

Intertek Testing Services

Report Date: July 27, 1999
Client: Vermont Castings Inc.

Report #: J99017767-231
Model: Aspen 1920

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TEST OF A WOOD BURNING STOVE
FOR

EMISSIONS AND EFFICIENCY

PER

EPA METHODS 28 AND 5G-3

FOR

VERMONT CASTINGS INC.

ROUTE 107

P.O. BOX 501

BETHEL, VERMONT

TESTED BY:

INTERTEK TESTING SERVICES NA INC.

8431 MURPHY DRIVE

MIDDLETON, WISCONSIN 53562

TEST DATES: JULY 15-23, 1999

REPORT DATE: JULY 27, 1999

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I. INTRODUCTION

I.A. GENERAL

From July 15 through 23, 1999 Intertek Testing Services NA Inc. (ITS) conducted tests on Vermont Castings' model 1920 Aspen wood burning stove to determine compliance with U.S. EPA emissions regulations.

Tests were conducted by Rick Armstrong. Present, as an observer for tests one through five was Ralph Morrison, a representative of Vermont Castings. The tests were conducted at the Intertek Testing Services NA Inc. laboratory located at 8431 Murphy Drive, Middleton, Wisconsin. The laboratory elevation is 860 feet above sea level. Tests were conducted to EPA Method 28 and 5G-3 criteria.

I.B. TEST UNIT DESCRIPTION

Vermont Castings' model 1920 wood burning stove is rectangular in shape. The unit is constructed of cast iron with a single glass and cast iron door that was hinged on the right. The unit sits on four cast iron legs. Behind the gasketed fuel-loading door is an ash pan. The firebox is of single wall construction with firebrick lining. The air control is located at the rear left-hand side. On the unit tested, the flue collar was located centrally at the rear of the top. It is also available with a rear flue collar.

I.C. RESULTS

The unit as tested produced a weighted average emissions rate of 4.2205 grams/hour and did not exceed any of the emissions rate caps specified in the EPA regulations. The unit thus meets EPA certification requirements for 1990.

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I.D. PRETEST INFORMATION

The test unit was received at Intertek Testing Services NA Inc. in Middleton, Wisconsin on July 14, 1999 via the manufacturer. The unit was inspected upon receipt and found to be in good condition. The unit was set up following the manufacturer's instructions without difficulty.

Following assembly, the unit was placed on the test stand and instrumented with thermocouples in the specified locations. Prior to beginning the emissions tests the unit was operated for a minimum of 10 hours at high-to-medium burn rates. The unit was found to be operating satisfactory during this break-in. The 18 plus hours of pre-burning was conducted on July 14, 1999. The fuel used for the break-in process is all Red Oak cordwood with Douglas Fir scrap as kindling. The moisture content of the cordwood was 16-20% on the wet basis.

Following the pre-burn break-in process, the unit was allowed to cool. The chimney system and laboratory dilution tunnel was cleaned using standard wire brush chimney cleaning equipment.

On July 15, 1999, the unit was ready for testing.

I.E. REPORT ORGANIZATION

This report includes summaries of all data necessary to determine compliance with the regulations. Raw data, calibration records, intermediate calculations, drawings and specifications and other supporting information are contained in appendices to this report.

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II. SUMMARY OF TEST RESULTS

II.A. EMISSIONS

Run Number	Test Date	Burn Rate (kg/hr)	Emission Rate (g/hr)	Adjusted Emission Rate (g/hr)	Heating Efficiency** (% Overall)
1	7/15/99	1.491	4.255	6.055	68.59
2	7/15/99	0.752	3.060	4.605	68.73
3	7/20/99	1.039	1.602	2.692	71.47
4	7/21/99	1.124	2.043	3.293	70.32
5	7/22/99	1.070	0.723	1.389	68.86
6	7/23/99	1.134	1.424	2.440	70.54

**Calculated as specified in CSA B-415

II.B. WEIGHTED AVERAGE CALCULATION

Run Number	Burn Rate	(E)		Output (BTU/HR)	Prob	(K)			
		Adjusted Emission Rate g/hr	(OHE)*			Weighting Factor	(KxE)	(KxOHE)	
2	0.752	4.605	68.73	9067.77	.1865	.4011	1.8469	27.56	
3	1.039	2.692	71.47	12528.47	.4011	.2418	.6509	17.28	
5	1.070	1.389	68.86	12902.27	.4282	.0733	.1019	5.05	
4	1.124	3.293	70.32	13553.42	.4744	.0522	.1719	3.67	
6	1.134	2.440	70.54	13674.00	.4804	.2706	.6602	19.09	
1	1.491	6.055	68.59	17978.78	.7450	.5196	3.1462	35.64	
Sums:						1.55856	6.5779	108.29	

Weighted Average Emissions Rate: $6.5779 \div 1.55856 = 4.2205$

Weighted Average Overall Heating Efficiency: $108.29 \div 1.55856 = 69.48\%$

*Calculated as specified in CSA B-415

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II.C.

TEST FACILITY CONDITIONS

Run Number	Room Temperature (F)		Barometric Pressure (in. Hg)		Relative Humidity (%)		Air Velocity (ft/min)	
	Before	After	Before	After	Before	After	Before	After
1	83	83	29.12	29.12	61	59	0	0
2	85	83	29.12	29.12	59	50	0	0
3	79	79	29.24	29.23	52	54	0	0
4	83	82	29.15	29.15	65	52	0	0
5	86	87	29.20	29.20	44	55	0	0
6	86	88	29.11	29.05	70	53	0	0

II.D.

FUEL QUALITIES

Run Number	Pre-Test Load			Test Load					
	Loading Weight (lb.)	Moisture Content Dry Basis (%)	Coal Bed Weight (lb.)	Weight Wet Basis (lb.)	Density Wet Basis (lbs/ft ³)	Moisture Content Dry Basis (%)	Piece Length (in.)	Number of 2x4's 4x4's	
1	6.71	19.26	1.4	6.69	7.178	19.72	14.00	4	0
2	6.60	19.42	1.4	6.89	7.393	20.48	14.00	4	0
3	6.61	21.21	1.4	6.78	7.275	21.68	12.50	4	0
4	5.90	22.37	1.5	6.82	7.318	22.32	12.50	4	0
5	7.25	20.96	1.4	6.68	7.167	21.38	12.50	4	0
6	7.41	20.55	1.5	6.77	7.264	21.31	12.50	4	0

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II.E. DILUTION TUNNEL FLOW RATE MEASUREMENTS AND SAMPLING DATA (5G-3)

Average Dilution Tunnel Measurements					Sample Data				
Run Number	Burn Time (min)	Velocity (ft/sec)	Volumetric Flow Rate (dscf/min)	Total Temp. (°R)	Sample Volume (dscf)		Particulate Catch (mg)		
					1	2	1	2	
1	102	13.57	142.66	552.42	22.79	23.67	11.3	11.8	
2	207	13.51	143.24	547.86	45.71	47.59	16.8	16.4	
3	146	13.45	143.91	545.06	32.72	34.08	6.0	6.4	
4	135	13.53	143.09	549.93	30.29	31.48	7.2	7.5	
5	140	13.64	142.76	556.33	31.27	32.62	2.4	3.0	
6	134	13.52	140.40	558.40	29.88	31.14	5.3	5.0	

II.F. DILUTION TUNNEL DUAL TRAIN PRECISION

Run Number	Sample Ratios		Total Emissions (grams)		% Deviation
	Train 1	Train 2	Train 1	Train 2	
1	638.47	614.74	7.21	7.25	0.45
2	648.71	623.02	10.90	10.22	5.35
3	642.16	616.54	3.85	3.95	1.98
4	637.68	613.70	4.59	4.60	0.21
5	639.16	612.76	1.53	1.84	2.78
6	629.70	604.26	3.34	3.02	2.68

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II.G.

GENERAL SUMMARY OF RESULTS

Run Number	Burn Rate (kg/hr)	Average Temperature (F) Combustion	Change		Initial Draft (in. H ₂ O)	Primary Air Setting	Run Time (min)	Average Draft (in. H ₂ O)
			Average Temperature (F) Surface	In Surface Temperature (F)				
1	1.491	1072.67	432.68	-33.00	.050	full open	102	.085
2	0.752	806.36	352.51	-39.80	.028	mark #2	207	.035
3	1.039	938.50	409.34	-64.40	.041	mark #3	146	.046
4	1.124	929.80	447.69	-81.40	.048	mark # 4	135	.052
5	1.070	945.93	433.53	-109.40	.060	mark # 4	140	.055
6	1.134	991.13	455.40	-111.20	.060	full open	134	.054

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III. PROCESS DESCRIPTION

III.A. DISCUSSION

RUN #1 (July 15, 1999). The primary air was set at full open. The test was loaded in 30 seconds. The door was closed immediately after loading and the primary air was not adjusted during loading. Burn time was 102 minutes making the burn rate 1.491 kg/hour, for a category 2-burn rate.

RUN #2 (July 15, 1999). The air control was set at the second mark. The test was loaded in 30 seconds. The door was closed after loading. The air control was open for 4 minutes then set to the second mark. Burn time was 207 minutes for a category 1-burn rate of .752 kg/hr.

RUN #3 (July 20, 1999). The air control was set to mark #3. The test was loaded in 45 seconds. The door was closed after loading. The air was set to mark #3 at 5 minutes. Burn time was 146 minutes for a category 2-burn rate of 1.039 kg/hr.

RUN #4 (July 21, 1999). The primary air control was set at mark # 4. The test was loaded in 42 seconds. The door was closed after loading. The air control was set to mark # 4 at 5 minutes. Burn time was 135 minutes for a category 2-burn rate of 1.124 kg/hr.

RUN #5 (July 22, 1999). The air control was set just above mark # 4. The test was loaded in 31 seconds. The door was closed after loading. The air control was set to just above mark #4 at five minutes. Burn time was 140 minutes for a category 2-burn rate of 1.070 kg/hour.

RUN #6 (July 23, 1999). The air control was set to full open. The air control was not adjusted during the test start-up. The test was loaded in 28 seconds and the door was closed after loading. Burn time was 134 minutes for a category 2-burn rate of 1.134 kg/hour.

Due to previous laboratory scheduling of personnel on July 16 and 19, no tests were run on those dates.

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III.B. UNIT DIMENSIONS

22" high, 15" wide and 22-1/2" deep.

III.C. AIR SUPPLY SYSTEM

Primary air enters the rear of the stove through a thermostatically controlled 3 in² opening and travels through two channels below the inner bottom then through a slot below the primary air plate and into the firebox. There is also some primary uncontrolled air entering between the gasketed glass and cast iron of the fuel-loading door. Secondary air is uncontrolled and enters the unit through two openings (one on each side of the primary air opening) measuring 1.202 in². Secondary air is channeled through two channels in the inner bottom then up risers on each side of the front of the unit and into the firebox through three secondary air tubes with seventeen .149 inch diameter holes in each. Total outlets for secondary air is .889 in².

III.D. OPERATION DURING TEST

Due to the small size of the stove, there was difficulty in obtaining high burn rates. Tests 1 and 2 were done with fuel that was 14 inches long. However, due to the unavailability of this lighter fuel the pieces were shortened to 12.5 inches. Tests 4, 5, and 6 were run trying to reach a category 3 burn rate but each fell into category 2 even though test 6 was run with the air control at full open.

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SFBA EPA ADJUSTED EMISSION RESULTS			
Manufacturer:	Vermont Castings	RESULTS	
Model:	1920		
Date:	7/15/99	AVERAGE ADJUSTED EMISSION RA	6.055
Run:	1		
Project #:	7767	Burn Rate (Dry kg/hr):	1.491
Test Duration: (minutes)	102		
PRESSURE FACTOR:	0.97326	BAROMETRIC PRESSURE	
TEMPERATURE FACTORS		Average:	29.12
DGM #1:	0.98669	Start:	29.12
DGM #2:	0.98799	End:	29.12
DRY GAS METER VALUES			
VOLUMES SAMPLED		DGM #1	Final: 619.451
DGM #1:	22.79048	Initial:	594.908
DGM #2:	23.67025	DGM #2	Final: 1016.031
TOTAL TUNNEL VOLUME (scf):	14551.019	Initial:	991.603
SAMPLE RATIOS		TEMPERATURES (DEG. RANKIN)	
Sample Train 1:	638.470	DGM #1:	535.125
Sample Train 2:	614.739	DGM #2:	534.417
TOTAL EMISSIONS		CALIBRATION FACTORS:	
Sample Train 1 (g):	7.2147	DGM #1:	0.9669
Sample Train 2 (g):	7.2539	DGM #2:	1.0077
EMISSION RATES:		TUNNEL FLOW RATE:	142.657
Sample Train 1 (g/hr):	4.2439	PARTICULATE CATCH (mg)	
Sample Train 2 (g/hr):	4.2670	Sample Train 1:	11.3
ADJUSTED EMISSION RATES		Sample Train 2:	11.8
Sample Train 1 (g/hr):	6.0412		
Sample Train 2 (g/hr):	6.0684		
DEVIATION:	0.45%		

Intertek Testing Services			
SFBA EPA ADJUSTED EMISSION RESULTS			
Manufacturer:	Vermont Castings	RESULTS	
Model:	1920		
Date:	7/15/99	AVERAGE ADJUSTED EMISSION RATE:	4.605
Run:	2		
Project #:	7767	Burn Rate (Dry kg/hr):	0.752
Test Duration: (minutes):	207		
PRESSURE FACTOR:		0.97326	BAROMETRIC PRESSURE
TEMPERATURE FACTORS		Average: 29.12	
DGM #1:	0.97910	Start: 29.12	
DGM #2:	0.97955	End: 29.12	
		DRY GAS METER VALUES	
VOLUMES SAMPLED		DGM #1	Final: 669.147
DGM #1:	45.70669	Initial:	619.540
DGM #2:	47.59117		
		DGM #2	Final: 65.657
TOTAL TUNNEL VOLUME (scf):	29650.256	Initial:	16.119
SAMPLE RATIOS		TEMPERATURES (DEG. RANKIN)	
Sample Train 1:	648.707	DGM #1:	539.273
Sample Train 2:	623.020	DGM #2:	539.023
TOTAL EMISSIONS		CALIBRATION FACTORS	
Sample Train 1 (g):	10.8983	DGM #1:	0.9669
Sample Train 2 (g):	10.2175	DGM #2:	1.0077
EMISSION RATES:		TUNNEL FLOW RATE:	
Sample Train 1 (g/hr):	3.1589	143.238	
Sample Train 2 (g/hr):	2.9616	PARTICULATE CATCH (mg)	
ADJUSTED EMISSION RATES		Sample Train 1:	16.8
Sample Train 1 (g/hr):	4.7281	Sample Train 2:	16.4
Sample Train 2 (g/hr):	4.4817		
DEVIATION:		5.35%	

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SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Vermont Castings	RESULTS	
Model:	1920		
Date:	7/20/99	AVERAGE ADJUSTED EMISSION RA	2.692
Run:	3		
Project #:	7767	Burn Rate (Dry kg/hr):	1.039
Test Duration (minutes):	146		
PRESSURE FACTOR:		0.97711	BAROMETRIC PRESSURE
TEMPERATURE FACTORS			Average: 29.235
DGM #1:	0.98929		Start: 29.24
DGM #2:	0.99027		End: 29.23
VOLUMES SAMPLED		DRY GAS METER VALUES	
DGM #1:	32.71802	DGM #1	Final: 779.472
DGM #2:	34.07799		Initial: 744.468
TOTAL TUNNEL VOLUME (scf):		21010.300	DGM #2
			Final: 176.194
			Initial: 140.244
SAMPLE RATIOS		TEMPERATURES (DEG RANKIN)	
Sample Train 1:	642.163	DGM #1:	533.719
Sample Train 2:	616.536	DGM #2:	533.188
TOTAL EMISSIONS		CALIBRATION FACTORS	
Sample Train 1 (g):	3.8530	DGM #1:	0.9669
Sample Train 2 (g):	3.9458	DGM #2:	1.0077
EMISSION RATES		TUNNEL FLOW RATE:	
Sample Train 1 (g/hr):	1.5834	143.906	
Sample Train 2 (g/hr):	1.6216	PARTICULATE CATCH (mg)	
ADJUSTED EMISSION RATES		Sample Train 1:	6
Sample Train 1 (g/hr):	2.6852	Sample Train 2:	6.4
Sample Train 2 (g/hr):	2.7184		
DEVIATION:		1.98%	

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SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer: Vermont Castings

RESULTS

Model: 1920

Date: 7/21/99

Run: 4

Project #: 7767

Test Duration (minutes): 135

AVERAGE ADJUSTED EMISSION RA 3.293

Burn Rate (Dry kg/hr): 1.124

PRESSURE FACTOR: 0.97426

BAROMETRIC PRESSURE

Average: 29.15

TEMPERATURE FACTORS

Start: 29.15

DGM #1: 0.98815

End: 29.15

DGM #2: 0.98944

DRY GAS METER VALUES

VOLUMES SAMPLED

DGM #1: 30.29269

DGM #1 Final: 812.102

Initial: 779.559

DGM #2: 31.47635

DGM #2 Final: 207.616

Initial: 175.213

TOTAL TUNNEL VOLUME (scf): 19317.159

SAMPLE RATIOS

Sample Train 1: 637.684

TEMPERATURES (DEG. RANKIN)

Sample Train 2: 613.704

DGM #1: 534.333

DGM #2: 533.633

TOTAL EMISSIONS

Sample Train 1 (g): 4.5913

CALIBRATION FACTORS

Sample Train 2 (g): 4.6028

DGM #1: 0.9669

DGM #2: 1.0077

EMISSION RATES

Sample Train 1 (g/hr): 2.0406

TUNNEL FLOW RATE: 143.090

Sample Train 2 (g/hr): 2.0457

PARTICULATE CATCH (mg)

ADJUSTED EMISSION RATES

Sample Train 1 (g/hr): 3.2898

Sample Train 1: 7.2

Sample Train 2 (g/hr): 3.2966

Sample Train 2: 7.5

DEVIATION: 0.21%

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SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer: Vermont Castings

RESULTS

Model: 1920

Date: 7/22/99

Run: 5

Project #: 7767

Test Duration: 140
(minutes)

AVERAGE ADJUSTED EMISSION RATE: 1.389

Burn Rate (Dry kg/hr): 1.070

PRESSURE FACTOR: 0.97594

BAROMETRIC PRESSURE

Average: 29.2

TEMPERATURE FACTORS

Start: 29.2

DGM #1: 0.98606

End: 29.2

DGM #2: 0.98772

DRY GAS METER VALUES

VOLUMES SAMPLED

DGM #1: Final: 845.779

DGM #1: 31.26951

Initial: 812.173

DGM #2: 32.61665

DGM #2: Final: 241.215

TOTAL TUNNEL VOLUME (scf): 19986.253

Initial: 207.637

SAMPLE RATIOS

Sample Train 1: 639.181

TEMPERATURES (DEG. RANKIN)

Sample Train 2: 612.762

DGM #1: 535.467

DGM #2: 534.567

TOTAL EMISSIONS

Sample Train 1 (g): 1.5340

CALIBRATION FACTORS

Sample Train 2 (g): 1.8383

DGM #1: 0.9669

DGM #2: 1.0077

EMISSION RATES

Sample Train 1 (g/hr): 0.6574

TUNNEL FLOW RATE: 142.759

Sample Train 2 (g/hr): 0.7878

PARTICULATE CATCH (mg)

ADJUSTED EMISSION RATES

Sample Train 1 (g/hr): 1.2849

Sample Train 1: 2.4

Sample Train 2 (g/hr): 1.4932

Sample Train 2: 3

DEVIATION: 14.99%

If deviation is greater than 7.5% due to low particulate catch
The two emission rates shall not differ by 7.5%
of the weighted average emission rate limit (4.1 or 7.5) (5g-3)

Use the following:

Catalytic units 5.08%

7.5% of 4.1 g/hr

Non catalytic units 2.78%

7.5% of 7.5 g/hr

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SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Vermont Castings	RESULTS
Model:	1920	
Date:	7/23/99	AVERAGE ADJUSTED EMISSION RATE
Run:	6	2.440
Project #:	6678	Burn Rate (Dry kg/hr):
Test Duration:	134	1.134
(minutes)		

PRESSURE FACTOR:	0.97193	BAROMETRIC PRESSURE	Average:	29.08
TEMPERATURE FACTORS			Start:	29.11
DGM #1:	0.98778		End:	29.05
DGM #2:	0.98889			

VOLUMES SAMPLED		DRY GAS METER VALUES	
DGM #1:	29.87724	DGM #1 Final:	878.038
DGM #2:	31.13518	DGM #1 Initial:	845.852
TOTAL TUNNEL VOLUME (scf):	18813.606	DGM #2 Final:	273.397
		DGM #2 Initial:	241.250

SAMPLE RATIOS		TEMPERATURES (DEG. RANKIN)	
Sample Train 1:	629.697	DGM #1:	534.533
Sample Train 2:	604.256	DGM #2:	533.933

TOTAL EMISSIONS		CALIBRATION FACTORS	
Sample Train 1 (g):	3.3374	DGM #1:	0.9669
Sample Train 2 (g):	3.0213	DGM #2:	1.0077

EMISSION RATES		TUNNEL FLOW RATE:	140.400
Sample Train 1 (g/hr):	1.4944	PARTICULATE CATCH (mg)	
Sample Train 2 (g/hr):	1.3528	Sample Train 1:	5.3

ADJUSTED EMISSION RATES		Sample Train 2:	6
Sample Train 1 (g/hr):	2.5402		
Sample Train 2 (g/hr):	2.3388		

DEVIATION: 8.25%

If deviation is greater than 7.5% due to low particulate catch
 The two emission rates shall not differ by 7.5%
 of the weighted average emission rate limit (4.1 or 7.5) (5g-3)

Use the following:

Catalytic units 4.91%
 7.5% of 4.1 g/hr

Non catalytic units 2.68%
 7.5% of 7.5 g/hr

Manufacturer VCI Model ASPEX Date 7-14-99

Job # 1111 Run _____ Tech RA

EMISSIONS TESTING UNIT PREPARATION

Unit description (check all that apply)

- | | | |
|---|---|--|
| <input checked="" type="checkbox"/> Stove | <input checked="" type="checkbox"/> Top Vent | <input checked="" type="checkbox"/> Manual Draft |
| <input type="checkbox"/> Insert | <input checked="" type="checkbox"/> Rear Vent | <input checked="" type="checkbox"/> Bimetal Spring |
| <input type="checkbox"/> Catalytic | <input checked="" type="checkbox"/> Grate | <input type="checkbox"/> Remote Thermostat |
| <input checked="" type="checkbox"/> Non-catalytic | <input checked="" type="checkbox"/> Ashpan | <input type="checkbox"/> Blower or Fans |
| Other: _____ | | |

Unit received with all parts: Yes No
 Manual: Yes No
 Drawings: Yes No
 Specifications: Yes No

Materials of construction: CAST IRON

Air introduction: _____

Control mechanism: LEVER AT REAR OF STOVE

Unit net weight with all components: 253 lbs. _____ Kg.
 Unit fire box volume: 9.38 Ft³ (attach fire box volume calculations and drawings)
 Ideal Load Weight: 6.57 lbs. (Volume x 7)
 Load Weight Range: ($\pm 10\%$ of ideal weight) 5.91 lbs. to 7.22 lbs.
 Ideal piece length specification: 15.2 inches. (5/6 of longest fire box dimension)
 Thermocouples attached: 5 Attached by: RA (attach T/C map)

Unit conditioned prior to test

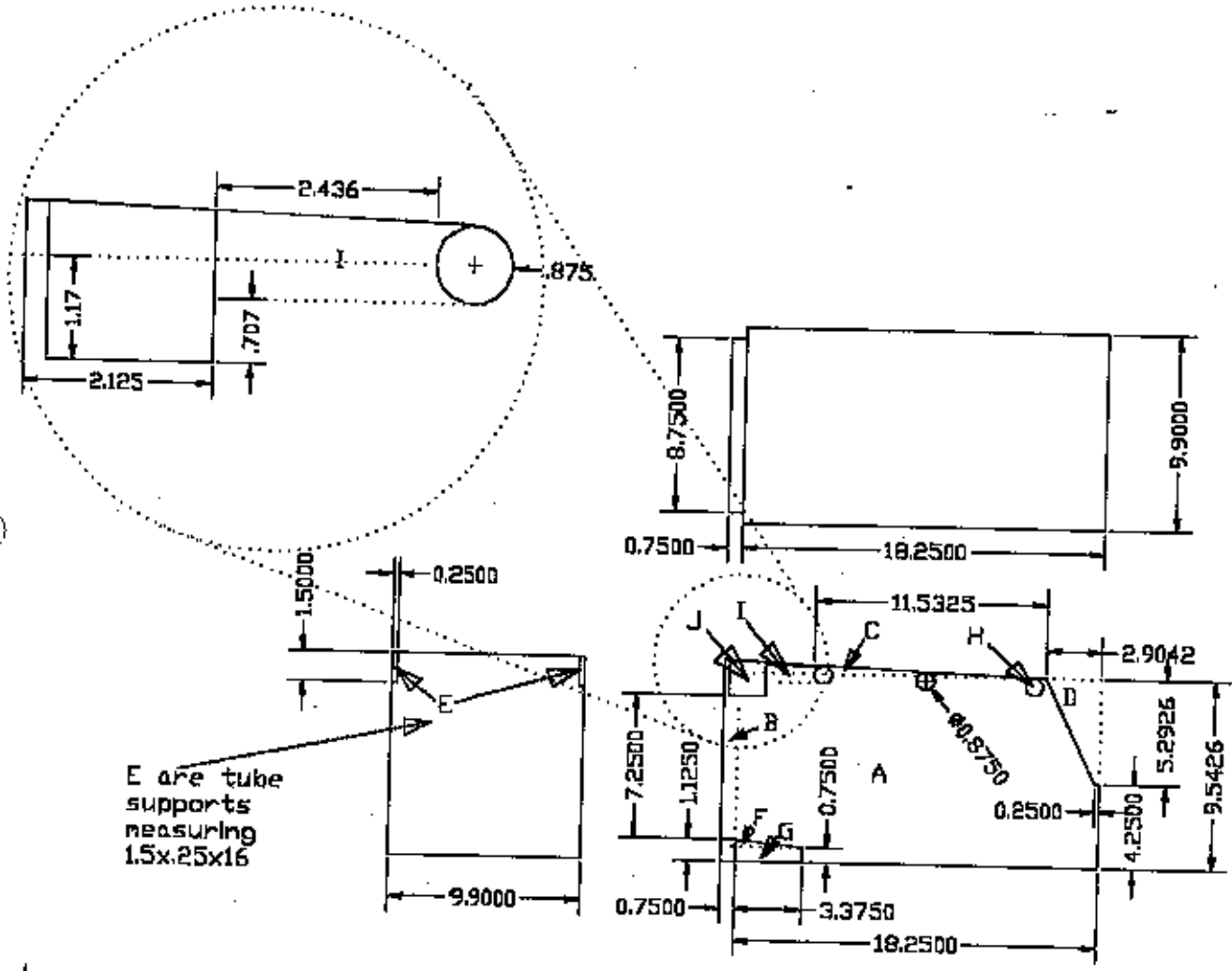
10 hours at medium burn rate (non-catalytic) (attach burn log) _____ 50 hours at medium burn rate (attach burn log)

Date started: 7-14 Date completed: _____
 Catalyst manufacturer: _____
 Serial number: _____ Dimensions: _____ Cell size: _____ cells/in.²
 Unit ready for testing (date): _____ Initialed: _____

Manufacturer Vet Model 1920 Date 7-14-89
 Job # _____ Run _____ Tech RA

Measurements By: RA Checked By: _____

FIRE BOX VOLUME CALCULATION



Volume = A + B + C - D - E - F - G - (3H) - I - J

A = 9.5426 * 9.9 * 18.25	= 1724.109
B = 7.25 * 8.75 * .75	= 49.219
C = 5 * (.4375 * 9.9 * 11.5324)	= 24.98
Sub total	= 1798.308
D = .5 * ((29.042 + .25) * (9.9) * (5.2926))	= 82.635
E = 2 * (1.5 * .25 * 16)	= 12.00
F = .5 * (.375 * 3.375 * 9.9)	= 6.265
G = .75 * 3.375 * 9.9	= 25.059
H = 3 * (pi * R squared * 9.4)	= 16.957
= 3 * (.601 * 9.9)	= 20.04
I = 2.436 * .875 * 9.4	= 23.37
J = 2.125 * 1.17 * 9.4	= 23.37
Sub total	= 186.326
Total = 1611.982 cubic inches or .932 cubic ft.	

Manufacturer

Vet

Model

1920

Date

2-14-99

Page 4 of 7

Job #

7767

Run

Tech

RA

Thermocouple Location

Five thermocouples were attached to the Vermont Castings' Model 1920 Aspen Wood burning stove:

TC number five was attached in the center of the top of the unit.

TC number six was attached to the center of the rear of the unit.

TC number seven was attached to the center of the right-hand side of the unit.

TC number eight was attached to the center of the left-hand side of the unit.

TC number nine was attached to the center of the bottom of the unit.

Additionally:

A 1/8" diameter thermocouple probe was inserted into a 1/8" hole located so that the tip would be in the secondary combustion chamber.

TC#	LOCATION
5	UNIT TOP
6	UNIT BACK
7	UNIT RIGHT
8	UNIT LEFT
9	UNIT BOTTOM

Manufacturer VCI Model 1920 Date 7-15-99
 Job # 7767 Run 1 Tech RS

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) _____ (inches Hg.) Static pressure (P_s) .125 (inches w.c.)
 Inside diameter: Port A 6in. Port B 6in. Tunnel cross sectional area: 0.1963Ft²
 Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δp (inches H ₂ O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.040	107	.2000
B-Centroid	3.00	.040	98	.2000
A-1	0.40	.036	101	.1897
A-2	1.50	.040	103	.2000
A-3	4.50	.040	102	.2000
A-4	5.60	.037	101	.1924
B-1	0.40	.038 .040	100	.1949
B-2	1.50	.040	99	.2000
B-3	4.50	.040	98	.2000
B-4	5.60	.036	100	.1897
AVERAGE			100.9	1967

Adjustment factor application

Where,

C_p = Pitot tube coefficient = 0.99 for standard pitot

Δp = manometer reading (inches H₂O)

T_s = average absolute dilution tunnel temperature (°F + 460)

$$V_s = K_p C_p F_p (\sqrt{\Delta p})_{AVG} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_s = K_p C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

P_s = absolute dilution tunnel gas pressure or $P_{bar} + P_s$

P_s = static pressure $\frac{\text{inches H}_2\text{O}}{13.6}$

M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)

K_p = 85.49 Pitot tube constant, (conversion factor for English units)

Adjustment factor for alternative Pitot tube placement

$$F_p = \frac{(\sqrt{\Delta p})_{avg}}{(\sqrt{\Delta p})_{centroid}}$$

$(\sqrt{\Delta p})_{avg}$ = Average of the square roots of the velocity heads (Q_p) measured at each traverse point.

$(\sqrt{\Delta p})_{centroid}$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H₂O)

.9834

ITS Intertek Testing Services

Manufacturer UCI Model 1920 Date 7-15-99
 Job # 7767 Run 1 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:

Time: <u>8:45</u>	X: <input checked="" type="checkbox"/>	Y: <input checked="" type="checkbox"/>	12: <input checked="" type="checkbox"/>	22: <input checked="" type="checkbox"/>
-------------------	--	--	---	---

Facility Conditions:

Air Velocity.....
 Smoke Capture Check.....

Pre-Test	Post-Test
0 fpm	0 fpm
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Wood Heater Conditions:

Date Wood Heater Stack Cleaned.....
 Date Dilution Tunnel Cleaned.....
 Induced Draft Check.....
 Tunnel Velocity.....

7-15-99	
7-15-99	
0	0
.040	

Flow Rate 140-cfm ±10%.....

142.657

Pitot Leak Check:

Side A.....
 Side B.....

<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Temperature System:

Ambient (65°- 90°F).....
 Wood Heater Surface (±125°F).....

	<input checked="" type="checkbox"/>	°F
-33		°F

Proportional Checks:

CO Analyzer Drift Check.....
 CO₂ Analyzer Check.....
 O₂ Analyzer Check.....
 Thermocouple check.....

	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	

Sampling Train ID Numbers:

Probe.....
 Filter Front.....
 Filter Back.....
 Filter Thermocouple.....
 Filter 5G-3 (<90°F).....

Train 1	Train 2
1	2
29	31
30	32
19	22
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Thermocouple Identification Number

Flue.....1	Room.....3
Dilution Tunnel Wet Bulb.....4	Unit Top.....5
Unit Right Side.....7	Unit Left Side.....8
Catalyst/Combustion Chamber.....10	

Dilution Tunnel Dry Bulb.....3
Unit Back.....6
Unit Bottom.....9

Manufacturer Vet Model 1920 Date 7-15-99
 Job # 7767 Run 1 Tech PA

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	<u>10</u> lbs., Class F	<u>10.00</u> lbs.
Wood	<u>10</u> lbs., Class F	<u>10.00</u> lbs.
Analytical	100 Grams <u>100</u> mg, Class S	<u>100</u> Grams <u>100</u> mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE.....50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Manufacturer Ve1 Model 1920 Date 7-15-99
 Job # 7767 Run 1 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

	SYSTEM 1		SYSTEM 2	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Unplugged Flow Rate = .25cfm				
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1 minute DGM (ft ³)	594.906	619.534	991.609	16.119
Initial 1 minute DGM (ft ³)	594.906	619.534	991.603	16.119
Change (C) (ft ³)	0	0	.006	16.119
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

	Pre Test	Post Test
Plugged Probe		
Vacuum (inches Hg.)	10"	10"
Rotometer Reading (rpm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Manufacturer VCI Model 1920 Date 7-15-99
 Job # 7767 Run 1 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
	Actual	Should Be	Actual	Should Be	Actual	Should Be
CO	0	0	9.99	9.99	.94	.991
CO ₂	0	0	24.63	24.63	9.66 9.77	10.02
O ₂	0	0	20.93	20.93	10.17	10.01

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO	0	10.00	.94	0	.01	0	/	
CO ₂	.01	24.68	9.68	.01	.05	.02	/	
O ₂	.05	20.87	10.24	.05	.06	.07	/	

* Greater than ± 5% of the range used.

Manufacturer VEL Model 1920 Date 7-15-99
 Job # 7767 Run 1 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelmac 47mm A/E

Samples in Desecrator: Date: Time:

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # 1	Filter Numbers <u>29+30</u>	Probe and Front Half Housing # 2	Filter Numbers <u>31+32</u>
Post Test Weight:	<u>91.4431</u> grams	<u>.2510</u> grams	<u>91.6277</u> grams	<u>.2509</u> grams
Pre Test Weight:	<u>91.4430</u> grams	<u>.2398</u> grams	<u>91.6275</u> grams	<u>.2393</u> Grams
Gain:	<u>.0001</u> grams	<u>11.2</u> μ grams	<u>.0002</u> grams	<u>.016</u> Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = 11.3 μ grams a2 + b2 = .018 grams

Pre-test Weight Record		SYSTEM 1			SYSTEM 2			TEMP	HUMID
Date	Time	Probe & Housing Number	Front Filter Number	Back Filter Number	Probe & Housing Number	Front Filter Number	Back Filter Number	°F	%
		1	29	30	2	31	32		
<u>7-13-99</u>	<u>7:00</u>	<u>91.4426</u>	<u>.1192</u>	<u>.1203</u>	<u>91.6270</u>	<u>.1182</u>	<u>.1210</u>	<u>73</u>	<u>49</u>
<u>7-14-99</u>	<u>7:10</u>	<u>91.4428</u>	<u>.1193</u>	<u>.1201</u>	<u>91.6274</u>	<u>.1186</u>	<u>.1210</u>	<u>73</u>	<u>47</u>
<u>7-15-99</u>	<u>7:15</u>	<u>91.4430</u>	<u>.1196</u>	<u>.1202</u>	<u>91.6275</u>	<u>.1186</u>	<u>.1207</u>	<u>74</u>	<u>49</u>
		Total	<u>.2398</u>		Total	<u>.2393</u>			

Pre-test Weight Record		SYSTEM 1	SYSTEM 2	TEMP	HUMID
Date	Time	Probe & Housing Number	Combined Filter Weight Number	Probe & Housing Number	Combined Filter Weight Number
		1	<u>29+30</u>	2	<u>31+32</u>
<u>7-15-99</u>	<u>13:14</u>	<u>91.4433</u>	<u>.2535</u>	<u>91.6278</u>	<u>.2533</u>
<u>7-16-99</u>	<u>6:55</u>	<u>91.4431</u>	<u>.2510</u>	<u>91.6277</u>	<u>.2509</u>
<u>7-19-99</u>	<u>7:00</u>	<u>91.4431</u>	<u>.2510</u>	<u>91.6277</u>	<u>.2509</u>

Manufacturer Ved Model 1920 Date 7-15-99

Job # 7767 Run 1 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft ³)	619.451	1016.031
Initial (ft ³)	594.906	991.603

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.12	29.12
Wet Bulb (°F)	71	72
Dry Bulb (°F)	81	83
Humidity (%)	41	59

ITS Intertek Testing Services

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Manufacturer Vel Model 192D Date 7-15-99
 Job # 7767 Run 1 Tech RA

AIR FULL OPEN

SWITCH NUMBER			1	2	3	4	5	6	7	8	9	10				
READING #	REAL TIME	ELAPSED TIME	WEIGHT REMAINING	FLUE GAS TEMP	KOCAM TEMP	TUNNEL DRY BULB	TUNNEL WET BULB	UNIT TOP	UNIT BACK	UNIT RIGHT SIDE	UNIT LEFT SIDE	UNIT BOTTOM	CATALYST DOWNSTREAM	TUNNEL VELOCITY	DRAFT	SMOKE
0	9:58	0	6.70	353	79	103	78	572	204	176	214	171	1292	0.39	0.60	M
1		10	5.10	409	80	106	79	766	221	220	249	252	1268	0.40	0.65	M
2		20	3.90	392	83	100	78	809	230	275	285	295	1391	0.36	0.64	L
3		30	3.10	353	84	97	77	744	287	329	327	324	1134	0.40	0.59	C
4		40	2.50	328	84	95	76	1076	314	364	365	347	1093	0.40	0.54	C
5		50	2.10	307	83	93	76	646	329	379	382	357	1039	0.40	0.52	C
6		60	1.70	291	83	92	75	603	339	390	391	378	961	0.40	0.50	C
7		70														
8		80														
9		90														
10		100														
11		110														
12		120														
13		130														
14		140														
15		150														
16		160														
17		170														
18		180														
19		190														
20		200														
21		210														
22		220														
23		230														
24		240														
25		250														

Comments: 11:01 FIRE STARTED DOOR OPEN 45 SET

WHI LTO#: 7767

MANUFACTURER: Vei

AIR CONTROL FULL UPON

SWITCH NUMBER:

MODEL: 1920

FIRE SIZE: HIGH

DATE: 7-15-99

RUN#: 1

page 15 of 71

TECHNICIAN: RA

READING#	REAL TIME	50 AMP INJ UNIT	WEIGHT REMAINT	CO ₂	CO	3	1 FILE GAS TEMP	2 ROOM TEMP	3 TUNNEL TEMP	4 TUNNEL VERT BULB	5 UNIT TOP	6 UNIT BACK	7 UNIT RT. SIDE	8 UNIT LEFT SIDE	9 UNIT BOTTOM	10 CAT EXIT	11 CAT CENTER	12	13	17 DOM TEMPL INLET	18 DOM TEMPL OUTLET	19 FILTER TEMP	DOM #2 READING	ROTO 2 READING	20 DOM TEMP INLET	21 DOM TEMP OUTLET	22 FILTER TEMP	TUNNEL VELOCITY	DRAFT	SNOW	MAX OCHA PRESS				
0	1103	0	667	1.57	9.129	4.99	531	83	98	75	622	345	393	391	380	1228			135	594.9	120	73	73	72	991.1	120	72	72	72	.040	.050	C	0		
1		10	530	3.43	1629	2.24	364	83	96	75	733	330	389	394	383	1357			135	597.3	120	73	73	79	994.0	120	72	72	79	.039	.027	H	2		
2		20	390	1.78	1744	2.18	376	84	97	75	800	318	379	409	388	1433			135	599.7	120	74	74	80	996.3	120	73	72	80	.040	.023	L	2		
3		30	270	1.54	1271	2.09	362	85	96	76	814	324	385	430	383	1437			135	602.1	120	75	74	81	998.7	120	74	73	81	.040	.061	L	2		
4		40	190	.41	1401	6.37	320	86	94	76	769	332	397	445	369	1165			135	604.5	120	75	75	81	1001.1	120	74	74	81	.040	.055	C	2		
5		50	140	.66	1148	8.47	289	85	92	76	679	352	405	451	353	1102			135	606.9	120	75	75	81	1003.5	120	75	75	81	.040	.051	C	2		
6		60	100	.97	935	10.59	269	85	90	76	605	363	412	451	346	934			125	609.3	120	76	76	81	1005.9	120	75	75	81	.040	.048	C	2		
7		70	70	.93	974	10.11	263	84	90	76	583	367	413	444	344	925			135	611.7	120	76	76	81	1008.3	120	75	75	81	.040	.047	C	2		
8		80	40	1.33	799	11.63	259	84	89	76	545	370	411	436	341	839			135	614.1	120	76	76	81	1010.7	120	76	76	81	.040	.048	C	2		
9		90	.20	1.66	577	13.77	250	84	89	76	489	371	408	426	344	748			135	616.5	120	76	76	81	1013.1	120	76	76	81	.041	.045	C	2		
10		100	.10	1.60	545	14.12	245	84	89	75	458	370	400	411	342	701			135	618.9	120	76	77	81	1015.5	120	76	76	81	.040	.044	C	2		
11	102	110	10	2.62	5.58	14.06	244	83	89	75	450	369	398	407	342	704			135	619.4	120	76	77	80	1016.0	120	76	76	80	.040	.043	C	2		
12		120																																	
13		130																																	
14		140																																	
15		150																																	
16		160																																	
17		170																																	
18		180																																	
19		190																																	
20		200																																	
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35		350																																	
36		360																																	
37		370																																	
38		380																																	
39		390																																	
40		400																																	
41		410																																	
42		420																																	
43		430																																	
44		440																																	
45		450																																	
46		460																																	
47		470																																	
48		480																																	

1.491 Kg/hr

102 MIN

COMMENTS:

TEST LOADED IN 30 SECONDS

DOOR CLOSED AFTER LOADING AIR CONTROL NOT ADJUSTED

Page 16 of 21

Manufacturer VCI Model 1920 Date 7-15-99
 Job # 7767 Run 2 Tech RA

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.12 (inches Hg.) Static pressure (P_s) .125 (inches w.c.)
 Inside diameter: Port A 6in. Port B 6in. Tunnel cross sectional area: 0.1963Ft²
 Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H ₂ O)	Tunnel Temperature (°F)	$\sqrt{\Delta_p}$
A-Centroid	3.00	.039	92	.1975
B-Centroid	3.00	.040	94	.2000
A-1	0.40	.036	93	.1897
A-2	1.50	.040	92	.2000
A-3	4.50	.040	92	.2000
A-4	5.60	.034	93	.1844
B-1	0.40	.036	93	.1897
B-2	1.50	.040	94	.2000
B-3	4.50	.040	94	.2000
B-4	5.60	.036	93	.1897
AVERAGE			93	.1951

Adjustment factor application

Where,

C_p = Pitot tube coefficient = 0.99 for standard pitot

Δ_p = manometer reading (inches H₂O)

T_s = average absolute dilution tunnel temperature ($^{\circ}P + 460$)

$$V_s = K_p C_p F_p (\sqrt{\Delta_p})_{AVG} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_c = K_p C_p (\sqrt{\Delta_p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

P_s = absolute dilution tunnel gas pressure or $P_{bar} + P_s$

P_s = static pressure inches H₂O

M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)

K_p = 85.49 Pitot tube constant, (conversion factor for English units)

$$F_p = \frac{(\sqrt{\Delta_p})_{avg}}{(\sqrt{\Delta_p})_{centroid}}$$

Adjustment factor for alternative Pitot tube placement

$(\sqrt{\Delta_p})_{avg}$ = Average of the square roots of the velocity heads (Δ_p) measured at each traverse point.

$(\sqrt{\Delta_p})_{centroid}$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H₂O)

.9817

Manufacturer Vel Model 1920 Date 7-15-99
 Job # 7767 Run 2 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:

Time: <u>8:45</u>	X: <input checked="" type="checkbox"/>	Y: <input checked="" type="checkbox"/>	12: <input checked="" type="checkbox"/>	22: <input checked="" type="checkbox"/>
-------------------	--	--	---	---

Facility Conditions:

Air Velocity.....
Smoke Capture Check.....

Pro-Test	Post-Test
<u>0</u> fpm	<u>0</u> fpm
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Wood Heater Conditions:

Date Wood Heater Stack Cleaned.....
Date Dilution Tunnel Cleaned.....
Induced Draft Check.....
Tunnel Velocity.....

<u>7-15-99</u>	
<u>7-15-99</u>	
<u>0</u>	<u>0</u>
<u>040</u>	

Flow Rate 140-cfm ±10%

143.238

Pitot Leak Check:

Side A.....
Side B.....

<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Temperature System:

Ambient (65°- 90°F).....
Wood Heater Surface (±125°F).....

<input checked="" type="checkbox"/>	°F
<u>-39.8</u>	°F

Proportional Checks:

CO Analyzer Drift Check.....
CO₂ Analyzer Check.....
O₂ Analyzer Check.....
Thermocouple check.....

<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>

Sampling Train ID Numbers:

Probe.....
Filter Front.....
Filter Back.....
Filter Thermocouple.....
Filter 5G-3 (<90°F).....

Train 1	Train 2
<u>3</u>	<u>4</u>
<u>33</u>	<u>35</u>
<u>34</u>	<u>36</u>
<u>19</u>	<u>22</u>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Thermocouple Identification Number

Flue.....1	Room.....2
Dilution Tunnel Wet Bulb.....4	Unit Top.....5
Unit Right Side.....7	Unit Left Side.....8
Catalyst/Combustion Chamber.....10	

Dilution Tunnel Dry Bulb.....3
 Unit Back.....6
 Unit Bottom.....9

Manufacturer VCI Model 1920 Date 7-15-98
 Job # 7767 Run 2 Tech RA

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	<u>10</u> lbs., Class F	<u>10.0</u> lbs.
Wood	<u>10</u> lbs., Class F	<u>10.00</u> lbs.
Analytical	100 Grams <u>100</u> mg, Class S	<u>100</u> Grams <u>100</u> mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE.....50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Manufacturer VCI Model 1920 Date 8-15-99
 Job # 7767 Run 2 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

	SYSTEM 1		SYSTEM 2	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Unplugged Flow Rate = .25cfm				
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1 minute DGM (ft ³)	619.540	669.155	16.119	65.668
Initial 1 minute DGM (ft ³)	619.537	669.155	14.119	65.668
Change (C) (ft ³)	.03	0	0	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

Plugged Probe	Pre Test	Post Test
Vacuum (inches Hg.)	10"	10"
Rotometer Reading (mm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Manufacturer Vci Model 1920 Date 7-15-99
 Job # 2767 Run 2 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
	Actual	Should Be	Actual	Should Be	Actual	Should Be
CO	0	0	9.99	9.99	.93	.991
CO ₂	0	0	24.63	24.63	9.66	10.02
O ₂	0	0	20.93	20.93	10.24	10.01

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO	.01	10.07	.94	.01	.08	.01	/	
CO ₂	.01	24.67	9.65	.01	.04	.01	/	
O ₂	.07	20.83	10.24	.07	.10	0	/	

* Greater than ± 5% of the range used.

Manufacturer Vel Model 1920 Date 7-15-99
 Job # 7767 Run 2 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft ³)	669.147.	65.657
Initial (ft ³)	619.540	16.119

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.12	29.12
Wet Bulb (°F)	72	71
Dry Bulb (°F)	83	85
Humidity (%)	59	56

Manufacturer VCI Model 1920 Date 7-15-99
 Job # 7267 Run 2 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Samples in Desecrator. Date: 7-15-99 Time: 19:48

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # <u>3</u>	Filter Numbers <u>33+34</u>	Probe and Front Half Housing # <u>4</u>	Filter Numbers <u>35+36</u>
Post Test Weight:	<u>93.1205</u> grams	<u>.2568</u> grams	<u>89.9725</u> grams	<u>.2561</u> grams
Pre Test Weight:	<u>93.1205</u> grams	<u>.2400</u> grams	<u>89.9725</u> grams	<u>.2397</u> Grams
Gain:	<u>0</u> grams	<u>.0168</u> grams	<u>0</u> grams	<u>.0164</u> Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0168 grams a2 + b2 = .0164 grams

Pre-test Weight Record		SYSTEM 1			SYSTEM 2			TEMP	HUMID
		Probe & Housing Number	Front Filter Number	Back Filter Number	Probe & Housing Number	Front Filter Number	Back Filter Number		
Date	Time	<u>3</u>	<u>33</u>	<u>34</u>	<u>4</u>	<u>35</u>	<u>36</u>	°F	%
<u>7-13-99</u>	<u>7:00</u>	<u>93.1205</u>	<u>1193</u>	<u>.1200</u>	<u>89.9725</u>	<u>.1193</u>	<u>.1197</u>	<u>73</u>	<u>49</u>
<u>7-14-99</u>	<u>7:10</u>	<u>93.1205</u>	<u>.1197</u>	<u>.1203</u>	<u>89.9725</u>	<u>.1195</u>	<u>.1203</u>	<u>73</u>	<u>47</u>
<u>7-15-99</u>	<u>7:15</u>	<u>93.1205</u>	<u>.1197</u>	<u>.1203</u>	<u>89.9725</u>	<u>.1195</u>	<u>.1202</u>	<u>74</u>	<u>49</u>
Total		<u>.2400</u>			Total			<u>.2397</u>	

Pre-test Weight Record		SYSTEM 1		SYSTEM 2		TEMP	HUMID
		Probe & Housing Number	Combined Filter Weight Number	Probe & Housing Number	Combined Filter Weight Number		
Date	Time	<u>3</u>	<u>33+34</u>	<u>4</u>	<u>35+36</u>	°F	%
<u>7-15-99</u>	<u>19:48</u>	<u>93.1206</u>	<u>.2589</u>	<u>89.9724</u>	<u>.2582</u>	<u>82</u>	<u>48</u>
<u>7-16-99</u>	<u>6:55</u>	<u>93.1205</u>	<u>.2571</u>	<u>89.9725</u>	<u>.2562</u>	<u>73</u>	<u>48</u>
<u>7-19-99</u>	<u>7:00</u>	<u>93.1205</u>	<u>.2568</u>	<u>89.9725</u>	<u>.2561</u>	<u>74</u>	<u>47</u>
<u>7-20-99</u>	<u>7:00</u>	<u>93.1205</u>	<u>.2568</u>	<u>89.9725</u>	<u>.2561</u>	<u>72</u>	<u>46</u>

Manufacturer VCI Model 1920 Date 7-15-99

Job # 7767 Run 2 Tech R4

AIR CONTROL ON # 2 MARK

SWITCH NUMBER		1	2	3	4	5	6	7	8	9	10					
READING #	REAL TIME	ELAPSED TIME	WEIGHT REMAINING	FLUE GAS TEMP	ROOM TEMP	TUNNEL DRY BULB	TUNNEL WET BULB	UNIT TOP	UNIT BACK	UNIT RIGHT SIDE	UNIT LEFT SIDE	UNIT BOTTOM	CATALYST DOWNSTREAM	TUNNEL VELOCITY	DRAFT	SMOKE
0	19:24	0	4.50	347	86	102	78	752	357	356	356	424	1357	040	063	L
1		10	3.80	258	87	77	78	729	348	378	366	407	1333	038	051	T
2		20	3.20	235	86	93	78	724	335	378	375	382	1324		046	T
3		30	2.80	215	87	92	79	692	332	373	381	362	1287	038	041	C
4		40	2.50	196	87	90	79	593	330	367	383	346	833	040	037	C
5		50	2.30	183	86	89	78	520	328	362	382	335	766	040	033	C
6		60	2.00	185	86	89	79	511	329	358	377	336	838	040	030	C
7		70	1.90	171	86	88	78	467	324	357	371	345	755	040	030	C
8		80	1.70	161	86	87	78	434	315	353	365	351	696	040	029	T
9		90	1.60	155	85	87	78	412	308	351	360	354	666	039	025	L
10		100	1.40	150	85	89	77	396	301	345	358	355	586	039	029	L
11		110														
12		120														
13		130														
14		140														
15		150														
16		160														
17		170														
18		180														
19		190														
20		200														
21		210														
22		220														
23		230														
24		240														
25		250														

Comments:

15:20 FIRE STOPPED 16:07 fire stopped door open 40sec

WHI LTO#: 7767

AIR CONTROL ON MARK 2

MANUFACTURER: VCI

MODEL: 1920

FIRE SIZE: LOW

DATE: 7-15-99

RUN#: 2

SWITCH NUMBER:

READING	REAL TIME	LEAKED TIME	WEIGHT (MIN/MAX)	CO	CO	CO	1 FILL GAS TEMP	2 ROOM TEMP	3 TUNNEL INLET TEMP	4 TUNNEL WET BULB	5 UNIT TOP	6 UNIT BACK	7 UNIT XT. SIDE	8 UNIT LEFT SIDE	9 UNIT BOTTOM	10 CAT INLET	11 CAT CENTER	12	13	17 GAS SUPPLY ROTO.	18 ICM #1 READING	19 ROTO 1 READING	20 ICM TEMP INLET	21 ICM TEMP OUTLET	22 FILTER TEMP	OCM #2 READING	ROTO 2 READING	ICM TEMP INLET	ICM TEMP OUTLET	FILTER TEMP	TUNNEL VELOCITY	INLET	SMOKE	MAX ICM PRESS	MAX ICM
0	16:11	0	6.89	2.02	5.19	13.99	168	85	88	78	392	300	345	358	354	592			135	619.5	120	79	79	75	16.1	120	79	79	76	.040	.028	L	0		
1		10	6.00	1.28	13.55	5.55	257	85	90	78	595	288	334	348	361	1298			135	621.9	120	79	79	74	18.4	120	79	79	79	.039	.049	H	2		
2		20	5.00	2.71	16.94	2.42	294	85	92	78	685	278	327	345	361	1284			135	624.3	120	79	79	77	20.8	120	80	80	80	.039	.054	L	2		
3		30	4.00	1.71	17.17	2.58	290	86	93	78	743	274	333	356	354	1321			135	626.7	120	80	80	79	23.2	120	81	81	81	.040	.054	L	2		
4		40	3.10	2.24	17.76	1.88	259	87	92	79	756	278	343	365	341	1363			135	629.1	120	79	80	80	25.6	120	80	80	82	.041	.050	L	2		
5		50	2.60	1.03	15.76	3.73	230	87	91	78	707	284	350	370	327	1178			135	631.5	120	79	79	80	28.0	120	78	79	82	.040	.043	T	2		
6		60	2.20	1.80	10.37	9.12	202	86	90	78	582	289	355	371	314	851			135	633.9	120	78	79	80	30.4	120	78	79	82	.040	.039	L	2		
7		70	2.00	1.94	10.50	8.80	190	86	89	78	542	294	354	365	303	839			135	636.3	120	79	79	80	32.8	120	78	79	82	.040	.035	M	2		
8		80	1.70	1.50	11.16	8.33	184	86	88	78	524	295	361	360	298	827			135	638.8	120	79	79	80	35.2	120	78	79	82	.041	.034	L	2		
9		90	1.40	2.12	8.88	10.32	178	86	88	78	483	295	347	355	294	789			135	641.0	120	79	79	80	37.6	120	79	79	82	.041	.031	T	2		
10		100	1.20	2.22	7.80	11.23	177	86	88	77	452	294	345	351	295	720			135	643.4	120	79	80	81	40.0	120	79	79	82	.041	.031	T	2		
11		110	1.10	2.11	7.73	11.22	176	85	87	77	425	294	345	348	286	682			135	645.8	120	79	80	80	42.4	120	79	79	82	.042	.031	T	2		
12		120	.90	2.15	7.16	11.86	178	85	87	77	406	295	346	347	295	674			135	648.2	120	79	80	80	44.8	120	79	78	82	.040	.031	T	2		
13		130	.80	1.68	6.99	12.55	175	85	87	77	392	295	345	347	295	644			135	650.6	120	79	79	80	47.2	120	79	79	82	.040	.030	C	2		
14		140	.70	1.89	6.26	13.01	171	84	86	77	380	293	341	347	298	623			135	653.0	120	79	79	80	49.6	120	79	79	81	.040	.030	C	2		
15		150	.60	1.89	6.04	13.26	172	84	86	76	368	290	337	346	298	597			135	655.4	120	79	79	80	52.0	120	79	79	81	.039	.030	C	2		
16		160	.50	1.67	5.67	13.84	173	84	86	76	352	289	332	346	297	583			135	657.8	120	79	80	80	54.3	120	79	79	81	.039	.030	C	2		
17		170	.40	1.84	4.92	14.57	174	84	85	76	349	288	327	344	291	572			135	660.2	120	79	80	80	56.7	120	79	79	81	.039	.029	C	3		
18		180	.30	1.81	5.39	14.15	174	83	85	76	344	287	322	340	281	569			135	662.6	120	79	80	80	59.1	120	79	79	81	.041	.030	C	2		
19		190	.20	1.78	5.60	13.95	176	83	85	76	341	288	319	336	273	577			135	665.0	120	79	80	80	61.5	120	79	79	81	.041	.030	C	2		
20		200	.10	1.70	5.90	13.71	177	83	85	76	341	291	319	333	267	579			135	667.4	120	80	80	80	63.9	120	79	79	81	.041	.030	C	2		
21	207	210	.0	1.79	6.00	13.55	177	83	85	75	340	294	319	332	265	573			135	669.4	120	80	80	80	65.6	120	79	79	81	.040	.030	C	2		
22		220																																	
23		230																																	
24		240																																	
25		250																																	
26		260																																	
27		270																																	
28		280																																	
29		290																																	
30		300																																	
31		310																																	
32		320																																	
33		330																																	
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35		350																																	
36		360																																	
37		370																																	
38		380																																	
39		390																																	
40		400																																	
41		410																																	
42		420																																	
43		430																																	
44		440																																	
45		450																																	
46		460																																	
47		470																																	
48		480																																	

207 MIN
752 Kg/HK

COMMENTS:

TEST LOADED IN 10 SECONDS DOOR CLOSED AFTER LOADING AIR CONTROL SET TO 2ND MARK AT 4 MIN

Manufacturer Vel Model 1920 Date 7-20-99
 Job # 7767 Run 3 Tech RA

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.24 (inches Hg.) Static pressure (P_s) .127 (inches w.c.)
 Inside diameter: Port A 6in. Port B 6in. Tunnel cross sectional area: $0.1963Ft^2$
 Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H ₂ O)	Tunnel Temperature (°F)	$\sqrt{\Delta_p}$
A-Centroid	3.00	.040	88	.2000
B-Centroid	3.00	.040	88	.2000
A-1	0.40	.035	93	.1871
A-2	1.50	.040	88	.2000
A-3	4.50	.040	88	.2000
A-4	5.60	.037	87	.1924
B-1	0.40	.037	89	.1924
B-2	1.50	.040	88	.2000
B-3	4.50	.040	88	.2000
B-4	5.60	.034	89	.1844
		AVERAGE	88.6	.1956

Adjustment factor application

Where,
 C_p = Pitot tube coefficient = 0.99 for standard pitot
 Δ_p = manometer reading (inches H₂O)
 T_s = average absolute dilution tunnel temperature (°F + 460)

.9781

$$V_s = K_p C_p F_p (\sqrt{\Delta_p})_{AVG} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_s = K_p C_p (\sqrt{\Delta_p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

P_s = absolute dilution tunnel gas pressure or $P_{bar} + P_s$

$$F_p = \frac{(\sqrt{\Delta_p})_{avg}}{(\sqrt{\Delta_p})_{centroid}}$$

P_s = static pressure inches H₂O
13.6

M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)
 K_p = 85.49 Pitot tube constant, (conversion factor for English units)

Adjustment factor for alternative Pitot tube placement:

$(\sqrt{\Delta_p})_{avg}$ = Average of the square roots of the velocity heads (Δ_p) measured at each traverse point.

$(\sqrt{\Delta_p})_{centroid}$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H₂O)

Manufacturer Ve1 Model 1920 Date 7-20-99
 Job # 7767 Run 3 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:

Time: <u>7:30</u>	X: <input checked="" type="checkbox"/>	Y: <input checked="" type="checkbox"/>	12: <input checked="" type="checkbox"/>	22: <input checked="" type="checkbox"/>
-------------------	--	--	---	---

Facility Conditions:

Air Velocity.....
 Smoke Capture Check.....

Pre-Test	Post-Test
0 fpm	0 fpm
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Wood Heater Conditions:

Date Wood Heater Stack Cleaned.....
 Date Dilution Tunnel Cleaned.....
 Induced Draft Check.....
 Tunnel Velocity.....
 Flow Rate 140-cfm ±10%.....

7-16-99	
7-16-99	
0	0
040	
	143.90

Pitot Leak Check:

Side A.....
 Side B.....

<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Temperature System:

Ambient (65°- 90°F).....
 Wood Heater Surface (±125°F).....

<input checked="" type="checkbox"/>	°F
-64.4	°F

Proportional Checks:

CO Analyzer Drift Check.....
 CO₂ Analyzer Check.....
 O₂ Analyzer Check.....
 Thermocouple check.....

/
/
/
/

Sampling Train ID Numbers:

Probe.....
 Filter Front.....
 Filter Back.....
 Filter Thermocouple.....
 Filter 5G-3 (<90°F).....

Train 1	Train 2
9	10
5	7
6	8
19	22
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Thermocouple Identification Number

Floor.....1
 Dilution Tunnel Wet Bulb.....4
 Unit Right Side.....7
 Catalyst/Combustion Chamber.....10

Room.....2
 Unit Top.....5
 Unit Left Side.....8

Dilution Tunnel Dry Bulb.....3
 Unit Back.....6
 Unit Bottom.....9

Manufacturer VLI Model 1920 Date 7-20-99
 Job # 7767 Run 3 Tech RA

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	<u>10</u> lbs., Class F	<u>10.0</u> lbs.
Wood	<u>10</u> lbs., Class F	<u>10.00</u> lbs.
Analytical	100 Grams <u>100</u> mg, Class S	<u>100</u> Grams <u>100</u> mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE.....50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Manufacturer ICI Model 1920 Date 7-20-99 Page 30 of 71
 Job # 7767 Run 3 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

	SYSTEM 1		SYSTEM 2	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Unplugged Flow Rate = .25cfm				
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1 minute DGM (ft ³)	744.46	779.480	140.244	175.204
Initial 1 minute DGM (ft ³)	744.466	779.480	140.241	175.201
Change (C) (ft ³)	0	0	.003	.003
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Fine Gas Sampler

	Pre Test	Post Test
Plugged Probe		
Vacuum (inches Hg.)	10"	10"
Rotometer Reading (mm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Manufacturer ICI Model 1920 Date 7-20-99 Page 31 of 71
 Job # 7767 Run 3 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
	Actual	Should Be	Actual	Should Be	Actual	Should Be
CO	0	0	9.99	9.99	.93	.991
CO ₂	0	0	24.63	24.63	9.66	10.02
O ₂	0	0	20.93	20.93	10.20	10.01

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO	0	9.97	.93	0	.02	.0	✓	
CO ₂	.02	24.60	9.65	.02	.03	.01	✓	
O ₂	.10	20.88	10.23	.10	.05	.03	✓	

* Greater than ± 5% of the range used.

Manufacturer VC1 Model 1920 Date 7-20-99
 Job # 7767 Run 3 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

Samples in Descrator. FILTER TYPE: G4man 47mm A/B Date: 7-20-99 Time: 12:00

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # <u>9</u>	Filter Numbers <u>5+6</u>	Probe and Front Half Housing # <u>10</u>	Filter Numbers <u>7+8</u>
Post Test Weight:	<u>92.2248</u> grams	<u>.2467</u> grams	<u>92.0568</u> grams	<u>.2470</u> grams
Pre Test Weight:	<u>92.2248</u> grams	<u>.2407</u> grams	<u>92.0568</u> grams	<u>.2406</u> grams
Gain:	<u>0</u> grams	<u>.0060</u> grams	<u>0</u> grams	<u>.0064</u> grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .006 grams a2 + b2 = .0064 grams

Pre-test Weight Record		SYSTEM 1			SYSTEM 2			TEMP	HUMID
Date	Time	Probe & Housing Number	Front Filter Number	Back Filter Number	Probe & Housing Number	Front Filter Number	Back Filter Number	°F	%
<u>7-14-99</u>	<u>6:55</u>	<u>92.2240</u>	<u>.1200</u>	<u>.1206</u>	<u>92.0566</u>	<u>.1206</u>	<u>.1199</u>	<u>73</u>	<u>48</u>
<u>7-19-99</u>	<u>7:00</u>	<u>92.2249</u>	<u>.1199</u>	<u>.1207</u>	<u>92.0566</u>	<u>.1205</u>	<u>.1199</u>	<u>74</u>	<u>47</u>
<u>7-20-99</u>	<u>7:00</u>	<u>92.2249</u>	<u>.1199</u>	<u>.1208</u>	<u>92.0568</u>	<u>.1206</u>	<u>.1200</u>	<u>72</u>	<u>46</u>
Total		<u>.2407</u>			Total <u>.2406</u>				

Pre-test Weight Record		SYSTEM 1	SYSTEM 2	TEMP	HUMID		
Date	Time	Probe & Housing Number	Combined Filter Weight Number	°F	%		
<u>7-19-99</u>	<u>12:00</u>	<u>92.2240</u>	<u>.2483</u>	<u>92.0572</u>	<u>.2482</u>	<u>76</u>	<u>50</u>
<u>7-21-99</u>	<u>8:00</u>	<u>92.2248</u>	<u>.2471</u>	<u>92.0568</u>	<u>.2470</u>	<u>70</u>	<u>45</u>
<u>7-22-99</u>	<u>10:20</u>	<u>92.2249</u>	<u>.2467</u>	<u>92.0568</u>	<u>.2470</u>	<u>73</u>	<u>47</u>
<u>7-22-99</u>	<u>6:35</u>	<u>92.2248</u>	<u>.2467</u>	<u>92.0568</u>	<u>.2470</u>	<u>72</u>	<u>47</u>

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Manufacturer Vel Model 1920 Date 7-20-99
 Job # 7767 Run 3 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (l ³)	779.472	175.194
Initial (l ³)	714.466	140.244 RA

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.24	29.23
Wet Bulb (°F)	66	67
Dry Bulb (°F)	75	79
Humidity (%)	52	54

Manufacturer UCI Model 1920 Date 7-20-99 Page 34 of 71
 Job # 7767 Run 3 Tech RA

AIR CONTROL SWT TO MARK #3

SWITCH NUMBER		1	2	3	4	5	6	7	8	9	10					
READING #	REAL TIME	ELAPSED TIME	WEIGHT REMAINING	FLUE GAS TEMP	ROOM TEMP	TUNNEL DRY BULB	TUNNEL WET BULB	UNIT TOP	UNIT BACK	UNIT RIGHT SIDE	UNIT LEFT SIDE	UNIT BOTTOM	CATALYST DOWNSTREAM	TUNNEL VELOCITY	DRAFT	SMOKE
0	8:20	0	370	590	75	90	66	799	201	270	248	261	1248	.039	.065	L
1		10	390	341	76	87	67	720	244	329	308	300	1001	.040	.059	C
2		20	330	354	77	88	67	752	280	367	349	329	1286	.040	.063	M
3		30	350	339	78	90	68	777	307	383	373	357	1283	.041	.060	M
4		40	280	279	78	85	68	731	318	386	388	357	1222	.041	.054	J
5		50	230	267	78	85	68	707	325	378	392	349	1097	.041	.049	C
6		60	150	275	79	85	69	753	332	374	393	359	1228	.041	.049	C
7		70														
8		80														
9		90														
10		100														
11		110														
12		120														
13		130														
14		140														
15		150														
16		160														
17		170														
18		180														
19		190														
20		200														
21		210														
22		220														
23		230														
24		240														
25		250														

Comments:
 8:34 1.35 lbs ADDED 18.090L UNCORRECTED
 8:46 1.36 lbs ADDED SAME MOISTURE
 9:21 FIRE STARTED DOOR OPEN 15 SEC

Manufacturer Vel Model 1920 Date 7-21-99
 Job # 7767 Run 4 Tech RA

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.15 (inches Hg.) Static pressure (P_s) .124 (inches w.c.)
 Inside diameter: Port A 6in. Port B 6in. Tunnel cross sectional area: 0.1963ft²
 Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H ₂ O)	Tunnel Temperature (°F)	$\sqrt{\Delta_p}$
A-Centroid	3.00	.039	97	.1975
B-Centroid	3.00	.041	94	.2025
A-1	0.40	.035	93	.1871
A-2	1.50	.040	97	.2000
A-3	4.50	.040	99	.2000
A-4	5.60	.035	93	.035
B-1	0.40	.035	95	.035
B-2	1.50	.042	95	.042
B-3	4.50	.040	95	.040
B-4	5.60	.036	95	.036
AVERAGE			95.3	.1956

Adjustment factor application

Where,
 C_p = Pitot tube coefficient = 0.99 for standard pitot
 Δ_p = manometer reading (inches H₂O)
 T_s = average absolute dilution tunnel temperature (°F + 460)

$$V_o = K_p C_p F_p (\sqrt{\Delta_p})_{AVG} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_s = K_p C_p (\sqrt{\Delta_p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

P_s = absolute dilution tunnel gas pressure or $P_{bar} + P_s$

$$F_p = \frac{(\sqrt{\Delta_p})_{avg}}{(\sqrt{\Delta_p})_{centroid}}$$

P_s = static pressure inches H₂O
 $M_s = 28.56$, wet molecular weight of stack gas (alternatively, it may be measured)
 $K_p = 35.49$ Pitot tube constant, (conversion factor for English units)

Adjustment factor for alternative Pitot tube placement:

$(\sqrt{\Delta_p})_{avg}$ = Average of the square roots of the velocity heads (Δ_p) measured at each traverse point.
 $(\sqrt{\Delta_p})_{centroid}$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H₂O)

.9780

Manufacturer Vel Model 192D Date 7-21-99
 Job # 7767 Run 4 Tech RA

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	<u>10</u> lbs., Class F	<u>10.0</u> lbs.
Wood	<u>10</u> lbs., Class F	<u>10.00</u> lbs.
Analytical	100 Grams <u>100</u> mg, Class S	<u>100</u> Grams <u>100</u> mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE.....50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE.....20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Manufacturer Vei Model 1920 Date 7-21-99
 Job # 7767 Run 4 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

	SYSTEM 1		SYSTEM 2	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Unplugged Flow Rate = .25cfm				
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1 minute DGM (ft ³)	779.559	812.113	175.213	207.628
Initial 1 minute DGM (ft ³)	779.559	812.113	175.210	207.626
Change (C) (ft ³)	0	0	.003	.002
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

	Pre Test	Post Test
Plugged Probe		
Vacuum (inches Hg.)	10"	10"
Rotometer Reading (mm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Page #2 of 71

Manufacturer Vei Model 1920 Date 7-21-99
 Job # 7267 Run 4 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	9.99	9.99	.93	.991
CO ₂	0	0	24.63	24.63	9.64	10.02
O ₂	0	0	20.93	20.93	10.20	10.01
	Actual	Should Be	Actual	Should Be	Actual	Should Be

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO	0	10.06	.94	0	.07	.01	/	
CO ₂	0	24.71	9.67	0	.08	.03	/	
O ₂	.05	20.95	10.24	.05	.02	.04	/	

* Greater than ± 5% of the range used.

Manufacturer Veil Model 1920 Date 7-21-99
 Job # 7767 Run 4 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

Samples in Desecrator. FILTER TYPE: Gelman 47mm A/E Date: 7-21-99 Time: 14:21

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing #	Filter Numbers	Probe and Front Half Housing #	Filter Numbers
Post Test Weight:	<u>92.4596</u> grams	<u>.2480</u> grams	<u>92.3775</u> grams	<u>.2476</u> grams
Pre Test Weight:	<u>92.4596</u> grams	<u>.2408</u> grams	<u>92.3775</u> grams	<u>.2401</u> Grams
Gain:	<u>0</u> grams	<u>.0072</u> grams	<u>0</u> grams	<u>.0075</u> Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0072 grams a2 + b2 = .0075 grams

Pre-test Weight Record		SYSTEM 1			SYSTEM 2			TEMP	HUMID
		Probe & Housing Number	Front Filter Number	Back Filter Number	Probe & Housing Number	Front Filter Number	Back Filter Number		
Date	Time	<u>A</u>	<u>9</u>	<u>10</u>	<u>B</u>	<u>11</u>	<u>12</u>	°F	%
<u>7-20-99</u>	<u>7:00</u>	<u>92.4598</u>	<u>.1207</u>	<u>.1199</u>	<u>92.3774</u>	<u>.1202</u>	<u>.1202</u>	<u>72</u>	<u>48</u>
<u>7-21-99</u>	<u>8:00</u>	<u>92.4596</u>	<u>.1207</u>	<u>.1201</u>	<u>92.3775</u>	<u>.1199</u>	<u>.1202</u>	<u>70</u>	<u>45</u>
Total		<u>.2408</u>			Total			<u>.2401</u>	

Pre-test Weight Record		SYSTEM 1		SYSTEM 2		TEMP	HUMID
		Probe & Housing Number	Combined Filter Weight Number	Probe & Housing Number	Combined Filter Weight Number		
Date	Time	<u>A</u>	<u>9+10</u>	<u>B</u>	<u>11+12</u>	°F	%
<u>7-21-99</u>	<u>14:21</u>	<u>92.4596</u>	<u>.2493</u>	<u>92.3776</u>	<u>.2485</u>	<u>77</u>	<u>50</u>
<u>7-22-99</u>	<u>10:30</u>	<u>92.4596</u>	<u>.2480</u>	<u>92.3775</u>	<u>.2479</u>	<u>73</u>	<u>47</u>
<u>7-25-99</u>	<u>8:00</u>	<u>92.4596</u>	<u>.2480</u>	<u>92.3775</u>	<u>.2476</u>	<u>72</u>	<u>47</u>
<u>7-26-99</u>	<u>6:35</u>	<u>92.4596</u>	<u>.2480</u>	<u>92.3775</u>	<u>.2476</u>	<u>72</u>	<u>47</u>

Manufacturer Ve1 Model 1920 Date 7-21-99 Page 44 of 71
Job # 7767 Run 4 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft ³)	812.102	207.616
Initial (ft ³)	779.559	175.213

AMBIENT CONDITIONS

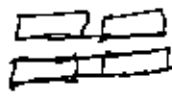
	Start	End
Barometer. (inches Hg)	29.15	29.14
Wet Bulb (°F)	64	69
Dry Bulb (°F)	72	82
Humidity (%)	65	52

ITS Intertek Testing Services

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Manufacturer Vci Model 1920 Date 7-21-99
 Job # 7767 Run 4 Tech RA

COMMENTS

9:38 1.56 lbs ADDED OF SAME MOISTURE	<p style="text-align: center;">TEST LOAD CONFIGURATION</p> 
9:55 1.56 lbs ADDED " " "	
10:25 STOVE CLEANED OUT SCALE ZEROED	
1.90 lbs HOT COALS PUT BACK IN ALONG WITH	
6.60 lbs PREBURN 18.66% UNC 19.93% DRY 16.62% WET	
THE AIR CONTROL WAS LEFT ON MARK #4	
DURING THIS PROCESS	
10:55 1.29 lbs ADDED OF SAME MOISTURE CONTENT	
11:17 1.40 lbs ADDED 17.89% UNC	

18.66
19.93
16.62

Manufacturer DCI Model 1920 Date 7-21-99
 Job # 7767 Run 4 Tech RA

AIR CONTROL SET TO MARK #4

SWITCH NUMBER		1	2	3	4	5	6	7	8	9	10					
READING #	REAL TIME	ELAPSED TIME	WEIGHT REMAINING	FLUE GAS TEMP	ROOM TEMP	TUNNEL DRY BULB	TUNNEL WET BULB	UNIT TOP	UNIT BACK	UNIT RIGHT SIDE	UNIT LEFT SIDE	UNIT BOTTOM	CATALYST DOWNSTREAM	TUNNEL VELOCITY	DRAFT	SMOKE
0	9:26	0	390	422	71	93	65	811	192	201	195	194	1322	044	069	M
1		10	260	419	73	92	66	837	236	276	264	245	1297		066	T
2		20	270	410	75	94	68	855	281	343	317	317	1367		069	L
3		30	330	404	76	103	69	797	319	394	359	384	1261	010	068	M
4		40	210	405	79	105	69	795	348	420	392	422	1301	059	065	L
5		50	140	325	79	70	70	733	365	431	416	452	1075	040	058	C
6		60														
7		70														
8		80														
9		90														
10		100														
11		110														
12		120														
13		130														
14		140														
15		150														
16		160														
17		170														
18		180														
19		190														
20		200														
21		210														
22		220														
23		230														
24		240														
25		250														

Comments:
 9:38 1.56 lbs ADDED
 9:55 1.56 lbs ADDED

1ST PRELOAD

Manufacturer VCI Model 1920 Date 7-21-99

Job # 7767 Run 4 Tech RA

AIR CONTROL AT MARK #4

SWITCH NUMBER			1	2	3	4	5	6	7	8	9	10				
READING #	REAL TIME	ELAPSED TIME	WEIGHT REMAINING	FLUE GAS TEMP	ROOM TEMP	TUNNEL DRY BULB	TUNNEL WET BULB	UNIT TOP	UNIT BACK	UNIT RIGHT SIDE	UNIT LEFT SIDE	UNIT BOTTOM	CATALYST DOWNSTREAM	TUNNEL VELOCITY	DRAFT	SMOKE
0	10:34	0	6.50	364	78	94	70	707	357	436	427	451	1200	.039	.064	H
1		10	4.60	375	77	95	70	735	336	415	409	477	1147	.038	.065	H
2		20	3.00	370	80	94	71	773	338	420	413	496	1265	.039	.063	M
3		30	3.10	359	81	95	71	775	356	441	433	516	1283	.040	.062	L
4		40	2.20	330	80	90	71	763	373	450	444	512	1291	.040	.060	T
5		50	2.60	327	81	90	71	761	385	454	455	509	1310	.041	.059	L
6		60	2.10	291	81	88	71	731	386	445	453	495	1190	.040	.053	C
7		70	1.70	280	80	87	71	682	384	439	446	471	962	.042	.050	C
8		80														
9		90														
10		100														
11		110														
12		120														
13		130														
14		140														
15		150														
16		160														
17		170														
18		180														
19		190														
20		200														
21		210														
22		220														
23		230														
24		240														
25		250														

Comments:
 10:55 1.29 lbs added FIRE STIRRED
 11:17 1.40 lbs added 17.9% UNCORRECTED
 11:48 FIRE STIRRED 32 SEC.

2ND PRELOAD

Manufacturer VCI Model 1920 Page 50 of 71
 Job # 7767 Run 5 Tech 124 Date 7-22-99

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.20 (inches Hg) Static pressure (P_s) .132 (inches w.c.)
 Inside diameter: Port A 6in. Port B 6in. Tunnel cross sectional area: 0.1963Ft^2
 Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H_2O)	Tunnel Temperature ($^{\circ}\text{F}$)	$\sqrt{\Delta_p}$
A-Centroid	3.00	.040	103	.2000
B-Centroid	3.00	.040	101	.2000
A-1	0.40	.036	101	.1897
A-2	1.50	.040	101	.2000
A-3	4.50	.040	102	.2000
A-4	5.60	.034	101	.1844
B-1	0.40	.036	101	.1897
B-2	1.50	.040	100	.2000
B-3	4.50	.040	100	.2000
B-4	5.60	.037	101	.1924
		AVERAGE	101.1	.1956

Adjustment factor application

Where,
 C_p = Pitot tube coefficient = 0.99 for standard pitot
 Δ_p = manometer reading (inches H_2O)
 T_s = average absolute dilution tunnel temperature ($^{\circ}\text{F} + 460$)

$$V_s = K_p C_p F_p (\sqrt{\Delta_p})_{AVG} \sqrt{\frac{T_s}{P_s M_s}}$$

P_s = absolute dilution tunnel gas pressure or $P_{bar} + P_s$

P_s = static pressure $\frac{\text{inches H}_2\text{O}}{13.6}$
 M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)
 K_p = 83.49 Pitot tube constant, (conversion factor for English units)

$$V_s = K_p C_p (\sqrt{\Delta_p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

$$F_p = \frac{(\sqrt{\Delta_p})_{avg}}{(\sqrt{\Delta_p})_{centroid}}$$

Adjustment factor for alternative Pitot tube placement

$(\sqrt{\Delta_p})_{avg}$ = Average of the square roots of the velocity heads (Δ_p) measured at each traverse point.
 $(\sqrt{\Delta_p})_{centroid}$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

.9781

ITS Intertek Testing Services

Manufacturer Vci Model 1420 Date 7-22-99 Page 51 of 71
 Job # 7767 Run 5 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:

Time: <u>10:15</u>	X: <input checked="" type="checkbox"/>	Y: <input checked="" type="checkbox"/>	12: <input checked="" type="checkbox"/>	22: <input checked="" type="checkbox"/>
--------------------	--	--	---	---

Facility Conditions:

Air Velocity.....

Smoke Capture Check.....

Pre-Test	Post-Test
0 fpm	0 fpm
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Wood Heater Conditions:

Date Wood Heater Stack Cleaned.....

Date Dilution Tunnel Cleaned.....

Induced Draft Check.....

Tunnel Velocity.....

Flow Rate 140-cfm \pm 10%.....

Pitot Leak Check:

Side A.....

Side B.....

7-16-99	
7-16-99	
0	0
.040	142.735
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Temperature System:

Ambient (65°- 90°F).....

Wood Heater Surface (\pm 125°F).....

<input checked="" type="checkbox"/>	°F
109.4	°F

Proportional Checks:

CO Analyzer Drift Check.....

CO₂ Analyzer Check.....

O₂ Analyzer Check.....

Thermocouple check.....

<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/>	

Sampling Train ID Numbers:

Probe.....

Filter Front.....

Filter Back.....

Filter Thermocouple.....

Filter 5G-3 (<90°F).....

Train 1	Train 2
C18	D
13	15
14	16
19	22
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Thermocouple Identification Number

Flue.....1
 Dilution Tunnel Wet Bulb.....4
 Unit Right Side.....7
 Catalyst/Combustion Chamber.....10

Room.....2
 Unit Top.....5
 Unit Left Side.....8

Dilution Tunnel Dry Bulb.....3
 Unit Back.....6
 Unit Bottom.....9

Manufacturer VC1 Model 1920 Date 7-22-99 Page 52 of 71
 Job # 7767 Run 5 Tech RA

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	10 lbs., Class F	10.0 lbs.
Wood	15 lbs., Class F	10.00 lbs.
Analytical	100 Grams	100 Grams
	100 mg. Class S	100 mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE..... 50%-150% of dry filter weight, ± 0.1 mg
 PLATFORM SCALE..... 20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
 WOOD SCALE..... 20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Manufacturer Vei Model 1920 Date 7-22-99
 Job # 7767 Run 5 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

Unplugged Flow Rate = .25cfm	SYSTEM 1		SYSTEM 2	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1 minute DGM (ft ³)	812.173	845.794	207.637	241.236
Initial 1 minute DGM (ft ³)	812.169	845.790	207.635	241.233
Change (C) (ft ³)	.004	.004	.002	.003
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

Plugged Probe	Pre Test	Post Test
Vacuum (inches Hg.)	10"	10"
Rotometer Reading (rpm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

Manufacturer Vel Model 1920 Date 7-22-99
 Job # 7267 Run 5 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
	Actual	Should Be	Actual	Should Be	Actual	Should Be
CO	0	0	9.99	9.99	.93	.991
CO ₂	0	0	24.63	24.63	9.64	10.02
O ₂	0	0	20.93	20.93	10.20	10.01

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO	0	10.03	.93	0	.01	0	✓	
CO ₂	-.01	24.40	9.65	-.01	.01	.01	✓	
O ₂	.04	20.79	10.21	.04	.10	.01	✓	

* Greater than ± 5% of the range used.

SPAN
 CO 10.00
 CO₂ 24.62
 O₂ 20.83

Manufacturer VCI Model 1920 Date 7-22-99
 Job # 7767 Run 5 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

Samples in Desiccator: _____ Date: 7-22-99 Time: 15:35
FILTER TYPE: G6max 47mm A/E

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # <u>C</u>	Filter Numbers <u>13+14</u>	Probe and Front Half Housing # <u>D</u>	Filter Numbers <u>15+16</u>
Post Test Weight:	90.9130 grams	.2431 grams	91.0424 grams	.2432 grams
Pre Test Weight:	90.9130 grams	.2407 grams	91.0424 grams	.2402 grams
Gain:	0 grams	.0024 grams	D grams	.003 grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0024 grams a2 + b2 = .003 grams

		SYSTEM 1			SYSTEM 2			TEMP	HUMID
Pre-test Weight Record		Probe & Housing Number	Front Filter Number	Back Filter Number	Probe & Housing Number	Front Filter Number	Back Filter Number		
Date	Time	<u>C</u>	<u>13</u>	<u>14</u>	<u>D</u>	<u>15</u>	<u>16</u>	°F	%
7-22-99	15:04	90.9130	.1204	.1198	91.0424	.1200	.1199	76	50
7-22-99	10:28	90.9130	.1207 1209	.1200	91.0424	.1201	.1201	73	47
		Total	.2407		Total	.2402			

		SYSTEM 1		SYSTEM 2		TEMP	HUMID
Pre-test Weight Record		Probe & Housing Number	Combined Filter Weight Number	Probe & Housing Number	Combined Filter Weight Number		
Date	Time	<u>C</u>	<u>13+14</u>	<u>D</u>	<u>15+16</u>	°F	%
7-22-99	15:35	90.9131	.2435	91.0424	.2435	79	50
7-23-99	8:00	90.9130	.2431	91.0424	.2432	72	47
7-24-99	6:35	90.9130	.2431	91.0424	.2432	72	47

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Manufacturer VCI Model 1920 Date 7-22-99
 Job # 7767 Run 5 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft ³)	845.719	241.215
Initial (ft ³)	812.173	207.637

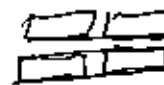
AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.20	29.20
Wet Bulb (°F)	61	75
Dry Bulb (°F)	75	88
Humidity (%)	44	55

ITS Intertek Testing Services

Manufacturer VC-1 Model 1920 Date 7-22-99 Page 68 of 71
 Job # 7767 Run 5 Tech RA

COMMENTS

12:10	1.47	10s	PRELOAD ADDED OF SAME MOISTURE
12:30	1.43	"	"
SPACERS CUT TO 4 1/4"			TEST LOAD CONFIGURATION 
FOR 9" WIDE FIREBOX			

Manufacturer VCI Model 1920 Date 7-22-99

Job # 7767 Run 5 Tech RA

AIRCONTROL SET ON MARK 4

SWITCH NUMBER		1	2	3	4	5	6	7	8	9	10					
READING #	REAL TIME	ELAPSED TIME	WEIGHT REMAINING	FLUE GAS TEMP	ROOM TEMP	TUNNEL DRY BULB	TUNNEL WET BULB	UNIT TOP	UNIT BACK	UNIT RIGHT SIDE	UNIT LEFT SIDE	UNIT BOTTOM	CATALYST DOWNSTREAM	TUNNEL VELOCITY	DRAFT	SMOKE
0	11:48	0	820	339	74	98	70	583	141	132	130	113	1114	088	062	H
1		10	560	426	80	102	72	828	185	193	188	194	1435	035	070	L
2		20	440	439	79	103	73	857	213	237	233	235	1423	040	071	L
3		30	400	422	81	104	74	822	256	304	299	319	1385	040	071	M
4		40	290	397	83	100	73	833	298	349	349	378	1311	041	066	T
5		50	290	390	85	101	74	816	334	384	388	430	1288	041	068	M
6		60	200	364	86	98	75	817	363	401	408	457	1382	038	063	L
7		70														
8		80														
9		90														
10		100														
11		110														
12		120														
13		130														
14		140														
15		150														
16		160														
17		170														
18		180														
19		190														
20		200														
21		210														
22		220														
23		230														
24		240														
25		250														

Comments:
 12:10 1.47 lbs PRELOAD ADDED
 12:30 1.43 lbs " "
 12:56 Fire stirred down 4/sec

Manufacturer Vet Model 1920 Date 7-23-99 Page 4 of 71
 Job # 7767 Run 6 Tech RA

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.11 (inches Hg) Static pressure (P_s) .132 (inches w.c.)
 Inside diameter: Port A 6in. Port B 6in. Tunnel cross sectional area: 0.1963Ft²
 Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H ₂ O)	Tunnel Temperature (°F)	$\sqrt{\Delta_p}$
A-Centroid	3.00	.041	98	.2025
B-Centroid	3.00	.040	104	.2000
A-1	0.40	.035	99	.1871
A-2	1.50	.040	98	.2000
A-3	4.50	.039	99	.1975
A-4	5.60	.034	100	.1844
B-1	0.40	.036	101	.1897
B-2	1.50	.040	101	.2000
B-3	4.50	.040	102	.2000
B-4	5.60	.035	100	.1871
AVERAGE				1948

Adjustment factor application

Where,
 C_p = Pitot tube coefficient = 0.99 for standard pitot
 Δ_p = manometer reading (inches H₂O)
 T_s = average absolute dilution tunnel temperature (°F + 460)

$$V_s = K_p C_p R_p (\sqrt{\Delta_p})_{AVG} \sqrt{\frac{T_s}{P_s M_s}}$$

P_s = absolute dilution tunnel gas pressure or $P_{bar} + P_s$

P_s = static pressure inches H₂O
13.6

M_s = 28.56, wet molecular weight of stack gas (alternatively, it may be measured)
 K_p = 85.49 Pitot tube constant, (conversion factor for English units)

$$V_s = K_p C_p (\sqrt{\Delta_p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

$$R_p = \frac{(\sqrt{\Delta_p})_{avg}}{(\sqrt{\Delta_p})_{centroid}}$$

Adjustment factor for alternative Pitot tube placement

$(\sqrt{\Delta_p})_{avg}$ = Average of the square roots of the velocity heads (Δ_p) measured at each traverse point.

$(\sqrt{\Delta_p})_{centroid}$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H₂O)

.9681



Intertek Testing Services

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Manufacturer UC-1 Model 1920 Date 7-23-99
 Job # 7767 Run 6 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:

Time: <u>8:30</u>	X: <input checked="" type="checkbox"/>	Y: <input checked="" type="checkbox"/>	12: <input checked="" type="checkbox"/>	22: <input checked="" type="checkbox"/>
-------------------	--	--	---	---

Facility Conditions:

Air Velocity.....
 Smoke Capture Check.....

Pre-Test	Post-Test
<u>0</u> fpm	<u>0</u> fpm
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Wood Heater Conditions:

Date Wood Heater Stack Cleaned.....
 Date Dilution Tunnel Cleaned.....
 Induced Draft Check.....
 Tunnel Velocity.....
 Flow Rate 140-cfm \pm 10%.....

<u>7-16-99</u>	
<u>7-16-99</u>	
<u>0</u>	<u>0</u>
<u>.041</u>	
	<u>1404</u>

Pitot Leak Check:

Side A.....
 Side B.....

<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Temperature System:

Ambient (65°-90°F).....
 Wood Heater Surface (\pm 125°F).....

<input checked="" type="checkbox"/>	°F
<u>-111.2</u>	°F

Proportional Checks:

CO Analyzer Drift Check.....
 CO₂ Analyzer Check.....
 O₂ Analyzer Check.....
 Thermocouple check.....

<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>

Sampling Train ID Numbers:

Probe.....
 Filter Front.....
 Filter Back.....
 Filter Thermocouple.....
 Filter 5G-3 (<90°F).....

Train 1	Train 2
<u>E</u>	<u>F</u>
<u>17</u>	<u>19</u>
<u>18</u>	<u>20</u>
<u>19</u>	<u>22</u>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Thermocouple Identification Number

Flue.....1
 Dilution Tunnel Wet Bulb.....4
 Unit Right Side.....7
 Catalyst/Combustion Chamber.....10

Room.....2
 Unit Top.....5
 Unit Left Side.....8

Dilution Tunnel Dry Bulb.....3
 Unit Back.....6
 Unit Bottom.....9

Manufacturer K1 Model 1920 Date 7-23-99 Page 13 of 71
 Job# 7767 Run 6 Tech RA

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	<u>10</u> lbs., Class F	<u>10.0</u> lbs.
Wood	<u>10</u> lbs., Class F	<u>10.00</u> lbs.
Analytical	100 Grams <u>100</u> mg, Class S	<u>100</u> Grams <u>100</u> mg.

LIMITS OF WEIGHT RANGES

ANALYTICAL SCALE..... 50%-150% of dry filter weight, ± 0.1 mg
PLATFORM SCALE..... 20%-80% of ideal test load weight, ± 0.1 lbs. or 1%
WOOD SCALE..... 20%-80% of ideal test load weight, ± 0.1 lbs. or 1%

Manufacturer VC1 Model 1920 Date 7-23-98 Page 6 of 71
 Job # 7767 Run 6 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

Unplugged Flow Rate = .25cfm	SYSTEM 1		SYSTEM 2	
	Pre-Test	Post-Test	Pre-Test	Post-Test
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1 minute DGM (ft ³)	845.852	878.052	241.250	273.419
Initial 1 minute DGM (ft ³)	845.845	878.055	241.243	273.419
Change (C) (ft ³)	.007	.001	.007	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

Plugged Probe	Pre Test	Post Test
Vacuum (inches Hg.)	10"	10"
Rotometer Reading (mm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

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Manufacturer VCI Model 1920 Date 7-23-99
 Job # 7767 Run 6 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	999	9.99	.93	991
CO ₂	0	0	24.63	24.63	9.67	10.02
O ₂	0	0	20.93	20.93	10.24	10.01
	Actual	Should Be	Actual	Should Be	Actual	Should Be

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO	.01	10.01	.93	.01	.02	0	✓	
CO ₂	.01	24.76	9.69	.01	.13	.02	✓	
O ₂	.07	20.76	10.22	.07	.17	.02	✓	

* Greater than ± 5% of the range used.

Manufacturer VC1 Model 1920 Date 7-23-99
 Job # 7767 Run 6 Tech 6

DILUTION TUNNEL PARTICULATE SAMPLER DATA

Samples in Descrator. FILTER TYPE: Gelman 47mm A/E Date: 7-23-99 Time: 13:45

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # <u>E</u>	Filter Numbers <u>17+18</u>	Probe and Front Half Housing # <u>F</u>	Filter Numbers <u>19+20</u>
Post Test Weight:	92.6258 grams	.2464 grams	90.9815 grams	.2462 grams
Pre Test Weight:	92.6258 grams	.2411 grams	90.9415 grams	.2412 grams
Gain:	0 grams	.0053 grams	0 grams	.0050 grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0053 grams a2 + b2 = .0050 grams

Date	Time	SYSTEM 1			SYSTEM 2			TEMP °F	HUMID %
		Probe & Housing Number <u>E</u>	Front Filter Number	Back Filter Number	Probe & Housing Number <u>F</u>	Front Filter Number	Back Filter Number		
7-22-99	15:45	92.6258	1204	1208	90.9815	1200	1209	79	49
7-23-99	8:00	92.6258	1204	1207	90.9815	1201	1211	72	47
Total			.2411	Total		.2412			

Date	Time	SYSTEM 1		SYSTEM 2		TEMP °F	HUMID %
		Probe & Housing Number <u>E</u>	Combined Filter Weight Number <u>17+18</u>	Probe & Housing Number <u>F</u>	Combined Filter Weight Number <u>19+20</u>		
7-23-99	13:15	92.6258	.2470	90.9816	.2472	79	49
7-24-99	6:35	92.6258	.2464	90.9815	.2462	72	47
7-27-99	15:00	92.6258	.2464	90.9815	.2462	76	50

Manufacturer Vel Model 1920 Date 7-23-99
 Job # 7767 Run 6 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft ³)	878.038	273.397
Initial (ft ³)	845.852	241.250

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.11	29.05
Wet Bulb (°F)	67	76
Dry Bulb (°F)	74	90
Humidity (%)	70	53

Manufacturer Vcl Model 1920 Date 7-23-99
 Job # 7767 Run 4 Tech RA

COMMENTS

9:59	1.65 lbs	ADDED OF SAME MOISTURE CONTENT
10:19	1.85 lbs	ADDED OF " " "
SPACERS CUT TO	TEST LOAD CONFIGURATION	
4.25" TO FIT		
IN 9" WIDE FIREBOX		

Manufacturer Vel Model 1920 Date 7-23-99

Job # 7767 Run L Tech RA

AIR CONTROL FULL OPEN

SWITCH NUMBER		1	2	3	4	5	6	7	8	9	10					
READING #	REAL TIME	ELAPSED TIME	WEIGHT REMAINING	FLUE GAS TEMP	ROOM TEMP	TUNNEL DRY BULB	TUNNEL WET BULB	UNIT TOP	UNIT BACK	UNIT RIGHT SIDE	UNIT LEFT SIDE	UNIT BOTTOM	CATALYST DOWNSTREAM	TUNNEL VELOCITY	DRAFT	SMOKE
0	9:38	0	820	345	74	93	69	595	128	138	127	129	869	041	060	H
1		10	610	422	76	98	70	735	168	175	183	202	1200	041	070	M
2		20	420	435	78	101	72	839	218	241	247	254	1292	040	070	M
3		30	410	432	79	104	73	863	267	307	307	330	1359	040	072	H
4		40	270	412	83	102	74	863	301	349	344	390	1349	041	068	L
5		50	300	400	84	104	75	821	336	386	382	454	1272	041	068	L
6		60	210	366	85	100	76	806	369	411	404	506	1231	040	061	C
7		70	150	339	86	98	76	576	387	435	430	422	1200	040	068	C
8		80														
9		90														
10		100														
11		110														
12		120														
13		130														
14		140														
15		150														
16		160														
17		170														
18		180														
19		190														
20		200														
21		210														
22		220														
23		230														
24		240														
25		250														

Comments:

9:59 1.65 lbs PRELOAD ADDED
 10:19 1.85 lbs " "
 10:49 Fine soot at 10:44
 door open 3530C

Manufacture Vermont Castings

Model: 1820
 Date: 36356
 Run: 1
 Control #: 7767
 Test Durati: 102

	Start	End
Barome	29.12	29.12
V	71	72
I	81	83
Hi	61	69

Average Stove Temperati 432.8833

Wemock Harsey Efficiency Test Report

Overall Heating Efficiency: 68.59%
 Combustion Efficiency: 85.39%
 Heat Transfer Efficiency: 71.91%

Heat Output: 20329 BTU/Hr 21430 KJ/Hr
 Heat Input: 29638 BTU/Hr 31244 KJ/Hr

Burn Duration: 1.70 Hours

Burn Rate: 3.94 Lb/Hr 1.786 Kg/Hr

Stack Temp: 297.7 Deg.F 147.6 Deg.C

Elapsed Time	Average Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	Comb % K	Combust Eff %	Heat Transfer	Net Eff	air Fuel	Unif MN
0	6.69	1.57	9.69	7.78	331	83	-2.18	131.6%	42.1%	55.4%	8	3.04
10	5.3	3.43	16.29	2.24	364	83	4.18	59.3%	56.0%	33.2%	4	2.40
20	3.9	1.79	17.44	2.18	376	84	3.41	68.7%	73.3%	50.3%	4	1.77
30	2.7	1.64	17.71	2.09	382	85	1.53	83.2%	82.2%	68.3%	5	1.23
40	1.9	0.41	14.01	8.37	320	86	0.14	96.7%	86.2%	83.4%	8	0.86
50	1.4	0.66	11.48	8.47	289	85	-0.53	105.0%	87.8%	92.3%	12	0.64
60	1	0.97	9.36	10.59	269	85	-0.39	101.8%	88.7%	90.1%	16	0.45
70	0.7	0.93	9.74	10.11	263	84	-0.52	104.3%	90.0%	93.8%	18	0.32
80	0.4	1.33	7.99	11.63	268	84	-0.49	101.4%	89.8%	91.0%	23	0.18
90	0.2	1.68	5.77	13.77	250	84	-0.34	94.6%	88.4%	88.8%	30	0.09
100	0.1	1.5	5.45	14.12	245	84	-0.34	94.8%	88.4%	88.8%	34	0.06
102	0	1.62	6.5	14.06	244	83	-0.31	93.8%	88.7%	83.3%	38	0.00

Manufacture Vermont Castings
 Model: 1920
 Date: 36356
 Run: 2
 Control #: 7767
 Test Durati 207

Warmock Hersey Efficiency Test Report

Overall Heating Efficiency: 68.73%
 Combustion Efficiency: 84.91%
 Heat Transfer Efficiency: 80.95%

	Start	End
Barome	28.12	29.12
V	72	71
I	83	85
Hi	58	60

Heat Output: 10071 BTU/Hr 10617 KJ/Hr
 Heat Input: 14652 BTU/Hr 15446 KJ/Hr

Burn Duration: 3.45 Hours

Burn Rate: 2.00 Lb/Hr 0.906 Kg/Hr

Average Stove Temp: 352.5091

Stack Temp: 197.9 Deg.F 92.1 Deg.C

Elapsed Time	Average Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	0.088521	0.243213	ERR	ERR	4.653062	0.233526	Unit	
													Comb % K	Combust Eff %
0	6.89	2.02	5.19	13.99	160	85	0.17	80.6%	23.1%	16.7%	9	3.13		
10	6	1.28	13.85	5.55	287	85	1.58	77.8%	57.9%	45.0%	5	2.72		
20	6	2.71	16.94	2.42	294	85	4.81	67.6%	64.6%	37.2%	4	2.27		
30	4	1.71	17.17	2.68	290	86	3.45	68.1%	75.9%	61.7%	4	1.81		
40	3.1	2.24	17.76	1.88	298	87	2.51	75.1%	82.7%	62.1%	4	1.41		
50	2.6	1.03	15.96	3.73	230	87	0.50	81.8%	86.3%	79.2%	6	1.18		
60	2.2	1.8	10.37	9.12	202	86	0.14	89.9%	87.1%	78.3%	8	1.00		
70	2	1.84	10.6	8.8	190	86	-0.12	92.9%	88.3%	82.1%	10	0.91		
80	1.7	1.5	11.16	8.33	184	86	-0.37	98.4%	90.0%	88.6%	11	0.77		
90	1.4	2.12	8.88	10.32	178	86	-0.40	95.2%	90.4%	88.1%	13	0.64		
100	1.2	2.22	7.8	11.23	177	88	-0.59	87.7%	90.6%	88.5%	16	0.54		
110	1.1	2.11	7.73	11.24	176	86	-0.76	101.8%	90.8%	92.4%	17	0.60		
120	0.9	2.15	7.16	11.86	178	85	-0.67	99.8%	91.1%	90.9%	19	0.41		
130	0.8	1.69	6.94	12.55	176	85	-0.44	97.9%	91.7%	89.7%	21	0.36		
140	0.7	1.89	6.28	13.01	171	84	-0.68	99.1%	91.5%	90.7%	24	0.32		
150	0.6	1.89	6.04	13.28	172	84	-0.52	97.9%	91.7%	89.7%	26	0.27		
160	0.5	1.67	5.67	13.84	173	84	-0.42	96.8%	91.7%	88.8%	28	0.23		
170	0.4	1.88	4.92	14.57	174	84	-0.28	90.4%	91.4%	82.6%	31	0.18		
180	0.3	1.81	5.39	14.13	174	83	-0.27	91.2%	92.2%	84.1%	30	0.14		
190	0.2	1.78	6.8	13.95	176	83	-0.23	90.6%	92.6%	83.9%	30	0.09		
200	0.1	1.7	6.9	13.71	177	83	-0.19	90.4%	93.2%	84.2%	30	0.05		
207	0	1.79	6	13.55	177	83	-0.17	89.2%	93.6%	83.4%	31	0.00		

Manufacture Vermont Castings

Model: 1920
 Date: 38361
 Run: 3
 Control #: 7767
 Test Durati 146

	Start	End
Baroma	29.24	29.23
V	66	67
I	75	79
H	52	54

Average Stove Temperature 409.3375

Wamock Hersey Efficiency Test Report

Overall Heating Efficiency: 71.47%
 Combustion Efficiency: 68.19%
 Heat Transfer Efficiency: 81.05%

Heat Output: 14624 BTU/Hr 15416 KJ/Hr
 Heat Input: 20461 BTU/Hr 21670 KJ/Hr

Sum Duration: 2.43 Hours

Sum Rate: 2.78 Lb/Hr 1.264 Kg/Hr

Stack Temp: 288.1 Deg.F 126.6 Deg.C

Average	1.043125	10.62683	9.276	258.125	60	0.090045	0.101656	ERR	ERR	3.176157	0.203792	
Elapsed Time	Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	Comb % K	Combust Eff %	Heat Transfer	Net Eff	air Fuel	Unit MN
0	6.78	1	15.32	4.2	273	79	1.01	86.5%	28.0%	22.5%	4	3.08
10	5.9	1.18	13.93	5.52	283	79	2.09	73.7%	65.1%	40.6%	5	2.58
20	6.1	0.66	14.73	5.19	284	80	2.73	70.2%	66.2%	46.8%	5	2.31
30	4.3	0.55	14.63	6.29	301	81	2.24	75.0%	73.6%	56.2%	5	1.95
40	3.5	0.48	14.72	5.41	301	81	1.67	81.0%	79.0%	63.9%	6	1.59
50	2.7	0.71	15.27	4.94	298	81	1.04	87.1%	83.5%	72.7%	6	1.23
60	2.1	0.77	14	6.21	293	81	0.35	83.1%	86.3%	80.3%	8	0.96
70	1.8	0.71	11.38	6.71	258	81	-0.26	100.4%	86.0%	85.4%	11	0.73
80	1.3	0.69	9.63	10.48	247	80	-0.37	102.7%	88.5%	90.9%	15	0.58
90	1	0.87	8.5	11.58	210	80	-0.34	102.6%	89.1%	91.4%	18	0.45
100	0.8	1.45	6.12	13.53	227	80	-0.43	99.3%	88.1%	87.5%	24	0.36
110	0.6	1.73	6.16	12.98	228	80	-0.86	108.7%	88.4%	96.1%	28	0.27
120	0.4	1.67	6.39	12.96	228	80	-0.60	101.7%	89.4%	90.9%	27	0.18
130	0.2	1.67	6.41	13.12	228	79	-0.32	94.7%	90.2%	85.4%	28	0.09
140	0.1	1.51	5.89	13.78	223	79	-0.27	93.9%	90.1%	84.6%	32	0.05
146	0	1.24	5.34	14.4	220	79	-0.39	100.0%	89.4%	88.4%	38	0.00

Manufacture Vermont Castings
 Model: 1920
 Date: 86362
 Run: 4
 Control #: 7767
 Test Durati 136

Wamock Hersey Efficiency Test Report

Overall Heating Efficiency: 70.32%
 Combustion Efficiency: 87.94%
 Heat Transfer Efficiency: 79.97%

	Start	End
Baroms	29.15	29.16
V	54	69
I	72	62
H	65	52

Heat Output: 15619 BTU/Hr 16465 KJ/Hr
 Heat Input: 22209 BTU/Hr 23412 KJ/Hr

Burn Duration: 2.25 Hours

Burn Rate: 3.03 Lb/Hr 1.375 Kg/Hr

Stack Temp: 293.5 Deg.F 145.3 Deg.C

1.124
 Average Stove Temperature 447.6933

Elapsed Time	Average Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	Comb % K	Combust Eff %	Heat Transfer	ERR	ERR	air Fuel	Unit MN
0	6.82	0.39	9.53	10.87	274	83	0.58	88.1%	24.8%	21.9%		7	3.09
10	6	0.3	14.32	5.65	330	81	1.91	77.8%	53.7%	41.8%		6	2.72
20	5.2	0.78	14.81	5.08	355	83	2.79	89.6%	63.0%	43.8%		6	2.38
30	4	2.25	16.09	3.22	373	82	3.22	87.4%	72.3%	48.7%		4	1.81
40	3.1	2.24	16.12	3.26	364	85	1.97	77.0%	79.3%	61.1%		6	1.41
50	2.1	0.6	16.37	4.65	341	85	0.05	95.7%	85.4%	82.6%		7	0.95
60	1.6	0.52	10.86	8.87	303	86	-0.76	110.0%	86.5%	95.1%		12	0.73
70	1.2	0.73	9.64	10.13	285	86	-0.79	110.6%	87.6%	98.8%		16	0.64
80	0.9	0.74	8.73	11.32	277	84	-0.44	104.4%	88.2%	92.1%		16	0.41
90	0.7	1.14	6.18	13.68	263	84	-0.40	101.1%	88.8%	87.7%		26	0.32
100	0.6	1.07	6.14	13.76	256	84	-0.41	102.0%	87.3%	89.1%		27	0.27
110	0.4	1.04	6.64	14.23	249	81	-0.45	103.7%	87.2%	90.6%		32	0.18
120	0.3	0.96	6.01	13.86	246	82	-0.36	101.6%	88.4%	89.8%		32	0.14
130	0.1	1.09	6.05	14	245	82	-0.11	93.2%	89.3%	83.2%		32	0.05
135	0	1.09	5.89	14.09	242	82	-0.18	95.1%	89.3%	85.0%		35	0.00

Manufacture Vermont Castings
 Model: 1920
 Date: 38363
 Run: 5
 Control #: 7767
 Test Duratl 140

Warrock Hersey Efficiency Test Report

Overall Heating Efficiency: 68.86%
 Combustion Efficiency: 90.70%
 Heat Transfer Efficiency: 76.93%

	Start	End
Baromet	29.2	29.2
V	61	76
I	75	88
Hi	44	55

Heat Output: 14814 BTU/Hr 15617 KJ/Hr
 Heat Input: 21513 BTU/Hr 22679 KJ/Hr

Burn Duration: 2.33 Hours

Burn Rate: 2.86 Lb/Hr 1.289 Kg/Hr

Stack Temp: 316.8 Deg.F 157.7 Deg.C

Average Stove Temp: 433.5333

Elapsed Time	Average Weight Remaining	0.733333	9.086	10.988	316.8	87.2	0.070434	0.17138	ERR	ERR	3.879589	0.181376
	CO	CO2	O2	Flue Gas	Room Temp	Comb % K	Combust Eff %	Heat Transfer	Net Eff	air Fuel	Unit MN	
0	6.58	0.42	9.6	10.04	364	86	-0.34	103.7%	29.0%	30.1%	7	3.03
10	5.6	0.62	14.88	4.64	342	86	2.19	75.1%	58.2%	43.7%	5	2.64
20	4.7	0.2	13.95	6.4	367	87	2.61	70.9%	67.1%	47.8%	5	2.13
30	3.7	0.31	14.73	5.7	362	88	2.24	76.0%	75.3%	67.2%	6	1.68
40	2.9	0.91	14.35	5.96	361	89	1.69	80.6%	79.9%	64.5%	6	1.32
50	2.2	0.42	13	6.87	344	88	-0.34	102.8%	68.9%	66.3%	9	1.00
60	1.7	0.25	10.5	9.91	334	88	-0.19	101.9%	64.8%	66.4%	12	0.77
70	1.3	0.41	8.41	11.82	327	88	-0.46	107.1%	84.7%	90.7%	17	0.69
80	1.1	0.7	7.96	12.06	315	88	-0.54	107.2%	85.4%	91.6%	18	0.50
90	0.8	0.89	6.81	13.43	303	87	-0.11	95.7%	85.5%	81.8%	22	0.36
100	0.6	1.17	4.68	15.48	284	88	-0.01	88.1%	83.3%	73.4%	31	0.27
110	0.5	1.27	4.22	15.7	270	86	-0.24	94.0%	83.1%	78.1%	36	0.23
120	0.4	1.24	3.88	16.97	253	86	-0.22	93.2%	83.1%	77.6%	40	0.18
130	0.2	1.16	4.34	16.62	256	86	-0.24	95.1%	85.0%	80.8%	41	0.09
140	0	1.03	5	15	268	87	-0.24	96.8%	87.1%	84.4%	41	0.00

Manufacture Vermont Castings

Model: 1920
 Date: 36384
 Run: 6
 Control #: 6876
 Test Durati 134

	Start	End
Baromet	29.11	29.05
V	67	76
I	74	90
Hi	70	63

Average Blows Temperature: 455.4

Warnock Hersey Efficiency Test Report

Overall Heating Efficiency: 70.64%
 Combustion Efficiency: 98.47%
 Heat Transfer Efficiency: 75.47%

Heat Output: 18705 BTU/hr 16356 KJ/hr
 Heat Input: 22264 BTU/hr 23470 KJ/hr

Burn Duration: 2.23 Hours

Burn Rate: 3.03 Lb/hr 1.375 Kg/hr

Stack Temp: 320.4 Deg F 160.2 Deg C

Elapsed Time	Average Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	K	0.034804	0.17729	ERR	ERR	3.737274	0.174038
								Comb %	Combust Eff %	Heat Transfer	Net Eff	air Fuel	Unit MN
0	6.77	0.48	13.04	4.88	341	88	-2.12	130.6%	43.4%	56.6%	6	3.07	
10	5.9	0.26	14.18	5.98	367	86	2.17	75.1%	52.4%	39.4%	5	2.68	
20	4.8	0.43	14.79	5.24	393	87	2.59	72.0%	66.1%	47.8%	5	2.18	
30	3.7	1.03	16.81	3.96	405	87	2.17	76.7%	74.6%	57.3%	5	1.69	
40	2.6	1.08	15.8	3.98	387	87	0.71	89.6%	81.9%	73.4%	6	1.18	
50	1.9	0.3	12.89	7.66	359	89	0.08	87.7%	84.8%	82.8%	9	0.68	
60	1.5	0.19	10.79	9.83	328	89	-0.04	99.6%	86.1%	85.8%	12	0.68	
70	1.1	0.3	10.77	8.9	322	88	-1.25	121.7%	87.3%	106.2%	16	0.50	
80	0.8	0.69	7.69	12.83	302	88	0.24	90.0%	87.0%	79.3%	20	0.36	
90	0.7	0.99	6.83	14.2	289	87	-0.31	99.8%	84.9%	84.8%	27	0.32	
100	0.6	1.23	6.22	14.64	272	87	-0.33	98.1%	85.4%	83.7%	31	0.23	
110	0.4	1.23	4.55	15.64	264	86	-0.04	87.8%	84.8%	74.5%	35	0.18	
120	0.3	1.24	3.9	18.04	254	85	-0.23	93.2%	83.7%	78.0%	42	0.14	
130	0.1	1.12	4.79	15.01	260	87	-0.45	103.6%	85.9%	88.9%	41	0.05	
134	0	1.14	6.01	14.81	283	88	-0.38	100.7%	86.6%	87.2%	41	0.00	