace code information.



SAFETY / LISTING
LABEL - MODEL
GV230GL

CONTACT LOCAL BUILDING OR FIRE OFFICIALS ABOUT RESTRICTIONS AND INSTALLATION INSPECTION IN YOUR AREA. ROOM HEATER, SOLID FUEL TYPE, ALSO FOR USE IN MOBILE HOMES PURSUANT TO (UM) 84-HUD.

COMMUNIQUEZ AVEC LES AUTORITÉS LOCALES EN BÂTIMENT OU LE SERVICE DE PRÉVENTION DES INCENDIES POUR CONNAÎTRE LES NORMES D'INSTALLATION ET D'INSPECTION DE VOTRE RÉGION. APPAREIL DE CHAUFFAGE CERTIFIÉ POUR COMBUSTIBLE SOLIDE PEUT ÊTRE INSTALLÉ DANS UNE MAISON MOBILE SELON (UM) 84-HUD

Report No./Numéro de Rapport 14-182	Model /Modèle Grandview™ 230GL	Serial No./Numéro de série: GV230GL-
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Tested to: UL 1482, ULC S627
Type Of Fuel: Solid Wood Only
Optional Blower: Part No. H8350, Model BLUVR-GV700-SS
Blower Electrical Rating: 120V, 60 Hz, 1 Amp
Specification: Electrical Du Ventilateur: 120V, 60 Hz, 1 Amp
Ne pas faire passer le fil électrique sous ou en avant de l'appareil.
Do not route power cord under or in front of appliance.
Replace glass only with 5mm ceramic.
Operate only with doors closed.
Do not obstruct the space beneath the heater.
This wood heater needs periodic inspection and repair for proper operation.
Consult the owner's manual for further information. It is against federal regulations to operate this wood heater in a manner inconsistent with the operating instructions in the owner's manual.
Certified to comply with 2020 particulate emission standards using crib wood - Emissions: 1, 7 grains/hr



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Manufactured By / Fabriqué Par:
INNOVATIVE HEARTH PRODUCTS
1302 14th St NW
Auburn, WA 98001 USA



Tested to: UL 1482, ULC S627
Type of combustible: Bois seulement
Ventilateur Optionnel, No. De Pièces: H8350, Modèle BLUVR-GV700-SS
Spécification Électrique Du Ventilateur: 120V, 60 Hz, 1 Amp
Ne pas faire passer le fil électrique sous ou en avant de l'appareil.
Remplacez la vitre seulement avec la céramique de 5 millimètres.
Faire fonctionner uniquement lorsque les portes sont fermées.
Ne pas obstruer l'espace sous la bouche de chaleur.
Ce appareil de chauffage au bois doit être inspecté et entretenu périodiquement pour fonctionner correctement. Voir le manuel du propriétaire pour plus d'information. L'utilisation de cet appareil de chauffage au bois de manière incompatible avec les instructions du manuel du propriétaire constitue une infraction aux réglementations fédérales.
Valeur d'émission du test d'homologation 1,7 g/h selon la norme 2020

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Sample Pre-Test Tare Sheet: ☐ Probes☒ Filters☐ O-RingsDate/Time In Desiccator: 8/15/18 - 12:00 Balance ID#: 107 Audit Weight ID# / Weight(mg): 1094 - 100mg

Sample ID	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Tech. Initials	Project/Run #
3261	8/20-16:00	118.6	8/21-7:45	118.7	-	-	-	-	SB	18-428 #1
3262		120.4		120.4	-	-	-	-	SB	
3263		121.2		121.1	-	-	-	-	SB	
3264		122.4		122.5	-	-	-	-	SB	
3265		122.2		122.3	-	-	-	-	SB	
3266		118.5		118.6	-	-	-	-	SB	
3267		121.6	9/7-16:00	121.6	-	-	-	-	SB	18-428 #1 & D
3268		121.5		121.6	-	-	-	-	SB	
3269		119.5		119.5	-	-	-	-	SB	
3270		121.1		121.0	-	-	-	-	SB	
3271		122.3		122.3	-	-	-	-	SB	
3272		118.6		118.6	-	-	-	-	SB	
3273		121.2	9/10-7:00	121.2	-	-	-	-	SB	18-428 #2 & D
3274		118.8		118.7	-	-	-	-	SB	
3275		122.8		122.8	-	-	-	-	SB	
3276		121.0		121.0	-	-	-	-	SB	
3277		118.7		118.5	-	-	-	-	SB	
3278		122.4		122.5	-	-	-	-	SB	
3279		121.7		121.5	-	-	-	-	SB	18-428 #1
3280		122.5		122.5	-	-	-	-	SB	
3281		117.3		117.1	-	-	-	-	SB	
3282		121.5		121.4	-	-	-	-	SB	
3283		118.8		118.7	-	-	-	-	SB	
3284		121.9		122.0	-	-	-	-	SB	
3285		120.9		120.8	-	-	-	-	SB	18-428 #2
3286		119.0		119.0	-	-	-	-	SB	
3287		122.9		122.8	-	-	-	-	SB	
3288		120.9		120.7	-	-	-	-	SB	
3289		118.8		118.7	-	-	-	-	SB	
3290		122.8		122.7	-	-	-	-	SB	

Sample Post-Test Analysis Sheet: ☐ Probes☒ Filters☐ O-Rings

Balance ID#: 107 Audit Weight ID# / Weight (mg): 109 A/B - 100/20 mg

Sample ID	Tare (mg)	Date/Time in Desiccator	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Tech. Initials
3261	118.7	8/21-19:45	8/22-16:30	119.5	8/23-11:40	119.4					SB
3262	120.4	↓	↓	122.2	↓	122.3					SB
3263	121.1	↓	↓	120.8	↓	120.9					SB
3264	122.5	↓	↓	125.0	↓	124.9					SB
3265	122.3	↓	↓	122.1	↓	122.1					SB
3266	118.6	↓	↓	118.6	↓	118.6					SB
3267	121.6	9/10-19:30									
3268	121.6	↓									
3269	119.5	↓									
3270	121.0	↓									
3271	122.3	↓									
3272	118.6	↓									
3273	121.2	9/11-16:50									
3274	118.7	↓									
3275	122.8	↓									
3276	121.0	↓									
3277	118.5	↓									
3278	122.5	↓									
3279	121.5	9/12/18-17:00	9/13-17:30	128.8	9/16-6:30	128.8					SB
3280	122.5	↓	↓	125.1	↓	125.1					SB
3281	117.1	↓	↓	117.6	↓	117.5					SB
3282	121.4	↓	↓	130.1	↓	130.1					SB
3283	118.2	↓	↓	119.2	↓	119.1					SB
3284	122.0	↓	↓	122.0	↓	122.0					SB
3285	120.8	9/13-19:00	9/16-6:30	122.9	9/17-8:00	122.9					SB
3286	119.0	↓	↓	119.4	↓	119.4					SB
3287	122.8	↓	↓	122.7	↓	122.7					SB
3288	120.7	↓	↓	123.0	↓	123.1					SB
3289	118.7	↓	↓	119.1	↓	119.0					SB
3290	122.7	↓	↓	122.8	↓	122.8					SB

Sample Pre-Test Tare Sheet: ☐ Probes☒ Filters☐ O-RingsDate/Time In Desiccator: 8/30/18 - 16:20 Balance ID#: 107 Audit Weight ID# / Weight(mg): 109A - 100mg

Sample ID	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Tech. Initials	Project/Run #
3291	9/12-12:00	122.9	9/13-8:00	122.9	-	-	-	-	SB	18-428 #3
3292		118.5		118.6	-	-	-	-	SB	
3293		122.0		121.9	-	-	-	-	SB	
3294		118.1		118.0	-	-	-	-	SB	
3295		122.9		122.9	-	-	-	-	SB	
3296		122.0		122.1	-	-	-	-	SB	
3297		123.0	9/14-7:45	122.8	-	-	-	-	SB	18-428 #4
3298		118.8		118.6	-	-	-	-	SB	
3299		121.5		121.4	-	-	-	-	SB	
3300		122.6		122.4	-	-	-	-	SB	
3301		118.8		118.8	-	-	-	-	SB	
3302		121.3		121.4	-	-	-	-	SB	
3303		122.7		122.7	-	-	-	-	SB	18-428 #5
3304		118.0		118.0	-	-	-	-	SB	
3305		121.4		121.6	-	-	-	-	SB	
3306		118.2		118.3	-	-	-	-	SB	
3307		122.4		122.4	-	-	-	-	SB	
3308		121.5		121.5	-	-	-	-	SB	
3309		121.4		121.4	-	-	-	-	SB	18-428 #6
3310		118.3		118.2	-	-	-	-	SB	
3311		123.3		123.2	-	-	-	-	SB	
3312	9/14-7:45	123.4	9/17-8:00	123.2	-	-	-	-	SB	
3313		122.9		123.0	-	-	-	-	SB	
3314		118.3		118.4	-	-	-	-	SB	
3315		122.2		122.3	-	-	-	-	SB	18-433 Field Blank
3316		122.7		122.8	-	-	-	-	SB	18-433 Field Blank
3317		117.4		117.6	-	-	-	-	SB	18-433 #1
3318		121.1		121.3	-	-	-	-	SB	
3319		119.4		118.3	-	-	-	-	SB	
3320		122.6		122.4	-	-	-	-	SB	

Sample Post-Test Analysis Sheet: ☐ Probes☒ Filters☐ O-Rings

Balance ID#: 107 Audit Weight ID# / Weight (mg): 1092 - 100 mg

Sample ID	Tare (mg)	Date/Time in Desiccator	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Tech. Initials
3291	122.9	9/13-18:20	9/16-6:30	126.2	9/17-8:00	126.3					SB
3292	118.6	↓	↓	119.4	↓	119.3					SB
3293	121.9	↓	↓	121.8	↓	121.8					SB
3294	118.0	↓	↓	122.0	↓	122.0					SB
3295	122.9	↓	↓	123.1	↓	123.0					SB
3296	122.1	↓	↓	122.9	↓	122.1					SB
3297	122.8	9/14-16:20	↓	131.5	↓	131.6					SB
3298	118.6	↓	↓	121.2	↓	121.3					SB
3299	121.4	↓	↓	121.2	↓	121.1					SB
3300	122.4	↓	↓	132.9	↓	132.8					SB
3301	118.8	↓	↓	118.9	↓	119.0					SB
3302	121.4	↓	↓	121.5	↓	121.5					SB
3303	122.7	9/17-15:35	9/23-6:00	126.6	9/24-8:30	126.6					SB
3304	118.0	↓	↓	119.1	↓	119.1					SB
3305	121.6	↓	↓	121.2	↓	121.3					SB
3306	118.3	↓	↓	122.7	↓	122.7					SB
3307	122.4	↓	↓	122.8	↓	122.8					SB
3308	121.5	↓	↓	121.6	↓	121.5					SB
3309	121.4	9/25-15:50	9/27-7:30	128.7	9/27-15:00	128.7					SB
3310	118.2	↓	↓	119.5	↓	119.4					SB
3311	123.2	↓	↓	123.4	↓	123.3					SB
3312	123.2	↓	↓	130.4	↓	130.2					SB
3313	123.0	↓	↓	123.9	↓	123.7					SB
3314	118.4	↓	↓	118.4	↓	118.4					SB
3315	122.3	9/26-11:00	9/27-15:00	122.2	9/27-15:00	122.2					SB
3316	122.8	9/26-18:00	9/27-15:00	122.7	9/27-15:00	122.7					SB
3317	117.8	9/26-15:45	9/28-9:30	123.4	10/1-7:40	123.4					SB
3318	121.3	↓	↓	121.0	↓	121.1					SB
3319	118.3/118.3	↓	↓	124.1	↓	124.2					SB
3320	122.4	↓	↓	122.6	↓	122.7					SB

Sample Pre-Test Tare Sheet: ☒ Probes☐ Filters☐ O-RingsDate/Time In Desiccator: 7/16/18 Balance ID#: 107 Audit Weight ID# / Weight(mg): 109A - 100mg

Sample ID	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Tech. Initials	Project/Run #
1A	8/16/18-8:00	116562.3	8/20-16:00	116628.2	-	-	-	-	SB	18-422 #1
1B	8/16/18-8:00	115902.8	8/20-16:00	115902.9	-	-	-	-	SB	18-422 #1
2A	9/5/18-8:30	116240.7	9/7-11:00	116240.7	-	-	-	-	SB	18-428 #1 RHP
2B	↓	116330.8	↓	116330.9	-	-	-	-	SB	18-428 #1 RHP
3A	↓	116073.3	↓	116073.4	-	-	-	-	SB	18-428 #2 RHP
3B	↓	116340.3	↓	116340.4	-	-	-	-	SB	18-428 #2 RHP
4A	↓	116182.9	↓	116183.0	-	-	-	-	SB	18-428 #1
4B	↓	116366.1	↓	116366.0	-	-	-	-	SB	18-428 #1
5A	↓	116770.1	↓	116770.1	-	-	-	-	SB	18-428 #2
5B	↓	116880.5	↓	116880.7	-	-	-	-	SB	18-428 #2
6A	9/7/18-16:00	116564.9	9/10-7:00	116564.9	-	-	-	-	SB	18-428 #3
6B	9/7/18-16:00	116117.3	9/10-7:00	116117.3	9/13-8:00	116117.2	-	-	SB	18-428 #3
7A	9/13/18-8:00	116739.9	9/14-7:45	116739.8	-	-	-	-	SB	18-428 #4
7B	↓	117304.4	↓	117304.5	-	-	-	-	SB	18-428 #4
8A	↓	116829.6	↓	116829.4	-	-	-	-	SB	18-428 #5
8B	↓	116825.4	↓	116825.3	-	-	-	-	SB	18-428 #5
9A	↓	116720.9	9/17-8:00	116720.4	9/24-8:30	116720.4	-	-	SB	18-428 #6
9B	↓	117135.4	↓	117135.4	9/22-8:30	117135.2	-	-	SB	18-428 #6
10A	9/24-8:30	116826.4	9/25-9:15	116826.6	-	-	-	-	SB	18-433 Add Blank
10B	↓	117167.8	↓	117167.9	-	-	-	-	SB	-
11A	↓	117034.6	↓	117035.0	9/26-7:15	117034.8	-	-	SB	18-433 #1
11B	↓	116673.9	↓	116674.1	-	-	-	-	SB	18-433 #1
12A	↓	116888.1	↓	116888.4	9/26-7:15	116888.2	-	-	SB	18-433 #2
12B	↓	117051.7	↓	117051.9	9/26-7:15	117051.7	-	-	SB	18-433 #2
13A	↓	117456.2	↓	117456.3	-	-	-	-	SB	18-433 #3
13B	↓	117065.0	↓	117065.4	9/26-7:15	117065.0	9/27-7:30	117065.1	SB	18-433 #3
14A										
14B										

Sample Post-Test Analysis Sheet: ☒ Probes☐ Filters☐ O-Rings

Balance ID#: 107 Audit Weight ID# / Weight (mg): 109A/B 100/100 mg

Sample ID	Tare (mg)	Date/Time in Desiccator	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Tech. Initials
1A	116628.2	8/21-14:45	8/22-16:30	116628.0	8/23-11:00	116628.1					SB
1B	115902.9	8/21-14:45	8/22-16:30	115902.9	8/23-11:00	115902.8					SB
2A	116240.7	9/10-19:30									
2B	116330.9	9/10-19:30									
3A	116033.4	9/11-16:50									
3B	116340.4	9/11-16:50									
4A	116183.0	9/12-17:20	9/13-17:30	116183.4	9/16-6:30	116183.2					SB
4B	116366.0	9/12-17:20	9/13-17:30	116366.1	9/16-6:30	116366.0					SB
5A	116770.1	9/13-13:00	9/16-6:30	116770.0	9/17-8:00	116770.0					SB
5B	116880.7	9/13-13:00	9/16-6:30	116880.7	9/17-8:00	116880.6					SB
6A	116564.9	9/13-18:20	9/16-6:30	116565.0	9/17-8:00	116565.0					SB
6B	116117.2	9/13-18:20	9/16-6:30	116117.3	9/17-8:00	116117.3					SB
7A	116730.8	9/14-16:20	9/16-6:30	116740.0	9/18-8:45	116740.1					SB
7B	117304.5	9/14-16:20	9/16-6:30	117304.7	9/18-8:45	117304.8					SB
8A	116829.4	9/17-15:35	9/23-6:00	116829.5	9/24-8:30	116829.5					SB
8B	116825.3	9/17-15:35	9/23-6:00	116825.4	9/24-8:30	116825.5					SB
9A	116720.4	9/25-15:50	9/27-7:30	116721.1	9/27-15:00	116720.9					SB
9B	117135.2	9/25-15:50	9/27-7:30	117135.5	9/27-15:00	117135.5					SB
10A	116826.6	9/26-11:00	9/27-15:00	116826.7	9/28-9:30	116826.6					SB
10B	-	-	-	-	-	-	-	-	-	-	-
11A	117034.8	9/26-15:45	9/28-9:30	117034.8	10/1-7:40	117034.9					SB
11B	116674.1	9/26-15:45	9/28-9:30	116674.0	10/1-7:40	116674.1					SB
12A	116888.2	9/27-12:35	10/1-7:40	116888.0	10/1-15:00	116888.1					SB
12B	117051.7	9/27-12:35	10/1-7:40	117052.0	10/1-15:00	117052.0					SB
13A	117456.3	9/27-17:05	10/1-7:40	117456.1	10/1-15:00	117456.2					SB
13B	117065.1	9/27-17:05	10/1-7:40	117065.1	10/1-15:00	117065.3					SB
14A											
14B											

Sample Pre-Test Tare Sheet: ☐ Probes☐ Filters☒ O-RingsDate/Time In Desiccator: 8/16/18 - 12:00 Balance ID#: 107 Audit Weight ID# / Weight(mg): 109 A/B - 100/200mg

Sample ID	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Tech. Initials	Project/Run #
1A	8/16/18 - 8:00	3554.4	8/20-16:00	3554.4	-	-	-	-	JB	18-422 #1
1B	8/16/18 - 8:00	3565.9	8/20-16:00	3566.0	-	-	-	-	JB	18-422 #1
2A	9/6/18-10:30	3551.9	9/7-11:00	3551.8	-	-	-	-	JB	18-428 #1
2B		3570.4		3570.3	-	-	-	-	JB	18-428 #1
3A		3579.3		3579.3	-	-	-	-	SB	18-428 #2
3B		3567.6		3567.6	-	-	-	-	SB	18-428 #2
4A		3592.8		3592.8	-	-	-	-	SB	18-428 #3
4B		3580.5		3580.5	-	-	-	-	SB	18-428 #3
5A		3530.1		3530.1	-	-	-	-	SB	18-428 #2
5B		3533.8		3533.6	-	-	-	-	SB	18-428 #2
6A		3615.1		3615.2	-	-	-	-	SB	18-428 #3
6B		3396.0		3396.0	-	-	-	-	SB	18-428 #3
7A	9/13/18-8:00	3573.8	9/14-7:45	3573.9	-	-	-	-	SB	18-428 #4
7B		3521.8	9/17-8:00	3521.7	-	-	-	-	SB	18-428 #4
8A		3551.5		3551.5	-	-	-	-	SB	18-428 #5
8B		3585.2		3585.2	-	-	-	-	SB	18-428 #5
9A		3581.6		3581.4	-	-	-	-	SB	18-428 #6
9B		3524.5		3524.4	-	-	-	-	SB	18-428 #6
10A	9/24-8:30	3431.3	9/25-9:15	3431.1	-	-	-	-	SB	18-433 Field Blank
10B		3570.2		3570.2	-	-	-	-	SB	
11A		3424.3		3423.8	9/26-7:15	3424.0	-	-	SB	18-433 #1
11B		4234.9		4234.6	9/26-7:15	4234.5	-	-	SB	18-433 #1
12A		3432.3		3432.1	-	-	-	-	SB	18-433 #2
12B		3404.4		3404.2	-	-	-	-	SB	18-433 #2
13A		3459.7		3459.8	-	-	-	-	SB	18-433 #3
13B		3499.7		3499.7	-	-	-	-	SB	18-433 #3
14A		3362.2		33						
14B		3336.2								

Sample Post-Test Analysis Sheet: ☐ Probes☐ Filters☒ O-Rings

Balance ID#: 107 Audit Weight ID# / Weight (mg): 109 A/B - 100/20 mg

Sample ID	Tare (mg)	Date/Time in Desiccator	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Date/Time	Weight (mg)	Tech. Initials
1A	3554.4	8/21-14:25	8/22-16:20	3554.7	8/23-11:00	3554.7					JB
1B	3566.0	8/21-14:25	8/22-16:20	3566.6	8/23-11:00	3566.5					JB
2A	3551.8	9/10-19:30									
2B	3570.3	9/10-19:30									
3A	3579.3	9/11-16:30									
3B	3567.8	9/11-16:30									
4A	3592.8	9/12-17:20	9/13-17:30	3593.3	9/16-6:30	3593.1					JB
4B	3580.5	9/12-17:20	9/13-17:30	3581.2	9/16-6:30	3581.0					JB
5A	3570.1	9/13-13:00	9/16-6:30	3531.4	9/17-8:00	3531.2					JB
5B	3533.0	9/13-13:00	9/16-6:30	3534.8	9/17-8:00	3534.7					JB
6A	3615.2	9/13-18:20	9/16-6:30	3616.0	9/17-8:00	3615.9					JB
6B	3396.0	9/13-18:20	9/16-6:30	3397.0	9/17-8:00	3397.0					JB
7A	3573.9	9/14-16:20	9/16-6:30	3574.3	9/18-8:45	3574.3					JB
7B	3521.7	9/14-16:20	9/16-6:30	3522.5	9/18-8:45	3522.6					JB
8A	3551.5	9/17-15:35	9/23-6:00	3552.2	9/24-8:30	3552.3					JB
8B	3585.2	9/17-15:35	9/23-6:00	3586.1	9/24-8:30	3586.0					JB
9A	3581.4	9/25-15:50	9/27-7:30	3581.9	9/27-15:00	3582.0					JB
9B	3524.4	9/25-15:50	9/27-7:30	3524.8	9/27-15:00	3524.8					JB
10A	3431.1	9/26-11:00	9/27-15:00	3431.4	9/28-9:30	3431.4					JB
10B	-	-	-	-	-	-					-
11A	3424.0	9/26-15:45	9/28-9:30	3424.5	10/1-7:40	3424.4					JB
11B	4234.5	9/26-15:45	9/28-9:30	4235.5	10/1-7:40	4235.4					JB
12A	3432.1	9/27-12:35	10/1-7:40	3432.8	10/1-15:00	3432.9					JB
12B	3404.2	9/27-12:35	10/1-7:40	3404.9	10/1-15:00	3404.9					JB
13A	3459.8	9/27-17:05	10/1-7:40	3460.9	10/1-15:00	3460.9					JB
13B	3499.7	9/27-17:05	10/1-7:40	3500.8	10/1-15:00	3500.7					JB
14A											
14B											

WOOD STOVE TEST DATA PACKET
ASTM E2780/E2515



Run 5 Data Summary

Client: IHP
Model: GV230GL
Job #: 18-428
Tracking #: 0008
Test Date: 9/17/2018

A handwritten signature in dark ink, appearing to be "JL", is written over a horizontal line.

Techician Signature

9/24/2018

Date

TEST RESULTS - ASTM E2780 / ASTM E2515

Client: IHP

Model: GV230GL

Run #: 5

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/17/2018

Burn Rate (kg/hr):	0.95
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	Ambient Sample	Sample Train A	Sample Train B	1st Hour Filter
Total Sample Volume (ft ³)	66.875	59.351	57.864	8.713
Average Gas Velocity in Dilution Tunnel (ft/sec)	14.9			
Average Gas Flow Rate in Dilution Tunnel (dscf/hr)	9960.2			
Average Gas Meter Temperature (°F)	74.6	97.6	95.8	79.9
Total Sample Volume (dscf)	66.223	56.812	55.282	10.245
Average Tunnel Temperature (°F)	87.3			
Total Time of Test (min)	400			
Total Particulate Catch (mg)	0.0	5.6	5.8	3.9
Particulate Concentration, dry-standard (g/dscf)	0.0000000	0.0000986	0.0001049	0.0003807
Total PM Emissions (g)	0.00	6.55	6.97	3.79
Particulate Emission Rate (g/hr)	0.00	0.98	1.04	3.79
Emissions Factor (g/kg)	-	1.04	1.10	-
Difference from Average Total Particulate Emissions (g)	-	0.21	0.21	-
Difference from Average Emissions Factor (g/kg)	-	0.03	0.03	-

Final Average Results	
Total Particulate Emissions (g)	6.76
Particulate Emission Rate (g/hr)	1.01
Emissions Factor (g/kg)	1.07
HHV Efficiency (%)	75.2%
LHV Efficiency (%)	81.3%
CO Emissions (g/min)	1.31

Quality Checks	Requirement	Observed	Result
Dual Train Precision	Each train within 7.5% of average emissions (in grams), or emission factors within 0.5 g/kg	See Above	OK
Filter Temps	<90 °F	86.0	OK
Face Velocity	< 30 ft/min	8.0	OK
Leakage Rate	Less than 4% of average sample rate	0.001 cfm	OK
Ambient Temp	55-90 °F	Min: 71 / Max: 76	OK
Negative Probe Weight Evaluation	<5% of Total Catch	Probe Catch Not Negative	OK
Pro-Rate Variation	90% of readings between 90-110%; none greater than 120% or less than 80%	See Data Tabs	OK
Stove Surface ΔT	<126°F	98.2	OK

B415.1 Efficiency Results

Manufacturer: IHP
Model: GV230GL
Date: 09/17/18
Run: 5
Control #: 18-428
Test Duration: 400
Output Category: 2

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	75.2%	81.3%
Combustion Efficiency	94.1%	94.1%
Heat Transfer Efficiency	79.9%	86.4%

Output Rate (kJ/h)	13,998	13,279	(Btu/h)
Burn Rate (kg/h)	0.94	2.07	(lb/h)
Input (kJ/h)	18,617	17,661	(Btu/h)

Test Load Weight (dry kg)	6.27	13.81	dry lb
MC wet (%)	16.31		
MC dry (%)	19.49		
Particulate (g)	6.76		
CO (g)	523		
Test Duration (h)	6.67		

Emissions	Particulate	CO
g/MJ Output	0.07	5.60
g/kg Dry Fuel	1.08	83.44
g/h	1.01	78.41
g/min	0.02	1.31
lb/MM Btu Output	0.17	13.02

Air/Fuel Ratio (A/F)	14.23
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VERSION:

2.2

12/14/2009

WOODSTOVE FUEL DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 5

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/17/2018

Preburn Fuel Information						
Size	Length (in)	Moisture Content (% DB)		Size	Length (in)	Moisture Content (% DB)
2x4	16.00	19.4		2x4	16.00	20.0
2x4	16.00	18.6		2x4	16.00	19.8
2x4	16.00	19.1				
2x4	16.00	19.4				
2x4	16.00	20.1				
2x4	16.00	21.4				
2x4	16.00	18.7				
2x4	16.00	20.6				
Total Fuel Weight (lbs):		14.88	Average Moisture (%DB):		19.7	

Firebox Volume (ft³): 2.30
 Total 2x4 Crib Weight, with spacers (lbs): 8.02
 Total 4x4 Crib Weight, with spacers (lbs): 8.43
 Total Wet Fuel Weight, with spacers (lbs): 16.45

Coal Bed Range (20-25%):

Min (lbs): 3.29
 Max (lbs): 4.11

Test Fuel Information						
Size	Length (in)	Weight (lbs)	Moisture Content (%DB)			Dry Weight (lbs)
2x4	15.00	1.43	19.1	19.2	21.2	1.19
2x4	15.00	1.83	19.1	21.5	18.9	1.53
2x4	15.00	1.87	19.0	19.7	18.6	1.57
2x4	15.00	1.74	19.3	18.9	19.0	1.46
4x4	15.00	3.81	18.8	21.3	19.0	3.18
4x4	15.00	3.86	18.8	20.0	19.4	3.23
Total Dry Weight, no spacers (lbs):						12.17
Total Dry Weight, with spacers (lbs):						13.91

Spacer Moisture Readings (%DB)							
9.8	10.4	7.6	9.8	8.4			
10.2	10.3	8.8	8.0	10.1			
8.8	8.5	9.8	8.9	10.3			
9.9	9.9	9.9	9.8	7.8			

Quality Checks	Requirement	Observed	Result
Fuel Density	25 - 36 (lbs/ft ³ , DB)	30.8	OK
Loading Density	6.3 - 7.7 (lbs/ft ³ , WB)	7.15	OK
2x4 Fuel Mix	35 - 65 % of total weight	49%	OK

WOODSTOVE PREBURN DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 5

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/17/2018

Preburn Start Time: 9:45
 Recording Interval (min): 10
 Run Time (min): 60

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
0	8.2	-0.086	416	615	383	1146	160	544.0	707	66
10	6.5	-0.049	454	642	311	875	204	497.2	428	66
20	5.4	-0.054	464	616	294	716	217	461.4	363	65
30	4.9	-0.032	472	580	283	560	217	422.4	290	64
40	4.6	-0.042	455	529	273	442	217	383.2	239	64
50	4.4	-0.015	427	493	265	366	218	353.8	209	63
60	4.1	-0.022	409	469	262	319	220	335.8	190	62

DILUTION TUNNEL & MISC. DATA - ASTM E2780 / E2515

Client: IHP
 Model: GV230GL
 Run #: 5
 Test Start Time: 10:50

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/17/2018

Total Sampling Time (min): 400
 Recording Interval (min): 10

	Beginning	Middle	End	Avg.
P _{bar} (in Hg):	30.09	30.03	30	30.04

Meter Box γ Factor: 1.002 (A)
 Meter Box γ Factor: 0.997 (B)
 Meter Box γ Factor: 0.999 (Amb)

Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Tunnel Area: 0.1963 ft²
 Dilution Tunnel H₂O: 2.00 percent
 Tunnel Diameter: 6 inches
 Pitot Tube Cp: 0.99
 Dilution Tunnel Static: -0.190 in H₂O

Post-Test Leak Check

(A) 0.001 cfm @ -13 in. Hg
 (B) 0.000 cfm @ -12 in. Hg
 (AMB) 0.000 cfm @ -14 in. Hg

Ambient Sample Volume: 66.875 ft³

	Tunnel Traverse Information								
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (in H ₂ O)	0.028	0.054	0.060	0.036	0.030	0.058	0.066	0.046	0.07
Tunnel Temp (°F)	85	85	85	85	85	85	85	85	85

V_{strav}: 14.81 ft/sec

F_p: 0.833 [ratio]

V_{scent}: 17.77 ft/sec

Initial Tunnel Flow: 162.2 scf/min

Test Fuel Properties

Default Fuel Values

Fuel Type:	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Actual Fuel Used Properties

Fuel Type:	D. Fir
HHV (kJ/kg)	19,810
%C	48.73
%H	6.87
%O	43.9
%Ash	0.5
MC (%DB)	19.5

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 5

Technician: SJB

Date: 9/17/2018

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
0	0.000		0.070	0.01	71	-0.07		16.5		107	268	83	71
10	1.448	0.145	0.070	2.23	73	-0.01	104	15.2	-1.3	105	419	85	71
20	2.895	0.145	0.070	2.18	76	0	104	13.1	-2.1	113	484	83	72
30	4.342	0.145	0.070	2.17	80	-2.27	102	11.7	-1.4	103	394	85	72
40	5.793	0.145	0.070	2.18	83	-0.28	102	10.4	-1.3	101	385	83	73
50	7.251	0.146	0.070	2.16	87	-2.49	101	9.3	-1.1	99	356	84	73
60	8.713	0.146	0.070	2.18	89	-2.4	101	8.3	-1	97	339	85	73
70	10.195	0.148	0.070	2.20	92	-2.13	102	7.3	-1	96	338	85	74
80	11.671	0.148	0.070	2.18	94	-0.68	101	6.4	-0.9	96	327	84	73
90	13.151	0.148	0.070	2.20	95	-1.13	101	5.5	-0.9	94	315	84	74
100	14.629	0.148	0.070	2.16	96	0	100	4.9	-0.6	92	287	85	74
110	16.110	0.148	0.070	2.18	97	-0.36	100	4.3	-0.6	91	267	83	75
120	17.592	0.148	0.070	2.18	98	-2	100	3.9	-0.4	89	242	86	75
130	19.076	0.148	0.070	2.18	99	-1.88	100	3.6	-0.3	87	217	84	75
140	20.563	0.149	0.070	2.19	100	0	100	3.3	-0.3	85	198	85	75
150	22.053	0.149	0.070	2.18	100	-1.5	100	3.1	-0.2	84	187	84	75
160	23.540	0.149	0.070	2.17	101	-1.11	99	3.0	-0.1	84	180	84	75
170	25.027	0.149	0.070	2.18	101	-2.17	99	2.8	-0.2	83	174	85	75
180	26.518	0.149	0.070	2.18	101	-1.66	99	2.8	0	83	169	85	75
190	28.010	0.149	0.070	2.17	102	0	99	2.5	-0.3	83	164	84	75
200	29.500	0.149	0.070	2.20	102	-1.99	99	2.4	-0.1	82	161	85	75
210	30.989	0.149	0.070	2.19	102	-0.07	99	2.2	-0.2	82	158	84	75
220	32.481	0.149	0.070	2.19	102	-1.67	99	2.1	-0.1	82	156	86	75
230	33.974	0.149	0.070	2.18	102	-1.73	99	2.0	-0.1	82	153	84	75
240	35.465	0.149	0.070	2.19	103	0	99	1.8	-0.2	82	151	85	75
250	36.954	0.149	0.070	2.19	103	0	99	1.7	-0.1	81	149	84	75
260	38.446	0.149	0.070	2.18	103	-1.08	99	1.5	-0.2	81	147	85	75
270	39.941	0.150	0.070	2.17	103	0	99	1.4	-0.1	81	146	84	76
280	41.432	0.149	0.070	2.19	103	0	99	1.3	-0.1	81	145	85	75
290	42.923	0.149	0.070	2.20	103	0	99	1.1	-0.2	81	144	84	74
300	44.417	0.149	0.070	2.17	103	-2.43	99	1.0	-0.1	81	143	85	75
310	45.912	0.150	0.070	2.17	103	-0.62	99	0.9	-0.1	81	141	84	75

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP Job #: 18-428
 Model: GV230GL Tracking #: 0008
 Run #: 5 Technician: SJB
 Date: 9/17/2018

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
320	47.403	0.149	0.070	2.17	103	-0.8	99	0.7	-0.2	81	140	85	76
330	48.895	0.149	0.070	2.18	103	-0.64	99	0.7	0	81	139	85	76
340	50.392	0.150	0.070	2.16	104	-1.25	99	0.6	-0.1	81	136	85	76
350	51.887	0.150	0.070	2.16	104	-2.15	99	0.4	-0.2	81	133	85	76
360	53.378	0.149	0.070	2.19	104	0	99	0.3	-0.1	81	131	84	76
370	54.870	0.149	0.070	2.17	104	-0.32	99	0.2	-0.1	81	130	84	75
380	56.367	0.150	0.070	2.16	104	-0.05	99	0.1	-0.1	81	129	85	76
390	57.859	0.149	0.070	2.17	104	-0.4	99	0.1	0	81	129	84	76
400	59.351	0.149	0.070	2.17	104	0	99	0.0	-0.1	81	129	84	76
Avg/Tot	59.351	0.148	0.070	2.13	98	-0.91	100			87	212	84	74.6

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 5

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/17/2018

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
0	0.000		0.00	70	-1		84	0.000	2.08	0.41
10	1.407	0.141	2.15	72	-2.73	103	85	-0.070	10.43	0.43
20	2.819	0.141	2.14	75	-2.75	104	84	-0.070	12.80	0.72
30	4.234	0.142	2.13	79	-1.39	102	85	-0.070	10.07	0.40
40	5.657	0.142	2.14	82	-0.96	102	84	-0.060	12.69	0.38
50	7.085	0.143	2.13	85	-1.47	102	84	-0.060	11.54	0.29
60	8.513	0.143	2.11	88	-2.78	101	85	-0.040	10.51	0.22
70	9.951	0.144	2.13	90	-2.74	101	84	-0.050	11.61	0.29
80	11.390	0.144	2.12	92	-0.97	101	86	-0.040	11.52	0.35
90	12.829	0.144	2.13	93	-1.66	101	83	-0.040	10.75	0.41
100	14.273	0.144	2.10	95	-2.58	100	86	-0.040	9.49	0.62
110	15.719	0.145	2.12	96	-2.66	100	83	-0.020	9.12	0.45
120	17.167	0.145	2.10	97	-2.75	100	85	-0.020	8.08	0.80
130	18.615	0.145	2.11	97	-2.44	100	83	-0.020	7.05	1.14
140	20.063	0.145	2.13	98	-0.63	99	86	-0.020	6.98	1.04
150	21.514	0.145	2.09	98	-2.73	100	83	-0.020	6.92	1.17
160	22.966	0.145	2.12	99	-0.99	99	86	-0.010	7.07	1.25
170	24.419	0.145	2.12	99	-0.78	99	83	-0.010	6.76	1.14
180	25.872	0.145	2.11	99	-0.56	99	86	-0.010	6.62	1.28
190	27.324	0.145	2.12	100	-0.66	99	83	-0.020	6.64	1.38
200	28.776	0.145	2.11	100	-2.25	99	86	-0.020	6.45	1.49
210	30.228	0.145	2.11	100	-2.75	99	83	-0.020	6.52	1.51
220	31.680	0.145	2.11	100	-0.66	99	86	-0.020	6.45	1.57
230	33.136	0.146	2.11	100	-2.55	99	83	0.010	6.41	1.61
240	34.589	0.145	2.11	100	-0.71	99	86	-0.010	6.12	1.77
250	36.043	0.145	2.10	101	-2.87	99	83	-0.020	6.08	1.57
260	37.497	0.145	2.10	101	-2.17	99	85	-0.010	6.52	1.58
270	38.951	0.145	2.11	101	-0.6	99	84	-0.010	6.22	1.79
280	40.403	0.145	2.11	101	-0.86	99	85	-0.010	5.95	1.80
290	41.858	0.146	2.11	101	-0.65	99	84	0.010	5.89	1.82
300	43.312	0.145	2.11	101	-2.67	99	85	0.000	5.60	1.94
310	44.769	0.146	2.10	101	-1.66	99	84	-0.010	6.16	1.48

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 5

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/17/2018

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
320	46.224	0.146	2.11	101	-1.68	99	85	-0.010	6.15	1.80
330	47.681	0.146	2.11	101	-2.84	99	84	-0.010	5.27	1.77
340	49.135	0.145	2.09	102	-2.05	99	85	-0.020	5.03	1.84
350	50.590	0.146	2.10	102	-1.09	99	84	0.000	4.94	1.82
360	52.043	0.145	2.10	102	-1.98	99	85	-0.010	5.18	1.79
370	53.498	0.146	2.11	102	-1.71	99	84	0.010	5.42	1.53
380	54.953	0.146	2.10	102	-2.75	99	85	0.000	5.82	1.15
390	56.408	0.146	2.10	102	-0.72	99	84	0.000	5.62	1.33
400	57.864	0.146	2.10	102	-2.63	99	85	0.000	5.86	1.26
Avg/Tot	57.864	0.145	2.06	96	-1.78	100	84	-0.020	7.38	1.18

WOODSTOVE SURFACE TEMPERATURE DATA

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 5

Technician: SJB

Date: 9/17/2018

Stove ΔT : 98

Temperature Data (°F)							
Elapsed Time (min)	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
0	406	460	261	278	221	325.2	N/A
10	385	421	326	398	202	346.4	N/A
20	388	434	330	607	203	392.4	N/A
30	408	455	262	673	209	401.4	N/A
40	418	454	218	548	206	368.8	N/A
50	426	465	209	624	198	384.4	N/A
60	424	475	212	511	192	362.8	N/A
70	427	479	216	591	186	379.8	N/A
80	431	486	223	566	181	377.4	N/A
90	439	493	230	572	177	382.2	N/A
100	449	491	241	506	175	372.4	N/A
110	449	486	254	457	175	364.2	N/A
120	447	477	266	302	175	333.4	N/A
130	445	467	272	260	176	324.0	N/A
140	435	457	271	242	177	316.4	N/A
150	424	449	270	226	180	309.8	N/A
160	414	440	267	217	182	304.0	N/A
170	405	431	265	212	184	299.4	N/A
180	394	421	260	207	186	293.6	N/A
190	385	413	254	201	188	288.2	N/A
200	378	405	248	196	190	283.4	N/A
210	371	399	245	191	192	279.6	N/A
220	365	393	242	189	194	276.6	N/A
230	359	386	237	185	195	272.4	N/A
240	355	379	233	183	197	269.4	N/A
250	350	372	230	179	199	266.0	N/A
260	347	364	224	178	200	262.6	N/A
270	346	355	219	177	201	259.6	N/A
280	347	347	213	176	202	257.0	N/A
290	344	342	208	172	203	253.8	N/A
300	342	336	202	173	203	251.2	N/A
310	343	330	198	172	203	249.2	N/A
320	343	325	193	175	205	248.2	N/A
330	344	320	189	173	205	246.2	N/A
340	342	313	185	167	204	242.2	N/A
350	338	306	182	162	202	238.0	N/A
360	334	300	180	158	200	234.4	N/A
370	331	296	180	155	197	231.8	N/A
380	329	295	180	154	193	230.2	N/A
390	325	294	180	153	191	228.6	N/A
400	322	292	179	153	189	227.0	N/A
Average	382	398	231	288	194	298	N/A

LAB SAMPLE DATA - ASTM E2515

Client: IHP

Model: GV230GL

Run #: 5

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/17/2018

TRAIN A (1st Hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3303	126.6	122.7	3.9
B. Rear filter catch	Filter				0.0
C. Probe catch*	Probe				0.0
D. O-Ring catch*	O-Ring				0.0

Sub-Total

Total Particulate, mg:

3.9

TRAIN A (Post 1st hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3304	119.1	118.0	1.1
B. Rear filter catch	Filter	3305	121.3	121.6	-0.3
C. Probe catch*	Probe	8A	116829.5	116829.4	0.1
D. O-Ring catch*	O-Ring	8A	3552.3	3551.5	0.8

Sub-Total

Total Particulate, mg:

1.7

Train A Aggregate

Total Particulate, mg:

5.6

TRAIN B

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3306	122.7	118.3	4.4
B. Rear filter catch	Filter	3307	122.8	122.4	0.4
C. Probe catch*	Probe	8B	116825.5	116825.3	0.2
D. O-Ring catch*	O-Ring	8B	3586.0	3585.2	0.8

Total Particulate, mg:

5.8

AMBIENT

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Filter catch*	Filter	3308	121.5	121.5	0.0

Total Particulate, mg:

0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and O-rings, negative numbers for filters are assumed to be part of the O-Ring weight.

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 5 Test Date: 9/17/2018

Wood Heater Run Notes

Test Control Settings

Primary Air Setting(s): Fully Closed

Preburn Notes

Preburn Start Time: 9:45

Time	Notes
8:42	Loaded 10.5 lbs of kindling
9:20	Loaded Pre-burn Fuel
9:45	Turned fan to low setting, air control set at test setting.
10:48	Leveled coal bed, turned off convection fan in preparation of fuel loading.

Test Notes

Test Burn Start Time: 10:50
 Test Fuel Loaded by: 50 seconds
 Door Closed: 4.25 minutes
 Air Control Set at: 5 minutes
 Other Loading Notes: N/A

Time	Notes
25 min	Turned convection fan on low, per manufacturer's instructions.
60 min	Changed 1-hour filter.
400 min	End of Test

Test Burn End Time: 17:30
 Background Filter Volume (ft³): 66.875

Filter Data

Train	A	A	A	A	A	B	B	B	B	AMB
Element	Front Filter (First Hour)	Front Filter (Remainder)	Rear Filter	Probe	O-Ring Pair	Front Filter	Rear Filter	Probe	O-Ring Pair	Filter
ID #	3303	3304	3305	8A	8A	3306	3307	8B	8B	3308
Tare (mg)	122.7	118.0	121.6	116829.4	3551.5	118.3	122.4	116825.3	3585.2	121.5
Final Weight (mg)	126.6	119.1	121.3	116829.5	3552.3	122.7	122.8	116825.5	3586.0	121.5

Sample Train Leak Check: A: 0.001 @ -13 "Hg B: 0.000 @ -12 "Hg AMB: 0.000 @ -14 "Hg

Technician Signature: [Signature] Date: 9/24/2018

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 5 Test Date: 9/17/2018

Flue Gas Concentration Measurement

Calibration Gas Values: Span Gas CO₂ (%): 16.93 CO (%): 4.33
 Mid Gas CO₂ (%): - CO (%): -

Calibration Results:

	Pre Test			Post Test		
	Zero	Mid	Span	Zero	Mid	Span
Time	9:00	-	9:03	17:45	-	17:48
CO ₂	0.00	-	16.93	0.04	-	17.00
CO	0.000	-	4.330	-0.018	-	4.314

Flue Gas Probe Leak Check: Initial: No Leakage Final: No Leakage

Dilution Tunnel Flow

Pitot Tube Leak Test: Initial: No Leakage Final: No Leakage

Velocity Traverse Data

	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (inH ₂ O):	0.028	0.054	0.060	0.036	0.030	0.058	0.066	0.046	0.070
Temp (°F):	85	85	85	85	85	85	85	85	85

Dilution Tunnel Static Pressure (inH₂O): -0.19

Supplemental Data

Room Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10 Final: 10

Stack Diameter (in): 6

Induced Draft (in H₂O): 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in

Series: Date: 9/10/2018

	Initial	Middle	Ending
P _b (inHg)	30.09	30.03	30.00
RH (%)	44.5	36.2	31.9

Technician Signature:  Date: 9/24/2018

WOOD STOVE TEST DATA PACKET
ASTM E2780/E2515



Run 6 Data Summary

Client: IHP
Model: GV230GL
Job #: 18-428
Tracking #: 0008
Test Date: 9/25/2018

A handwritten signature in dark ink, appearing to be "JL", is written over a horizontal line.

Techician Signature

9/27/2018

Date

TEST RESULTS - ASTM E2780 / ASTM E2515

Client: IHP

Model: GV230GL

Run #: 6

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/25/2018

Burn Rate (kg/hr):	1.23
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	Ambient Sample	Sample Train A	Sample Train B	1st Hour Filter
Total Sample Volume (ft ³)	53.425	47.252	46.078	8.695
Average Gas Velocity in Dilution Tunnel (ft/sec)	17.1			
Average Gas Flow Rate in Dilution Tunnel (dscf/hr)	11307.5			
Average Gas Meter Temperature (°F)	74.7	95.9	94.2	79.7
Total Sample Volume (dscf)	53.037	45.483	44.266	10.246
Average Tunnel Temperature (°F)	95.6			
Total Time of Test (min)	320			
Total Particulate Catch (mg)	0.0	9.7	8.4	7.3
Particulate Concentration, dry-standard (g/dscf)	0.0000000	0.0002133	0.0001898	0.0007125
Total PM Emissions (g)	0.00	12.86	11.44	8.06
Particulate Emission Rate (g/hr)	0.00	2.41	2.15	8.06
Emissions Factor (g/kg)	-	1.97	1.75	-
Difference from Average Total Particulate Emissions (g)	-	0.71	0.71	-
Difference from Average Emissions Factor (g/kg)	-	0.11	0.11	-

Final Average Results	
Total Particulate Emissions (g)	12.15
Particulate Emission Rate (g/hr)	2.28
Emissions Factor (g/kg)	1.86
HHV Efficiency (%)	72.5%
LHV Efficiency (%)	78.3%
CO Emissions (g/min)	2.03

Quality Checks	Requirement	Observed	Result
Dual Train Precision	Each train within 7.5% of average emissions (in grams), or emission factors within 0.5 g/kg	See Above	OK
Filter Temps	<90 °F	86.0	OK
Face Velocity	< 30 ft/min	8.0	OK
Leakage Rate	Less than 4% of average sample rate	0.002 cfm	OK
Ambient Temp	55-90 °F	Min: 71 / Max: 77	OK
Negative Probe Weight Evaluation	<5% of Total Catch	Probe Catch Not Negative	OK
Pro-Rate Variation	90% of readings between 90-110%; none greater than 120% or less than 80%	See Data Tabs	OK
Stove Surface ΔT	<126°F	99.2	OK

B415.1 Efficiency Results

Manufacturer: IHP
Model: GV230GL
Date: 09/25/18
Run: 6
Control #: 18-428
Test Duration: 320
Output Category: 2

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	72.5%	78.3%
Combustion Efficiency	92.8%	92.8%
Heat Transfer Efficiency	78.1%	84.4%

Output Rate (kJ/h)	17,403	16,509	(Btu/h)
Burn Rate (kg/h)	1.21	2.67	(lb/h)
Input (kJ/h)	24,011	22,777	(Btu/h)

Test Load Weight (dry kg)	6.46	14.25	dry lb
MC wet (%)	16.19		
MC dry (%)	19.32		
Particulate (g)	12.15		
CO (g)	648		
Test Duration (h)	5.33		

Emissions	Particulate	CO
g/MJ Output	0.13	6.98
g/kg Dry Fuel	1.88	100.28
g/h	2.28	121.54
g/min	0.04	2.03
lb/MM Btu Output	0.30	16.23

Air/Fuel Ratio (A/F)	13.89
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VERSION:

2.2

12/14/2009

WOODSTOVE FUEL DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 6

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/25/2018

Preburn Fuel Information						
Size	Length (in)	Moisture Content (% DB)		Size	Length (in)	Moisture Content (% DB)
2x4	16.00	19.4		2x4	16.00	19.7
2x4	16.00	18.9		2x4	16.00	19.0
2x4	16.00	20.1				
2x4	16.00	19.3				
2x4	16.00	19.7				
2x4	16.00	18.8				
2x4	16.00	18.4				
2x4	16.00	19.3				
Total Fuel Weight (lbs):		15.56	Average Moisture (%DB):		19.3	

Firebox Volume (ft³): 2.30
 Total 2x4 Crib Weight, with spacers (lbs): 8.18
 Total 4x4 Crib Weight, with spacers (lbs): 8.82
 Total Wet Fuel Weight, with spacers (lbs): 17.00

Coal Bed Range (20-25%):

Min (lbs): 3.40
 Max (lbs): 4.25

Test Fuel Information						
Size	Length (in)	Weight (lbs)	Moisture Content (%DB)			Dry Weight (lbs)
2x4	15.00	1.74	18.9	19.5	20.3	1.46
2x4	15.00	1.74	19.4	18.8	19.3	1.46
2x4	15.00	1.74	19.3	18.8	19.9	1.46
2x4	15.00	1.70	19.4	19.2	19.9	1.42
4x4	15.00	4.08	19.3	18.9	19.0	3.43
4x4	15.00	3.92	19.9	18.8	19.2	3.29
Total Dry Weight, no spacers (lbs):						12.51
Total Dry Weight, with spacers (lbs):						14.41

Spacer Moisture Readings (%DB)							
8.8	7.6	11.1	9.0	7.7			
9.4	10.3	10.5	8.0	8.1			
10.1	9.9	10.4	9.4	9.3			
8.4	9.4	11.0	9.3	8.2			

Quality Checks	Requirement	Observed	Result
Fuel Density	25 - 36 (lbs/ft ³ , DB)	31.7	OK
Loading Density	6.3 - 7.7 (lbs/ft ³ , WB)	7.39	OK
2x4 Fuel Mix	35 - 65 % of total weight	48%	OK

WOODSTOVE PREBURN DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 6

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/25/2018

Preburn Start Time: 9:09
 Recording Interval (min): 10
 Run Time (min): 60

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
0	8.5	-0.084	434	613	444	917	173	516.2	731	64
10	6.7	-0.068	477	637	484	819	215	526.4	473	65
20	5.6	-0.056	501	607	488	724	230	510.0	406	66
30	4.9	-0.060	515	578	486	681	229	497.8	367	68
40	4.5	-0.050	509	544	485	569	229	467.2	312	68
50	4.2	-0.048	504	521	482	522	227	451.2	284	67
60	4.0	-0.045	502	505	477	497	232	442.6	265	66

DILUTION TUNNEL & MISC. DATA - ASTM E2780 / E2515

Client: IHP
 Model: GV230GL
 Run #: 6
 Test Start Time: 10:10

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/25/2018

Total Sampling Time (min): 320
 Recording Interval (min): 10

	Beginning	Middle	End	Avg.
P _{bar} (in Hg):	30.15	30.12	30.09	30.12

Meter Box γ Factor: 1.002 (A)
 Meter Box γ Factor: 0.997 (B)
 Meter Box γ Factor: 0.999 (Amb)

Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Tunnel Area: 0.1963 ft²
 Dilution Tunnel H₂O: 2.00 percent
 Tunnel Diameter: 6 inches
 Pitot Tube Cp: 0.99
 Dilution Tunnel Static: -0.205 in H₂O

Post-Test Leak Check

(A) 0.002 cfm @ -15 in. Hg
 (B) 0.000 cfm @ -12 in. Hg
 (AMB) 0.002 cfm @ -14 in. Hg

Ambient Sample Volume: 53.425 ft³

	Tunnel Traverse Information								
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (in H ₂ O)	0.060	0.068	0.064	0.062	0.064	0.070	0.062	0.052	0.07
Tunnel Temp (°F)	93	93	93	93	93	93	93	93	93

V_{strav}: 17.02 ft/sec

F_p: 0.952 [ratio]

V_{scent}: 17.88 ft/sec

Initial Tunnel Flow: 187.7 scf/min

Test Fuel Properties

Default Fuel Values

Fuel Type:	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Actual Fuel Used Properties

Fuel Type:	D. Fir
HHV (kJ/kg)	19,810
%C	48.73
%H	6.87
%O	43.9
%Ash	0.5
MC (%DB)	19.3

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 6

Technician: SJB

Date: 9/25/2018

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
0	0.000		0.070	0.01	70	-0.12		17.0		114	333	84	71
10	1.436	0.144	0.070	2.21	72	-2.37	103	15.5	-1.5	110	463	84	72
20	2.878	0.144	0.070	2.17	76	-2.42	102	13.6	-1.9	107	446	85	72
30	4.324	0.145	0.070	2.17	80	-1.41	102	12.0	-1.6	106	436	83	72
40	5.778	0.145	0.070	2.17	83	-0.09	102	10.2	-1.8	109	465	85	73
50	7.234	0.146	0.070	2.17	87	-1.2	101	8.9	-1.3	107	434	85	74
60	8.695	0.146	0.070	2.17	90	-2.56	101	7.5	-1.4	107	429	83	73
70	10.171	0.148	0.070	2.19	92	-1.3	101	6.6	-0.9	102	384	84	72
80	11.644	0.147	0.070	2.19	93	-0.16	101	5.7	-0.9	101	357	85	74
90	13.117	0.147	0.070	2.19	95	-2.58	100	5.0	-0.7	99	329	84	74
100	14.591	0.147	0.070	2.20	96	0	100	4.5	-0.5	98	317	84	74
110	16.070	0.148	0.070	2.18	97	-0.54	100	4.0	-0.5	97	314	86	75
120	17.549	0.148	0.070	2.18	98	-2.51	100	3.7	-0.3	95	286	84	75
130	19.032	0.148	0.070	2.19	99	0	100	3.5	-0.2	94	270	84	75
140	20.512	0.148	0.070	2.20	100	-2.29	99	3.1	-0.4	92	260	86	75
150	21.993	0.148	0.070	2.18	100	-2.54	99	3.0	-0.1	92	252	85	75
160	23.475	0.148	0.070	2.20	101	-1.9	99	2.8	-0.2	92	247	84	76
170	24.957	0.148	0.070	2.18	101	-2.15	99	2.6	-0.2	91	243	86	76
180	26.442	0.149	0.070	2.19	102	0	99	2.4	-0.2	91	240	84	76
190	27.928	0.149	0.070	2.19	102	-1.63	99	2.2	-0.2	89	238	84	75
200	29.415	0.149	0.070	2.19	102	-1.62	99	2.0	-0.2	89	236	85	75
210	30.900	0.149	0.070	2.18	102	-2.53	99	1.8	-0.2	89	234	83	75
220	32.385	0.149	0.070	2.17	102	-1.94	99	1.6	-0.2	89	231	85	75
230	33.873	0.149	0.070	2.17	102	0	99	1.3	-0.3	88	228	84	75
240	35.362	0.149	0.070	2.20	102	-0.02	99	1.3	0	89	226	83	75
250	36.848	0.149	0.070	2.19	102	-2.51	99	1.1	-0.2	89	221	86	76
260	38.333	0.149	0.070	2.18	102	0	99	0.9	-0.2	89	218	84	76
270	39.819	0.149	0.070	2.18	102	-0.55	99	0.7	-0.2	89	217	84	76
280	41.306	0.149	0.070	2.18	102	0	99	0.6	-0.1	89	215	85	76
290	42.792	0.149	0.070	2.18	103	-2.56	99	0.4	-0.2	90	212	84	76
300	44.278	0.149	0.070	2.18	103	0	99	0.3	-0.1	90	208	85	76
310	45.764	0.149	0.070	2.17	104	-0.83	99	0.1	-0.2	90	205	85	77

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 6

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/25/2018

	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
Elapsed Time (min)	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
320	47.252	0.149	0.070	2.17	104	-2.3	99	0.0	-0.1	91	202	84	77
Avg/Tot	47.252	0.148	0.070	2.12	96	-1.29	100			96	291	84	74.7

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 6

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/25/2018

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
0	0.000		0.00	69	-1		85	0.000	2.33	0.38
10	1.398	0.140	2.15	71	-1.64	103	83	-0.080	12.32	0.89
20	2.805	0.141	2.14	74	-0.68	102	85	-0.060	10.25	0.85
30	4.220	0.142	2.13	78	-2.74	102	84	-0.080	13.26	0.66
40	5.638	0.142	2.10	82	-2.01	102	84	-0.090	15.63	1.41
50	7.060	0.142	2.11	85	-2.23	101	85	-0.070	13.07	0.22
60	8.485	0.143	2.11	88	-0.73	101	84	-0.070	13.47	0.46
70	9.919	0.143	2.12	90	-2.62	101	85	-0.060	10.65	0.63
80	11.354	0.144	2.10	92	-2.12	101	84	-0.060	9.73	0.67
90	12.790	0.144	2.10	93	-1.3	100	84	-0.060	8.13	0.94
100	14.230	0.144	2.11	94	-0.66	100	86	-0.050	8.53	0.69
110	15.673	0.144	2.10	95	-1.43	100	84	-0.060	8.44	0.47
120	17.114	0.144	2.10	96	-0.88	100	85	-0.060	7.05	0.89
130	18.558	0.144	2.09	97	-2.74	100	85	-0.040	6.87	1.10
140	20.004	0.145	2.10	98	-2	99	83	-0.050	6.82	1.15
150	21.452	0.145	2.11	99	-2.78	99	86	-0.040	6.63	1.12
160	22.898	0.145	2.11	99	-0.82	99	84	-0.040	6.82	1.11
170	24.343	0.145	2.10	100	-2.09	99	84	-0.040	6.78	1.18
180	25.792	0.145	2.10	100	-2.33	99	85	-0.040	6.96	1.14
190	27.242	0.145	2.11	100	-0.8	99	84	-0.050	6.68	1.22
200	28.692	0.145	2.11	100	-0.72	99	85	-0.040	6.66	1.20
210	30.143	0.145	2.11	100	-0.82	99	85	-0.040	6.54	1.31
220	31.591	0.145	2.11	100	-2.01	99	84	-0.040	6.19	1.57
230	33.038	0.145	2.11	100	-1.53	99	85	-0.060	6.09	1.51
240	34.487	0.145	2.11	100	-1.21	99	84	-0.040	5.82	1.59
250	35.937	0.145	2.10	100	-2.68	99	86	-0.030	5.62	1.57
260	37.387	0.145	2.09	100	-2.61	99	84	-0.040	5.59	1.53
270	38.833	0.145	2.10	100	-0.76	99	86	-0.040	5.58	1.58
280	40.279	0.145	2.09	101	-0.82	99	84	-0.050	5.37	1.67
290	41.729	0.145	2.10	101	-2.77	99	85	-0.030	4.68	1.79
300	43.178	0.145	2.09	101	-1.89	99	85	-0.030	4.29	1.92
310	44.628	0.145	2.10	102	-1.27	99	84	-0.040	4.35	1.72

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 6

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/25/2018

	Particulate Sampling Data							Flue Gas Data		
Elapsed Time (min)	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
320	46.078	0.145	2.09	102	-2.2	99	85	-0.030	3.89	2.04
Avg/Tot	46.078	0.144	2.04	94	-1.66	100	85	-0.049	7.61	1.16

WOODSTOVE SURFACE TEMPERATURE DATA

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 6

Technician: SJB

Date: 9/25/2018

Stove ΔT : 99

Elapsed Time (min)	Temperature Data (°F)						
	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
0	500	502	477	454	234	433.4	N/A
10	463	460	458	504	224	421.8	N/A
20	456	471	419	544	224	422.8	N/A
30	447	470	402	538	221	415.6	N/A
40	461	477	394	817	214	472.6	N/A
50	481	495	392	805	206	475.8	N/A
60	494	507	399	779	201	476.0	N/A
70	504	521	411	713	196	469.0	N/A
80	509	528	429	584	191	448.2	N/A
90	504	521	454	530	188	439.4	N/A
100	492	509	482	502	185	434.0	N/A
110	485	505	486	490	184	430.0	N/A
120	477	494	482	503	185	428.2	N/A
130	463	483	476	507	184	422.6	N/A
140	453	475	469	477	184	411.6	N/A
150	446	472	464	460	183	405.0	N/A
160	439	465	458	474	185	404.2	N/A
170	433	461	453	466	184	399.4	N/A
180	428	461	448	455	184	395.2	N/A
190	424	464	443	441	189	392.2	N/A
200	420	464	437	436	189	389.2	N/A
210	417	464	433	427	190	386.2	N/A
220	412	461	428	414	192	381.4	N/A
230	409	458	423	408	193	378.2	N/A
240	405	451	418	405	194	374.6	N/A
250	402	443	413	396	196	370.0	N/A
260	402	434	405	390	197	365.6	N/A
270	400	427	399	389	194	361.8	N/A
280	399	422	394	385	197	359.4	N/A
290	399	416	390	378	193	355.2	N/A
300	388	406	384	368	194	348.0	N/A
310	381	394	374	360	195	340.8	N/A
320	373	384	366	353	195	334.2	N/A
Average	441	466	429	489	196	404	N/A

LAB SAMPLE DATA - ASTM E2515

Client: IHP

Model: GV230GL

Run #: 6

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/25/2018

TRAIN A (1st Hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3309	128.7	121.4	7.3
B. Rear filter catch	Filter				0.0
C. Probe catch*	Probe				0.0
D. O-Ring catch*	O-Ring				0.0

Sub-Total

Total Particulate, mg:

7.3

TRAIN A (Post 1st hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3310	119.4	118.2	1.2
B. Rear filter catch	Filter	3311	123.3	123.2	0.1
C. Probe catch*	Probe	9A	116720.9	116720.4	0.5
D. O-Ring catch*	O-Ring	9A	3582.0	3581.4	0.6

Sub-Total

Total Particulate, mg:

2.4

Train A Aggregate

Total Particulate, mg:

9.7

TRAIN B

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3312	130.2	123.2	7.0
B. Rear filter catch	Filter	3313	123.7	123.0	0.7
C. Probe catch*	Probe	9B	117135.5	117135.2	0.3
D. O-Ring catch*	O-Ring	9B	3524.8	3524.4	0.4

Total Particulate, mg:

8.4

AMBIENT

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Filter catch*	Filter	3314	118.4	118.4	0.0

Total Particulate, mg:

0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and O-rings, negative numbers for filters are assumed to be part of the O-Ring weight.

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 6 Test Date: 9/25/2018

Wood Heater Run Notes

Test Control Settings

Primary Air Setting(s): Fully Closed – Fan Confirmation Test

Preburn Notes

Preburn Start Time: 9:09

Time	Notes
8:03	Loaded 10.1 lbs of kindling
8:40	Loaded Pre-burn Fuel
9:09	Air control set at test setting, fan off (fan confirmation test).
10:09	Leveled coal bed in preparation of fuel loading.

Test Notes

Test Burn Start Time: 10:10
 Test Fuel Loaded by: 50 seconds
 Door Closed: 4.25 minutes
 Air Control Set at: 5 minutes
 Other Loading Notes: N/A

Time	Notes
60 min	Changed 1-hour filter.
320 min	End of Test

Test Burn End Time: 15:30
 Background Filter Volume (ft³): 53.425

Filter Data

Train	A	A	A	A	A	B	B	B	B	AMB
Element	Front Filter (First Hour)	Front Filter (Remainder)	Rear Filter	Probe	O-Ring Pair	Front Filter	Rear Filter	Probe	O-Ring Pair	Filter
ID #	3309	3310	3311	9A	9A	3312	3313	9B	9B	3314
Tare (mg)	121.4	118.2	123.2	116720.4	3581.4	123.2	123.0	117135.2	3524.4	118.4
Final Weight (mg)	128.7	119.4	123.3	116720.9	3582.0	130.2	123.7	117135.5	3524.8	118.4

Sample Train Leak Check: A: 0.002 @ -15 "Hg B: 0.000 @ -12 "Hg AMB: 0.002 @ -14 "Hg

Technician Signature:  Date: 9/27/2018

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 6 Test Date: 9/25/2018

Flue Gas Concentration Measurement

Calibration Gas Values: Span Gas CO₂ (%): 16.93 CO (%): 4.33
 Mid Gas CO₂ (%): - CO (%): -

Calibration Results:

	Pre Test			Post Test		
	Zero	Mid	Span	Zero	Mid	Span
Time	9:40	-	9:43	16:00	-	16:04
CO ₂	0.00	-	16.93	0.06	-	16.99
CO	0.000	-	4.330	-0.012	-	4.309

Flue Gas Probe Leak Check: Initial: No Leakage Final: No Leakage

Dilution Tunnel Flow

Pitot Tube Leak Test: Initial: No Leakage Final: No Leakage

Velocity Traverse Data

	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (inH ₂ O):	0.060	0.068	0.064	0.062	0.064	0.070	0.062	0.052	0.070
Temp (°F):	93	93	93	93	93	93	93	93	93

Dilution Tunnel Static Pressure (inH₂O): -0.205

Supplemental Data

Room Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10 Final: 10

Stack Diameter (in): 6

Induced Draft (in H₂O): 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in

Series: Date: 9/10/2018

	Initial	Middle	Ending
P _b (inHg)	30.15	30.12	30.09
RH (%)	37.2	30.4	26.3

Technician Signature:  Date: 9/27/2018

WOOD STOVE TEST DATA PACKET
ASTM E2780/E2515



Run 4 Data Summary

Client: IHP
Model: GV230GL
Job #: 18-428
Tracking #: 0008
Test Date: 9/14/2018

A handwritten signature in dark ink, appearing to be "JL", is written over a horizontal line.

Techician Signature

9/18/2018

Date

TEST RESULTS - ASTM E2780 / ASTM E2515

Client: IHP

Model: GV230GL

Run #: 4

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/14/2018

Burn Rate (kg/hr):	1.23
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	Ambient Sample	Sample Train A	Sample Train B	1st Hour Filter
Total Sample Volume (ft ³)	48.455	42.758	41.736	8.654
Average Gas Velocity in Dilution Tunnel (ft/sec)	14.9			
Average Gas Flow Rate in Dilution Tunnel (dscf/hr)	9868.9			
Average Gas Meter Temperature (°F)	75.1	95.1	93.8	78.3
Total Sample Volume (dscf)	47.790	40.986	39.894	10.146
Average Tunnel Temperature (°F)	91.8			
Total Time of Test (min)	290			
Total Particulate Catch (mg)	0.1	11.9	11.8	8.8
Particulate Concentration, dry-standard (g/dscf)	0.0000021	0.0002903	0.0002958	0.0008673
Total PM Emissions (g)	0.10	13.75	14.01	8.54
Particulate Emission Rate (g/hr)	0.02	2.84	2.90	8.54
Emissions Factor (g/kg)	-	2.32	2.36	-
Difference from Average Total Particulate Emissions (g)	-	0.13	0.13	-
Difference from Average Emissions Factor (g/kg)	-	0.02	0.02	-

Final Average Results	
Total Particulate Emissions (g)	13.88
Particulate Emission Rate (g/hr)	2.87
Emissions Factor (g/kg)	2.34
HHV Efficiency (%)	73.0%
LHV Efficiency (%)	78.9%
CO Emissions (g/min)	2.11

Quality Checks	Requirement	Observed	Result
Dual Train Precision	Each train within 7.5% of average emissions (in grams), or emission factors within 0.5 g/kg	See Above	OK
Filter Temps	<90 °F	86.0	OK
Face Velocity	< 30 ft/min	8.0	OK
Leakage Rate	Less than 4% of average sample rate	0.001 cfm	OK
Ambient Temp	55-90 °F	Min: 71 / Max: 77	OK
Negative Probe Weight Evaluation	<5% of Total Catch	Probe Catch Not Negative	OK
Pro-Rate Variation	90% of readings between 90-110%; none greater than 120% or less than 80%	See Data Tabs	OK
Stove Surface ΔT	<126°F	83.8	OK

B415.1 Efficiency Results

Manufacturer: IHP
Model: GV230GL
Date: 09/14/18
Run: 4
Control #: 18-428
Test Duration: 290
Output Category: 2

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	73.0%	78.9%
Combustion Efficiency	92.5%	92.5%
Heat Transfer Efficiency	78.9%	85.3%

Output Rate (kJ/h)	17,526	16,625	(Btu/h)
Burn Rate (kg/h)	1.21	2.67	(lb/h)
Input (kJ/h)	24,009	22,775	(Btu/h)

Test Load Weight (dry kg)	5.86	12.91	dry lb
MC wet (%)	16.71		
MC dry (%)	20.06		
Particulate (g)	13.88		
CO (g)	612		
Test Duration (h)	4.83		

Emissions	Particulate	CO
g/MJ Output	0.16	7.23
g/kg Dry Fuel	2.37	104.52
g/h	2.87	126.67
g/min	0.05	2.11
lb/MM Btu Output	0.38	16.80

Air/Fuel Ratio (A/F)	14.08
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VERSION:

2.2

12/14/2009

WOODSTOVE FUEL DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 4

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/14/2018

Preburn Fuel Information						
Size	Length (in)	Moisture Content (% DB)		Size	Length (in)	Moisture Content (% DB)
2x4	16.00	19.4		2x4	16.00	18.6
2x4	16.00	20.1		2x4	16.00	20.0
2x4	16.00	18.4				
2x4	16.00	19.8				
2x4	16.00	22.6				
2x4	16.00	19.9				
2x4	16.00	21.1				
2x4	16.00	23.4				
Total Fuel Weight (lbs):		15.5	Average Moisture (%DB):		20.3	

Firebox Volume (ft³): 2.30
 Total 2x4 Crib Weight, with spacers (lbs): 7.41
 Total 4x4 Crib Weight, with spacers (lbs): 8.13
 Total Wet Fuel Weight, with spacers (lbs): 15.54

Coal Bed Range (20-25%):

Min (lbs): 3.11
 Max (lbs): 3.89

Test Fuel Information						
Size	Length (in)	Weight (lbs)	Moisture Content (%DB)			Dry Weight (lbs)
2x4	15.00	1.85	21.9	20.6	18.7	1.54
2x4	15.00	1.79	21.9	22.0	21.0	1.47
2x4	15.00	1.34	19.1	18.9	19.7	1.12
2x4	15.00	1.37	19.8	19.0	19.3	1.15
4x4	15.00	4.28	18.9	20.2	21.1	3.56
4x4	15.00	3.06	19.5	20.6	18.8	2.56
Total Dry Weight, no spacers (lbs):						11.40
Total Dry Weight, with spacers (lbs):						13.09

Spacer Moisture Readings (%DB)							
10.3	10.1	9.6	9.8	10.0			
8.4	10.9	9.5	9.8	8.0			
10.1	9.6	9.2	10.0	9.5			
10.2	8.2	10.4	10.1	10.7			

Quality Checks	Requirement	Observed	Result
Fuel Density	25 - 36 (lbs/ft ³ , DB)	28.9	OK
Loading Density	6.3 - 7.7 (lbs/ft ³ , WB)	6.76	OK
2x4 Fuel Mix	35 - 65 % of total weight	48%	OK

WOODSTOVE PREBURN DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 4

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/14/2018

Preburn Start Time: 9:28
 Recording Interval (min): 10
 Run Time (min): 80

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
0	8.1	-0.077	458	592	440	1120	195	561.0	693	60
10	6.1	-0.085	496	627	330	896	242	518.2	480	61
20	5.1	-0.049	505	611	294	726	253	477.8	377	62
30	4.7	-0.040	496	571	290	532	245	426.8	299	60
40	4.4	-0.028	471	535	287	434	233	392.0	257	59
50	4.2	-0.030	455	513	276	376	247	373.4	233	58
60	3.9	-0.030	443	496	266	344	254	360.6	220	58
70	3.7	-0.024	430	480	257	325	256	349.6	210	58
80	3.5	-0.016	418	469	249	305	259	340.0	204	59

DILUTION TUNNEL & MISC. DATA - ASTM E2780 / E2515

Client: IHP
 Model: GV230GL
 Run #: 4
 Test Start Time: 10:50

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/14/2018

Total Sampling Time (min): 290
 Recording Interval (min): 10

	Beginning	Middle	End	Avg.
P _{bar} (in Hg):	30	29.94	29.91	29.95

Meter Box γ Factor: 1.002 (A)
 Meter Box γ Factor: 0.997 (B)
 Meter Box γ Factor: 0.999 (Amb)

Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Tunnel Area: 0.1963 ft²
 Dilution Tunnel H₂O: 2.00 percent
 Tunnel Diameter: 6 inches
 Pitot Tube Cp: 0.99
 Dilution Tunnel Static: -0.165 in H₂O

Post-Test Leak Check

(A) 0.001 cfm @ -14 in. Hg
 (B) 0.000 cfm @ -12 in. Hg
 (AMB) 0.000 cfm @ -13 in. Hg

Ambient Sample Volume: 48.455 ft³

	Tunnel Traverse Information								
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (in H ₂ O)	0.032	0.052	0.056	0.032	0.036	0.054	0.062	0.048	0.07
Tunnel Temp (°F)	91	91	91	91	91	91	91	91	91

V_{strav}: 14.86 ft/sec

F_p: 0.830 [ratio]

V_{scent}: 17.89 ft/sec

Initial Tunnel Flow: 160.4 scf/min

Test Fuel Properties

Default Fuel Values

Fuel Type:	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Actual Fuel Used Properties

Fuel Type:	D. Fir
HHV (kJ/kg)	19,810
%C	48.73
%H	6.87
%O	43.9
%Ash	0.5
MC (%DB)	20.1

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 4

Technician: SJB

Date: 9/14/2018

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
0	0.000		0.070	0.00	69	-0.09		15.5		101	250	84	71
10	1.421	0.142	0.070	2.19	71	-0.89	102	14.0	-1.5	105	382	84	71
20	2.859	0.144	0.070	2.17	74	-2.21	103	12.0	-2	109	452	85	72
30	4.299	0.144	0.070	2.15	78	-0.03	102	10.4	-1.6	108	443	83	73
40	5.746	0.145	0.070	2.15	82	0	102	8.9	-1.5	108	433	85	73
50	7.198	0.145	0.070	2.14	86	-2.57	101	7.5	-1.4	106	408	84	74
60	8.654	0.146	0.070	2.14	88	-0.93	101	6.4	-1.1	102	364	84	75
70	10.130	0.148	0.070	2.16	91	-2.2	102	5.5	-0.9	99	330	85	75
80	11.598	0.147	0.070	2.17	93	-1.75	100	4.6	-0.9	97	314	85	75
90	13.071	0.147	0.070	2.17	95	-0.93	100	4.0	-0.6	95	295	84	75
100	14.544	0.147	0.070	2.16	96	-2.22	100	3.5	-0.5	92	264	85	75
110	16.020	0.148	0.070	2.16	97	-1.27	100	3.1	-0.4	91	247	83	76
120	17.497	0.148	0.070	2.15	98	-1.8	99	2.8	-0.3	90	232	86	75
130	18.977	0.148	0.070	2.17	99	-2.35	99	2.6	-0.2	88	216	84	75
140	20.458	0.148	0.070	2.18	99	-0.11	99	2.4	-0.2	87	206	85	75
150	21.942	0.148	0.070	2.18	100	-2.39	99	2.3	-0.1	87	199	85	75
160	23.426	0.148	0.070	2.16	100	-0.2	99	2.0	-0.3	86	193	84	75
170	24.908	0.148	0.070	2.17	101	-0.26	99	1.8	-0.2	86	189	85	76
180	26.391	0.148	0.070	2.15	101	-0.16	99	1.7	-0.1	86	186	84	76
190	27.877	0.149	0.070	2.16	102	-2.54	99	1.5	-0.2	85	184	86	76
200	29.366	0.149	0.070	2.17	102	-2.14	99	1.3	-0.2	85	182	84	76
210	30.853	0.149	0.070	2.16	102	-2.37	99	1.2	-0.1	85	180	84	76
220	32.338	0.149	0.070	2.15	103	-2.17	99	1.0	-0.2	85	178	85	76
230	33.824	0.149	0.070	2.18	103	-0.25	99	0.8	-0.2	85	177	84	76
240	35.312	0.149	0.070	2.15	103	0	99	0.7	-0.1	85	174	86	77
250	36.802	0.149	0.070	2.15	104	-2.48	99	0.6	-0.1	85	170	85	77
260	38.290	0.149	0.070	2.17	104	-0.75	99	0.4	-0.2	84	167	84	77
270	39.777	0.149	0.070	2.16	104	-0.58	99	0.3	-0.1	84	163	86	77
280	41.266	0.149	0.070	2.15	104	-2.3	99	0.2	-0.1	84	160	84	77
290	42.758	0.149	0.070	2.15	104	-0.1	99	0.0	-0.2	84	158	86	77
Avg/Tot	42.758	0.147	0.070	2.09	95	-1.27	100			92	250	85	75.1

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 4

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/14/2018

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
0	0.001		0.00	69	-1		83	0.000	2.02	0.47
10	1.372	0.137	2.15	70	-1.73	101	85	-0.040	8.93	0.95
20	2.777	0.141	2.12	74	-2.94	103	83	-0.060	12.80	0.72
30	4.191	0.141	2.11	78	-1.16	103	85	-0.060	13.75	0.70
40	5.606	0.142	2.10	81	-0.87	102	84	-0.050	13.66	0.59
50	7.029	0.142	2.10	85	-0.79	102	83	-0.060	12.71	0.35
60	8.454	0.143	2.09	87	-1.88	101	84	-0.050	11.28	0.59
70	9.886	0.143	2.10	90	-2.51	101	85	-0.040	10.23	0.74
80	11.322	0.144	2.10	92	-2.84	101	84	-0.040	9.81	0.84
90	12.757	0.144	2.10	93	-0.74	100	83	-0.040	9.36	0.59
100	14.198	0.144	2.09	95	-1.29	100	85	-0.030	7.90	0.94
110	15.641	0.144	2.10	96	-2.49	100	85	-0.010	8.04	0.83
120	17.083	0.144	2.10	97	-0.72	99	83	-0.030	7.12	1.31
130	18.527	0.144	2.09	98	-1.88	99	84	-0.020	6.61	1.49
140	19.974	0.145	2.10	98	-1.02	99	85	-0.020	6.31	1.48
150	21.423	0.145	2.10	99	-0.62	99	83	-0.010	6.03	1.55
160	22.872	0.145	2.10	99	-2.67	99	85	-0.020	6.16	1.64
170	24.320	0.145	2.09	99	-0.63	99	85	-0.020	5.96	1.42
180	25.767	0.145	2.10	100	-1.01	99	83	-0.020	6.30	1.32
190	27.217	0.145	2.08	100	-2.72	99	85	-0.020	5.95	1.32
200	28.669	0.145	2.09	100	-2.09	99	85	-0.010	6.13	1.29
210	30.120	0.145	2.10	101	-1.47	99	84	-0.010	6.10	1.36
220	31.572	0.145	2.09	101	-2.66	99	84	-0.010	6.05	1.34
230	33.023	0.145	2.09	101	-2.38	99	86	-0.010	5.22	1.65
240	34.472	0.145	2.08	101	-0.92	99	84	-0.020	4.78	1.80
250	35.925	0.145	2.09	102	-0.65	99	83	-0.010	4.55	1.97
260	37.377	0.145	2.10	102	-2.84	99	86	-0.010	4.48	2.04
270	38.831	0.145	2.09	102	-0.82	99	85	-0.010	4.38	1.91
280	40.284	0.145	2.09	102	-1.82	99	84	-0.010	5.06	1.76
290	41.736	0.145	2.09	102	-1.52	99	85	-0.020	4.91	1.82
Avg/Tot	41.736	0.144	2.03	94	-1.62	100	84	-0.025	7.42	1.23

WOODSTOVE SURFACE TEMPERATURE DATA

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 4

Technician: SJB

Date: 9/14/2018

Stove ΔT : 84

Elapsed Time (min)	Temperature Data (°F)						
	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
0	418	468	260	314	259	343.8	N/A
10	397	446	335	539	237	390.8	N/A
20	401	454	333	756	239	436.6	N/A
30	426	480	258	794	238	439.2	N/A
40	448	499	220	776	235	435.6	N/A
50	466	511	225	724	225	430.2	N/A
60	483	521	238	628	219	417.8	N/A
70	494	529	257	546	213	407.8	N/A
80	498	530	285	504	208	405.0	N/A
90	496	528	307	471	204	401.2	N/A
100	488	521	321	427	202	391.8	N/A
110	471	504	319	388	200	376.4	N/A
120	461	488	303	367	201	364.0	N/A
130	441	472	287	334	200	346.8	N/A
140	424	456	276	312	203	334.2	N/A
150	415	439	272	296	201	324.6	N/A
160	409	424	269	285	201	317.6	N/A
170	404	412	265	276	200	311.4	N/A
180	400	404	261	270	200	307.0	N/A
190	396	399	258	266	201	304.0	N/A
200	393	393	257	262	200	301.0	N/A
210	388	390	255	259	201	298.6	N/A
220	381	387	254	255	201	295.6	N/A
230	375	384	252	252	201	292.8	N/A
240	364	376	244	246	201	286.2	N/A
250	355	368	231	238	200	278.4	N/A
260	348	360	220	232	199	271.8	N/A
270	343	352	212	226	198	266.2	N/A
280	341	348	204	220	197	262.0	N/A
290	344	345	199	216	196	260.0	N/A
Average	416	440	263	389	209	343	N/A

LAB SAMPLE DATA - ASTM E2515

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 4

Technician: SJB

Date: 9/14/2018

TRAIN A (1st Hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3297	131.6	122.8	8.8
B. Rear filter catch	Filter				0.0
C. Probe catch*	Probe				0.0
D. O-Ring catch*	O-Ring				0.0

Sub-Total

Total Particulate, mg: 8.8

TRAIN A (Post 1st hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3298	121.3	118.6	2.7
B. Rear filter catch	Filter	3299	121.1	121.4	-0.3
C. Probe catch*	Probe	7A	116740.1	116739.8	0.3
D. O-Ring catch*	O-Ring	7A	3574.3	3573.9	0.4

Sub-Total

Total Particulate, mg: 3.1

Train A Aggregate

Total Particulate, mg: 11.9

TRAIN B

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3300	132.8	122.4	10.4
B. Rear filter catch	Filter	3301	119.0	118.8	0.2
C. Probe catch*	Probe	7B	117304.8	117304.5	0.3
D. O-Ring catch*	O-Ring	7B	3522.6	3521.7	0.9

Total Particulate, mg: 11.8

AMBIENT

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Filter catch*	Filter	3302	121.5	121.4	0.1

Total Particulate, mg: 0.1

*Particulate catch that results in a negative number, is assumed to be zero for probes and O-rings, negative numbers for filters are assumed to be part of the O-Ring weight.

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
Model: GV230GL Run Number: 4 Test Date: 9/14/2018

Wood Heater Run Notes

Test Control Settings

Primary Air Setting(s): Medium Low Test Setting (0.430" from bottom of channel to bottom of control rod)

Preburn Notes

Preburn Start Time: 9:28

Time	Notes
8:19	Loaded 10.2 lbs of kindling
9:00	Loaded Pre-burn Fuel
9:28	Turned fan to low setting, air control set at test setting.
10:48	Leveled coal bed, turned off convection fan in preparation of fuel loading.

Test Notes

Test Burn Start Time: 10:50
Test Fuel Loaded by: 50 seconds
Door Closed: 4 minutes
Air Control Set at: 5 minutes
Other Loading Notes: N/A

Time	Notes
25 min	Turned convection fan on low, per manufacturer's instructions.
60 min	Changed 1-hour filter.
290 min	End of Test

Test Burn End Time: 15:40
Background Filter Volume (ft³): 48.455

Filter Data

Train	A	A	A	A	A	B	B	B	B	AMB
Element	Front Filter (First Hour)	Front Filter (Remainder)	Rear Filter	Probe	O-Ring Pair	Front Filter	Rear Filter	Probe	O-Ring Pair	Filter
ID #	3297	3298	3299	7A	7A	3300	3301	7B	7B	3302
Tare (mg)	122.8	118.6	121.4	116739.8	3573.9	122.4	118.8	117304.5	3521.7	121.4
Final Weight (mg)	131.6	121.3	121.1	116740.1	3574.3	132.8	119.0	117304.8	3522.6	121.5

Sample Train Leak Check: A: 0.001 @ -14 "Hg B: 0.000 @ -12 "Hg AMB: 0.000 @ -13 "Hg

Technician Signature: 

Date: 9/18/2018

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 4 Test Date: 9/14/2018

Flue Gas Concentration Measurement

Calibration Gas Values: Span Gas CO₂ (%): 16.93 CO (%): 4.33
 Mid Gas CO₂ (%): - CO (%): -

Calibration Results:

	Pre Test			Post Test		
	Zero	Mid	Span	Zero	Mid	Span
Time	9:50	-	9:52	16:05	-	16:08
CO ₂	0.00	-	16.93	0.04	-	16.94
CO	0.000	-	4.330	-0.018	-	4.277

Flue Gas Probe Leak Check: Initial: No Leakage Final: No Leakage

Dilution Tunnel Flow

Pitot Tube Leak Test: Initial: No Leakage Final: No Leakage

Velocity Traverse Data

	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (inH ₂ O):	0.032	0.052	0.056	0.032	0.036	0.054	0.062	0.048	0.070
Temp (°F):	91	91	91	91	91	91	91	91	91

Dilution Tunnel Static Pressure (inH₂O): -0.165

Supplemental Data

Room Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10 Final: 10

Stack Diameter (in): 6

Induced Draft (in H₂O): 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in

Series: Date: 9/10/2018

	Initial	Middle	Ending
P _b (inHg)	30.00	29.94	29.91
RH (%)	46.8	35.7	31.5

Technician Signature: 

Date: 9/18/2018

WOOD STOVE TEST DATA PACKET
ASTM E2780/E2515



Run 3 Data Summary

Client: IHP
Model: GV230GL
Job #: 18-428
Tracking #: 0008
Test Date: 9/13/2018

A handwritten signature in dark ink, appearing to be "JL", is written over a horizontal line.

Techician Signature

9/18/2018

Date

TEST RESULTS - ASTM E2780 / ASTM E2515

Client: IHP

Model: GV230GL

Run #: 3

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/13/2018

Burn Rate (kg/hr):	1.86
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	Ambient Sample	Sample Train A	Sample Train B	1st Hour Filter
Total Sample Volume (ft ³)	31.944	27.925	27.269	8.686
Average Gas Velocity in Dilution Tunnel (ft/sec)	17.3			
Average Gas Flow Rate in Dilution Tunnel (dscf/hr)	11261.9			
Average Gas Meter Temperature (°F)	74.0	92.4	91.2	84.3
Total Sample Volume (dscf)	31.597	26.915	26.204	10.202
Average Tunnel Temperature (°F)	103.5			
Total Time of Test (min)	190			
Total Particulate Catch (mg)	0.0	4.8	5.3	3.4
Particulate Concentration, dry-standard (g/dscf)	0.0000000	0.0001783	0.0002023	0.0003333
Total PM Emissions (g)	0.00	6.36	7.21	3.75
Particulate Emission Rate (g/hr)	0.00	2.01	2.28	3.75
Emissions Factor (g/kg)	-	1.08	1.22	-
Difference from Average Total Particulate Emissions (g)	-	0.43	0.43	-
Difference from Average Emissions Factor (g/kg)	-	0.07	0.07	-

Final Average Results	
Total Particulate Emissions (g)	6.79
Particulate Emission Rate (g/hr)	2.14
Emissions Factor (g/kg)	1.15
HHV Efficiency (%)	72.7%
LHV Efficiency (%)	78.6%
CO Emissions (g/min)	2.00

Quality Checks	Requirement	Observed	Result
Dual Train Precision	Each train within 7.5% of average emissions (in grams), or emission factors within 0.5 g/kg	See Above	OK
Filter Temps	<90 °F	86.0	OK
Face Velocity	< 30 ft/min	8.0	OK
Leakage Rate	Less than 4% of average sample rate	0.001 cfm	OK
Ambient Temp	55-90 °F	Min: 72 / Max: 76	OK
Negative Probe Weight Evaluation	<5% of Total Catch	Probe Catch Not Negative	OK
Pro-Rate Variation	90% of readings between 90-110%; none greater than 120% or less than 80%	See Data Tabs	OK
Stove Surface ΔT	<126°F	54.4	OK

B415.1 Efficiency Results

Manufacturer: IHP
Model: GV230GL
Date: 09/13/18
Run: 3
Control #: 18-428
Test Duration: 190
Output Category: 3

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	72.7%	78.6%
Combustion Efficiency	95.4%	95.4%
Heat Transfer Efficiency	76.2%	82.4%

Output Rate (kJ/h)	26,547	25,183	(Btu/h)
Burn Rate (kg/h)	1.84	4.06	(lb/h)
Input (kJ/h)	36,504	34,628	(Btu/h)

Test Load Weight (dry kg)	5.84	12.86	dry lb
MC wet (%)	16.49		
MC dry (%)	19.74		
Particulate (g)	6.79		
CO (g)	380		
Test Duration (h)	3.17		

Emissions	Particulate	CO
g/MJ Output	0.08	4.51
g/kg Dry Fuel	1.16	65.04
g/h	2.14	119.85
g/min	0.04	2.00
lb/MM Btu Output	0.19	10.49

Air/Fuel Ratio (A/F)	13.38
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VERSION:

2.2

12/14/2009

WOODSTOVE FUEL DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 3

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Preburn Fuel Information						
Size	Length (in)	Moisture Content (% DB)		Size	Length (in)	Moisture Content (% DB)
2x4	16.00	21.4		2x4	16.00	22.1
2x4	16.00	24.6		2x4	16.00	24.3
2x4	16.00	22.5		2x4	16.00	21.0
2x4	16.00	18.7		2x4	16.00	19.5
2x4	16.00	20.2				
2x4	16.00	23.4				
2x4	16.00	24.1				
2x4	16.00	19.4				
Total Fuel Weight (lbs):		15.2	Average Moisture (%DB):		21.8	

Firebox Volume (ft³): 2.30
 Total 2x4 Crib Weight, with spacers (lbs): 7.23
 Total 4x4 Crib Weight, with spacers (lbs): 8.18
 Total Wet Fuel Weight, with spacers (lbs): 15.40

Coal Bed Range (20-25%):

Min (lbs): 3.08
 Max (lbs): 3.85

Test Fuel Information						
Size	Length (in)	Weight (lbs)	Moisture Content (%DB)			Dry Weight (lbs)
2x4	15.00	1.37	19.2	18.8	19.7	1.15
2x4	15.00	1.41	19.4	19.9	19.7	1.18
2x4	15.00	1.69	20.2	19.5	19.3	1.41
2x4	15.00	1.59	18.9	19.3	19.6	1.33
4x4	15.00	4.00	21.1	21.7	20.2	3.31
4x4	15.00	3.34	20.2	18.8	19.9	2.79
Total Dry Weight, no spacers (lbs):						11.17
Total Dry Weight, with spacers (lbs):						12.99

Spacer Moisture Readings (%DB)							
9.5	10.6	10.9	9.4	7.9			
9.3	10.9	8.7	10.6	8.9			
10.7	10.9	9.3	10.2	9.6			
11.0	10.9	10.9	9.8	8.4			

Quality Checks	Requirement	Observed	Result
Fuel Density	25 - 36 (lbs/ft ³ , DB)	28.3	OK
Loading Density	6.3 - 7.7 (lbs/ft ³ , WB)	6.70	OK
2x4 Fuel Mix	35 - 65 % of total weight	47%	OK

WOODSTOVE PREBURN DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 3

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Preburn Start Time: 13:38
 Recording Interval (min): 10
 Run Time (min): 80

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
0	16.2	-0.064	499	539	415	641	235	465.8	427	64
10	13.6	-0.070	445	541	226	769	290	454.2	573	65
20	10.8	-0.066	424	569	199	805	289	457.2	572	65
30	8.3	-0.067	445	602	201	814	287	469.8	560	65
40	6.1	-0.065	473	640	209	783	281	477.2	519	66
50	5.0	-0.047	502	636	219	593	277	445.4	433	66
60	4.4	-0.043	501	598	231	462	274	413.2	363	63
70	4.1	-0.034	469	556	225	355	274	375.8	304	62
80	3.8	-0.026	453	525	214	313	272	355.4	279	61

DILUTION TUNNEL & MISC. DATA - ASTM E2780 / E2515

Client: IHP
 Model: GV230GL
 Run #: 3
 Test Start Time: 15:00

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Total Sampling Time (min): 190
 Recording Interval (min): 10

	Beginning	Middle	End	Avg.
P _{bar} (in Hg):	29.97	29.97	29.97	29.97

Meter Box γ Factor: 1.002 (A)
 Meter Box γ Factor: 0.997 (B)
 Meter Box γ Factor: 0.999 (Amb)

Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Tunnel Area: 0.1963 ft²
 Dilution Tunnel H₂O: 2.00 percent
 Tunnel Diameter: 6 inches
 Pitot Tube Cp: 0.99
 Dilution Tunnel Static: -0.300 in H₂O

Post-Test Leak Check

(A) 0.001 cfm @ -15 in. Hg
 (B) 0.000 cfm @ -12 in. Hg
 (AMB) 0.000 cfm @ -13 in. Hg

Ambient Sample Volume: 31.944 ft³

	Tunnel Traverse Information								
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (in H ₂ O)	0.048	0.068	0.078	0.062	0.052	0.070	0.072	0.048	0.085
Tunnel Temp (°F)	156	156	156	156	156	156	156	156	156

V_{strav}: 18.12 ft/sec
 V_{scent}: 20.86 ft/sec

F_p: 0.869 [ratio]
 Initial Tunnel Flow: 176.1 scf/min

Test Fuel Properties

Default Fuel Values

Fuel Type:	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Actual Fuel Used Properties

Fuel Type:	D. Fir
HHV (kJ/kg)	19,810
%C	48.73
%H	6.87
%O	43.9
%Ash	0.5
MC (%DB)	19.7

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: <u>IHP</u>	Job #: <u>18-428</u>
Model: <u>GV230GL</u>	Tracking #: <u>0008</u>
Run #: <u>3</u>	Technician: <u>SJB</u>
	Date: <u>9/13/2018</u>

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
0	0.000		0.085	0.00	79	-0.07		15.4		114	304	86	74
10	1.418	0.142	0.085	2.21	79	-0.33	101	13.3	-2.1	128	564	85	74
20	2.865	0.145	0.085	2.19	81	-1.02	103	10.8	-2.5	129	558	83	74
30	4.312	0.145	0.085	2.15	84	-2.12	102	8.6	-2.2	128	545	85	74
40	5.766	0.145	0.085	2.16	87	-2.58	101	7.0	-1.6	121	481	86	75
50	7.223	0.146	0.085	2.16	89	-2.36	101	5.6	-1.4	116	450	85	75
60	8.686	0.146	0.085	2.17	91	-2.65	101	4.5	-1.1	112	411	83	76
70	10.164	0.148	0.085	2.17	93	-1.57	101	3.7	-0.8	106	369	84	75
80	11.637	0.147	0.085	2.19	94	-2	100	3.0	-0.7	103	352	86	75
90	13.110	0.147	0.085	2.16	95	-2.18	100	2.5	-0.5	101	334	85	75
100	14.587	0.148	0.085	2.18	96	-0.51	99	2.1	-0.4	97	294	84	75
110	16.064	0.148	0.085	2.18	97	-0.78	99	1.9	-0.2	95	271	86	74
120	17.545	0.148	0.085	2.18	97	-0.54	99	1.6	-0.3	93	262	84	74
130	19.025	0.148	0.085	2.16	98	-0.65	99	1.3	-0.3	92	258	84	73
140	20.507	0.148	0.085	2.18	98	0	99	1.0	-0.3	91	255	86	73
150	21.986	0.148	0.085	2.19	98	-1.29	98	0.8	-0.2	90	250	84	73
160	23.468	0.148	0.085	2.19	98	-0.34	99	0.6	-0.2	90	243	86	73
170	24.953	0.149	0.085	2.19	98	-0.5	99	0.3	-0.3	89	237	84	73
180	26.439	0.149	0.085	2.19	98	-0.97	99	0.1	-0.2	88	233	85	72
190	27.925	0.149	0.085	2.19	98	0	99	0.0	-0.1	87	228	84	72
Avg/Tot	27.925	0.147	0.085	2.07	92	-1.12	100			104	345	85	74.0

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 3

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
0	0.001		0.00	78	-1		85	0.000	2.02	0.46
10	1.380	0.138	2.13	78	-2.8	101	86	-0.070	13.45	0.62
20	2.800	0.142	2.11	80	-2.1	103	84	-0.080	14.27	0.51
30	4.219	0.142	2.10	83	-2.83	103	85	-0.060	15.46	0.35
40	5.643	0.142	2.10	86	-2.33	102	86	-0.060	12.26	0.30
50	7.072	0.143	2.10	88	-1.18	101	84	-0.060	11.73	0.36
60	8.501	0.143	2.10	90	-2.53	101	86	-0.060	10.33	0.45
70	9.938	0.144	2.10	91	-0.7	100	83	-0.040	8.87	0.37
80	11.375	0.144	2.10	93	-0.72	100	86	-0.050	8.54	0.43
90	12.814	0.144	2.09	94	-0.99	100	85	-0.050	8.30	0.47
100	14.255	0.144	2.10	95	-0.8	99	84	-0.040	6.33	1.20
110	15.700	0.145	2.10	95	-1.33	99	86	-0.010	6.41	1.24
120	17.145	0.145	2.10	96	-0.66	99	85	-0.030	6.42	1.12
130	18.590	0.145	2.08	96	-0.71	99	83	-0.040	6.32	1.24
140	20.034	0.144	2.10	96	-2.8	99	85	-0.030	6.42	1.22
150	21.481	0.145	2.12	97	-2.41	99	86	-0.030	5.78	1.48
160	22.928	0.145	2.11	97	-0.7	99	83	-0.030	5.59	1.51
170	24.375	0.145	2.11	97	-2.76	98	84	-0.030	5.41	1.48
180	25.822	0.145	2.10	97	-2.42	98	86	-0.020	5.50	1.46
190	27.269	0.145	2.11	97	-2.49	98	83	-0.030	5.23	1.37
Avg/Tot	27.269	0.144	2.00	91	-1.71	100	85	-0.041	8.23	0.88

WOODSTOVE SURFACE TEMPERATURE DATA

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 3

Technician: SJB

Date: 9/13/2018

Stove ΔT: 54

Temperature Data (°F)							
Elapsed Time (min)	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
0	452	520	228	316	274	358.0	N/A
10	441	491	346	770	242	458.0	N/A
20	458	540	248	839	255	468.0	N/A
30	480	581	204	789	254	461.6	N/A
40	495	611	205	674	247	446.4	N/A
50	503	617	219	620	241	440.0	N/A
60	508	623	250	550	235	433.2	N/A
70	502	621	281	470	229	420.6	N/A
80	488	614	288	424	225	407.8	N/A
90	478	601	281	396	221	395.4	N/A
100	469	569	267	345	220	374.0	N/A
110	450	539	250	303	220	352.4	N/A
120	445	519	239	286	217	341.2	N/A
130	448	508	231	279	216	336.4	N/A
140	450	502	227	274	212	333.0	N/A
150	450	496	222	268	210	329.2	N/A
160	442	487	217	259	209	322.8	N/A
170	432	475	209	250	208	314.8	N/A
180	422	466	203	244	207	308.4	N/A
190	416	458	200	239	205	303.6	N/A
Average	461	542	241	430	227	380	N/A

LAB SAMPLE DATA - ASTM E2515

Client: IHP

Model: GV230GL

Run #: 3

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/13/2018

TRAIN A (1st Hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3291	126.3	122.9	3.4
B. Rear filter catch	Filter				0.0
C. Probe catch*	Probe				0.0
D. O-Ring catch*	O-Ring				0.0

Sub-Total

Total Particulate, mg:

3.4

TRAIN A (Post 1st hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3292	119.3	118.6	0.7
B. Rear filter catch	Filter	3293	121.8	121.9	-0.1
C. Probe catch*	Probe	6A	116565.0	116564.9	0.1
D. O-Ring catch*	O-Ring	6A	3615.9	3615.2	0.7

Sub-Total

Total Particulate, mg:

1.4

Train A Aggregate

Total Particulate, mg:

4.8

TRAIN B

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3294	122.0	118.0	4.0
B. Rear filter catch	Filter	3295	123.1	122.9	0.2
C. Probe catch*	Probe	6B	116117.3	116117.2	0.1
D. O-Ring catch*	O-Ring	6B	3397.0	3396.0	1.0

Total Particulate, mg:

5.3

AMBIENT

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Filter catch*	Filter	3296	122.1	122.1	0.0

Total Particulate, mg:

0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and O-rings, negative numbers for filters are assumed to be part of the O-Ring weight.

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 3 Test Date: 9/13/2018

Wood Heater Run Notes

Test Control Settings

Primary Air Setting(s): Medium High Test Setting (0.850" from bottom of channel to bottom of control rod)

Preburn Notes

Preburn Start Time: 13:38

Time	Notes
13:05	Loaded 9.9 lbs of kindling
13:38	Loaded Pre-burn Fuel, turned fan to high setting, air control set at test setting
14:58	Leveled coal bed, turned off convection fan in preparation of fuel loading.

Test Notes

Test Burn Start Time: 15:00
 Test Fuel Loaded by: 40 seconds
 Door Closed: 3.5 minutes
 Air Control Set at: 5 minutes
 Other Loading Notes: N/A

Time	Notes
15 min	Turned convection fan on high, per manufacturer's instructions.
60 min	Changed 1-hour filter.
190 min	End of Test

Test Burn End Time: 18:10
 Background Filter Volume (ft³): 31.944

Filter Data

Train	A	A	A	A	A	B	B	B	B	AMB
Element	Front Filter (First Hour)	Front Filter (Remainder)	Rear Filter	Probe	O-Ring Pair	Front Filter	Rear Filter	Probe	O-Ring Pair	Filter
ID #	3291	3292	3293	6A	6A	3294	3295	6B	6B	3296
Tare (mg)	122.9	118.6	121.9	116564.9	3615.2	118.0	122.9	116117.2	3396.0	122.1
Final Weight (mg)	126.3	119.3	121.8	116565.0	3615.9	122.0	123.1	116117.3	3397.0	122.1

Sample Train Leak Check: A: 0.001 @ -15 "Hg B: 0.000 @ -12 "Hg AMB: 0.000 @ -13 "Hg

Technician Signature: 

Date: 9/18/2018

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 3 Test Date: 9/13/2018

Flue Gas Concentration Measurement

Calibration Gas Values: Span Gas CO₂ (%): 16.93 CO (%): 4.33
 Mid Gas CO₂ (%): - CO (%): -

Calibration Results:

	Pre Test			Post Test		
	Zero	Mid	Span	Zero	Mid	Span
Time	9:20	-	9:27	18:30	-	18:34
CO ₂	0.00	-	16.93	0.00	-	17.05
CO	0.000	-	4.330	0.033	-	4.280

Flue Gas Probe Leak Check: Initial: No Leakage Final: No Leakage

Dilution Tunnel Flow

Pitot Tube Leak Test: Initial: No Leakage Final: No Leakage

Velocity Traverse Data

	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (inH ₂ O):	0.048	0.068	0.078	0.062	0.052	0.070	0.072	0.048	0.085
Temp (°F):	156	156	156	156	156	156	156	156	156

Dilution Tunnel Static Pressure (inH₂O): -0.30

Supplemental Data

Room Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10 Final: 10

Stack Diameter (in): 6

Induced Draft (in H₂O): 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in

Series: Date: 9/10/2018

	Initial	Middle	Ending
P _b (inHg)	29.97	29.97	29.97
RH (%)	40.4	35.4	33.4

Technician Signature: 

Date: 9/18/2018

WOOD STOVE TEST DATA PACKET
ASTM E2780/E2515



Run 2 Data Summary

Client: IHP
Model: GV230GL
Job #: 18-428
Tracking #: 0008
Test Date: 9/13/2018



Technician Signature

9/18/2018

Date

TEST RESULTS - ASTM E2780 / ASTM E2515

Client: IHP

Model: GV230GL

Run #: 2

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/13/2018

Burn Rate (kg/hr):	2.58
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	Ambient Sample	Sample Train A	Sample Train B	1st Hour Filter
Total Sample Volume (ft ³)	23.417	20.369	19.930	8.593
Average Gas Velocity in Dilution Tunnel (ft/sec)	17.5			
Average Gas Flow Rate in Dilution Tunnel (dscf/hr)	11136.2			
Average Gas Meter Temperature (°F)	70.3	83.8	82.8	76.4
Total Sample Volume (dscf)	23.344	19.960	19.466	10.085
Average Tunnel Temperature (°F)	116.9			
Total Time of Test (min)	140			
Total Particulate Catch (mg)	0.1	3.5	3.8	2.1
Particulate Concentration, dry-standard (g/dscf)	0.0000043	0.0001754	0.0001952	0.0002082
Total PM Emissions (g)	0.11	4.45	4.96	2.27
Particulate Emission Rate (g/hr)	0.05	1.91	2.13	2.27
Emissions Factor (g/kg)	-	0.74	0.82	-
Difference from Average Total Particulate Emissions (g)	-	0.26	0.26	-
Difference from Average Emissions Factor (g/kg)	-	0.04	0.04	-

Final Average Results	
Total Particulate Emissions (g)	4.70
Particulate Emission Rate (g/hr)	2.02
Emissions Factor (g/kg)	0.78
HHV Efficiency (%)	71.0%
LHV Efficiency (%)	76.7%
CO Emissions (g/min)	1.87

Quality Checks	Requirement	Observed	Result
Dual Train Precision	Each train within 7.5% of average emissions (in grams), or emission factors within 0.5 g/kg	See Above	OK
Filter Temps	<90 °F	86.0	OK
Face Velocity	< 30 ft/min	7.9	OK
Leakage Rate	Less than 4% of average sample rate	0.002 cfm	OK
Ambient Temp	55-90 °F	Min: 68 / Max: 71	OK
Negative Probe Weight Evaluation	<5% of Total Catch	-2.9%	OK
Pro-Rate Variation	90% of readings between 90-110%; none greater than 120% or less than 80%	See Data Tabs	OK
Stove Surface ΔT	<126°F	69.8	OK

B415.1 Efficiency Results

Manufacturer: IHP
Model: GV230GL
Date: 09/13/18
Run: 2
Control #: 18-428
Test Duration: 140
Output Category: 4

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	71.0%	76.7%
Combustion Efficiency	96.9%	96.9%
Heat Transfer Efficiency	73.2%	79.2%

Output Rate (kJ/h)	35,748	33,911	(Btu/h)
Burn Rate (kg/h)	2.54	5.60	(lb/h)
Input (kJ/h)	50,352	47,764	(Btu/h)

Test Load Weight (dry kg)	5.93	13.07	dry lb
MC wet (%)	16.74		
MC dry (%)	20.11		
Particulate (g)	4.70		
CO (g)	262		
Test Duration (h)	2.33		

Emissions	Particulate	CO
g/MJ Output	0.06	3.14
g/kg Dry Fuel	0.79	44.20
g/h	2.02	112.35
g/min	0.03	1.87
lb/MM Btu Output	0.13	7.30

Air/Fuel Ratio (A/F)	12.57
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VERSION:

2.2

12/14/2009

WOODSTOVE FUEL DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 2

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Preburn Fuel Information						
Size	Length (in)	Moisture Content (% DB)		Size	Length (in)	Moisture Content (% DB)
2x4	16.00	20.4		2x4	16.00	19.9
2x4	16.00	21.6		2x4	16.00	21.7
2x4	16.00	19.3		2x4	16.00	22.8
2x4	16.00	22.4		2x4	16.00	24.3
2x4	16.00	24.7				
2x4	16.00	23.7				
2x4	16.00	18.6				
2x4	16.00	21.3				
Total Fuel Weight (lbs):		19.5	Average Moisture (%DB):		21.7	

Firebox Volume (ft³): 2.30
 Total 2x4 Crib Weight, with spacers (lbs): 7.30
 Total 4x4 Crib Weight, with spacers (lbs): 8.38
 Total Wet Fuel Weight, with spacers (lbs): 15.68

Coal Bed Range (20-25%):

Min (lbs): 3.14
 Max (lbs): 3.92

Test Fuel Information						
Size	Length (in)	Weight (lbs)	Moisture Content (%DB)			Dry Weight (lbs)
2x4	15.00	1.70	19.1	19.2	19.4	1.43
2x4	15.00	1.48	22.4	20.6	22.1	1.22
2x4	15.00	1.34	22.0	21.7	21.0	1.10
2x4	15.00	1.30	18.9	19.3	19.7	1.09
4x4	15.00	4.06	20.3	19.0	18.9	3.40
4x4	15.00	3.44	18.7	20.2	19.5	2.88
Total Dry Weight, no spacers (lbs):						11.11
Total Dry Weight, with spacers (lbs):						13.27

Spacer Moisture Readings (%DB)							
10.6	9.6	8.5	9.9	8.9			
9.6	9.6	9.6	7.7	10.0			
8.7	9.5	10.2	8.3	9.4			
10.0	10.2	9.2	10.7	9.9			

Quality Checks	Requirement	Observed	Result
Fuel Density	25 - 36 (lbs/ft ³ , DB)	28.1	OK
Loading Density	6.3 - 7.7 (lbs/ft ³ , WB)	6.82	OK
2x4 Fuel Mix	35 - 65 % of total weight	47%	OK

WOODSTOVE PREBURN DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 2

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Preburn Start Time: 9:29
 Recording Interval (min): 10
 Run Time (min): 80

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
0	20.2	-0.062	414	466	370	587	141	395.6	398	69
10	18.2	-0.080	380	478	224	671	168	384.2	611	67
20	14.1	-0.079	370	567	192	841	175	429.0	699	67
30	10.2	-0.078	386	648	203	887	185	461.8	686	67
40	7.3	-0.084	423	689	227	882	202	484.6	649	67
50	5.9	-0.059	464	707	247	829	218	493.0	603	67
60	4.9	-0.062	502	699	278	612	234	465.0	476	66
70	4.4	-0.039	515	674	294	475	252	442.0	409	66
80	3.9	-0.058	524	644	292	410	260	426.0	385	65

DILUTION TUNNEL & MISC. DATA - ASTM E2780 / E2515

Client: IHP
 Model: GV230GL
 Run #: 2
 Test Start Time: 10:25

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Total Sampling Time (min): 140
 Recording Interval (min): 10

	Beginning	Middle	End	Avg.
P _{bar} (in Hg):	30	30	30	30.00

Meter Box γ Factor: 1.002 (A)
 Meter Box γ Factor: 0.997 (B)
 Meter Box γ Factor: 0.999 (Amb)

Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Tunnel Area: 0.1963 ft²
 Dilution Tunnel H₂O: 2.00 percent
 Tunnel Diameter: 6 inches
 Pitot Tube Cp: 0.99
 Dilution Tunnel Static: -0.300 in H₂O

Post-Test Leak Check

(A) 0.002 cfm @ -13 in. Hg
 (B) 0.000 cfm @ -12 in. Hg
 (AMB) 0.000 cfm @ -13 in. Hg

Ambient Sample Volume: 23.417 ft³

	Tunnel Traverse Information								
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (in H ₂ O)	0.048	0.068	0.078	0.062	0.052	0.070	0.072	0.048	0.085
Tunnel Temp (°F)	156	156	156	156	156	156	156	156	156

V_{strav}: 18.11 ft/sec
 V_{scent}: 20.85 ft/sec

F_p: 0.869 [ratio]
 Initial Tunnel Flow: 176.2 scf/min

Test Fuel Properties

Default Fuel Values

Fuel Type:	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Actual Fuel Used Properties

Fuel Type:	D. Fir
HHV (kJ/kg)	19,810
%C	48.73
%H	6.87
%O	43.9
%Ash	0.5
MC (%DB)	20.1

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 2

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
0	0.000		0.085	0.02	70	-0.09		15.7		126	377	84	69
10	1.411	0.141	0.085	2.13	71	-2.49	101	13.2	-2.5	137	630	85	68
20	2.827	0.142	0.085	2.10	73	-2.55	102	10.4	-2.8	143	639	84	69
30	4.265	0.144	0.085	2.15	76	-2.48	103	7.7	-2.7	143	638	84	70
40	5.704	0.144	0.085	2.13	79	-2.68	101	6.0	-1.7	132	548	86	70
50	7.144	0.144	0.085	2.17	82	-0.73	100	4.7	-1.3	123	494	85	71
60	8.593	0.145	0.085	2.16	84	-0.6	100	3.7	-1	117	458	84	71
70	10.060	0.147	0.085	2.16	86	-2.53	100	2.7	-1	114	446	85	70
80	11.523	0.146	0.085	2.17	88	-1.78	99	2.2	-0.5	111	420	84	71
90	12.992	0.147	0.085	2.17	89	-0.72	99	1.7	-0.5	107	396	85	71
100	14.465	0.147	0.085	2.18	90	-0.1	99	1.2	-0.5	103	363	84	71
110	15.939	0.147	0.085	2.18	91	-0.28	99	0.9	-0.3	101	347	85	71
120	17.414	0.148	0.085	2.19	92	0	98	0.6	-0.3	100	338	84	71
130	18.892	0.148	0.085	2.18	93	-1.99	98	0.3	-0.3	99	325	86	71
140	20.369	0.148	0.085	2.19	93	-2.55	98	0.0	-0.3	97	315	84	71
Avg/Tot	20.369	0.145	0.085	2.02	84	-1.44	100			117	449	85	70.3

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 2

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
0	0.000		0.00	70	-1		85	0.000	6.74	0.49
10	1.384	0.138	2.14	70	-1.83	101	84	-0.070	14.52	0.85
20	2.792	0.141	2.13	72	-1.48	103	84	-0.070	15.14	0.29
30	4.195	0.140	2.11	75	-2.89	102	84	-0.080	15.37	0.20
40	5.609	0.141	2.11	78	-2.85	102	86	-0.070	11.90	0.26
50	7.022	0.141	2.09	81	-1.32	100	86	-0.060	10.32	0.25
60	8.445	0.142	2.09	83	-2.73	100	84	-0.050	9.15	0.32
70	9.869	0.142	2.10	85	-0.84	99	84	-0.050	8.96	0.24
80	11.300	0.143	2.12	87	-0.91	99	85	-0.060	8.16	0.33
90	12.734	0.143	2.12	88	-2.8	99	86	-0.040	7.72	0.42
100	14.170	0.144	2.13	89	-1.27	99	86	-0.050	6.70	0.62
110	15.611	0.144	2.12	90	-0.71	99	85	-0.050	6.54	0.58
120	17.051	0.144	2.11	91	-2.76	98	83	-0.050	6.26	0.66
130	18.489	0.144	2.11	91	-1.49	98	85	-0.040	5.67	0.75
140	19.930	0.144	2.12	92	-1.64	98	86	-0.030	5.61	0.78
Avg/Tot	19.930	0.142	1.97	83	-1.77	100	85	-0.051	9.25	0.47

WOODSTOVE SURFACE TEMPERATURE DATA

Client: IHP
 Model: GV230GL
 Run #: 2

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/13/2018

Stove ΔT : 70

Temperature Data (°F)							
Elapsed Time (min)	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
0	526	639	298	408	268	427.8	N/A
10	508	600	281	743	273	481.0	N/A
20	508	619	221	850	278	495.2	N/A
30	526	640	215	874	270	505.0	N/A
40	544	656	220	716	263	479.8	N/A
50	542	662	231	605	257	459.4	N/A
60	530	645	248	532	253	441.6	N/A
70	523	621	258	501	253	431.2	N/A
80	521	600	258	474	254	421.4	N/A
90	518	578	252	429	259	407.2	N/A
100	522	558	247	384	261	394.4	N/A
110	527	540	242	351	263	384.6	N/A
120	531	524	238	335	265	378.6	N/A
130	524	506	231	318	265	368.8	N/A
140	509	491	223	303	264	358.0	N/A
Average	524	592	244	522	263	429	N/A

LAB SAMPLE DATA - ASTM E2515

Client: IHP

Model: GV230GL

Run #: 2

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/13/2018

TRAIN A (1st Hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3285	122.9	120.8	2.1
B. Rear filter catch	Filter				0.0
C. Probe catch*	Probe				0.0
D. O-Ring catch*	O-Ring				0.0

Sub-Total

Total Particulate, mg:

2.1

TRAIN A (Post 1st hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3286	119.4	119.0	0.4
B. Rear filter catch	Filter	3287	122.7	122.8	-0.1
C. Probe catch*	Probe	5A	116770.0	116770.1	0.0
D. O-Ring catch*	O-Ring	5A	3531.2	3530.1	1.1

Sub-Total

Total Particulate, mg:

1.4

Train A Aggregate

Total Particulate, mg:

3.5

TRAIN B

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3288	123.1	120.7	2.4
B. Rear filter catch	Filter	3289	119.0	118.7	0.3
C. Probe catch*	Probe	5B	116880.6	116880.7	0.0
D. O-Ring catch*	O-Ring	5B	3534.7	3533.6	1.1

Total Particulate, mg:

3.8

AMBIENT

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Filter catch*	Filter	3290	122.8	122.7	0.1

Total Particulate, mg:

0.1

*Particulate catch that results in a negative number, is assumed to be zero for probes and O-rings, negative numbers for filters are assumed to be part of the O-Ring weight.

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 2 Test Date: 9/13/2018

Wood Heater Run Notes

Test Control Settings

Primary Air Setting(s): Fully Open

Preburn Notes

Preburn Start Time: 9:29

Time	Notes
8:20	Loaded 9.9 lbs of kindling
9:04	Loaded Pre-burn Fuel, turned fan to high setting, air control set at test setting
10:24	Leveled coal bed, turned off convection fan in preparation of fuel loading.

Test Notes

Test Burn Start Time: 10:25
 Test Fuel Loaded by: 40 seconds
 Door Closed: 2 minutes
 Air Control Set at: 0 minutes
 Other Loading Notes: N/A

Time	Notes
5 min	Turned convection fan on high, per manufacturer's instructions.
60 min	Changed 1-hour filter.
140 min	End of Test

Test Burn End Time: 12:15
 Background Filter Volume (ft³): 23.417

Filter Data

Train	A	A	A	A	A	B	B	B	B	AMB
Element	Front Filter (First Hour)	Front Filter (Remainder)	Rear Filter	Probe	O-Ring Pair	Front Filter	Rear Filter	Probe	O-Ring Pair	Filter
ID #	3285	3286	3287	5A	5A	3288	3289	5B	5B	3290
Tare (mg)	120.8	119.0	122.8	116770.1	3530.1	120.7	118.7	116880.7	3533.6	122.7
Final Weight (mg)	122.9	119.4	122.7	16770.0	3531.2	123.1	119.0	116880.6	3534.7	122.8

Sample Train Leak Check: A: 0.002 @ -13 "Hg B: 0.000 @ -12 "Hg AMB: 0.000 @ -13 "Hg

Technician Signature:  Date: 9/18/2018

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 2 Test Date: 9/13/2018

Flue Gas Concentration Measurement

Calibration Gas Values: Span Gas CO₂ (%): 16.93 CO (%): 4.33
 Mid Gas CO₂ (%): - CO (%): -

Calibration Results:

	Pre Test			Post Test		
	Zero	Mid	Span	Zero	Mid	Span
Time	9:20	-	9:27	18:30	-	18:34
CO ₂	0.00	-	16.93	0.00	-	17.05
CO	0.000	-	4.330	0.033	-	4.280

Flue Gas Probe Leak Check: Initial: No Leakage Final: No Leakage

Dilution Tunnel Flow

Pitot Tube Leak Test: Initial: No Leakage Final: No Leakage

Velocity Traverse Data

	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (inH ₂ O):	0.048	0.068	0.078	0.062	0.052	0.070	0.072	0.048	0.085
Temp (°F):	156	156	156	156	156	156	156	156	156

Dilution Tunnel Static Pressure (inH₂O): -0.30

Supplemental Data

Room Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10 Final: 10

Stack Diameter (in): 6

Induced Draft (in H₂O): 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in

Series: Date: 9/10/2018

	Initial	Middle	Ending
P _b (inHg)	30.00	30.00	30.00
RH (%)	51.5	48.0	42.3

Technician Signature:  Date: 9/18/2018

WOOD STOVE TEST DATA PACKET
ASTM E2780/E2515



Run 1 Data Summary

Client: IHP
Model: GV230GL
Job #: 18-428
Tracking #: 0008
Test Date: 9/12/2018

A handwritten signature in dark ink, appearing to be "JL", is written over a horizontal line.

Techician Signature

9/18/2018

Date

TEST RESULTS - ASTM E2780 / ASTM E2515

Client: IHP

Model: GV230GL

Run #: 1

Job #: 18-428

Tracking #: 0008

Technician: SJB

Date: 9/12/2018

Burn Rate (kg/hr):	0.91
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	Ambient Sample	Sample Train A	Sample Train B	1st Hour Filter
Total Sample Volume (ft ³)	65.199	57.033	56.224	8.575
Average Gas Velocity in Dilution Tunnel (ft/sec)	14.9			
Average Gas Flow Rate in Dilution Tunnel (dscf/hr)	9978.1			
Average Gas Meter Temperature (°F)	74.8	97.2	95.6	81.7
Total Sample Volume (dscf)	64.293	54.411	53.525	10.053
Average Tunnel Temperature (°F)	86.8			
Total Time of Test (min)	390			
Total Particulate Catch (mg)	0.0	10.8	9.6	7.3
Particulate Concentration, dry-standard (g/dscf)	0.0000000	0.0001985	0.0001794	0.0007261
Total PM Emissions (g)	0.00	12.87	11.63	7.25
Particulate Emission Rate (g/hr)	0.00	1.98	1.79	7.25
Emissions Factor (g/kg)	-	2.16	1.96	-
Difference from Average Total Particulate Emissions (g)	-	0.62	0.62	-
Difference from Average Emissions Factor (g/kg)	-	0.10	0.10	-

Final Average Results	
Total Particulate Emissions (g)	12.25
Particulate Emission Rate (g/hr)	1.89
Emissions Factor (g/kg)	2.06
HHV Efficiency (%)	74.1%
LHV Efficiency (%)	80.1%
CO Emissions (g/min)	1.65

Quality Checks	Requirement	Observed	Result
Dual Train Precision	Each train within 7.5% of average emissions (in grams), or emission factors within 0.5 g/kg	See Above	OK
Filter Temps	<90 °F	86.0	OK
Face Velocity	< 30 ft/min	7.9	OK
Leakage Rate	Less than 4% of average sample rate	0 cfm	OK
Ambient Temp	55-90 °F	Min: 72 / Max: 77	OK
Negative Probe Weight Evaluation	<5% of Total Catch	Probe Catch Not Negative	OK
Pro-Rate Variation	90% of readings between 90-110%; none greater than 120% or less than 80%	See Data Tabs	OK
Stove Surface ΔT	<126°F	109.0	OK

B415.1 Efficiency Results

Manufacturer: IHP
Model: GV230GL
Date: 09/12/18
Run: 1
Control #: 18-428
Test Duration: 390
Output Category: 2

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	74.1%	80.1%
Combustion Efficiency	92.1%	92.1%
Heat Transfer Efficiency	80.4%	86.9%

Output Rate (kJ/h)	13,316	12,631	(Btu/h)
Burn Rate (kg/h)	0.91	2.00	(lb/h)
Input (kJ/h)	17,978	17,054	(Btu/h)

Test Load Weight (dry kg)	5.90	13.00	dry lb
MC wet (%)	16.66		
MC dry (%)	19.99		
Particulate (g)	12.25		
CO (g)	645		
Test Duration (h)	6.50		

Emissions	Particulate	CO
g/MJ Output	0.14	7.45
g/kg Dry Fuel	2.08	109.36
g/h	1.89	99.25
g/min	0.03	1.65
lb/MM Btu Output	0.33	17.32

Air/Fuel Ratio (A/F)	13.97
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VERSION:

2.2

12/14/2009

WOODSTOVE FUEL DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 1

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/12/2018

Preburn Fuel Information						
Size	Length (in)	Moisture Content (% DB)		Size	Length (in)	Moisture Content (% DB)
2x4	16.00	24.3		2x4	16.00	22.4
2x4	16.00	22.4		2x4	16.00	23.7
2x4	16.00	21.4				
2x4	16.00	24.3				
2x4	16.00	18.4				
2x4	16.00	19.8				
2x4	16.00	18.9				
2x4	16.00	20.5				
Total Fuel Weight (lbs):		15.6	Average Moisture (%DB):		21.6	

Firebox Volume (ft³): 2.30
 Total 2x4 Crib Weight, with spacers (lbs): 7.96
 Total 4x4 Crib Weight, with spacers (lbs): 7.60
 Total Wet Fuel Weight, with spacers (lbs): 15.56

Coal Bed Range (20-25%):

Min (lbs): 3.11
 Max (lbs): 3.89

Test Fuel Information						
Size	Length (in)	Weight (lbs)	Moisture Content (%DB)			Dry Weight (lbs)
2x4	15.50	1.85	19.6	20.1	18.7	1.55
2x4	15.50	1.70	20.1	20.3	19.3	1.42
2x4	15.50	1.70	20.0	20.4	20.5	1.41
2x4	15.50	1.61	18.9	19.4	19.3	1.35
4x4	15.50	3.55	19.2	21.2	22.3	2.94
4x4	15.50	3.35	21.7	19.0	19.8	2.79
Total Dry Weight, no spacers (lbs):						11.45
Total Dry Weight, with spacers (lbs):						13.11

Spacer Moisture Readings (%DB)							
7.0	7.4	10.4	7.7	10.3			
8.0	9.5	7.1	8.8	8.4			
9.3	8.8	8.9	9.2	9.6			
8.7	7.3	9.3	9.1	10.4			

Quality Checks	Requirement	Observed	Result
Fuel Density	25 - 36 (lbs/ft ³ , DB)	28.1	OK
Loading Density	6.3 - 7.7 (lbs/ft ³ , WB)	6.77	OK
2x4 Fuel Mix	35 - 65 % of total weight	51%	OK

WOODSTOVE PREBURN DATA - ASTM E2780

Client: IHP
 Model: GV230GL
 Run #: 1

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/12/2018

Preburn Start Time: 9:29
 Recording Interval (min): 10
 Run Time (min): 70

Elapsed Time (min)	Scale Reading (lbs)	Flue Draft (in H ₂ O)	Temperatures (°F)							
			FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Flue	Ambient
0	8.2	-0.071	451	630	436	1072	194	556.6	695	62
10	6.3	-0.076	481	657	339	853	231	512.2	428	60
20	5.4	-0.049	485	625	314	759	243	485.2	361	59
30	4.7	-0.037	483	579	303	582	245	438.4	290	58
40	4.5	-0.022	461	530	295	443	243	394.4	232	59
50	4.3	-0.021	431	504	283	358	241	363.4	202	59
60	4.1	-0.012	410	485	271	311	242	343.8	184	59
70	3.9	-0.005	398	468	260	286	242	330.8	174	59

DILUTION TUNNEL & MISC. DATA - ASTM E2780 / E2515

Client: IHP
 Model: GV230GL
 Run #: 1
 Test Start Time: 10:41

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/12/2018

Total Sampling Time (min): 390
 Recording Interval (min): 10

	Beginning	Middle	End	Avg.
P _{bar} (in Hg):	29.94	29.92	29.91	29.92

Meter Box γ Factor: 1.002 (A)
 Meter Box γ Factor: 0.997 (B)
 Meter Box γ Factor: 0.999 (Amb)

Dilution Tunnel MW(dry): 29.00 lb/lb-mole
 Dilution Tunnel MW(wet): 28.78 lb/lb-mole
 Tunnel Area: 0.1963 ft²
 Dilution Tunnel H₂O: 2.00 percent
 Tunnel Diameter: 6 inches
 Pitot Tube Cp: 0.99
 Dilution Tunnel Static: -0.180 in H₂O

Post-Test Leak Check

(A) 0.000 cfm @ -14 in. Hg
 (B) 0.000 cfm @ -12 in. Hg
 (AMB) 0.000 cfm @ -13 in. Hg

Ambient Sample Volume: 65.199 ft³

	Tunnel Traverse Information								
	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (in H ₂ O)	0.032	0.050	0.062	0.048	0.036	0.058	0.058	0.034	0.07
Tunnel Temp (°F)	99	99	99	99	99	99	99	99	99

V_{strav}: 15.08 ft/sec
 V_{scent}: 18.04 ft/sec

F_p: 0.836 [ratio]
 Initial Tunnel Flow: 160.4 scf/min

Test Fuel Properties

Default Fuel Values

Fuel Type:	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Actual Fuel Used Properties

Fuel Type:	D. Fir
HHV (kJ/kg)	19,810
%C	48.73
%H	6.87
%O	43.9
%Ash	0.5
MC (%DB)	20.0

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 1

Technician: SJB

Date: 9/12/2018

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
0	0.001		0.070	0.00	73	-0.09		15.6		105	251	83	73
10	1.395	0.139	0.070	2.11	75	-1.67	101	14.1	-1.5	104	378	85	73
20	2.825	0.143	0.070	2.11	78	-2.62	103	12.4	-1.7	108	444	84	74
30	4.252	0.143	0.070	2.10	82	-0.26	102	10.9	-1.5	103	399	85	73
40	5.692	0.144	0.070	2.10	85	-1.87	102	9.4	-1.5	104	406	85	75
50	7.133	0.144	0.070	2.12	88	0	101	8.2	-1.2	101	366	85	76
60	8.576	0.144	0.070	2.11	91	-0.25	101	7.1	-1.1	100	358	83	76
70	10.038	0.146	0.070	2.12	93	0	102	6.2	-0.9	97	314	85	76
80	11.491	0.145	0.070	2.13	95	-0.01	100	5.5	-0.7	95	282	85	76
90	12.951	0.146	0.070	2.11	97	-1.16	100	4.8	-0.7	92	258	84	76
100	14.411	0.146	0.070	2.11	98	0	100	4.3	-0.5	91	243	86	77
110	15.872	0.146	0.070	2.13	99	0	100	3.8	-0.5	90	236	83	76
120	17.335	0.146	0.070	2.12	100	-0.73	100	3.4	-0.4	89	224	86	77
130	18.800	0.147	0.070	2.10	101	-0.98	100	3.1	-0.3	87	199	84	77
140	20.265	0.147	0.070	2.11	101	-1.76	100	2.9	-0.2	87	186	86	77
150	21.732	0.147	0.070	2.14	102	0	99	2.8	-0.1	86	178	84	75
160	23.199	0.147	0.070	2.12	102	-0.47	99	2.6	-0.2	85	170	86	77
170	24.667	0.147	0.070	2.10	102	-1.23	99	2.5	-0.1	85	164	84	76
180	26.136	0.147	0.070	2.11	103	-2.12	99	2.3	-0.2	84	159	86	77
190	27.605	0.147	0.070	2.11	103	-0.48	99	2.2	-0.1	84	154	84	77
200	29.075	0.147	0.070	2.11	103	-0.81	99	2.1	-0.1	83	153	85	76
210	30.545	0.147	0.070	2.12	103	-0.93	99	1.9	-0.2	82	152	85	75
220	32.017	0.147	0.070	2.13	103	-2.45	99	1.8	-0.1	81	148	85	74
230	33.491	0.147	0.070	2.13	102	-2.04	99	1.6	-0.2	81	146	83	74
240	34.965	0.147	0.070	2.12	102	0	99	1.6	0	81	143	85	73
250	36.438	0.147	0.070	2.14	101	-2.2	99	1.5	-0.1	80	142	84	73
260	37.910	0.147	0.070	2.13	101	-0.2	99	1.3	-0.2	80	140	84	73
270	39.383	0.147	0.070	2.12	100	-0.87	100	1.2	-0.1	79	138	86	73
280	40.856	0.147	0.070	2.14	100	-2.53	100	1.1	-0.1	79	135	84	73
290	42.328	0.147	0.070	2.14	100	-0.65	99	1.0	-0.1	79	132	83	72
300	43.797	0.147	0.070	2.14	99	0	99	1.0	0	78	128	85	72
310	45.267	0.147	0.070	2.12	99	-0.1	99	0.9	-0.1	79	127	84	73

BOX A TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP Job #: 18-428
 Model: GV230GL Tracking #: 0008
 Run #: 1 Technician: SJB
 Date: 9/12/2018

Elapsed Time (min)	Particulate Sampling Data							Fuel Weight (lb)		Temperature Data (°F)			
	Gas Meter (ft ³)	Sample Rate (cfm)	Dilution Tunnel dP (in H ₂ O)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Scale Reading	Weight Change	Dilution Tunnel	Flue	Filter	Ambient
320	46.738	0.147	0.070	2.10	99	-2.51	100	0.8	-0.1	79	125	83	74
330	48.208	0.147	0.070	2.12	100	-2.55	99	0.7	-0.1	79	124	85	74
340	49.678	0.147	0.070	2.11	100	-2.54	99	0.5	-0.2	79	124	84	74
350	51.148	0.147	0.070	2.11	101	-1.65	99	0.3	-0.2	79	123	84	74
360	52.618	0.147	0.070	2.11	101	-2.38	99	0.3	0	79	123	85	74
370	54.088	0.147	0.070	2.12	102	-0.18	99	0.2	-0.1	79	123	83	75
380	55.560	0.147	0.070	2.12	102	-2.52	99	0.1	-0.1	79	124	85	75
390	57.033	0.147	0.070	2.11	102	-2.54	99	0.0	-0.1	80	126	83	75
Avg/Tot	57.033	0.146	0.070	2.07	97	-1.13	100			87	201	84	74.8

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHP
 Model: GV230GL
 Run #: 1

Job #: 18-428
 Tracking #: 0008
 Technician: SJB
 Date: 9/12/2018

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
0	0.000		0.00	72	-1		85	0.000	1.83	0.48
10	1.373	0.137	2.14	74	-1.08	101	85	-0.040	8.97	0.90
20	2.789	0.142	2.12	77	-1.89	104	85	-0.060	12.91	0.63
30	4.206	0.142	2.11	81	-2.79	102	83	-0.060	13.09	0.46
40	5.629	0.142	2.10	84	-1.68	102	83	-0.050	15.11	0.74
50	7.053	0.142	2.09	87	-0.78	102	85	-0.040	13.02	0.39
60	8.486	0.143	2.09	90	-1.33	102	86	-0.050	12.99	0.37
70	9.916	0.143	2.08	92	-2.79	101	83	-0.020	10.44	0.68
80	11.354	0.144	2.08	94	-2.16	101	85	-0.040	9.63	0.78
90	12.795	0.144	2.09	95	-0.68	101	86	-0.020	9.46	0.81
100	14.236	0.144	2.09	97	-1.66	100	84	-0.040	9.03	0.86
110	15.678	0.144	2.08	98	-1.52	100	84	-0.040	9.03	0.85
120	17.123	0.145	2.08	99	-2.16	100	86	-0.020	8.09	0.98
130	18.571	0.145	2.08	99	-1.59	100	85	-0.020	7.04	1.17
140	20.020	0.145	2.08	100	-1.28	100	83	0.000	7.18	1.40
150	21.468	0.145	2.09	100	-2.03	100	85	-0.010	7.15	1.52
160	22.914	0.145	2.09	100	-1.79	99	86	-0.010	6.91	1.45
170	24.362	0.145	2.08	101	-2.76	99	85	-0.010	6.75	1.30
180	25.812	0.145	2.08	101	-2.73	99	83	-0.010	6.62	1.43
190	27.261	0.145	2.08	101	-2.69	99	84	-0.010	6.52	1.52
200	28.709	0.145	2.08	102	-2.8	99	85	0.000	6.44	1.62
210	30.158	0.145	2.09	101	-2.69	99	86	-0.020	6.30	1.71
220	31.609	0.145	2.09	101	-2.43	99	85	-0.010	6.45	1.41
230	33.059	0.145	2.08	100	-2.78	99	84	0.000	6.18	1.36
240	34.511	0.145	2.09	100	-1.66	99	84	-0.010	6.16	1.54
250	35.962	0.145	2.10	99	-2.76	99	83	-0.010	6.01	1.68
260	37.411	0.145	2.09	99	-2.52	99	83	-0.010	5.40	1.84
270	38.859	0.145	2.09	98	-1.39	99	84	-0.010	5.02	2.04
280	40.307	0.145	2.09	98	-2.68	99	85	-0.010	5.04	1.88
290	41.755	0.145	2.10	98	-0.73	99	85	0.000	4.49	2.02
300	43.203	0.145	2.10	97	-2.8	99	85	0.000	4.60	2.06
310	44.652	0.145	2.11	97	-2.77	100	85	-0.020	4.52	2.02

BOX B TEST DATA - ASTM E2780 / ASTM E2515

Client: IHPJob #: 18-428Model: GV230GLTracking #: 0008Run #: 1Technician: SJBDate: 9/12/2018

Elapsed Time (min)	Particulate Sampling Data							Flue Gas Data		
	Gas Meter (ft ³)	Sample Rate (cfm)	Orifice dH (in H ₂ O)	Meter Temp (°F)	Meter Vacuum (in Hg)	Pro. Rate (%)	Filter (°F)	Flue Draft (in H ₂ O)	CO ₂ (%)	CO (%)
320	46.097	0.145	2.10	97	-1.52	99	85	-0.010	4.20	1.95
330	47.542	0.145	2.11	98	-1.18	99	85	0.020	4.38	2.92
340	48.988	0.145	2.09	98	-1.5	99	85	0.000	4.39	2.84
350	50.436	0.145	2.09	99	-2.69	99	85	-0.010	4.73	2.86
360	51.883	0.145	2.09	99	-0.92	99	85	0.000	4.64	3.16
370	53.330	0.145	2.10	100	-2.84	99	84	-0.010	5.99	2.10
380	54.777	0.145	2.09	100	-0.68	99	84	0.010	5.99	2.03
390	56.224	0.145	2.08	100	-0.94	99	83	0.000	5.50	2.15
Avg/Tot	56.224	0.144	2.04	96	-1.92	100	85	-0.016	7.21	1.50

WOODSTOVE SURFACE TEMPERATURE DATA

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 1

Technician: SJB

Date: 9/12/2018

Stove ΔT: 109

Temperature Data (°F)							
Elapsed Time (min)	FB Left	FB Right	FB Back	FB Top	FB Bottom	Stove Surface Average	Catalyst Exit
0	397	465	261	286	241	330.0	N/A
10	382	431	327	545	221	381.2	N/A
20	378	432	322	763	224	423.8	N/A
30	386	446	244	730	228	406.8	N/A
40	410	460	202	737	220	405.8	N/A
50	433	470	196	685	213	399.4	N/A
60	447	477	200	667	207	399.6	N/A
70	455	483	209	586	202	387.0	N/A
80	457	484	222	512	198	374.6	N/A
90	456	482	236	458	195	365.4	N/A
100	450	478	242	425	193	357.6	N/A
110	446	473	248	404	192	352.6	N/A
120	444	467	253	394	190	349.6	N/A
130	426	449	253	345	191	332.8	N/A
140	409	433	248	314	193	319.4	N/A
150	398	418	242	294	195	309.4	N/A
160	390	405	236	281	196	301.6	N/A
170	382	396	231	269	198	295.2	N/A
180	371	388	225	259	198	288.2	N/A
190	362	379	220	251	200	282.4	N/A
200	353	373	215	245	199	277.0	N/A
210	344	368	211	241	199	272.6	N/A
220	336	365	208	234	198	268.2	N/A
230	329	362	204	232	198	265.0	N/A
240	323	359	200	228	198	261.6	N/A
250	316	358	196	226	196	258.4	N/A
260	310	356	193	221	198	255.6	N/A
270	304	349	189	214	196	250.4	N/A
280	297	342	186	206	196	245.4	N/A
290	290	335	183	199	194	240.2	N/A
300	284	327	180	192	191	234.8	N/A
310	280	319	178	188	188	230.6	N/A
320	275	312	175	185	186	226.6	N/A
330	271	303	173	180	184	222.2	N/A
340	270	294	173	178	179	218.8	N/A
350	273	287	175	175	175	217.0	N/A
360	276	283	177	175	172	216.6	N/A
370	279	281	178	177	169	216.8	N/A
380	283	285	178	182	166	218.8	N/A
390	287	290	179	186	163	221.0	N/A
Average	356	387	214	332	196	297	N/A

LAB SAMPLE DATA - ASTM E2515

Client: IHP

Job #: 18-428

Model: GV230GL

Tracking #: 0008

Run #: 1

Technician: SJB

Date: 9/12/2018

TRAIN A (1st Hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3279	128.8	121.5	7.3
B. Rear filter catch	Filter				0.0
C. Probe catch*	Probe				0.0
D. O-Ring catch*	O-Ring				0.0

Sub-Total

Total Particulate, mg:

7.3

TRAIN A (Post 1st hour)

Sample Component	Sample Type	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3280	125.1	122.5	2.6
B. Rear filter catch	Filter	3281	117.5	117.1	0.4
C. Probe catch*	Probe	4A	116183.2	116183.0	0.2
D. O-Ring catch*	O-Ring	4A	3593.1	3592.8	0.3

Sub-Total

Total Particulate, mg:

3.5

Train A Aggregate

Total Particulate, mg:

10.8**TRAIN B**

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Front filter catch	Filter	3282	130.1	121.4	8.7
B. Rear filter catch	Filter	3283	119.1	118.7	0.4
C. Probe catch*	Probe	4B	116366.0	116366.0	0.0
D. O-Ring catch*	O-Ring	4B	3581.0	3580.5	0.5

Total Particulate, mg:

9.6**AMBIENT**

Sample Component	Reagent	Filter, Probe, or O-Ring #	Weights		
			Final, mg	Tare, mg	Particulate, mg
A. Filter catch*	Filter	3284	122.0	122.0	0.0

Total Particulate, mg:

0.0

*Particulate catch that results in a negative number, is assumed to be zero for probes and O-rings, negative numbers for filters are assumed to be part of the O-Ring weight.

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 1 Test Date: 9/12/2018

Wood Heater Run Notes

Test Control Settings

Primary Air Setting(s): Fully closed

Preburn Notes

Preburn Start Time: 9:29

Time	Notes
8:14	Loaded 9.9 lbs of kindling
9:05	Loaded Pre-burn Fuel
9:29	Set air to test setting, turned fan on to low setting
10:39	Leveled coal bed, turned off convection fan in preparation of fuel loading.

Test Notes

Test Burn Start Time: 10:41
 Test Fuel Loaded by: 50 seconds
 Door Closed: 4 minutes
 Air Control Set at: 5 minutes
 Other Loading Notes: N/A

Time	Notes
25 min	Turned convection fan on low, per manufacturer's instructions.
60 min	Changed 1-hour filter.
390 min	End of Test

Test Burn End Time: 17:11
 Background Filter Volume (ft³): 65.199

Filter Data

Train	A	A	A	A	A	B	B	B	B	AMB
Element	Front Filter (First Hour)	Front Filter (Remainder)	Rear Filter	Probe	O-Ring Pair	Front Filter	Rear Filter	Probe	O-Ring Pair	Filter
ID #	3279	3280	3281	4A	4A	3282	3283	4B	4B	3284
Tare (mg)	121.5	122.5	117.1	116183.0	3592.8	121.4	118.7	116366.0	3580.5	122.0
Final Weight (mg)	128.8	125.1	117.5	116183.2	3593.1	130.1	119.1	116366.0	3581.0	122.0

Sample Train Leak Check: A: 0.000 @ -14 "Hg B: 0.000 @ -12 "Hg AMB: 0.000 @ -13 "Hg

Technician Signature: 

Date: 9/18/2018

ASTM E2780 Wood Heater Run Sheets

Client: IHP Job Number: 18-428 Tracking #: 0008
 Model: GV230GL Run Number: 1 Test Date: 9/12/2018

Flue Gas Concentration Measurement

Calibration Gas Values: Span Gas CO₂ (%): 16.93 CO (%): 4.33
 Mid Gas CO₂ (%): - CO (%): -

Calibration Results:

	Pre Test			Post Test		
	Zero	Mid	Span	Zero	Mid	Span
Time	8:34	-	8:37	17:30	-	17:34
CO ₂	0.00	-	16.93	0.10	-	17.08
CO	0.000	-	4.330	-0.011	-	4.347

Flue Gas Probe Leak Check: Initial: No Leakage Final: No Leakage

Dilution Tunnel Flow

Pitot Tube Leak Test: Initial: No Leakage Final: No Leakage

Velocity Traverse Data

	Pt.1	Pt.2	Pt.3	Pt.4	Pt.5	Pt.6	Pt.7	Pt.8	Center
dP (inH ₂ O):	0.032	0.050	0.062	0.048	0.036	0.058	0.058	0.034	0.070
Temp (°F):	99	99	99	99	99	99	99	99	99

Dilution Tunnel Static Pressure (inH₂O): -0.18

Supplemental Data

Room Air Velocity (ft/min): Initial: <50 Final: <50

Scale Audit (lbs): Initial: 10 Final: 10

Stack Diameter (in): 6

Induced Draft (in H₂O): 0

% Smoke Capture: 100

Flue Pipe Cleaned Prior to First Test in

Series: Date: 9/10/2018

	Initial	Middle	Ending
P _b (inHg)	29.94	29.92	29.91
RH (%)	47.8	43.5	37.9

Technician Signature: 

Date: 9/18/2018

Sample Calculations – ASTM E2780 & E2515

Client: IHP
 Model: GV230GL
 Run: 1

Equations used to calculate the parameters listed below are described in this appendix. Sample calculations are provided for each equation. The raw data and printout results from a sample run are also provided for comparison to the sample calculations.

M_{Sdb} – Weight of test fuel spacers, dry basis, kg
 M_{Cdb} – Weight of test fuel crib, excluding nails and spacers, dry basis, kg
 D_{Cdb} - Density of fuel crib, excluding spacers and nails, dry basis, lbs/ft³
 M_{FTAdb} - Total weight of fuel crib excluding nails, dry basis, kg
 BR – Dry burn rate, kg/hr
 V_s – Average gas velocity in the dilution tunnel, ft/sec
 Q_{sd} – Average gas flow rate in dilution tunnel, dscf/hr
 $V_{m(std)}$ – Volume of gas sampled, corrected to dry standard conditions, dscf
 m_n – Total particulate matter collected, mg
 C_s - Concentration of particulate matter in tunnel gas, dry basis, corrected to STP, g/dscf
 E_T – Total particulate emissions, g
 PR - Proportional rate variation
 PM_R – Particulate emissions for test run, g/hr
 PM_F – Particulate emission factor for test run, g/dry kg of fuel burned

M_{Sdb} – Weight of test fuel spacers, dry basis, kg

ASTM E2780 equation (1)

$$M_{Sdb} = (M_{Swb})(100/(100 + FM_S))$$

Where,

FM_S = average fuel moisture of test fuel spacers, % dry basis

M_{Swb} = weight of test fuel spacers, wet basis, kg

Sample Calculation:

$$FM_S = 8.8 \%$$

$$M_{Swb} = 1.8 \text{ lbs}$$

0.4536 = Conversion factor from lbs to kg

$$M_{Sdb} = [(1.8 \times 0.4536) (100/(100 + 8.8))]$$

$$M_{Sdb} = 0.75 \text{ kg}$$

M_{Cdb}— Weight of test fuel crib, excluding nails and spacers, dry basis, kg

ASTM E2780 equation (2)

$$M_{Cdb} = \Sigma[(M_{CPnwb})(100/(100 + FM_{CPn}))]$$

Where,

M_{CPnwb} = weight of each test fuel piece n in fuel crib, excluding nails and spacers, wet basis, kg

FM_{CPn} = Average fuel moisture of test fuel n in fuel crib, % dry basis

Sample Calculation (test fuel piece 1):

$$M_{CPnwb} = 1.85$$

$$FM_{CPn} = 19.5$$

$$= 1.9 \left(100 / (100 + 19.5) \right)$$

$$= 1.5 \text{ lbs}$$

Total dry crib weight, excluding spacers = 11.45 lbs

$$M_{Cdb} = \mathbf{5.20 \text{ kg}}$$

D_{Cdb} - Density of fuel crib, excluding spacers and nails, dry basis, lbs/ft³
ASTM E2780 equation (3)

$$D_{Cdb} = M_{Cdb} / V_C$$

Where,

$$V_C = \text{Volume of fuel crib, ft}^3$$

Sample calculation:

$$V_C = 705.3 \text{ in}^3$$

$$1728 = \text{conversion from in}^3 \text{ to ft}^3$$

$$D_{Cdb} = 11.45 / 705.3 * 1728$$

$$= \mathbf{28.07 \text{ lbs/ft}^3}$$

M_{FTAdb} - Total weight of fuel crib excluding nails, dry basis, kg
ASTM E2780 equation (4)

$$M_{FTAdb} = M_{Sdb} + M_{Cdb}$$

Sample calculation:

$$M_{FTAdb} = 0.75 + 5.20$$

$$= 5.95 \text{ kg}$$

BR – dry burn rate, kg/hr

ASTM E2780 equation (5)

$$BR = \frac{60 M_{FTAdb}}{\theta}$$

Where,

θ = Total length of test run, min

Sample Calculation:

$$M_{Bdb} = 5.95 \quad \text{kg}$$

$$\theta = 390 \quad \text{min}$$

$$BR = \frac{60 \times 5.95}{390}$$

$$BR = \mathbf{0.91} \quad \text{kg/hr}$$

V_s – Average gas velocity in the dilution tunnel, ft/sec

ASTM E2515 equations (9)

$$V_s = F_p \times k_p \times C_p \times (\sqrt{\Delta P})_{avg} \times \sqrt{\frac{T_{s(avg)}}{P_s \times M_s}}$$

Where:

- F_p = Adjustment factor for pitot tube center point reading = $\frac{V_{strav}}{V_{scent}}$, ASTM E2515 Equation (1)
 V_{scent} = Dilution tunnel velocity calculated after the multi-point pitot traverse at the center, ft/sec
 V_{strav} = Dilution tunnel velocity calculated after the multi-point pitot traverse, ft/sec
 k_p = Pitot tube constant, 85.49
 C_p = Pitot tube coefficient: 0.99, unitless
 ΔP^* = Velocity pressure in the dilution tunnel, in H₂O
 T_s = Absolute average gas temperature in the dilution tunnel, °R; (°R = °F + 460)
 P_s = Absolute average gas static pressure in dilution tunnel, = $P_{bar} + P_g$, in Hg
 P_{bar} = Barometric pressure at test site, in. Hg
 P_g = Static pressure of tunnel, in. H₂O; (in Hg = in H₂O/13.6)
 M_s = **The dilution tunnel wet molecular weight; $M_s = 28.78$ assuming a dry weight of 29 lb/lb-mole

Sample calculation:

$$F_p = \frac{15.08}{18.04} = 0.836$$

$$V_s = 0.836 \times 85.49 \times 0.99 \times 0.265 \times \left(\left(\frac{86.8}{29.92} + \frac{460}{-0.18} \right) \times \frac{28.78}{13.6} \right)^{1/2}$$

$$V_s = 14.92 \text{ ft/s}$$

*The ASTM test standard mistakenly has the square root of the average delta p instead of the average of the square root of delta p. The current EPA Method 2 is also incorrect. This was verified by Mike Toney at EPA.

**The ASTM test standard mistakenly identifies M_s as the dry molecular weight. It should be the wet molecular weight as indicated in EPA Method 2.

Q_{sd} – Average gas flow rate in dilution tunnel, dscf/hr

ASTM E2515 equation (3)

$$Q_{sd} = 3600 \times (1 - B_{ws}) \times v_s \times A \times \frac{T_{std}}{T_{s(avg)}} \times \frac{P_s}{P_{std}}$$

Where:

- 3600 = Conversion from seconds to hours (ASTM method uses 60 to convert in minutes)
- B_{ws} = Water vapor in gas stream, proportion by volume; assume 2%
- A = Cross sectional area of dilution tunnel, ft²
- T_{std} = Standard absolute temperature, 528 °R
- P_s = Absolute average gas static pressure in dilution tunnel, = P_{bar} + P_g, in Hg
- T_{s(avg)} = Absolute average gas temperature in the dilution tunnel, °R; (°R = °F + 460)
- P_{std} = Standard absolute pressure, 29.92 in Hg

Sample calculation:

$$Q_{sd} = 3600 \times (1 - 0.02) \times 14.92 \times 0.1963 \times \frac{528}{86.8 + 460} \times \frac{29.92 + \frac{-0.18}{13.6}}{29.92}$$

Q_{sd} = 9978.1 dscf/hr

$V_{m(std)}$ – Volume of Gas Sampled Corrected to Dry Standard Conditions, dscf
 ASTM E2515 equation (6)

$$V_{m(std)} = K_1 V_m Y \frac{P_{bar} + \left(\frac{\Delta H}{13.6} \right)}{T_m}$$

Where:

K_1	=	17.64 °R/in. Hg
V_m	=	Volume of gas sample measured at the dry gas meter, dcf
Y	=	Dry gas meter calibration factor, dimensionless
P_{bar}	=	Barometric pressure at the testing site, in. Hg
ΔH	=	Average pressure differential across the orifice meter, in. H ₂ O
T_m	=	Absolute average dry gas meter temperature, °R

Sample Calculation:

Using equation for Train 1:

$$V_{m(std)} = 17.64 \times 57.033 \times 1.002 \times \frac{\left(29.92 + \frac{2.07}{13.6} \right)}{\left(97.2 + 460 \right)}$$

$$V_{m(std)} = \mathbf{54.411} \text{ dscf}$$

Using equation for Train 2:

$$V_{m(std)} = 17.64 \times 56.224 \times 0.997 \times \frac{\left(29.92 + \frac{2.04}{13.6} \right)}{\left(95.6 + 460 \right)}$$

$$V_{m(std)} = \mathbf{53.525} \text{ dscf}$$

Using equation for ambient train:

$$V_{m(std)} = 17.64 \times 65.20 \times 0.999 \times \frac{\left(\underline{29.923} + \frac{0.00}{13.6} \right)}{\left(74.8 + 460 \right)}$$

$$V_{m(std)} = \mathbf{64.293} \text{ dscf}$$

m_n – Total Particulate Matter Collected, mg

ASTM E2515 Equation (12)

$$m_n = m_p + m_f + m_g$$

Where:

 m_p = mass of particulate matter from probe, mg m_f = mass of particulate matter from filters, mg m_g = mass of particulate matter from filter seals, mg

Sample Calculation:

Using equation for Train A (first hour):

$$m_n = 0.0 + 7.3 + 0.0$$

$$m_n = 7.3 \text{ mg}$$

Using equation for Train A (post-first hour):

$$m_n = 0.2 + 3.0 + 0.3$$

$$m_n = 3.5 \text{ mg}$$

Train A aggregate:

$$m_n = 7.3 + 3.5$$

$$m_n = \mathbf{10.8 \text{ mg}}$$

Using equation for Train B:

$$m_n = 0 + 9.1 + 0.5$$

$$m_n = \mathbf{9.6 \text{ mg}}$$

C_s - Concentration of particulate matter in tunnel gas, dry basis, corrected to STP, g/dscf
 ASTM E2515 equation (13)

$$C_s = K_2 \times \frac{m_n}{V_{m(\text{std})}}$$

Where:

- K_2 = Constant, 0.001 g/mg
 m_n = Total mass of particulate matter collected in the sampling train, mg
 $V_{m(\text{std})}$ = Volume of gas sampled corrected to dry standard conditions, dscf

Sample calculation:

For Train 1:

$$C_s = 0.001 \times \frac{10.8}{54.41}$$

$$C_s = \mathbf{0.00020} \text{ g/dscf}$$

For Train 2

$$C_s = 0.001 \times \frac{9.6}{53.52}$$

$$C_s = \mathbf{0.00018} \text{ g/dscf}$$

For Ambient Train

$$C_r = 0.001 \times \frac{0.0}{64.29}$$

$$C_r = \mathbf{0.000000} \text{ g/dscf}$$

E_T – Total Particulate Emissions, g

ASTM E2515 equation (15)

$$E_T = (c_s - c_r) \times Q_{std} \times \theta$$

Where:

C _s	=	Concentration of particulate matter in tunnel gas, g/dscf
C _r	=	Concentration particulate matter room air, g/dscf
Q _{std}	=	Average dilution tunnel gas flow rate, dscf/hr
θ	=	Total time of test run, minutes

Sample calculation:

For Train 1

$$E_T = (\underline{0.000198} - 0.000000) \times \underline{9978.1} \times \underline{390} / 60$$

$$E_T = \underline{12.87} \text{ g}$$

For Train 2

$$E_T = (\underline{0.000179} - 0.000000) \times \underline{9978.1} \times \underline{390} / 60$$

$$E_T = \underline{11.63} \text{ g}$$

Average

$$E = \underline{12.25} \text{ g}$$

Total emission values shall not differ by more than 7.5% from the total average emissions

$$7.5\% \text{ of the average} = \underline{0.92}$$

$$\text{Train 1 difference} = \underline{0.62}$$

$$\text{Train 2 difference} = \underline{0.62}$$

PR - Proportional Rate Variation

ASTM E2515 equation (16)

$$PR = \left[\frac{\theta \times V_m \times V_s \times T_m \times T_{si}}{\theta_i \times V_m \times V_{si} \times T_m \times T_s} \right] \times 100$$

Where:

- θ = Total sampling time, min
 θ_i = Length of recording interval, min
 V_{mi} = Volume of gas sample measured by the dry gas meter during the "ith" time interval, dcf
 V_m = Volume of gas sample as measured by dry gas meter, dcf
 V_{si} = Average gas velocity in the dilution tunnel during the "ith" time interval, ft/sec
 V_s = Average gas velocity in the dilution tunnel, ft/sec
 T_{mi} = Absolute average dry gas meter temperature during the "ith" time interval, °R
 T_m = Absolute average dry gas meter temperature, °R
 T_{si} = Absolute average gas temperature in the dilution tunnel during the "ith" time interval, °R
 T_s = Absolute average gas temperature in the dilution tunnel, °R

Sample calculation (for the first 1 minute interval of Train 1):

$$PR = \left(\frac{390 \times 1.394 \times 14.92 \times (104.0 + 460) \times (97.2 + 460)}{10 \times 57.033 \times 15.15 \times (86.8 + 460) \times (73.0 + 460)} \right) \times 100$$

$$PR = \underline{101} \%$$

PM_R – Particulate emissions for test run, g/hr

ASTM E2780 equation (6)

$$PM_R = 60 (E_T/\theta)$$

Where,

E_T = Total particulate emissions, grams

θ = Total length of full integrated test run, min

Sample Calculation:

$$E_T \text{ (Dual train average)} = 12.25 \text{ g}$$

$$\theta = 390 \text{ min}$$

$$PM_R = 60 \times (12.25 / 390)$$

$$PM_R = 1.89 \text{ g/hr}$$

PM_F – Particulate emission factor for test run, g/dry kg of fuel burned
ASTM E2780 equation (7)

$$PM_F = E_T / M_{FTAdB}$$

Sample Calculation:

$$E_T \text{ (Dual train average)} = 12.25 \text{ g}$$

$$M_{Bdb} = 5.95 \text{ kg}$$

$$PM_F = 12.25 / 5.95$$

$$PM_F = \mathbf{2.06} \text{ g/kg}$$

Conditioning Data

Client: IHP	Job #: 18-428
Model: GV230GL	Tracking #: 0008
Date(s): 8/27/18 - 9/7/2018	Technician: SJB

Elapsed Time (hrs)	Scale Reading (lbs)	Average: Weight Change (lbs)	207.4	76.8	N/A
			Flue (°F)	Ambient (°F)	Catalyst Exit (°F)
0	15.2	-	203	73	N/A
1	6.4	-8.9	334	74	N/A
2	3.0	-3.4	236	71	N/A
3	1.9	-1.1	182	72	N/A
4	1.1	-0.8	165	72	N/A
5	0.4	-0.7	156	73	N/A
6	15.5	15.1	237	75	N/A
7	6.3	-9.2	332	79	N/A
8	2.6	-3.7	260	78	N/A
9	1.6	-1.0	181	75	N/A
10	0.9	-0.8	162	76	N/A
11	0.2	-0.7	155	75	N/A
12	14.3	14.1	180	75	N/A
13	6.8	-7.5	326	77	N/A
14	3.5	-3.3	216	79	N/A
15	2.1	-1.4	143	79	N/A
16	1.6	-0.6	124	80	N/A
17	1.0	-0.6	124	80	N/A
18	0.2	-0.8	124	80	N/A
19	16.6	16.4	209	80	N/A
20	8.8	-7.8	302	80	N/A
21	4.2	-4.6	246	79	N/A
22	2.7	-1.5	149	79	N/A
23	2.0	-0.7	133	79	N/A
24	1.4	-0.7	129	80	N/A
25	0.5	-0.8	120	77	N/A
26	26.7	26.2	378	83	N/A
27	16.5	-10.2	376	80	N/A
28	10.4	-6.1	355	83	N/A
29	6.4	-4.0	286	84	N/A
30	5.0	-1.4	139	82	N/A
31	4.2	-0.8	128	80	N/A
32	16.2	12.0	206	72	N/A
33	7.1	-9.1	317	77	N/A
34	3.3	-3.8	234	75	N/A
35	2.2	-1.1	161	77	N/A
36	1.5	-0.7	145	78	N/A
37	0.7	-0.8	143	78	N/A
38	15.5	14.9	211	72	N/A
39	8.0	-7.5	313	73	N/A
40	3.8	-4.2	232	75	N/A
41	2.4	-1.5	157	74	N/A
42	1.5	-0.8	150	74	N/A
43	0.7	-0.8	150	76	N/A
44	16.6	15.9	220	73	N/A
45	8.6	-8.0	323	74	N/A
46	4.3	-4.4	249	76	N/A
47	2.8	-1.5	161	76	N/A
48	1.9	-0.9	150	76	N/A
49	1.7	-0.2	139	76	N/A
50	0.6	-1.1	128	76	N/A

EPA Method 28R Weighted Average Emissions

Client: IHP
 Stove Model: GV230GL
 Test Dates: 9/12/18 - 9/17/18
 Job Number: 18-428

Signature/Date: _____

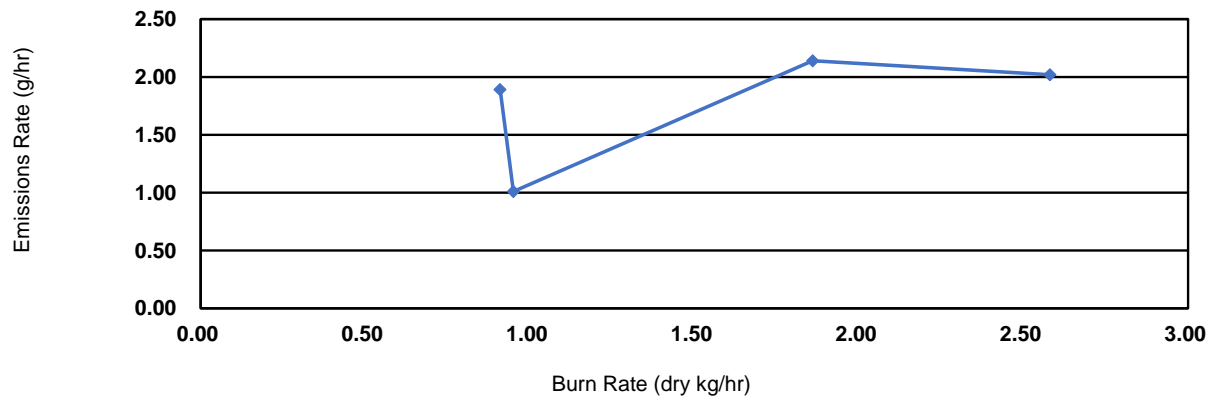
9/24/2018

Weighted Average Particulate Emissions (g/hr):	1.7
Weighted Average HHV Efficiency (%):	73.7%
Weighted Average LHV Efficiency (%):	79.7%
Average CO Emissions (g/min):	1.7

Individual Run Summaries

Run Number:	1	Run Number:	5
Burn Rate (dry kg/hr):	0.91	Burn Rate (dry kg/hr):	0.95
Emissions Rate (g/hr):	1.89	Emissions Rate (g/hr):	1.01
HHV Efficiency (%):	74.1%	HHV Efficiency (%):	75.2%
LHV Efficiency (%):	80.1%	LHV Efficiency (%):	81.3%
Weighting Percentage (%):	19.70%	Weighting Percentage (%):	34.78%
Run Number:	3	Run Number:	2
Burn Rate (dry kg/hr):	1.86	Burn Rate (dry kg/hr):	2.58
Emissions Rate (g/hr):	2.14	Emissions Rate (g/hr):	2.02
HHV Efficiency (%):	72.7%	HHV Efficiency (%):	71.0%
LHV Efficiency (%):	78.6%	LHV Efficiency (%):	76.7%
Weighting Percentage (%):	38.59%	Weighting Percentage (%):	6.93%

Emission Rate vs Burn Rate Plot





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 Clackamas, OR 97015

Report Number: DIRI01A05026180111

A2LA ACCREDITED
CERTIFICATE OF CALIBRATION WITH DATA

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Scale	Rice Lake	IQ+355E-2A x 1000	A05026	N/A	Lab
Units	Readability	SOP	Cal Date	Last Cal Date	Cal Due Date
lbs	1	QC033	1/11/18	6/27/17	6/2018

FUNCTIONAL CHECKS

SHIFT TEST	LINEARITY	REPEATABILITY	ENVIRONMENTAL CONDITIONS
Test Wt: 250 Tol: 1	Test Wt: HB44 Tol: HB44	Test Wt: 100 Tol: 1	
As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	<input type="checkbox"/> Good <input checked="" type="checkbox"/> Fair <input type="checkbox"/> Poor
As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	Temperature: 17.7°C

CALIBRATION DATA

Standard	As-Found	As-Left	Expanded Uncertainty
1000	1000.1	1000.1	0.5
700	700.3	700.3	0.5
500	499.8	499.8	0.5
300	300.0	300.0	0.5
100	100.0	100.0	0.5
50	50.0	50.0	0.5

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Avoirdupois Cast W	Rice Lake	25 and 50lb	PWO990-CA	11/24/17	11/2019	20172265

Permanent Information Concerning this Equipment:

2000lbs platform. Has a custom pan.

Comments/Information Concerning this Calibration

1/18 RH = 58.5

Report prepared/reviewed by: 

Date: 1-11-18

Technician: D. Oudeans

Signature: 

THIS CERTIFICATE SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE APPROVAL OF QUALITY CONTROL SERVICES, INC.

The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with the observed standard deviation of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy.



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PFS Teco
11785 SE Hwy 212 STE#305
Clackamas, OR 97015

Report Number: DIRI0182484A0912013i180613

A2LA ACCREDITED **CERTIFICATE OF CALIBRATION WITH DATA**

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Scale	Digiweigh	DWP12i 400x.01	82484A0912013i	#050	Lab
Units	Readability	SOP	Cal Date	Last Cal Date	Cal Due Date
lbs	0.01	QC033	6/13/18	1/11/18	12/2018

FUNCTIONAL CHECKS

SHIFT TEST	LINEARITY	REPEATABILITY	ENVIRONMENTAL CONDITIONS
Test Wt: 50 Tol: 0.05	Test Wt: HB44 Tol: HB44	Test Wt: 50 Tol: 0.01	
As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	As-Found: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> Good Fair Poor
As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	As-Left: Pass: <input checked="" type="checkbox"/> Fail: <input type="checkbox"/>	Temperature: 22.2°C

CALIBRATION DATA

Standard	As-Found	As-Left	Expanded Uncertainty
400	399.98	399.98	0.058
300	300.00	300.00	0.058
200	200.00	200.00	0.058
100	100.00	100.00	0.012
50	50.00	50.00	0.012
20	20.00	20.00	0.012

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Avoirdupois Cast W	Rice Lake	25 and 50lb	PWO990-CA	11/24/17	11/2019	20172265
Weight Set	Rice Lake	.001 to 10lb	PW0990	9/23/16	9/2018	20161896

Permanent Information Concerning this Equipment:

6 month calibration cycle. Relative humidity= 56%.

Comments/Information Concerning this Calibration

Report prepared/reviewed by: Jake C

Date: 6/13/18

Technician: J. Colacchio

Signature: [Signature]

THIS CERTIFICATE SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE APPROVAL OF QUALITY CONTROL SERVICES, INC.

The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with the observed standard deviation of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy.

Dry Gas Meter Calibration

Meter Manufacturer: Apex
 Model: XC-60-ED
 Lab ID #: 053
 Serial #: 1902130
 Calibration Date: 6/13/2018
 Calibration Expiration: 12/13/2018
 Barometric Pressure: 29.84 in. Hg



Reference Standard DGM	
Manufacturer:	Apex
Model:	SK25DA
Lab ID#:	047
Serial #:	1101001
Calibration Expiration Date:	3/5/2019
Calibration γ Factor:	0.998

Unit Under Test Previous Calibration	
Date	1/10/2018
γ Factor:	0.995
Allowable Deviation ($\pm 5\%$):	0.04975
Actual Deviation:	0.01
Result:	PASS

Calibration Data	Run 1	Run 2	Run 3
Standard DGM Initial Volume (L)	0.000	0.000	0.000
Standard DGM Final Volume (L)	144.977	146.222	201.016
Standard DGM Temperature ($^{\circ}\text{F}$)	73.2	73.0	72.0
Standard DGM Pressure (in H_2O)	0.00	0.00	0.0
DGM Initial Volume (ft^3)	0.000	0.000	0.000
DGM Final Volume (ft^3)	5.194	5.278	7.307
DGM Temperature ($^{\circ}\text{F}$)	84.0	90.0	94.0
DGM Pressure (in H_2O)	2.10	2.58	1.4
Time (min)	36.0	32.0	60.0
Net Volume for Standard DGM (ft^3)	5.120	5.164	7.099
Net Volume for DGM (ft^3)	5.194	5.278	7.307

Dry Gas Meter γ Factor	0.999	1.001	1.006
γ Factor Deviation From Average	0.999	1.001	1.006

Average Gas Meter γ Factor

1.002

Calculations:

- Deviation = |Average value for all runs - current run value|
- $\gamma = [V_{\text{std}} \times (\gamma_{\text{std}}) \times (P_{\text{bar}} + P_{\text{std}}/13.6) \times (T_{\text{DGM}} + 460)] / [V_{\text{DGM}} \times (T_{\text{std}} + 460) \times (P_{\text{bar}} + P_{\text{DGM}}/13.6)]$

Standard Reference Meter is calibrated to NIST traceable standards. Uncertainty of measurement is $\pm 0.5\%$.

Dry Gas Meter Calibration

Meter Manufacturer: Apex
 Model: XC-60-ED
 Lab ID #: 054
 Serial #: 1902133
 Calibration Date: 6/13/2018
 Calibration Expiration: 12/13/2018
 Barometric Pressure: 29.84 in. Hg



Reference Standard DGM	
Manufacturer:	Apex
Model:	SK25DA
Lab ID#:	047
Serial #:	1101001
Calibration Expiration Date:	3/5/2019
Calibration γ Factor:	0.998

Unit Under Test Previous Calibration	
Date	1/11/2018
γ Factor:	1.000
Allowable Deviation ($\pm 5\%$):	0.05
Actual Deviation:	0.00
Result:	PASS

Calibration Data	Run 1	Run 2	Run 3
Standard DGM Initial Volume (L)	0.000	0.000	0.000
Standard DGM Final Volume (L)	158.715	148.505	236.136
Standard DGM Temperature ($^{\circ}\text{F}$)	72.5	73.2	73.0
Standard DGM Pressure (in H_2O)	0.00	0.00	0.0
DGM Initial Volume (ft^3)	0.000	0.000	0.000
DGM Final Volume (ft^3)	5.777	5.426	8.616
DGM Temperature ($^{\circ}\text{F}$)	93.5	94.0	90.0
DGM Pressure (in H_2O)	2.50	2.00	1.5
Time (min)	37.0	38.5	71.5
Net Volume for Standard DGM (ft^3)	5.605	5.244	8.339
Net Volume for DGM (ft^3)	5.777	5.426	8.616
Dry Gas Meter γ Factor	1.000	0.997	0.993
γ Factor Deviation From Average	1.000	0.997	0.993

Average Gas Meter γ Factor

0.997

Calculations:

- Deviation = |Average value for all runs - current run value|
- $\gamma = [V_{\text{std}} \times (\gamma_{\text{std}}) \times (P_{\text{bar}} + P_{\text{std}}/13.6) \times (T_{\text{DGM}} + 460)] / [V_{\text{DGM}} \times (T_{\text{std}} + 460) \times (P_{\text{bar}} + P_{\text{DGM}}/13.6)]$

Standard Reference Meter is calibrated to NIST traceable standards. Uncertainty of measurement is $\pm 0.5\%$.

Dry Gas Meter Calibration

Meter Manufacturer: Apex
 Model: Apex-AK-600
 Lab ID #: 055
 Serial #: 810016
 Calibration Date: 6/15/2018
 Calibration Expiration: 6/15/2019
 Barometric Pressure: 29.83 in. Hg



Reference Standard DGM	
Manufacturer:	Apex
Model:	SK25DA
Lab ID#:	047
Serial #:	1101001
Calibration Expiration Date:	3/5/2019
Calibration γ Factor:	0.998

Unit Under Test Previous Calibration	
Date	1/18/2017
γ Factor:	0.997
Allowable Deviation ($\pm 5\%$):	0.04985
Actual Deviation:	0.00
Result:	PASS

Calibration Data	Run 1	Run 2	Run 3
Standard DGM Initial Volume (L)	0.000	0.000	0.000
Standard DGM Final Volume (L)	145.479	148.058	143.802
Standard DGM Temperature ($^{\circ}\text{F}$)	71.0	71.0	71.0
Standard DGM Pressure (in H_2O)	0.00	0.00	0.0
DGM Initial Volume (ft^3)	0.000	0.000	0.000
DGM Final Volume (ft^3)	5.146	5.254	5.114
DGM Temperature ($^{\circ}\text{F}$)	75.0	76.5	77.5
DGM Pressure (in H_2O)	1.80	1.80	1.8
Time (min)			
Net Volume for Standard DGM (ft^3)	5.138	5.229	5.078
Net Volume for DGM (ft^3)	5.146	5.254	5.114

Dry Gas Meter γ Factor	0.999	0.999	0.999
γ Factor Deviation From Average	0.999	0.999	0.999

Average Gas Meter γ Factor

0.999

Calculations:

- Deviation = |Average value for all runs - current run value|
- $\gamma = [V_{\text{std}} \times (\gamma_{\text{std}}) \times (P_{\text{bar}} + P_{\text{std}}/13.6) \times (T_{\text{DGM}} + 460)] / [V_{\text{DGM}} \times (T_{\text{std}} + 460) \times (P_{\text{bar}} + P_{\text{DGM}}/13.6)]$

Standard Reference Meter is calibrated to NIST traceable standards. Uncertainty of measurement is $\pm 0.5\%$.



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Report of Calibration

Firm: Dirigo Laboratories
Address: 11785 SE Hwy 212, Ste 305
City/State/Zip: Clackamas, OR 97015

Test Completed: 03/21/17
Submitted By: John Steiner
Traceable Number: 20170468

Test Item: 200mg and 100mg Individual Weights
Serial No.: Listed in Table

Manufacturer: Troemner

<u>Material</u>	<u>Assumed Density</u>	<u>Range</u>	<u>Tolerance Class</u>
Stainless Steel	7.95 g/cm ³	200mg & 100mg	ASTM Class 1

Method and Traceability

The procedure used for this calibration is NIST IR 6969 SOP 4 Double Substitution Weighing Design. Standards used for comparison are traceable to the National Institute of Standards and Technology (reports on file) and are part of a comprehensive measurement assurance program for ensuring continued accuracy and traceability within the level of uncertainty reported. The Traceable Number listed above is Traceable to National Standards through an unbroken chain of comparison each having stated uncertainties.

Standards Used:

100g to 1mg Working Standards Were Calibrated: 03/03/17 Due: 03/31/18 Standards ID: 723318

Mass Comparators Used: MET-05

Tested by: D. Thompson

Conventional Mass: “The conventional value of the result of weighing a body in air is equal to the mass of a standard, of conventionally chosen density, at a conventionally chosen temperature, which balances this body at this reference temperature in air of conventionally chosen density. International Recommendation 33 (OIML IR 33 1973, 1979). “Conventional Value of the Result of Weighing in Air” (Previously known as “Apparent Mass vs. 8.0g/cm³).

Uncertainty Statement: The uncertainty conforms to the ISO Guide to the Expressions of Uncertainty in Measurement. Uncertainty as reported is based on a coverage factor k=2 for an approximate 95 percent level of uncertainty. Uncertainty components include the standard deviation of the process, the uncertainty of the standard used, an uncertainty component associated with the potential drift of the standard used, and the estimated uncertainty related to measuring and determining the air buoyancy effect.

Conventional Mass Values are listed on page 2 of this report.

page 1 of 2

Quality Control Services, Inc.
Metrology Laboratory Manager
E-mail dthompson@qc-services.com

Date: 03/21/17

Signature David S. Thompson

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Member: National Conference of Standards Laboratories and Weights & Measures



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Report of Calibration

Firm: Dirigo Laboratories
Address: 11785 SE Hwy 212, Ste 305
City/State/Zip: Clackamas, OR 97015

Test Completed: 03/21/17
Submitted By: John Steiner
Traceable Number: 20170468

Test Item: 200mg and 100mg Individual Weights
Serial No.: Listed in Table

Manufacturer: Troemner

Laboratory Environment at time of test

Temperature °C	Pressure mmHg	Humidity %RH
21.967	753.44	49.44

Conventional Mass Value

Nominal Value	As Found grams	As Found Correction* (mg)	Uncertainty (mg)	Tolerance (mg)
200mg SN 1000101395	0.2000061	0.0061	0.0026	0.01
100mg SN 1000126267	0.1000046	0.0046	0.0028	0.01

*Correction is the difference between the conventional mass value of a weight and its nominal value.

Comments: These weights were new from the manufacturer and were within ASTM Class 1 tolerances As Found. No adjustments or changes were made so As Found values should be considered to be As Left values.

Accredited by the American Association for Laboratory Accreditation (A2LA) under Calibration Laboratory Code 115953 and Certificate Number 1550.01. This laboratory meets the requirements of ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and any additional program requirements in the field of calibration.

page 2 of 2

Quality Control Services, Inc.
Metrology Laboratory Manager
E-mail dthompson@qc-services.com

Date: 03/21/17

Signature David S. Thompson



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Report of Calibration

Firm: Dirigo Laboratories
Address: 11785 SE Hwy 212, Ste 305
City/State/Zip: Clackamas, OR 97015

Test Completed: 01/15/16
Purchase Order: 1001
Traceable Number: 20152489

Test Item: 20lb and 10lb Individual Grip Handle Weights
Serial No.: Listed in Table

Manufacturer: Unknown

Laboratory Environment at time of test

Temperature °C	Pressure mmHg	Humidity %RH
21.448	760.64	44.58

Conventional Mass Value

Nominal Value	As Found pounds	As Found Correction* (mg)	Uncertainty (mg)	Tolerance (mg)
20lb #098	19.9995450	-206.4	6.4	910
10lb #097	10.0006510	295.3	5.1	450
10lb #051	10.0003421	155.2	5.1	450

*Correction is the difference between the conventional mass value of a weight and its nominal value.


Comments: These weights were received in good condition and were within NIST Handbook 105-1 Class F tolerances As Found. No adjustments or changes were made so As Found values should be considered to be As Left values.

Accredited by the American Association for Laboratory Accreditation (A2LA) under Calibration Laboratory Code 115953 and Certificate Number 1550.01. This laboratory meets the requirements of ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCCL Z540-1-1994 and any additional program requirements in the field of calibration.

page 2 of 2

Quality Control Services, Inc.
Metrology Laboratory Manager
E-mail dthompson@qc-services.com

Date: 01/15/16


Signature David S. Thompson



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PFS Teco
11785 SE Hwy 212 STE#305
Clackamas, OR 97015

Report Number: DIRI0134307497180613

A2LA ACCREDITED **CERTIFICATE OF CALIBRATION WITH DATA**

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Balance	Sartorius	ENTRIS224-1S	34307497	#107	Lab
Units	Readability	SOP	Cal Date	Last Cal Date	Cal Due Date
g	0.0001	QC012	6/13/18	1/11/18	12/2018

FUNCTIONAL CHECKS

ECCENTRICITY		LINEARITY		STANDARD DEVIATION			ENVIRONMENTAL CONDITIONS
Test Wt:	Tol:	Test Wt:	Tol:	Test Wt:	Tol:		
100	0.0003	50 x 4	0.0002	100	0.0001		<input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>
As-Found:		As-Found:		1.100.0000	5.100.0001	9.100.0001	Good Fair Poor
Pass: <input checked="" type="checkbox"/>	Fail: <input type="checkbox"/>	Pass: <input checked="" type="checkbox"/>	Fail: <input type="checkbox"/>	2.100.0000	6.100.0001	10.100.0001	
As-Left:		As-Left:		3.100.0000	7.100.0001	Result	Temperature: 22.8°C
Pass: <input checked="" type="checkbox"/>	Fail: <input type="checkbox"/>	Pass: <input checked="" type="checkbox"/>	Fail: <input type="checkbox"/>	4.100.0000	8.100.0001	0.00005	

A2LA ACCREDITED SECTION OF REPORT

Standard	As-Found	As-Left	Expanded Uncertainty
200	199.9980	200.0000	0.00015
100	99.9991	100.0000	0.00015
50	49.9995	50.0001	0.00015
20	19.9998	20.0000	0.00015
1	1.0000	1.0000	0.00015
0.1	0.1000	0.1000	0.00015

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Weight Set	Rice Lake	20 kg to 1mg	2831W	1/3/18	1/2019	20152429

Permanent Information Concerning this Equipment:

6 month calibration cycle. Relative humidity= 47%

Comments/Info Concerning this Calibration:

6/13/18: Adjusted span.

Report prepared/reviewed by:

Jake C Date: 6/13/18

Technician: J. Colacchio

Signature: [Signature]

THIS CERTIFICATE SHALL NOT BE REPRODUCED WITHOUT THE APPROVAL OF QUALITY CONTROL SERVICES, INC.

The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with the observed standard deviation and readability of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy. Calibrations comply with ISO/IEC 17025 and ANSI/Z540-1-1994 quality standards.

NIST Traceable Calibration Report



1375092

Reference Number: 1200788
PO Number: JSTEINERT013118

PFS-TECO

11785 SE Highway 212
Suite 305
Clackamas, OR 97015 United States

Manufacturer: Dwyer Instruments Inc.
Model Number: 471
Description: Air Velocity, Digital Thermo Anemometer
Asset Number: #095
Serial Number: #095
Procedure: DS Universal Speed/Time/Temperature

Calibration Date: 02/14/2018
Calibration Due Date: 02/14/2019
Condition As Found: Limited In Tol See Comments
Condition As Left: Limited See Comments

Remarks:

NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures. No adjustments were made to the unit.

This calibration is considered limited due to the requested test range.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP105979	Kanomax	X5602	Air Velocity, Wind Tunnel, Open Jet	01/06/2018	01/31/2019
CP144554	Fluke Corporation	1551A EX	Temperature, Stik Thermometer	01/08/2018	01/31/2019

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Speed Accuracy Air Velocity	50 ft/min	43		Same		35 to 65 ft/min [EMU 1.3 ft/min][TUR 12:1]
Speed Accuracy Air Velocity	100 ft/min	90		Same		85 to 115 ft/min [EMU 1.5 ft/min][TUR 9.8:1]
Speed Accuracy Air Velocity	150 ft/min	140		Same		135 to 165 ft/min [EMU 1.8 ft/min][TUR 8.3:1]
Speed Accuracy Air Velocity	200 ft/min	192		Same		185 to 215 ft/min [EMU 2.1 ft/min][TUR 7.1:1]
Speed Accuracy Air Velocity	250 ft/min	240		Same		235 to 265 ft/min [EMU 2.4 ft/min][TUR 6.2:1]
Speed Accuracy Air Velocity	300 ft/min	288		Same		285 to 315 ft/min [EMU 2.7 ft/min][TUR 5.6:1]
Speed Accuracy Air Velocity	400 ft/min	395		Same		385 to 415 ft/min [EMU 3.3 ft/min][TUR 4.5:1]
Speed Accuracy Air Velocity	500 ft/min	485		Same		485 to 515 ft/min [EMU 3.9 ft/min][TUR 3.8:1]
Temperature Accuracy	72.0 °F	71.9		Same		70.0 to 74.0 °F [EMU 0.11 °F][TUR 18:1]

Temperature: 23° C
Humidity: 20% RH
Rpt. No.: 1375092

Calibration Performed By:				Quality Reviewer:	
Mathews, Rich	314	Metrologist	847-327-5314	Szplit, Tony	02/14/2018
Name	ID #	Title	Phone	Name	Date

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Model 1430 Microtector® Electronic Point Gage

Installation and Operating Instructions



Model 1430 Microtector® Portable Electronic Point Gage combines modern, solid-state integrated circuit electronics with a time-proven point gage manometer to provide fast, accurate pressure measurements.

SPECIFICATIONS AND FEATURES

- Accurate and repeatable to $\pm .00025$ inches water column
- Pressure range: 0 - 2" w.c., positive, negative, or differential pressures
- Non-toxic and inexpensive gage fluid consists of distilled water mixed with a small amount of fluorescein green color concentrate
- Convenient, portable, lightweight and self-contained, the unit requires no external power connections and is operated by a 1.5 volt penlight cell
- A.C. detector current eliminates point plating, fouling and erosion
- Micrometers are manufactured in accordance with ASME B89.1.13-2001, and are traceable to a standard at the National Institute of Standards and Technology

- Three-point mounting, dual leveling adjustment, and circular level vial assure rapid setup
- Durablock® precision-machined acrylic plastic gage body
- Sensitive 0 - 50 microamp D.C. meter acts as a detector and also indicates battery and probe condition
- Heavy 2" thick steel base plate provides steady mounting
- Top-quality glass epoxy circuit board and solid-state, integrated circuit electronics
- Electronic enclosure of tough, molded styrene acrylonitrile provides maximum protection to components yet allows easy access to battery compartment
- Rugged sheet steel cover and carrying case protects the entire unit when not in use
- Accessories included are (2) 3-foot lengths Tygon® tubing, (2) 1/8" pipe thread adapters and 3/4 oz. bottle of fluorescein green color concentrate with wetting agent

Maximum pressure: 100 psig with optional pipe thread connections.

Tygon® is a registered trademark of Saint-Gobain Corporation

DWYER INSTRUMENTS, INC.

P.O. BOX 373

MICHIGAN CITY, INDIANA 46361, U.S.A

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www.dwyer-inst.com

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DocNumber: 000113537

Praxair
5700 South Alameda Street
Los Angeles, CA 90058
Tel: (323) 585-2154 Fax: (714) 542-6689
PGVPID: F22017

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

Customer & Order Information:

PXPKG TUALATIN OR H
10450 SW TUALATIN SHERWOOD
TUALATIN OR 97062

Praxair Order Number: 70337802
Customer P. O. Number:
Customer Reference Number:

Fill Date: 8/7/2017
Part Number: NI CD17CO8E-AS
Lot Number: 70086721903
Cylinder Style & Outlet: AS CGA 590
Cylinder Pressure & Volume: 1290 psig 99 cu ft.

Certified Concentration:

Expiration Date:	8/11/2025	NIST Traceable
Cylinder Number:	CC700832	Analytical Uncertainty:
4.33 %	CARBON MONOXIDE	± 0.5 %
16.93 %	CARBON DIOXIDE	± 0.3 %
16.99 %	OXYGEN	± 0.2 %
Balance	NITROGEN	

Certification Information:

Certification Date: 8/11/2017

Term: 96 Months

Expiration Date: 8/11/2025

This cylinder was certified according to the 2012 EPA Traceability Protocol, Document #EPA-600/R-12/531, using Procedure G1. Do Not Use this Standard if Pressure is less than 100 PSIG.

CO2 responses have been corrected for O2 IR boardening effect. O2 responses have been corrected for CO2 interference.

Analytical Data:

(R=Reference Standard, Z=Zero Gas, C=Gas Candidate)

1. Component: CARBON MONOXIDE

Requested Concentration: 4.25 %
Certified Concentration: 4.33 %
Instrument Used: Horiba VIA-510 S/N UB9UCSYX
Analytical Method: NDIR
Last Multipoint Calibration: 7/23/2017

First Analysis Data:
Date: 8/11/2017
Z: 0 R: 5 C: 4.33 Conc: 4.333
R: 4.99 Z: 0 C: 4.33 Conc: 4.333
Z: 0 C: 4.32 R: 5 Conc: 4.323
UOM: %
Mean Test Assay: 4.33 %

2. Component: CARBON DIOXIDE

Requested Concentration: 17 %
Certified Concentration: 16.93 %
Instrument Used: Horiba VIA-510 S/N 20C194WK
Analytical Method: NDIR
Last Multipoint Calibration: 7/20/2017

First Analysis Data:
Date: 8/11/2017
Z: 0 R: 20.08 C: 16.99 Conc: 16.936
R: 20.08 Z: 0 C: 16.99 Conc: 16.936
Z: 0 C: 16.98 R: 20.09 Conc: 16.926
UOM: %
Mean Test Assay: 16.933 %

Reference Standard Type: GMIS
Ref. Std. Cylinder #: CC242633
Ref. Std. Conc: 5.00%
Ref. Std. Traceable to SRM #: 2642a
SRM Sample #: 51-D-23
SRM Cylinder #: FF23106

Second Analysis Data:
Date:
Z: 0 R: 0 C: 0 Conc: 0
R: 0 Z: 0 C: 0 Conc: 0
Z: 0 C: 0 R: 0 Conc: 0
UOM: %
Mean Test Assay: 0 %

Reference Standard Type: GMIS
Ref. Std. Cylinder #: SA10234
Ref. Std. Conc: 20.02%
Ref. Std. Traceable to SRM #: RGM#CC28
SRM Sample #: N/A
SRM Cylinder #: RGM#CC28033

Second Analysis Data:
Date:
Z: 0 R: 0 C: 0 Conc: 0
R: 0 Z: 0 C: 0 Conc: 0
Z: 0 C: 0 R: 0 Conc: 0
UOM: %
Mean Test Assay: 0 %

Information contained herein has been prepared at your request by qualified experts within Praxair Distribution, Inc. While we believe that the information is accurate within the limits of the analytical methods employed and is complete to the extent of the specific analyses performed, we make no warranty or representation as to the suitability of the use of the information for any purpose. The information is offered with the understanding that any use of the information is at the sole discretion and risk of the user. In no event shall the liability of Praxair Distribution, Inc., arising out of the use of the information contained herein exceed the fee established for providing such information.

Report and Certificate of Calibration

CAL-CERT
CALIBRATION CERTIFICATION



6709 SE Lake Road
Milwaukie, OR 97222
1-800-356-4662
CL-108

www.Cal-Cert.com

"Measure The Difference"

14 Inverness Drive East, Ste B-128
Englewood, CO 80112
1-800-983-7832
CL-157



ACCREDITED
Calibration
Laboratory

Report #: 2260-28789-46
Customer Name: PFS TECO
Customer Address: 11785 Southeast Highway 212
City: Clackamas
Contact: John Steinert
Service Address: 6709 Southeast Lake Road
Customer PO#:
State: OR
Zip: 97015
Milwaukie, OR 97222

Calibration Standards

10-RH/00192 Comark Thermohygrometer S/N 6217150049 Cal Date 11/17/17 Due Date 11/30/18 Vendor Cal-Cert REPORT # 1573-C-01
10-SR1/00515 SPI Steel Rule S/N 00515 Cal Date 3/21/17 Due Date 3/21/18 Vendor Cal-Cert REPORT# 59499-C-07

Instrument Data

Calibration Date:	January 25, 2018	Reference:	Manufacturer's Spec
Calibration Due Date:	January 25, 2019	Cal-Cert Procedure:	CP-115
Calibration Frequency:	12 Months	Indicating System:	Scaling
Manufacturer:	Dewalt	Temperature:	71 °F
Type:	Tape Measure	Humidity:	29% RH
Model Number:	DWHT33372	Asset #:	#090
Serial #:	#1 TAPE	Service Location:	Cal-Cert Lab
Capacity:	192 Inches	As Found:	Pass
		As Left:	Pass

Instrument Range:	192.000 Inches	Range Resolution:	0.0625 Inches
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Calibration Standard	As Found Reading	Verification Reading #1	Verification Reading #2
0.000	0.000	0.000	0.000
0.063	0.063	0.063	0.063
1.000	1.000	1.000	1.000
12.000	12.000	12.000	12.000
48.000	48.000	48.000	48.000
96.000	96.000	96.000	96.000
192.000	192.000	192.000	192.000

Expanded Uncertainty ± 0.07217 Inches

Remarks:

We sincerely thank you for your business. Please call us at 1-800-356-4662 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.

Cal-Cert is accredited by the International Accreditation Service, Inc. (IAS) under Calibration Laboratory Code CL-108 & CL-157.
IAS is recognized under the ILAC mutual recognition agreement (MRA).

This certificate is hereby issued that the above instrument was tested for accuracy with calibrated standards traceable to the National Institute of Standards and Technology (NIST). The information provided on this form complies with the data gathering and reporting requirements of ISO/IEC 17025 and ANSI/NCSL Z540.3, and meets the requirements of all applicable references and Cal-Cert procedures listed above. Any stated measurement uncertainty includes the uncertainty of the Calibration standards used, combined with the uncertainty of the measurement process using the RSS method with a k=2 for an approximate 95% level of confidence. The calibration process meets or exceeds a ratio of 4:1 unless otherwise stated.
All tolerances were derived from the applicable standards and pass/fail determination is based on those tolerances. The customer determined any recommended due dates indicated on the certificate.

This report shall not be reproduced except in full, without written approval from Cal-Cert.

Service Engineer: TYSON MORAN
Technical Manager: MARSHALL DOYLE

Date: January 25, 2018
Signature: *M. Doyle*

Report and Certificate of Calibration



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Milwaukie, OR 97222
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Englewood, CO 80112
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CL-157



"Measure The Difference"

Report #: 2260-28781-66 Customer PO#:
Customer Name: PFS TECO
Customer Address: 11785 SE Highway 212
City: Clackamas State: OR Zip: 97015
Contact: John Steinert
Service Address: 6709 SE Lake Road, Milwaukie, OR 97222

Calibration Standards

10-RH/00192 Comark Thermohygrometer S/N 6217150049 Cal Date: 11/17/17 Due Date: 11/30/18 Vendor: CC REPORT # 1573-C-01
L-GB-0/00397 Mitutoyo 83 Piece Gage Block Set S/N 0509020 Cal Date: 9/8/16 Due Date: 9/30/18 Vendor: American Gage REPORT# 83181-2-354224

Instrument Data

Calibration Date:	January 23, 2018	Reference:	NAVAIR 17-20MD-07
Calibration Due Date:	January 23, 2019	Cal-Cert Procedure:	CP-008
Calibration Frequency:	12 Months	Indicating System:	Digital
Manufacturer:	General	Temperature:	72 °F
Type:	Digital Caliper	Humidity:	31% RH
Model Number:	147	Asset #:	#092
Serial #:	#092	Service Location:	Cal-Cert Lab
Capacity:	6 Inches	As Found:	PASS
Resolution:	0.0005 Inches	As Left:	PASS

Instrument Range:	6 Inches	Range Resolution:	0.0005 Inches
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Outside Jaws / Linearity				
Calibration Standard Inches	As Found Inches	As Left Reading 1 Inches	As Left Reading 2 Inches	Tolerance ± Inches
0.0000	0.0000	0.0000	0.0000	0.0000
0.0500	0.0500	0.0500	0.0500	0.0010
0.3000	0.3000	0.3000	0.3005	0.0010
0.6000	0.6000	0.6000	0.6000	0.0010
1.2000	1.2005	1.2005	1.2000	0.0010
2.4000	2.4000	2.4000	2.4005	0.0010
3.5000	3.5000	3.5000	3.5000	0.0010
5.0000	5.0000	5.0000	5.0000	0.0010
6.0000	6.0000	6.0000	6.0000	0.0010

Expanded Uncertainty ± 0.00129 Inches

Verifications (for information only)			
	Target	Measured	Tolerance ±
Resolution Check	0.10050	0.10050	N/A
Depth	1.000	1.00000	N/A
Step	1.000	1.00000	N/A
Inside Jaws	1.000	1.00000	N/A

Inspections	
Jaws Parallel	Acceptable

Remarks:

We sincerely thank you for your business. Please call us at 1-800-356-4662 for all your sales and calibration needs.
Cleaning and preventative maintenance were performed as part of this service.

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IAS is recognized under the ILAC mutual recognition agreement (MRA).

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Any stated measurement uncertainty includes the uncertainty of the Calibration standards used, combined with the uncertainty of the measurement process using the RSS method with a k=2 for an approximate 95% level of confidence. The calibration process meets or exceeds a ratio of 4:1 unless otherwise stated.

All tolerances were derived from the applicable standards and pass/fail determination is based on those tolerances. The customer determined any recommended due dates indicated on the certificate.

This report shall not be reproduced except in full, without written approval from Cal-Cert.

Service Engineer: NICOLAS ILLA Date: January 23, 2018
Technical Manager: MARSHALL DOYLE Signature: *M Doyle*

Caliper CF-008-01

Revision 13 6/29/2017

J-2000

owner's manual



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Calibration complies with ISO/IEC
17025, ANSI/NCSL Z540-1, and 9001



Cert. No.: 4198-9765787

Traceable® Certificate of Calibration for Hand Held Barometer

Customer : PFS TECO Suite 305 , 11785 SE Highway 212 , Clackamas , OR-97015 , U.S.A.

Instrument Identification:

Model: 4198,

S/N: 80531676

Manufacturer: Control Company

Standards/Equipment:

Description	Serial Number	Due Date	NIST Traceable Reference
Digital Barometer	D4540001	09 Oct 2018	1000415948
Digital Thermometer	111879345	09 Apr 2019	4000-9377595

Certificate Information:

Technician: 57

Procedure: CAL-32

Cal Date: 29 Aug 2018

Cal Due Date: 29 Aug 2019

Test Conditions: 62.73%RH 23.92°C 1018mBar

Calibration Data:

Unit(s)	Nominal	As Found	In Tol	Nominal	As Left	In Tol	Min	Max	±U	TUR
°C	24.10	24.1	Y	23.51	23.9	Y	22.01	25.01	0.05	>4:1
mb/hPa	551.55	552	Y	551.62	546	Y	544	560	0.62	>4:1
mb/hPa	751.22	744	Y	748.87	746	Y	741	757	0.62	>4:1
mb/hPa	1015.90	1011	Y	1018.22	1017	Y	1010	1026	0.62	>4:1

This certificate indicates Traceability to standards provided by (NIST) National Institute of Standards and Technology and/or a National Standards Laboratory.

A Test Uncertainty Ratio of at least 4:1 is maintained unless otherwise stated and is calculated using the expanded measurement uncertainty. Uncertainty evaluation includes the instrument under test and is calculated in accordance with the ISO "Guide to the Expression of Uncertainty in Measurement : (GUM). The uncertainty represents an expanded uncertainty using a coverage factor k=2 to approximate a 95% confidence level. In tolerance conditions are based on test results falling within specified limits with no reduction by the uncertainty of the measurement. The results contained herein relate only to the item calibrated. This certificate shall not be reproduced except in full, without written approval of Control Company.

Nominal=Standard's Reading; As Left=Instrument's Reading; In Tol=In Tolerance; Min/Max=Acceptance Range; ±U=Expanded Measurement Uncertainty; TUR=Test Uncertainty Ratio; Accuracy=±(Max-Min)/2; Min=As Left Nominal(Rounded) - Tolerance; Max= As Left Nominal(Rounded) + Tolerance;

Nicol Rodriguez

Nicol Rodriguez, Quality Manager

Aaron Judice

Aaron Judice, Technical Manager

Note :

Maintaining Accuracy:

In our opinion once calibrated your Hand Held Barometer should maintain its accuracy. There is no exact way to determine how long calibration will be maintained. Hand Held Barometer change little, if any at all, but can be affected by aging, temperature, shock, and contamination.

Recalibration:

For factory calibration and re-certification traceable to National Institute of Standards and Technology contact Control Company.

CONTROL COMPANY 12554 Galveston RD Suite B230 Webster TX USA 77598
Phone 281 482-1714 Fax 281 482-9448 sales@control3.com www.control3.com

Control Company is an ISO/IEC 17025:2005 Calibration Laboratory Accredited by (A2LA) American Association for Laboratory Accreditation, Certificate No. 1750.01.
Control Company is ISO 9001:2008 Quality Certified by DNV GL, Certificate No. CERT-01805-2006-AQ-HOU-RvA.
International Laboratory Accreditation Cooperation (ILAC) - Multilateral Recognition Arrangement (MRA).