


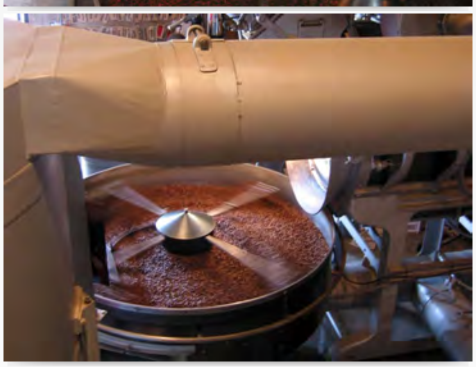

Stumptown Coffee Roasters

Stumptown Coffee Roasters employed advanced energy design services to create an integrated energy system for its roasting facility in Southeast Portland. The project identified design and engineering strategies to capture, redistribute and use excess energy and heat from the very energy-intensive coffee roasting process. As new owners of the building, Stumptown also evaluated energy distribution opportunities in an initial master plan and/or feasibility study for the whole block, including future retail tenant build-outs in the remaining space.

Project Highlights

Energy efficient roasting system

Portfolio Contents

Process Energy Recovery Study

EnergyTrust of Oregon
Portland Water Bureau — From Forest to Faucet
Environmental Services
Bureau of Planning and Sustainability
Innovation. Collaboration. Practical Solutions.
City of Portland, Oregon
Sam Adams, Mayor • Susan Anderson, Director

Stumptown Roasters Process Energy Recovery

Study Report

October 13, 2006

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inspire interpret integrate

Stumptown Roasters
Process Energy Recovery

Study Report

I. PROJECT DESCRIPTION

A. Background

Stumptown Coffee Roasters in Portland, Oregon currently has one coffee roaster and are looking to expand into a new location and add an additional roaster. In order to meet current air emissions standards, Stumptown currently uses an afterburner to clean the coffee roasting exhaust. The afterburner takes 420 F air from the roaster and heats it up to 1200 F prior to directly exhausting into the atmosphere. This process uses approximately $18,600 per year of natural gas.

B. Project Goals

One of Stumptown's goals is to reduce their fossil fuel usage and this report discusses ways of doing this by recovering heat from the discharge of the afterburner. If available, Stumptown would like to use the recovered heat for uses such as comfort heating, domestic hot water heating, and process heating. Another option for reducing fossil fuel usage is to replace the afterburner with a catalytic converter, which requires less energy input to operate.

This study summarizes the various options investigated by PAE to recover the heat from the coffee roasting process and starts the discussion into how this heat may be used in the building.

C. Executive Summary

In order to maximize the fossil fuel and energy cost savings, PAE recommends installing the system described in Option 5, the Self-cleaning Ceramic Filter (SCCF) from Anguil. Although this system has the highest first cost ($95,000), it also provides the greatest annual energy savings of $16,245, resulting in a return on investment of 17 percent. The ceramic filter system addresses Stumptown's primary goal of reducing fossil fuel usage by reducing the input energy required to clean the coffee roaster exhaust. In addition, since this system is equipped with a fan, the low static pressure available in the stack (0.03-0.04 in. w.c.), will not be a concern. The SCCF will need an approximate footprint of 15 feet x 9 feet, either on the roof or on grade. This system reduces the discharge temperature from 1200 F to 675 F and saves energy without needing to recover the heat through a secondary heat exchanger. A secondary heat exchanger could be added for an additional $47,000, but the ROI would drop below 10 percent.

For lowest first cost, Option 3, installing a heat exchanger from Cain downstream of the afterburner, is recommended. The heat exchanger, which has approximate dimensions of 51 inches x 49 inches x 41 inches high, can be retrofitted onto the existing stack. The first cost of this system including a hot water storage tank and piping, but not including the afterburner is $47,000. The building heating and domestic hot water loads will not correspond directly with the time of heat recovery; therefore 100% of the heat recovered will not be available for use.

Assuming that 50% of the available heat is recovered annually, this system saves $5,420 per year, resulting in a return on investment of 10 percent. This system however will not reduce overall energy input. In addition, the pressure drop through the heat exchanger is 0.04 inches w.c. which is just adequate for the existing stack pressure of 0.03-0.04 in. w.c.

D. Next Steps

After Stumptown has selected one of the Options, further detailed analysis of the new building facility needs to be conducted to determine how best to incorporate this system.

If Option 5 is selected, a location must be selected for the unit (i.e. rooftop, on grade) and the routing of the exhaust stack into the unit must be confirmed.

If Option 3 is selected, the new building load must be evaluated to determine the load profile throughout the year. The heat recovery profile needs to match the heat load profile of the building as much as possible to maximize the energy savings. Otherwise, methods of thermal storage, such as a hot water storage tank, need to be evaluated. In addition, a location must be found to install the heating water storage tank and pumps.

Energy credits for installing this system may be possible. However, since Option 5 is a process only related energy savings measure and Option 3 is a combined process recovery with recovered energy use in the building systems, both will have to be reviewed by the ETO on a case-by-case basis to ensure they meet the requirements of the incentive A whole building energy study must be performed as well as applying for these incentives and credits. PAE has initially approached these incentive programs and determined that a first year credit of up to $0.80 per therm saved may be possible. This results in a first year credit of $3,440 for Option 3 and $10,314 for Option 5.

II. EXISTING CONDITIONS

The coffee roaster exhaust stack was tested to determine the properties of the exhaust air. The test was conducted by Valid Results, Inc on August 31, 2006 (See Appendix for copy of test report). The results of the test are as follows;

Stack Diameter: 20-inches
Stack Height: 30 feet approximate

Parameter	Run 1	Run 2
Stack Temperature (F)	1204.5	1214.3
Stack Velocity (FPS)	24.15	21.78
Stack pressure (in. w.c.)	0.04	0.03
Stack Flow Rate (ACFM)	3,161	2,851
Stack Flow Rate (SCFM)	767	688
CO2 Concentration (%)	2.6	2.6
O2 Concentration (%)	14.2	14.2
Moisture Content (%H2O)	24.0	24.0

III. HEAT RECOVERY OPTIONS

Various options for recovering the heat from the coffee roasting process were investigated. Some options included adding a heat exchanger downstream of the afterburner. Other options included removing the afterburner and adding a catalytic oxidizer. The options are summarized below. The analysis assumes that of the heat recovered; approximately 50% can be utilized. 100 percent may be utilized in the winter, but summer utilization will be significantly less. Rather than recover heat, Options 3 and 4 reduce the amount of heat input required to clean the exhaust air.

A. <u>Option 1: Afterburner Only (Existing Condition)</u>

This is the baseline, existing case. The afterburner burns off any excess particulates and organics in the airstream prior to discharge. In this process, the temperature of the air is increased from 420 F (discharge of roaster) to 1200 F. The cost of an afterburner is approximately $30,000 plus installation. Approximately $18,600 of energy is used in this process.

B. <u>Option 2: Afterburner Plus Heat Exchanger from Anguil Systems</u>

This option adds a heat exchanger downstream of the afterburner. The heat exchanger recovers the heat to a water loop which distributes the heat to various building systems. The heat exchanger recovers heat from the exhaust airstream to reduce the temperature down to 700 F. The cost of the heat exchanger, hot water storage tank, and piping is considered for this study. The heat exchanger from Anguil costs approximately $47,000 plus $15,000 for installation. The storage tank and piping costs are about $20,000. There is a 10-12 week lead time on this unit.

C. <u>Option 3: Afterburner Plus Heat Exchanger from Cain Industries</u>

Similar to Option 2, this option adds a heat exchanger downstream of the afterburner. The heat exchanger recovers the heat to a water loop which distributes the heat to various systems. The heat exchanger recovers heat from the exhaust airstream to reduce the temperature down to 605 F. The cost of the heat exchanger, hot water storage tank, and piping is considered for this study. The heat exchanger from Cain costs approximately $19,000 plus $8,000 for installation. The storage tank and piping costs are about $20,000. There is a 9 week lead time on this unit.

D. Option 4: Catalytic Thermal Oxidizer from Probat

In this Option, the particulates and organics are reduced from the exhaust airstream through a catalytic process rather than a thermal process (afterburner). Although the catalytic bed must be heated to a certain extent, the amount of heat added is significantly reduced. The temperature of the airstream is only heated to 800 F compared to 1200 F for an afterburner. Heat is not recovered in this system. Rather, the amount of energy input to clean the airstream is significantly reduced. The unit cost is approximately $85,000 plus installation. The installation cost will be similar to that of an afterburner.

E. Option 5: Self-Cleaning Ceramic Filter from Anguil

Similar to Option 4, the particulates and organics are reduced from the exhaust airstream through a catalytic process rather than a thermal process (afterburner). Although the catalytic bed must be heated to a certain extent, the amount of heat added is significantly reduced. The temperature of the airstream is only heated to 675 F compared to 1200 F for an afterburner. Heat is not recovered in this system. Rather, the amount of energy input to clean the airstream is significantly reduced. The unit cost is approximately $95,000 plus installation. The installation cost will be similar to that of an afterburner. There is a 10-12 week lead time on this unit.

The table below summarizes all of the above Options and provides simple payback analysis for one roaster.

Option	Annual Therms Used (Therms/yr)	Annual Therms Saved (Therms/yr)	Gas Cost ($/therm)	Annual Energy Cost ($)	Annual Energy Savings ($)	First Cost	Simple Payback (Years)	Return on Investment (ROI)
1	14,750	0	$1.26	$18,580	0	0	0	0%
2	14,750	3,654 (5)	$1.26	$13,980	$4,600	$82,000	17.8	2%
3	14,750	4,300 (5)	$1.26	$13,167	$5,420	$47,000	8.7	10%
4	2,815	11,935	$1.26	$3,547	$15,038	$85,000	5.6	18%
5	1,857	12,893	$1.26	$2,340	$16,245	$95,000	5.8	17%

Notes:
1. Options 2 and 3 recover heat to a heating water system. Options 4 and 5 reduce input energy, but do not recover any heat.
2. Because the building heating demand is significantly less in the summertime, the total recoverable heat for Options 2 and 3 may not be usable. Therefore, it is assumed that only 50% of the recoverable heat is actually recovered. In contrast, since Options 3 and 4 reduce the input energy, 100% of this energy savings can be used for the calculations.
3. The annual energy savings calculation assumes that the coffee roasting process runs for 6 hours per day (12 minutes of every 15 minute cycle for 8 hours), 5 days per week, 52 weeks per year at an heat exchanger efficiency of 75%. The efficiency of Options 4 and 5 are set to 100%.
4. The first cost for Options 2 and 3 are in excess of the afterburner costs. The first costs for Options 4 and 5 are in lieu of the afterburner costs.
5. This is actually energy recovered from the exhaust airstream and used elsewhere in the building.

III. APPENDICES

A. **Coffee Roaster Testing Field Notes**

B. **Coffee Roaster Testing Report from Valid Results, Inc.**

C. **One-year Utility Bills**

D. **Cain Heat Exchanger Submittal (Option 3)**

E. **Anguil Self Cleaning Ceramic Filter Submittal (Option 5)**

Appendix A: Coffee Roaster Testing Field Notes

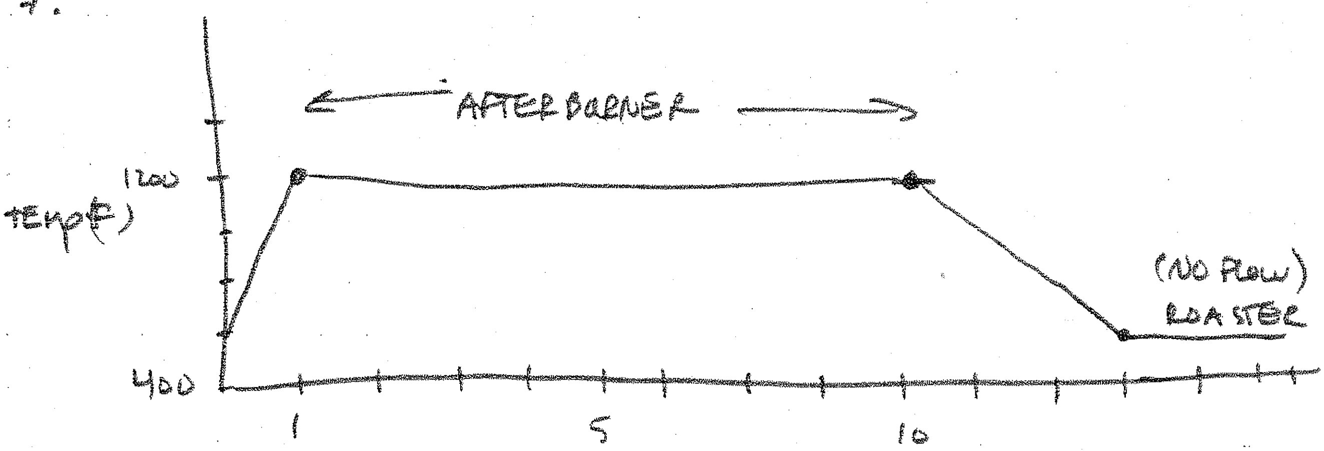
8·31·06

by CJB

Stumptown Roasting – FLUE GAS FLOW/TEMP TEST

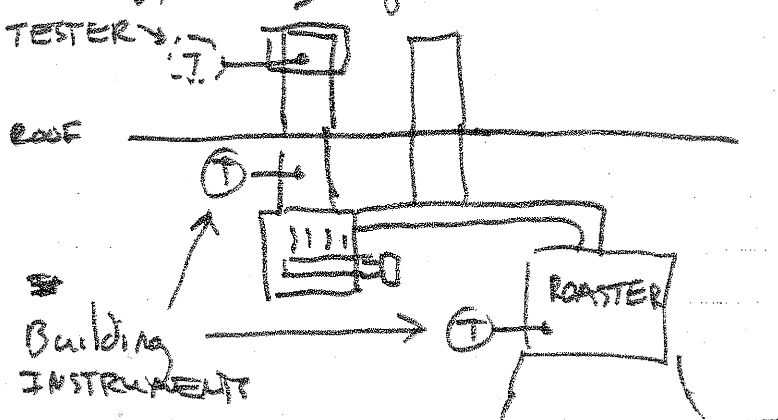
1. Roaster temp @ 420F STACK AT 250F
2. Roaster only operation uses ~ 0.04 ft³/min N.G.
3. Afterburner + roaster uses ~ 0.33 ft³/min N.G.
4. W/ AFTERBURNER FAN running there is only ~ 0.05" wc pressure.
5. airflow ~ 600 → 650 cfm.
6. STACK TEMP ~~constantly~~ constant @ ~1220F.

7.



Typical cycle.

8. 60 kg/batch of beans.



Appendix B: Coffee Roaster Testing Report from Valid Results, Inc.

PAE Consulting Engineers

Coffee Roaster Volumetric Flow Rate Test Report
Portland, Oregon

STR06805

Performed and Reported by:

VALID RESULTS, INC.
12025 Lake City Way NE, Suite B
Seattle, WA 98125-5331

For Submittal To:

PAE Consulting Engineers, Inc.
808 SW Third Avenue, Suite 300
Portland, OR 97402-2426

Submitted On:

September 27 2006

REVIEW AND CERTIFICATION

Team Leader:

The work performed herein was conducted under my supervision, and I certify that the details and results contained within this report are to the best of my knowledge an authentic and accurate representation of the test program. If this report is submitted for Compliance purposes it should only be reproduced in its entirety. If there are any questions concerning this report, please contact the Team Leader or Reviewer at (206) 522-5665.

Thomas Franett

Project Manager

Reviewer:

I have reviewed this report for presentation and accuracy of content, and hereby certify that to the best of my knowledge the information is complete and correct.

Tracy Prevo

Source Test Manager

TABLE of CONTENTS

SECTION 1. INTRODUCTION

1.1. Test Purpose

On August 31st, 2006, Volumetric Flow Rate tests were performed on the exhaust of the Coffee Roaster located at the Stumptown Roasters facility in Portland, Oregon.

Tests were performed with the facility operating at greater than 90% of full load.

1.2. Test Location

The testing was conducted on the outlet of the coffee roaster stack located at the Stumptown Roasters facility, in Portland, Oregon.

Two sample ports are located 90 degrees apart on the "20-inch" round outlet stack, more than 2 stack diameters downstream from the nearest flow disturbance and more than 0.5 stack diameters upstream from the stack exit. The stack exit height is approximately 30 feet.

A diagram of the outlet stack is contained in appendix F.

1.3. Test Date(s)

Testing was conducted on September 31st, 2006.

1.4. Pollutants Tested

Table 1.4-1 Emission Parameters Measured:

Parameters	Units	Test Methods	Replicates	Duration
Flow Rate	dscf/m	1, 2, 3 and 4	2	10 Minutes

Where:
dscf/m = dry standard cubic feet per minute

1.5. Sampling and Observing Personnel

Testing was performed by Thomas Franett with Valid Results, Inc. (VR). Mr. Conrad Brown with PAE Consulting Engineers coordinated the test program.

The Oregon Department of Environmental Quality (ODEQ) was not informed of the test program at least two weeks prior to testing. No ODEQ representative was present to witness the testing.

1.6. Other Important Background Information

Flow Rate testing was performed at an operating rate of greater than 90% of capacity.

SECTION 2. SUMMARY OF RESULTS

2.1. CERMS, CGA and Flow RAA Results

The results of the Flow Rate testing are summarized in Table 2.1-1.

Table 2.1-1 Flow Rate Results

Parameter	Reference Method	Units
Volumetric Flow Rate	727	Dry Standard Cubic Feet Per Minute

2.2. Process Data

No unit operating data was provided.

2.3. Performance Specifications

Testing was not for compliance purposes.

2.4. Comments: Discussion of Quality Assurance and Errors

Quality assurance procedures listed in the above referenced test methods were performed and documented. The QA/QC procedures are described in Section 4.3 of the report. Documentation of the QA/QC is provided in Appendix C.

SECTION 3. SOURCE OPERATION

3.1. Process Description

The emission source consisted of a natural gas-fired coffee roaster.

3.2. Pollution Control Equipment

The source currently utilizes an afterburner to reduce emissions.

3.3. Operational Monitoring System

No operational data was provided.

3.4. Flow Diagram

A drawing of the stack exhaust is contained in Appendix D.

3.5. Process and Control Operating Parameters During Testing

No operational data was provided.

3.6. Maximum Operating Conditions

During the test program, the plant was operating at greater than 90% of full load.

3.7. Testing or Process Interruptions and Changes

No interruptions occurred during the test program.

SECTION 4. SAMPLING AND ANALYSIS PROCEDURES

4.1. Port Location

Emissions from the coffee roaster outlet stack were sampled via two horizontally mounted ports located on the "20-inch" round outlet stack. The ports are located at least two inside stack diameters downstream and one-half inside stack diameters upstream from the nearest flow disturbance.

The stack exit height is approximately 30 feet.

A diagram of the outlet stack is contained in Appendix E.

4.2. Point Description/Labeling – Ports/Stack

The stack's ports were not labeled. The ports were designated as "North" and "East" for testing purposes.

4.3. Method Description, Equipment, Sampling, Analysis and QA/QC

Sampling and analytical procedures of the EPA Methods were followed as published in the "Quality Assurance Handbook for Air Pollution Measurement Systems" Volume III, US EPA 600/4-77-027b.

Table 4.3-1 EPA Test Methods:

Test Method	Test Parameter	Test Description
EPA 1	Sample Point Locations	Up & Down stream distances from flow disturbances
EPA 2C	Outlet Flow Rate	Standard-Type Pitot Tube & Type-K Thermocouple
EPA 3	Molecular Weight	3 thirty-minute ORSAT runs
EPA 4	Moisture Content	3 thirty-minute runs, H_2O impinger weight gain

4.3.1 Selection of Traverse Points

EPA Method 1 was used to determine the location of sample points for molecular weight, moisture and volumetric flow rate sampling. Flow rate was tested from two sample ports located 90^{o} apart on the main exhaust stack. The specific number of sample points used at each location was determined by the number of equivalent inside stack diameters that the sample ports were located from the nearest upstream and downstream flow disturbances. The number of points used and their location are provided in Appendix A.

4.3.2 Stack Gas Velocity and Volumetric Flow Rate Determination

EPA Method 2C was used to determine the outlet stack gas velocity and volumetric flow rate. Pressure and temperature readings were taken at the sample points determined by Method 1. Pressure readings were measured using an Standard-Type Pitot Tube and an inclined manometer connected through quarter inch tubing. Pitot tube leak checks were performed before and after every test run. The stack gas temperature was measured using a calibrated type-K thermocouple attached to the Pitot tube to provide the sampling point temperature simultaneously with the velocity measurement. The stack gas static pressure was measured each test run. The other data necessary for the calculation of the volumetric flow rate are the barometric pressure, moisture content of the stack gas, and the stack gas molecular weight.

4.3.3 Molecular Weight Determination (Oxygen and Carbon Dioxide)

EPA Method 3 was used in order to determine the concentration of O_2 and CO_2 in the stack gas. Integrated bag samples were collected concurrently with the moisture test and analyzed, within 8-hours of sample collection, using a Fyrite apparatus.

4.3.4 Percent Moisture Determination

Modified EPA Method 4 was used to determine the moisture content of the stack gas. The stack gas moisture was estimated from the stack gas temperature. Normally, a condenser assembly comprised of four glass impingers set in an ice bath is used to extract and collect the moisture from the effluent gas sample. The first and second impingers each contain 100 ml of de-ionized water. The third impinger is tare weighed and left empty to collect any potential condensate carryover, and the fourth impinger contains a pre-weighed amount of silica gel to act as the "absolute" collector of residual condensate.

A known volume of effluent gas is passed through a stainless steel probe into a condenser assembly for a specific period of time. After completion of the extraction, the amount of liquid (condensate) in the impingers was measured gravimetrically and the net weight gain determined. The total condensate gain of the condenser assembly is then determined and recorded along with the calculated volume of gas that was directed through the system. The subsequent moisture content of the stack gas is then determined from these collected variables.

APPENDICES

A. Tabulated Results and Calculations

B. Field Data Sheets

C. Calibration and Quality Assurance Records

D. Plant and Stack Diagrams

E. Sample Train Diagrams

A
Tabulated Results & Calculations

VALID RESULTS, INC.: EPA Method 2 Volumetric Flow Rate Determination

Client:	Pae Engineers	Barometric Pressure (Pbar):	30.15	Pitot Tube Coeff. (C_p):	0.99
Date:	8/31/2006	Standard Temperature (tstd):	68	% Oxygen (%O_2):	14.2
Operator:	TRF	Standard Pressure (Pstd):	29.92	% Carbon Dioxide (%CO_2):	2.6
Plant Location:	Stumptown Roasters	Stack Static Pressure (Pstatic):	-0.634	Moisture Content (%H_2O):	24.0
Source:	Roaster	Fuel Type:	Mixed	Stack Diameter (D_e\D_s):	20.00
Run #: 1	Time:	Load:	>50%	Stack Area (A_s):	2.182

Port ID#	Point #	% Stack Inside Diam.	Port Depth	Probe Marks	Cyclonic Zero Angle	Pitot Tube (ΔP)	Stack Temp. (T_s) °F	√(ΔP)
N	12	2.1%	2.5	2.9	<5	0.030	**1155**	**0.173**
	11	6.7%	2.5	3.8	<5	0.039	**1167**	**0.197**
	10	11.8%	2.5	4.9	<5	0.041	**1180**	**0.202**
	9	17.7%	2.5	6.0	<5	0.052	**1202**	**0.228**
	8	25.0%	2.5	7.5	<5	0.048	**1201**	**0.219**
	7	35.6%	2.5	9.6	<5	0.047	**1192**	**0.217**
	6	64.4%	2.5	15.4	<5	0.050	**1199**	**0.224**
	5	75.0%	2.5	17.5	<5	0.053	**1198**	**0.230**
	4	82.3%	2.5	19.0	<5	0.045	**1215**	**0.212**
	3	88.2%	2.5	20.1	<5	0.033	**1221**	**0.182**
	2	93.3%	2.5	21.2	<5	0.036	**1217**	**0.190**
	1	97.9%	2.5	22.1	<5	0.028	**1206**	**0.167**
E	12	Probe Marks Repeated			<5	0.020	**1212**	**0.141**
	11				<5	0.029	**1223**	**0.170**
	10				<5	0.032	**1224**	**0.179**
	9				<5	0.038	**1232**	**0.195**
	8				<5	0.042	**1232**	**0.205**
	7				<5	0.040	**1206**	**0.200**
	6				<5	0.040	**1191**	**0.200**
	5				<5	0.043	**1196**	**0.207**
	4				<5	0.041	**1203**	**0.202**
	3				<5	0.041	**1211**	**0.202**
	2				<5	0.035	**1216**	**0.187**
	1				<5	0.038	**1210**	**0.195**
<Average>							**<1204.5>**	**<0.197>**

Molecular Weight Dry (MW_d) = $((0.44*(\%CO_2) + 0.32*(\%O_2) + 0.28*(\%CO + \%N_2))$

MW_d = **28.98** Lb/Lb-Mole

Molecular Weight Wet (MW_s) = $(MW_d)*(100-\%H_2O) + 0.18*(\%H_2O))$

MW_s = **26.35** Lb/Lb-Mole

Stack Pressure (P_s) = $(P_{bar} + (P_{static}/13.6))$

P_s = **30.10** Lb/Lb-Mole

Stack Gas Velocity (V_s) = $(85.49*C_p*(\sqrt{(\Delta P)})*(\sqrt{((T_s + 460)/(P_s*MW_s))})$

V_s = **24.15** Feet per Second

Corrected Stack Gas Volumetric Flow Rate ($Q_{s(corr)}$) = $(60*((100-\%H_2O)/100)*V_s*A_s*((T_{std} + 460)/(T_s + 460))*(P_s/P_{std}))$

$Q_{s(corr)}$ = **767** Dry Standard Cubic Feet per Minute

Actual Cubic Feet per Second = $60*V_s*A_s$

$Q_{s(actual)}$ = **3,161** Actual Cubic Feet per Minute

VALID RESULTS, INC.: EPA Method 2 Volumetric Flow Rate Determination

Client:	Pae Engineers	Barometric Pressure (Pbar):	30.15	Pitot Tube Coeff. (C_p):	0.99
Date:	8/31/2006	Standard Temperature (tstd):	68	% Oxygen (%O_2):	14.2
Operator:	TRF	Standard Pressure (Pstd):	29.92	% Carbon Dioxide (%CO_2):	2.6
Plant Location:	Stumptown Roasters	Stack Static Pressure (Pstatic):	-0.634	Moisture Content (%H_2O):	24.0
Source:	Roaster	Fuel Type:	Mixed	Stack Diameter (D_e\D_s):	20.00
Run #: 2	Time :	Load:	>50%	Stack Area (A_s):	2.182

Port ID#	Point #	% Stack Inside Diam.	Port Depth	Probe Marks	Cyclonic Zero Angle	Pitot Tube (ΔP)	Stack Temp. (T_s) °F	√(ΔP)
N	12	2.1%	2.5	2.9	<5	0.023	**1212**	**0.152**
	11	6.7%	2.5	3.8	<5	0.034	**1219**	**0.184**
	10	11.8%	2.5	4.9	<5	0.042	**1223**	**0.205**
	9	17.7%	2.5	6.0	<5	0.033	**1232**	**0.182**
	8	25.0%	2.5	7.5	<5	0.037	**1228**	**0.192**
	7	35.6%	2.5	9.6	<5	0.041	**1221**	**0.202**
	6	64.4%	2.5	15.4	<5	0.043	**1206**	**0.207**
	5	75.0%	2.5	17.5	<5	0.030	**1211**	**0.173**
	4	82.3%	2.5	19.0	<5	0.028	**1217**	**0.167**
	3	88.2%	2.5	20.1	<5	0.024	**1203**	**0.155**
	2	93.3%	2.5	21.2	<5	0.023	**1195**	**0.152**
	1	97.9%	2.5	22.1	<5	0.019	**1206**	**0.138**
E	12	Probe Marks Repeated			<5	0.033	**1188**	**0.182**
	11				<5	0.039	**1196**	**0.197**
	10				<5	0.045	**1203**	**0.212**
	9				<5	0.041	**1214**	**0.202**
	8				<5	0.033	**1229**	**0.182**
	7				<5	0.026	**1222**	**0.161**
	6				<5	0.030	**1231**	**0.173**
	5				<5	0.033	**1219**	**0.182**
	4				<5	0.028	**1207**	**0.167**
	3				<5	0.025	**1222**	**0.158**
	2				<5	0.031	**1228**	**0.176**
	1				<5	0.022	**1212**	**0.148**
<Average>							**<1214.3>**	**<0.177>**

Molecular Weight Dry (MW_d) = ((0.44*(%CO_2) + 0.32*(%O_2) + 0.28*(%CO + %N_2))

MW_d = **28.98** Lb/Lb-Mole

Molecular Weight Wet (MW_s) = (MW_d)*(100-%H_2O) + 0.18*(%H_2O))

MW_s = **26.35** Lb/Lb-Mole

Stack Pressure (P_s) = (P_{bar} + (P_{static}/13.6))

P_s = **30.10** Lb/Lb-Mole

Stack Gas Velocity (V_s) = (85.49*C_p*(√(ΔP))*(√((T_s + 460)/(P_s*MW_s)))

V_s = **21.78** Feet per Second

Corrected Stack Gas Volumetric Flow Rate ($Q_{s(corr)}$) = (60*((100-%H_2O)/100)*V_s*A_s*((T_{std} + 460)/(T_s + 460))*(P_s/P_{std}))

$Q_{s(corr)}$ = **688** Dry Standard Cubic Feet per Minute

Actual Cubic Feet per Second = 60*V_s*A_s

$Q_{s(actual)}$ = **2,851** Actual Cubic Feet per Minute

B
Field Data Sheets

VALID RESULTS, INC.: EPA Method 2 - Volumetric Flow Rate Field Data Sheet

Client: PAE ENGINEERS	Barometric Pressure (P_{bar}): 30.15	Pitot Tube Coeff. (C_p): 0.84
Date: 8/31/06	Standard Temperature (t_{std}): 68	% Oxygen (%O_2):
Operator: TRK	Standard Pressure (P_{std}): 29.92	% Carbon Dioxide (%CO_2):
Location: STUMPTOWN ROASTERS	Stack Static Pressure (P_{static}):	Moisture Content (%H_2O):
Source: ROASTER	Fuel Type:	Stack Diameter (D_s\D_e): 20"
Run # 1 / Time:	Load Rating:	Pre-Test Pitot Tube Leak Check: ✓

Port ID #	Point #	% Stack Inside Diam.	Port Depth	Probe Marks	Cyclonic Zero Angle	Pitot Tube (ΔP)	Stack Temp. (t_s) °F	√ΔP
N	12		2.5"	22.0		0.030	1155	
	11			21.16		0.039	1167	
	10			20.14		0.041	1180	
	9			18.96		0.052	1202	
	8			17.5		0.048	1201	
	7			15.38		0.047	1192	
	6			9.62		0.050	1199	
	5			7.5		0.053	1198	
	4			6.04		0.045	1215	
	3			4.86		0.033	1221	
	2			3.84		0.036	1217	
	1			2.92		0.028	1206	
E	12					0.020	1212	
	11					0.029	1223	
	10					0.032	1224	
	9					0.038	1232	
	8					0.042	1232	
	7					0.040	1206	
	6					0.040	1191	
	5					0.043	1196	
	4					0.041	1203	
	3					0.041	1211	
	2					0.035	1216	
	1					0.038	1210	
<Average>			Post-Test Pitot Tube Leak Check: ✓					

Molecular Weight Wet (MW_s) = ((0.44*(%CO_2) + 0.32*(%O_2) + 0.28*(%CO + %N_2))*(100-%H_2O) + 0.18*(%H_2O))

MW_s = ____________ *lbs/lb-mole*

Stack Gas Velocity (V_s) = (85.49*C_p*(√ΔP)*(√((t_s + 460)/((P_{bar} + P_{static}/13.6)*MW_s)))

V_s = ____________ *feet per second*

Corrected Stack Gas Volumetric Flow Rate ($Q_{s(std)}$) = (60*((100-%H_2O)/100)*V_s*A_s*((t_{std} + 460)/(t_s + 460))*(P_s/P_{std}))

$Q_{s(std)}$ = ____________ *standard dry cubic feet per minute*

Actual Cubic Feet per Second ($Q_{s(actual)}$) = (60*V_s*A_s)

$Q_{s(actual)}$ = ____________ *actual cubic feet per minute*

VALID RESULTS, INC.: EPA Method 2 - Volumetric Flow Rate Field Data Sheet

Client: PAE ENGINEERS	Barometric Pressure (P_{bar}): 30.15	Pitot Tube Coeff. (C_p): 0.84
Date: 8/31/06	Standard Temperature (t_{std}): 68	% Oxygen (%O_2):
Operator: TRF	Standard Pressure (P_{std}): 29.92	% Carbon Dioxide (%CO_2):
Location: STUMPTOWN ROASTERS	Stack Static Pressure (P_{static}):	Moisture Content (%H_2O):
Source: ROASTER	Fuel Type:	Stack Diameter (D_e\D_s): 20"
Run # 2	Time : / Load Rating:	Pre-Test Pitot Tube Leak Check: ✓

Port ID #	Point #	% Stack Inside Diam.	Port Depth	Probe Marks	Cyclonic Zero Angle	Pitot Tube (ΔP)	Stack Temp. (t) °F	√ΔP
N	12			22.0		0.023	1212	
	11			21.16		0.034	1219	
	10			20.14		0.042	1223	
	9			18.96		0.033	1232	
	8			17.5		0.037	1228	
	7			15.38		0.041	1221	
	6			9.62		0.043	1204	
	5			7.5		0.030	1211	
	4			6.04		0.028	1217	
	3			4.86		0.024	1203	
	2			3.84		0.023	1195	
	1			2.92		0.019	1206	
E	12					0.033	1188	
	11					0.039	1196	
	10					0.045	1203	
	9					0.041	1214	
	8					0.033	1229	
	7					0.026	1222	
	6					0.030	1231	
	5					0.033	1219	
	4					0.028	1207	
	3					0.025	1222	
	2					0.031	1228	
	1					0.022	1212	
<Average>			Post-Test Pitot Tube Leak Check: ✓					

Molecular Weight Wet (MW_s) = ((0.44*(%CO_2) + 0.32*(%O_2) + 0.28*(%CO + %N_2))*(100-%H_2O) + 0.18*(%H_2O))

MW_s = ____________ *lbs/lb-mole*

Stack Gas Velocity (V_s) = (85.49*C_p*(√ΔP)*(√((t_s + 460)/((P_{bar} + P_{static}/13.6)*MW_s)))

V_s = ____________ *feet per second*

Corrected Stack Gas Volumetric Flow Rate ($Q_{s(std)}$) = (60*((100-%H_2O)/100)*V_s*A_s*((t_{std} + 460)/(t_s + 460))*(P_s/P_{std}))

$Q_{s(std)}$ = ____________ *standard dry cubic feet per minute*

Actual Cubic Feet per Second ($Q_{s(actual)}$) = (60*V_s*A_s)

$Q_{s(actual)}$ = ____________ *actual cubic feet per minute*

C
Calibrations & Quality Assurance Records

VALID RESULTS, INC.: Type-K Stack Thermocouple Calibration

Date: 8/14/06
Operator: JPM
Reference Thermometer: OMEGA CL-477
Barometric Pressure: 30.0

Thermocouple ID Pre-test	Identification	Reference Point	TC Reading °F	Ref Therm Reading °F	Difference	% Difference
STD 36A	Stack	Ice Water	34°	35°	1°	
		Ambient	62°	63°	1°	
		Boiling Water	214°	214°	Ø	Ø

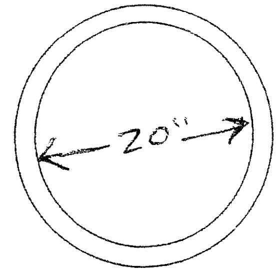
Thermocouple ID Post-test	Identification	Reference Point	TC Reading	Ref Therm Reading	Difference	% Difference
		*				

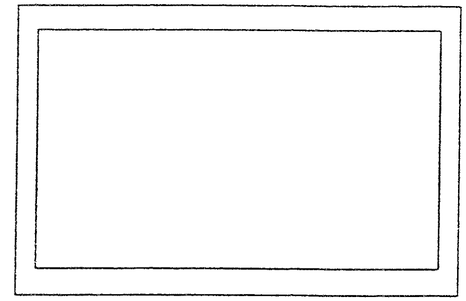
*+/- 10% absolute measured value

D
Plant and Stack Diagrams

VALID RESULTS, INC.: EPA Method 1 & 2 - Sample Point Location and Volumetric Flow Rate Field Data Sheet

Client: PAE ENGINEERS	Stack Diameter (D_s or D_e): 20."
Date: 8/31/06	Upstream (A): 70.5 D
Operator: TRF	Downstream (B): 72. D
Plant Location: PORTLAND, OR	Minimum # Points: 12
Source: COFFEE ROASTER	Pitot Tube ID#:
Fuel Type:	Pitot Tube Coeff. (C_p):
Load Rating: 790%	Pitot Cal. Date:
Barometric Pressure (P_{bar}):	Stack Temp. TC ID#:
Standard Temperature (t_{std}):	TC Cal. Date:
Standard Pressure (P_{std}):	% Oxygen (%O_2):
Stack Static Pressure (P_{static}):	% Carbon Dioxide (%CO_2):
Time:	Moisture Content (%H_2O):

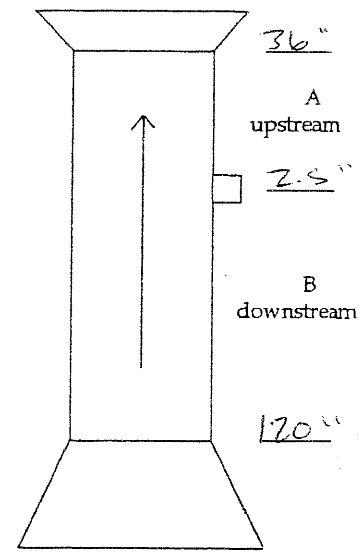




Equivalent Diameter = Stack Diameter (D_s) OR (D_e) $2*D_1*D_2/(D_1 + D_2)$

Stack Area (A_s) = $((1/4*144)*3.1416*(D_s)*(D_s))$ OR $((D_1)*(D_2)/144)$

Stack Pressure (P_s) = $P_{bar} + (P_{static}/13.6)$



Run #: | Pre-Test: Equipment Checklist: | Pitot Tube Leak Check:

Port ID#	Point #	% Stack ID	Port Depth	Probe Marks	Cyclonic Zero Angle	Pitot Tube ΔP	Stack Temp. t_s °F	√ΔP
N	12		2.5	22.0				
	11			21.16				
	10			20.14				
	9			18.96				
	8			17.5				
	7			15.38				
	6			9.62				
	5			7.5				
	4			6.04				
	3			4.86				
	2			3.84				
	1			2.92				
B	12							
	11							
	10							
	9							
	8							
	7							
	6							
	5							
	4							
	3							
	2							
	1							
<Average>								
Post-Test:	Pitot Tube Leak Check:							

Molecular Weight Wet (MW_s) = $((0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%CO + \%N_2))*(1-\%H_2O) + 18(\%H_2O))$

Stack Gas Velocity (V_s) = $(85.49*C_p*(\sqrt{\Delta P})*(t_s + 460)/(P_s*MW_s))$

Stack Gas Volumetric Flowrate = $(60*(1-\%H_2O)*V_s*A_s*((t_{std} + 460)/((t_s + 460))*(P_s/P_{std}))$

E
Sample Train Diagrams

17.0 Tables, Diagrams, Flowcharts, and Validation Data.

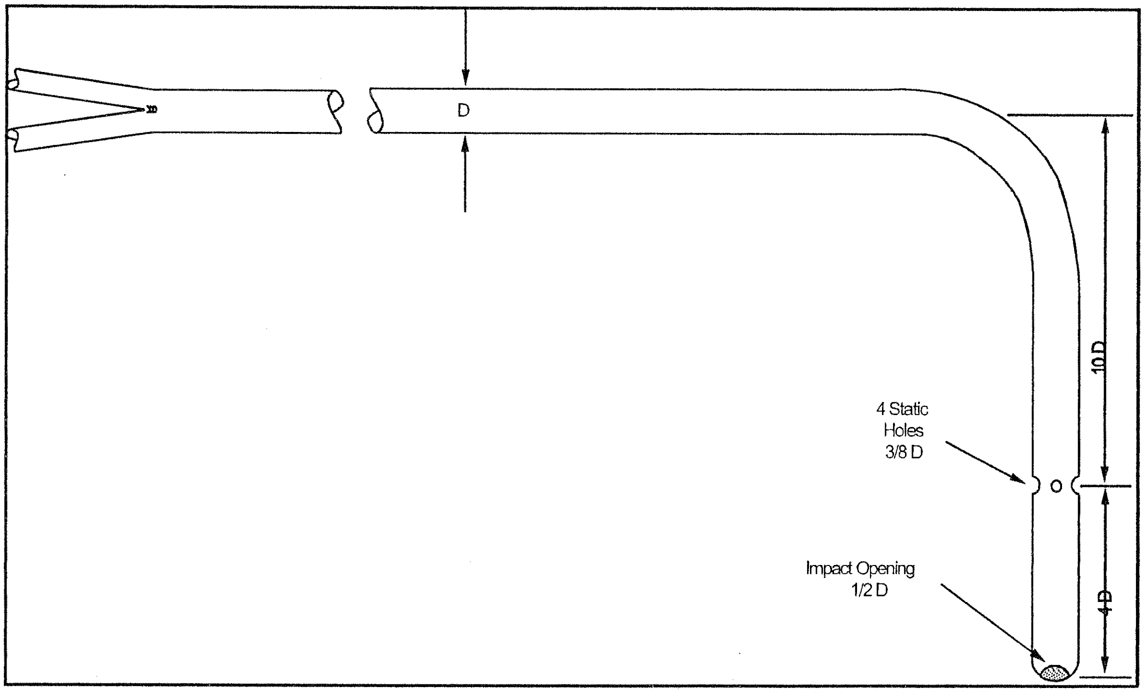
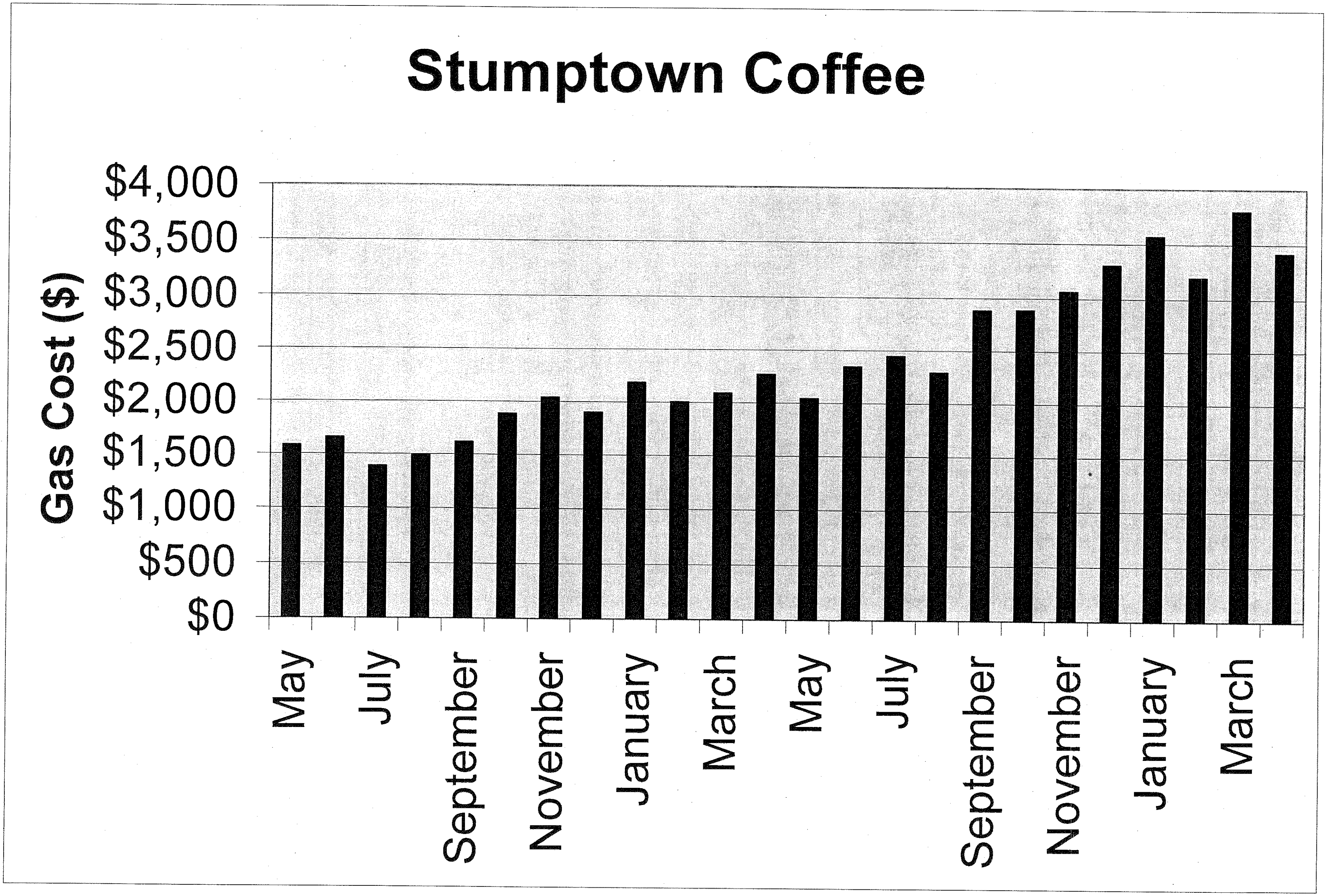
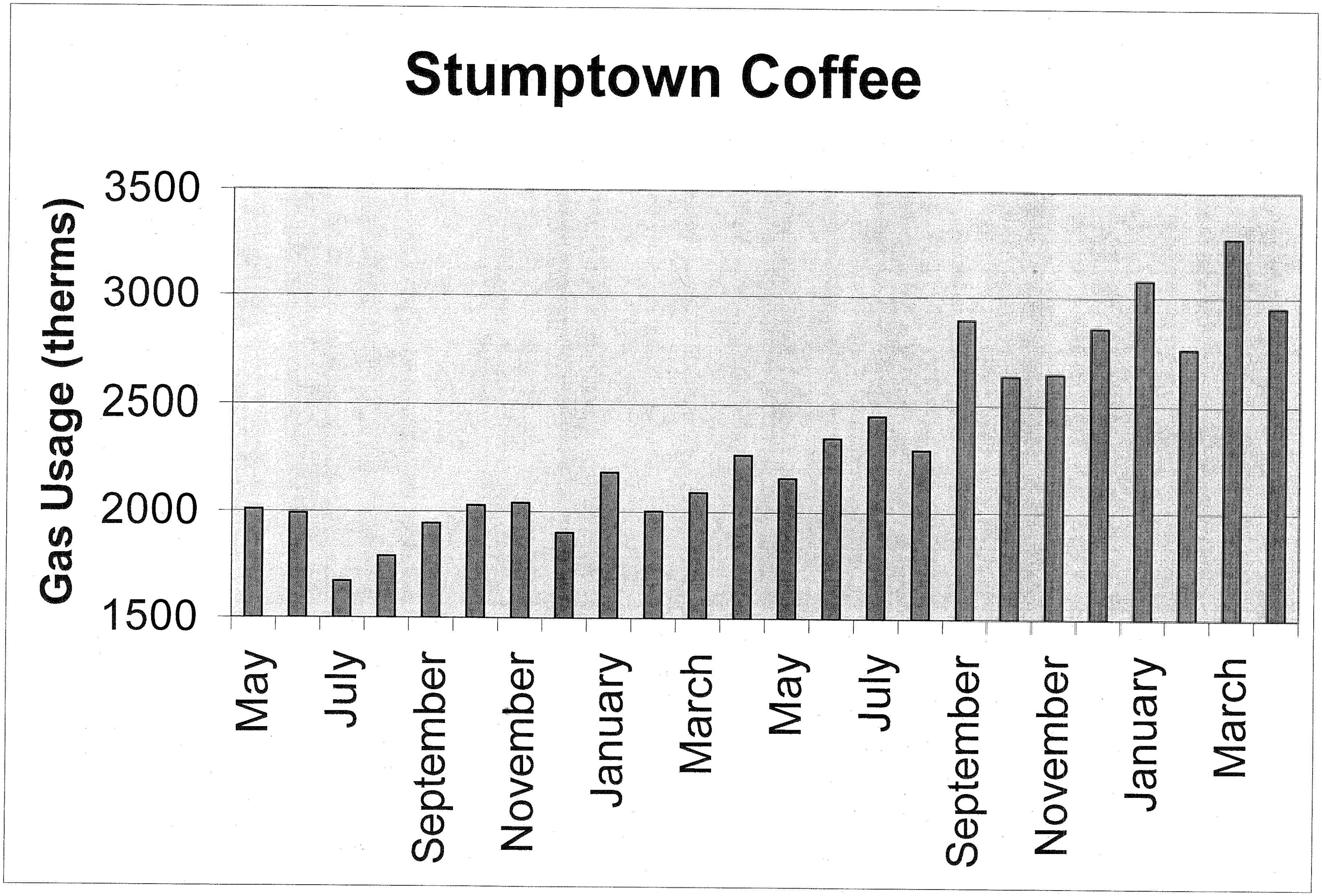
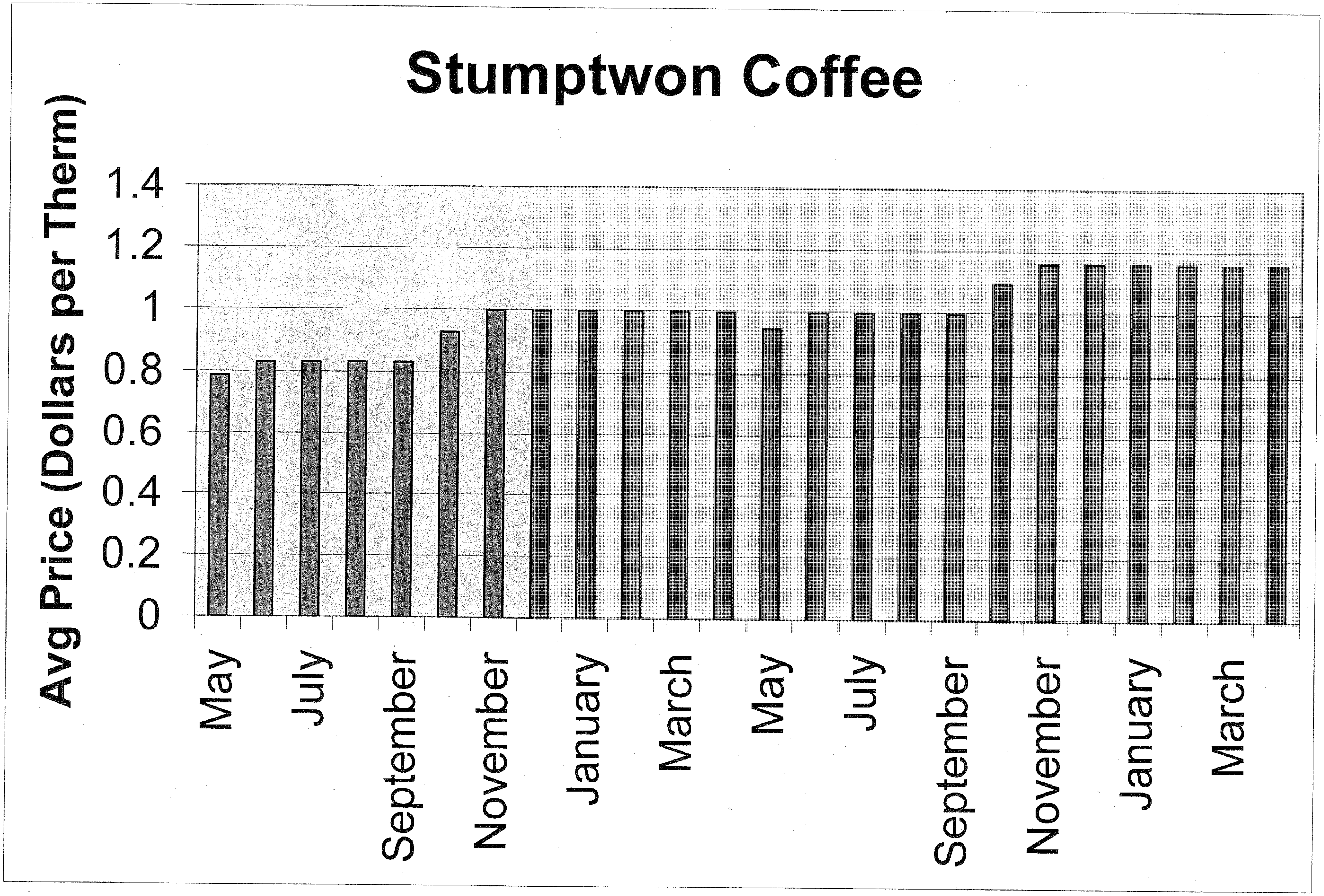


Figure 2C-1. Modified Hemispherical-Nosed Pitot Tube.

Appendix C: One-year Utility Bills


Stumptown Coffee
Gas Cost ($)
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
May
July
September
November
January
March
May
July
September
November
January
March


Stumptown Coffee
Gas Usage (therms)
3500
3000
2500
2000
1500
May
July
September
November
January
March
May
July
September
November
January
March


Stumptwon Coffee
Avg Price (Dollars per Therm)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
May
July
September
November
January
March
May
July
September
November
January
March

		Use	Cost	Avg Price	
May		2008.8	$1,580	0.786315	
June		1990.9	$1,652	0.829831	
July		1669.9	$1,387	0.830601	
August		1787.5	$1,484	0.830288	
September		1944	$1,613	0.829923	
October		2029.4	$1,881	0.927097	
November		2041.1	$2,036	0.997379	
December		1900.2	$1,896	0.997669	
January		2186.2	$2,180	0.997118	
February		2003.9	$1,999	0.99745	
March		2090.5	$2,085	0.997288	
April	**23922**	2269.6	$2,263	0.996986	**$22,055**
May		2161.1	$2,038	0.943172	
June		2348.7	$2,341	0.996866	
July		2451.6	$2,444	0.996725	
August		2295.5	$2,288	0.996946	
September		2891.4	$2,880	0.996227	
October		2633.8	$2,883	1.094719	
November		2643.4	$3,062	1.158266	
December		2853.9	$3,305	1.158043	
January		3080.3	$3,566	1.157839	
February		2758.5	$3,195	1.15814	
March		3282.2	$3,800	1.157678	
April	**32351.8**	2951.4	$3,418	1.157952	**$35,221**

Appendix D: Cain Heat Exchanger Submittal (Option 3)

"Manufacturing Waste Heat Transfer Products To Save Energy"
Boiler Economizer Systems · Gas & Diesel Cogeneration Systems · Fume Incineration Systems
Exhaust Steam Generators · Finned Tubing

cain industries

TRANSMITTAL COVER SHEET

COMPANY: PAE Consulting Engineers

ATTN: Mr. Ruwan Jayaweera

PHONE NO: 503-226-2921

E-MAIL: ruwanj@pae-engineers.com

DATE: 10/11/2006

FAX NO: 503-226-2930

PAGES: 8 (including cover sheet)

SUBMITTED BY: Jim Rozanski

SUBJECT: Stumptown Coffee Roasters - Heat Recovery

REFERENCE#: 99308 Rev. 1 (Cain computer printout)

IN:
[X] Phone Inquiry
[ ] Fax Inquiry
[ ] Mail Inquiry
[X] E-mail

OUT:
[ ] Fax Out & File
[X] Fax, Mail, File
[ ] Mail, File
[ ] OVERNITE, File
[X] E-mail

MESSAGE:

- As requested, please find your proposal attached.
- Water must be flowing through the economizer at all times that the incinerator is firing.
- The quoted price is f.o.b. Cain Industries.
- See attached Bul. #25500 for payment terms.
- Shipment in approximately 8-9 weeks after submittal approval.
- Our Terms of Sale, Bul. #25500, form part of this proposal. See this bulletin for payment terms.

Incinerator Exhaust Economizer
** Water Loop Heater **

Ref#: 00-99308
Date: 10/11/06
Page: 2
Rev#: 1

Quotation:

QTY.	PART #	UofM	DESCRIPTION	PRICE
1		EACH	ITR-124C26SSS -INCLUDING: 316SS Tube w/304SS Fin Compression Fitted Fintubes High Alloy Internal Bypass High Alloy Interior 10ga. Carbon Steel Exterior Inspection Door,(tube replace) Threaded Drain & Vent Conn.s	
1	967101	EACH	Condensate Drain Catch Assy.	
1	962010	EACH	ASME Stamp-SEC.VIII;DIV.I;(UM)	
1	964040	EACH	6" Thks. Factory Insulation	
1	967201	EACH	Hinged Access Door	
1	966040	EACH	Liq. Temp. Ctrl. Assy. Elec.	
1	430468	EACH	3/4 NPT ASME Relief Val:150PSI	
1	467205	EACH	T-METER,5"Dial 200-1000'F	
2	480190	EACH	3"Dial, bimetal 50-300 w/well	

TOTAL PRICE....................$ 18,981.00

ANNUAL RETURN ON INVESTMENT....% 92
5 YEAR SAVINGS................$ 87,496
10 YEAR SAVINGS................$ 174,991
PAYBACK PERIOD, MONTHS.......... 13.0

Terms of Sale:
* Delivery: 8-9 weeks
* Payment Schedule: See Bul. #25500
* See Bulletin 25500 including 'Warranty and Performance Guarantee'.

Representative

Jim Rozanski
Cain Industries

: jr

Incinerator Exhaust Economizer
** Water Loop Heater **

Ref#: 00-99308
Date: 10/11/06
Page: 1
Rev#: 1

Engineered for:
Stumptown Coffee Roasters
c/o PAE Consulting Engineers
808 SW 3rd Av., Suite 300, Portland, OR

Attn: Mr. Ruwan Jayaweera
Ph: (503)226-2921
FAX: (503)226-2930

System Description:

Cain Industries is pleased to propose the following replacement ITR model exhaust economizer to recover exhaust heat from an incinerator. This recovered heat will be transferred to a water loop.

The ITR model features: individually removable, type 316 stainless steel tubes with stainless steel fins; a stainless steel, internal, exhaust gas bypass (capable of reducing heat recovery up to 50%); a stainless steel interior lining; 6" of factory insulation (less liquid headers and stack adapters); a 10 gauge carbon steel exterior; a hinged, full face access door for inspecting and/or cleaning the finned tubing; and a condensate drain.

All of the ITR's water side surfaces are stainless steel.

The Liquid Temperature Control Assembly (LTCA) automatically modulates the internal exhaust gas bypass to control the temperature of the heated water leaving the heat exchanger. A desired maximum temperature is entered on the digital indicating controller. The controller has a continuous temperature display. The internal exhaust gas bypass can reduce heat recovery up to 50%; if more heat needs to be removed from the water loop, a trim radiator or some other means of removing heat from the loop must be added by others.

Water must be flowing through the economizer at all times that the incinerator is firing.

The annual operating hours and the cost per therm (100,000 Btu) of natural gas were assumed. It was also asssumed that the fuel fired source of heat to the water loop is 80% efficient.

Incinerator Exhaust Economizer
** Water Loop Heater **

Ref#: 00-99308
Date: 10/11/06
Page: 3
Rev#: 1

Waste Heat Exhaust:

Primary Fuel Type	Natural Gas
Exhaust Gas Flow Direction	Vertical
Heat Source Description	Incinerator
Heat Sink Description	Water loop

Model: ITR-124C26SSS

Overall Configuration, inches	51x49
Overall Height, inches	41.40
Liquid Connection	2
Exhaust Connection	24x24
Dry Weight, lbs.	1020
Surface Area, Ft2	182
Design Pressure, PSIG	150
Hydrostatic Test Pressure, PSIG	225
@ Design Temperature, 'F	650
Maximum Entering Temperature, 'F	1300

c a i n
industries
Heat Recovery Systems

Performance:

Fuel to Output Efficiency, %	80 %
Exhaust Flow Rate, SCFM	700
Exhaust Entering Temp. 'F	1200'F
Exhaust Gas Leaving Temp. 'F	605'F
Pressure Drop " W.C. Max.	0.05
Liquid Flow Rate, GPM	60
Liquid Entering Temp. 'F	140'F
Liquid Leaving Temp. 'F	158.4'F
Pressure Drop, PSIG	0.13
Heat Recovered, MBtu/hr.	534

Savings:

Heat Saved, (x 100,000 BTU/hr.)	6.677
Fuel Cost per 100,000 BTU:	1.26
Annual Hours of Operation	2080
Savings per Load:	$ 17499
ANNUAL SAVINGS....................	$ 17,499

SUBMITTAL

DATE: 10/11/06 REF#: 99308 FOR: Stumptown Coffee Roasters
MODEL: ITR-124C26SSS C/O: Cain Industries
HEAT SOURCE: Incinerator

Bul.#10411

PARTS LIST
(SEE DESIGN DATA FOR CONSTRUCTION)
1. 10 GA. C.S. GAS TIGHT WELDED EXTERIOR
2. DOOR HANDLE
3. **INSPECTION DOOR: TUBE CLEANING
4. STAINLESS STEEL EXHAUST BYPASS
5. STAINLESS STEEL INTERIOR (6 & 8" PYROBLOCK INSULATION REPLACES STAINLESS INTERIOR)
6. 4" STANDARD THKS. INSULATION: 6" [✓] 8" [ ] 12" [ ] (OPTIONAL)
7. ASME STAMP: [✓] (OPTIONAL)
8. ITR TO STACK ADAPTER: [ ] (OPTIONAL)

ITR

VERTICAL EXHAUST FLOW

NOTES:
* LIQUID CONNECTIONS 2" OR LESS = NPT

***FINTUBE MATERIALS:

TUBE TYPE:
- [ ] CARBON STEEL
- [✓] TP316 STAINLESS
- [ ] DUPLEX STAINLESS

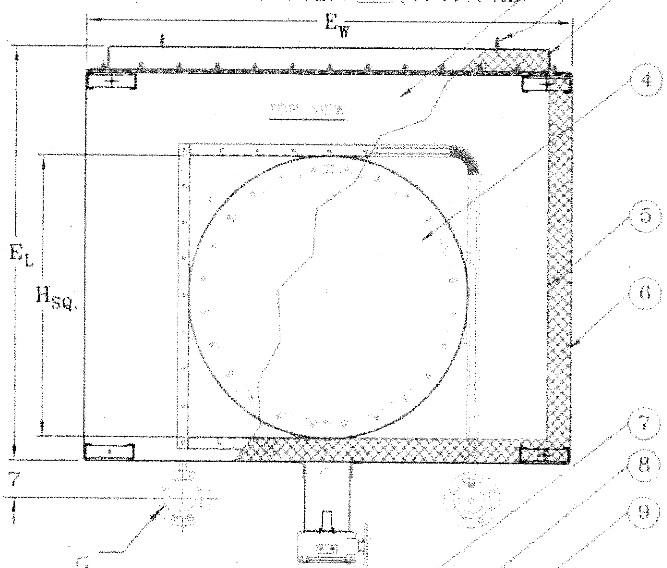
FIN TYPE:
- [ ] CARBON STEEL
- [✓] TP304 STAINLESS
- [ ] ALUMINUM

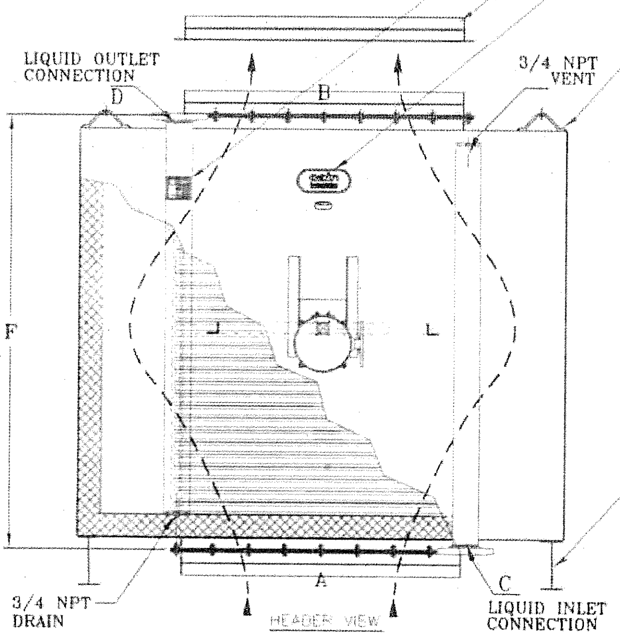
METHOD OF ATTACHMENT:
- [ ] COPPER BRAZED
- [✓] NICKEL BRAZED
- [ ] WELDED
- [ ] ALFUSE

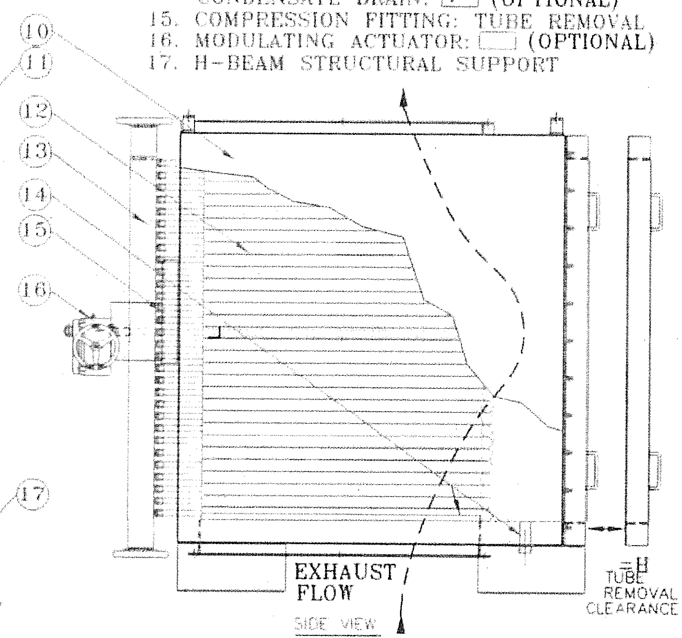
PERFORMANCE AND DIMENSION DATA

A.	1200°F	
B.	605°F	
C.	140°F	
D.	158°F	
E.	51x49"	
F.	41.40"	
G.	2"	CONN.
H.	24x24"	CONN.
	1020#	WGT
	182	H.S.
	150	PSIG
	1300	TEMP.

9. CAIN IND. LOGO & SERIAL NO. ID.
10. 2 x 2" GAS FLANGE CONNECTION: 3 x 3" ANGLE: [ ] (OPTIONAL)
11. LIFTING LUGS
12. ***REMOVABLE FIN TUBE ROWS
13. HEADER MANIFOLD, LOW PRESS. DROP
14. DRAIN CATCH ASSEMBLY AND CONDENSATE DRAIN: [✓] (OPTIONAL)
15. COMPRESSION FITTING: TUBE REMOVAL
16. MODULATING ACTUATOR: [ ] (OPTIONAL)
17. H-BEAM STRUCTURAL SUPPORT







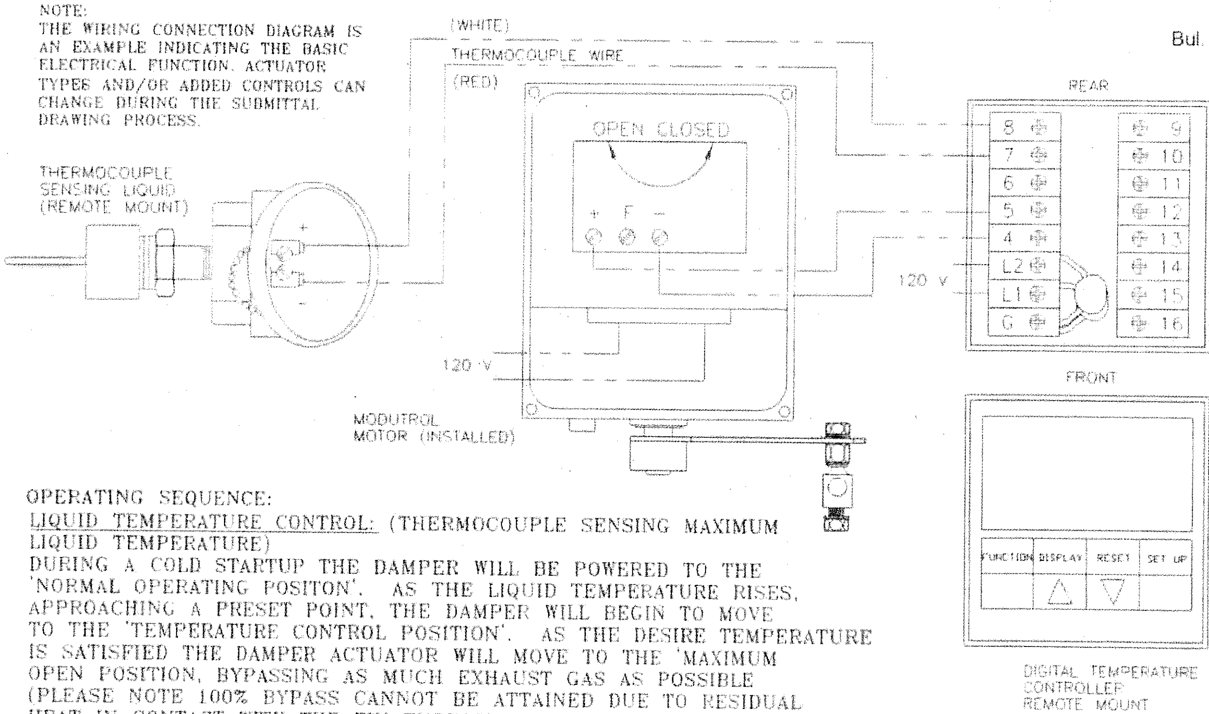
CAIN INDUSTRIES Inc. PO Box 189 W194 N11826 McCormick Drive Germantown, WI 53022
Phone (262) 251-0051 (800) 558-8690 Fax (262) 251-0118 sales@cainind.com www.cainind.com

SUBMITTAL

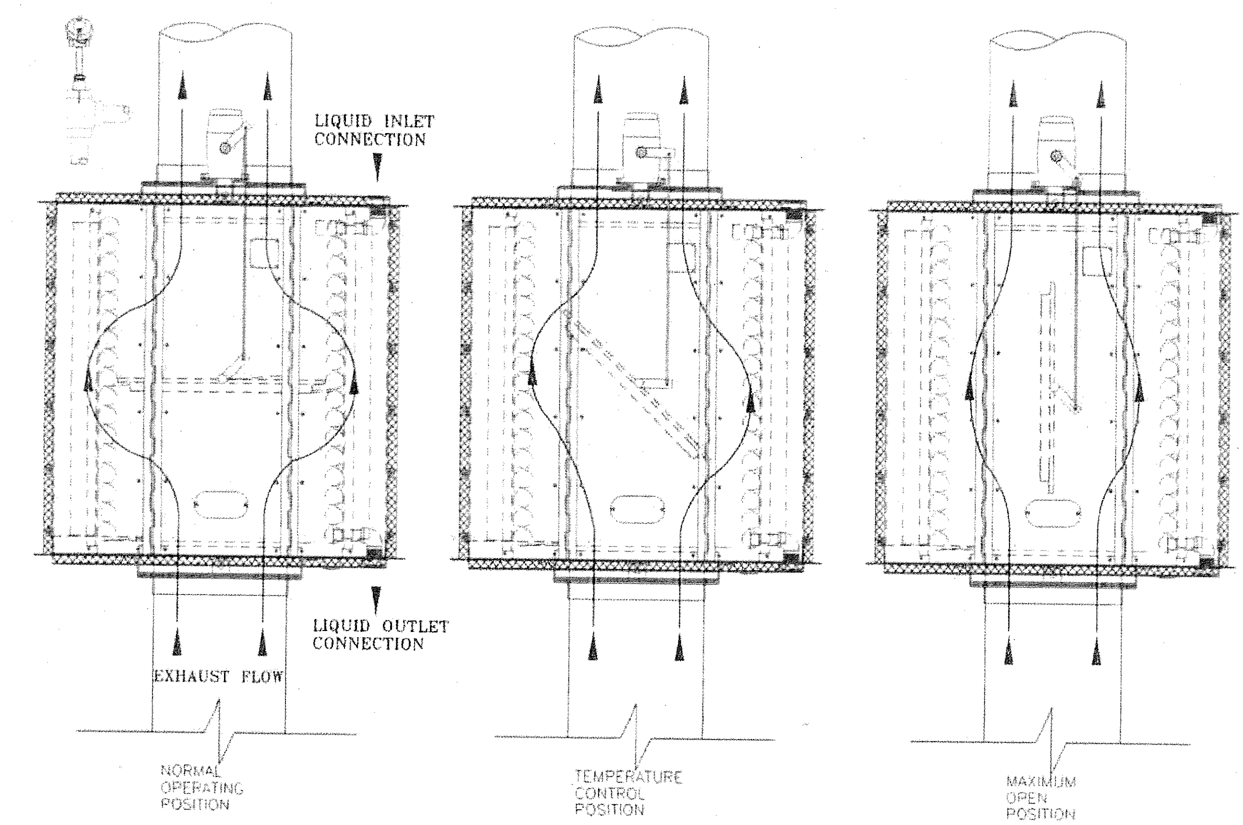
LIQUID TEMPERATURE CONTROL ASSEMBLY

NOTE:
THE WIRING CONNECTION DIAGRAM IS AN EXAMPLE INDICATING THE BASIC ELECTRICAL FUNCTION. ACTUATOR TYPES AND/OR ADDED CONTROLS CAN CHANGE DURING THE SUBMITTAL DRAWING PROCESS.

Bul. #11040



OPERATING SEQUENCE:
LIQUID TEMPERATURE CONTROL: (THERMOCOUPLE SENSING MAXIMUM LIQUID TEMPERATURE)
DURING A COLD STARTUP THE DAMPER WILL BE POWERED TO THE 'NORMAL OPERATING POSITON'. AS THE LIQUID TEMPERATURE RISES, APPROACHING A PRESET POINT, THE DAMPER WILL BEGIN TO MOVE TO THE 'TEMPERATURE CONTROL POSITION'. AS THE DESIRE TEMPERATURE IS SATISFIED THE DAMPER ACTUATOR WILL MOVE TO THE 'MAXIMUM OPEN POSITION, BYPASSING AS MUCH EXHAUST GAS AS POSSIBLE (PLEASE NOTE 100% BYPASS CANNOT BE ATTAINED DUE TO RESIDUAL HEAT IN CONTACT WITH THE FIN TUBING).



CAIN INDUSTRIES Inc. PO Box 189 W194 N11826 McCormick Drive Germantown, WI 53022
Phone (262) 251-0051 (800) 558-8690 Fax (262) 251-0118 sales@cainind.com www.cainind.com

TERMS OF SALE

Bul. 25500

The terms of the attached Limited Warranty are included in these Terms of Sale and are incorporated by reference herein. The following "Terms of Sale" forms as a part of the Cain Industries equipment proposal as attached herein. All proposed pricing is quoted F.O.B. factory. All pricing is quoted in U.S. currency.

QUOTED DELIVERY TIME:
Delivery times quoted are appropriate for various product lines, and based on conditions at the time of quotation. Cain Industries, Inc. will, in good faith, attempt to deliver the equipment within the time quoted. In no case shall Cain Industries, Inc. be liable for incidental or consequential damages resulting from failure to meet requested or quoted delivery schedules. Quoted delivery time is based from the date of receipt of an approved written purchase order including written authorization to proceed with fabrication and the initial down payment if required, or from date of receipt of submittal drawings when required (less 10 working days).

OFFER EXPIRATION:
All offers expire 60 days from the quotation date unless otherwise stated and are subject to cancellation by Cain Industries, Inc. at any time prior to the formal acceptance of our offer to furnish equipment quoted.

SUBMITTAL DRAWINGS:
Submittal drawings are issued 5-10 working days from receipt of written purchase order, when required by either Cain Industries and/or the Buyer, and must be returned (marked "Approved for Production", signed, and dated) in order to initiate production. Production cannot begin until the approved submittal drawings are returned.

SHIPMENT OF GOODS:
Unless otherwise specifically agreed, all shipments are made F.O.B. Factory via "best way" and shipped freight collect. Cain Industries, Inc. responsibility ceases upon acceptance by the carrier. SHOULD GOODS BECOME LOST OR DAMAGED IN SHIPMENT, THE PURCHASER OR RECIPIENT OF THE GOODS MUST IMMEDIATELY NOTIFY AND PLACE CLAIM WITH THE CARRIER. ADVISE CAIN INDUSTRIES, INC. OF ANY DAMAGE OR DISCREPANCY AND OBTAIN AUTHORIZATION FOR RETURN OR REPLACEMENT. As a courtesy, Cain Industries, Inc. will assist in tracing and recovering lost goods and the collection of just claims, but cannot guarantee safe delivery. Loss or damage in shipment does not release the purchaser from payment of the total invoice.

PAYMENT-ESTABLISHED ACCOUNTS:
Payments for established accounts with a credit limit are due on or before the Net 30 days from date of invoice due date, and coinciding with shipment date and/or 'ready for shipment date'.

EXPEDITING:
Expediting charges may be issued in order to improve delivery depending on the shorter delivery time required. Contact Cain Industries for pricing for the best possible delivery.

STORAGE:
When the equipment is ready for shipment, it will be shipped to the 'ship to' address noted on the Sales Order, unless other wise indicated. Should there be a request to hold the equipment beyond the 'ready for shipment date', Cain will store the equipment for up to 30 days at no cost providing storage space is available. Contact Cain Industries for storage costs when equipment is expected to be stored for more than 30 days. If storage space is unavailable, the buyer agrees to make provisions to receive the equipment when it becomes ready for shipment.

MINIMUM BILLING:
The minimum order is $100.00, plus shipping costs.

CREDIT LIMIT:
Accounts over credit limit will be on a "Cash with Order" basis until account is brought to below "Credit Limit" status. Special circumstances may occur where credit limits may be adjusted for companies with past credit history satisfactory to Cain Industries, Inc.

TAXES OR SURCHARGES:
Quoted prices do not include sales, use, excise, occupation, processing transportation or other similar taxes which Cain Industries, Inc. may be required to pay or collect with respect to any of the quoted materials. Such taxes which are or may be incurred shall be paid by the purchaser.

PAYMENT-NEW ACCOUNTS:
An initial purchase order received from a new account shall require a 50% down payment with the order, receipt of the completed credit application for immediate processing, and the balance due prior to shipment; or 30% with purchase order and receipt of the completed credit application (order will be held until credit limit has been established) in conjunction with credit limit and/or progress payment schedules. Allow a 3 week processing period to complete the credit check.

PAYMENT-ORDERS OUTSIDE THE UNITED STATES:
For purchase orders received wherein the the final installation and/or the Buyer is located outside the United States, payments shall be made according to the guide lines as set forth herein. It is recommended that a Letter of Credit be created and issued with the purchase order for immediate order processing. All costs associated with international payments such as but not limited to: proforma invoicing, letter of credit, agents of record processing, currency adjustments, tariffs and special taxes, etc. shall be the responsibility of the purchaser. All payments shall be made in U.S. currency and shall be paid in full prior to shipment outside the United States.

SERVICE CHARGE:
A 2% per month service charge will be assessed on all past due amounts.

PROGRESS PAYMENT SCHEDULES:
The following are payment schedules for orders exceeding credit limit:
- For purchase orders of $25,000 to $50,000:
  - -30% due with purchase order
  - -30% due at 45 days from receipt of approval drawings
  - -Balance due 30 days from shipment
- Over $50,000 or required for the ESG product orders:
  - -15% due with purchase order
  - -15% due with submittal approval drawings
  - -30% due 45 days from receipt of approved submittal drawings
  - -30% due prior to shipment
  - -Balance due 30 days from shipment.

OEM QUANTITY DISCOUNTS:

• A	(5-9)	Total Discount Each	8%
• B	(10-19)	Total Discount Each	13%
• C	(20-49)	Total Discount Each	17%
• D	(50-99)	Total Discount Each	20%

OEM DISCOUNT PROVISIONS:
OEM discounts are applicable only to the following product lines: Finned Tubing, EM, B-Series, FCR, UTR, & HRSA. OEM pricing is applicable only to a per model number quantity, per written purchase order. A shipping release schedule must also be included as required. Release dates for multiple unit order must fall within (1) year from date of purchase order to hold current OEM pricing. Individual invoicing for multiple unit releases begin at "Item A" of the quantity discount schedule and prorate through to the total quantity ordered as noted on the Sales Order acknowledgment. Minimum release for quantities C through D per shipment is (10) units. Special prototype order delivery requirements available upon request.

CANCELLATION AND CHANGES:
As many Cain Industries, Inc. products are manufactured and/or adjusted "to order", orders accepted and acknowledged by Cain Industries, Inc. are not subject to change or cancellation without prior consent of Cain Industries, Inc. Order quantity reductions or cancellations, if granted, will be subject to cancellation charges consistent with components "restockability versus made to order specifications" percent of production completion, etc.

EQUIPMENT STARTUP & SERVICE:
Pricing for equipment requiring startup or service: $900 per day for installations located within the continental United States; $1000 per day for installations located within the North American Continent; $1200 per day for all other installation locations. Travel, lodging, and subsistence expenses are in addition. Startup can only be initiated upon receipt of completed Pre-Startup form. ESG & ESG1 boiler startups must be completed by authorized Cain personnel to allow the warranty to become effective, unless otherwise stated in a written agreement issued by Cain Industries to the Buyer.

RETURN OF GOODS FOR WARRANTY REPAIR, REPLACEMENT, OR CREDIT:
Authorization to return goods for any reason must be obtained from Cain Industries, Inc. prior to the return of the shipment being made. All items returned for repair, replacement or credit shall be returned freight prepaid. Freight collect shipments will not be accepted. A 30% "minimum" restocking charge will be made on all items returned for credit. Cancellation and/or restocking charges will apply to the balance of the order pending with a maximum of 90% as determined at the point of cancellation dependent on the work in process. Quantities shipped prior to the point of cancellation shall be issued an additional invoice for the difference in price breaks between the original quantity ordered and the total shipped up to the point of cancellation.

PROPRIETARY DATA:
All manufacturing drawings, specifications and technical material submitted by Cain Industries, Inc. are the property of Cain Industries, Inc. and are to be considered as confidential. Except for its original intent the submittal information supplied herein attached cannot be copied, transferred, or used in any way without the express written authorization from Cain Industries, Inc.

LIMITATION OF REMEDIES:
Cain's liability is limited exclusively to its obligations under the attached **Limited Warranty**, the terms of which are incorporated by reference herein. Buyer agrees that in no event will Cain be liable for cost of processing, loss of profits, or any other consequential or incidental damages or cost of any kind resulting from the order and or use of its product, whether arising from breach of warranty, non-conformity to order specifications, delay in delivery or any other loss sustained by buyer.

LIMITED WARRANTY AND PERFORMANCE GUARANTEE

Bul. 25500

LIMITED WARRANTY AND PERFORMANCE GUARANTEE

Cain Industries, Inc. warrants all products manufactured to be free from defects in material or workmanship under normal use and conditions for a period of one year from the date of startup or 18 months from date of shipment from our factory whichever occurs first. Cain Industries liability under this warranty to the buyer shall be limited to Cain's decision to repair or replace, all its factory items deemed defective after inspection at the factory or in the field. When field service is deemed necessary in order to determine a warranty claim, the costs associated with travel, lodging, etc. shall be the responsibility of the buyer except under prior agreement for a field inspection. All warranty claim requests must be initiated with a Material Return Authorization (MRA) number for processing and tracking purposes. The MRA number shall be issued to the buyer upon Cain's receipt of a purchase order for replacement component(s) required immediately and prior to warranty claim approval and/or a field inspection. No agent or employee of Cain Industries, Inc. has any authority to make verbal representation or warranty of any goods manufactured and sold by Cain Industries, Inc. without written authorization signed by an executive officer of Cain Industries, Inc. Cain Industries, Inc. warrants the equipment designed and fabricated to perform in accordance with the specifications as stated in the proposal for the equipment, and while the equipment is in new and clean condition and properly operated within the specific design limits for that equipment. Should any piece of equipment designed by Cain Industries, Inc. not meet performance requirements when determined by standard test procedures, Cain will make corrections it deems necessary at its option under the limitations of this warranty. Any alterations or repair of Cain equipment by personnel other than those directly employed by Cain shall void this warranty unless otherwise stated under a specific written guideline issued by Cain Industries to the buyer. The ESG1 and ESG boiler startup must be completed by authorized Cain personnel to allow the warranty to take effect unless otherwise stated in a written agreement issued by Cain Industries to the buyer. This warranty does not cover damage resulting from misapplying Cain Industries products and/or improper installation. This warranty does not cover corrosion resulting from the effects of physical or chemical properties of water, steam or the liquids or gases used in the equipment. This warranty does not cover damage resulting from combustion source backfires or explosions which exceed Cain Industries product specific maximum design pressure and/or when explosion hatches are not properly installed where required. This warranty does not cover damage resulting from excessive vibration resulting from isolating vibration protection not properly installed where required. This warranty does not cover damage resulting from expansion due to expansion joints not properly installed where required. This warranty does not cover damage or lost performance due to combustion source related deficiency such as soot build up on the heating surface. Cain makes no other warranties of performance or product either expressed or implied which extends beyond the limits contained within this instrument. All acceptance tests shall be conducted at the buyer's expense. Any such tests shall be made when the equipment is new, clean, and before being placed into service, and shall be made within 120 days of delivery. Where field test are required, the following procedures are to be used. The exhaust gas and liquid inlet and outlet temperatures shall be recorded simultaneously and measured at a minimum distance of 6 pipe diameters from the equipment. Exhaust gas and liquid volumes shall be determined by actual measurement, if practical, or by calculations if necessary. All factors of O_2, CO_2, excess air, full input, altitude and the operating efficiency of the primary direct fired unit, shall be incorporated in the final determination and calculation of the volume of the exhaust gas. The expense incurred for such test shall be the responsibility of the buyer and a copy of the test procedures conducted, data accumulated, and calculations used to arrive at the final results shall be submitted to Cain Industries. All workmanship, material and performance requirements shall be deemed to have been met if a contrary report has not been furnished within 120 days of delivery. This "Limited Warranty and Performance Guarantee" forms as a part of the Cain Industries equipment proposal as attached herein.

IN NO EVENT SHALL SELLER BE LIABLE FOR CLAIMS (BASED UPON BREACH OF EXPRESS OR IMPLIED WARRANTY, NEGLIGENCE OR OTHERWISE) FOR ANY DAMAGES, WHETHER DIRECT, IMMEDIATE, INCIDENTAL, FORESEEABLE, CONSEQUENTIAL, OR SPECIAL.

Cain Industries, Inc. PO Box 189 Germantown, WI 53022 • 262-251-0051 • 800-558-8690 • 262-251-0118 Fax • sales@cainind.com

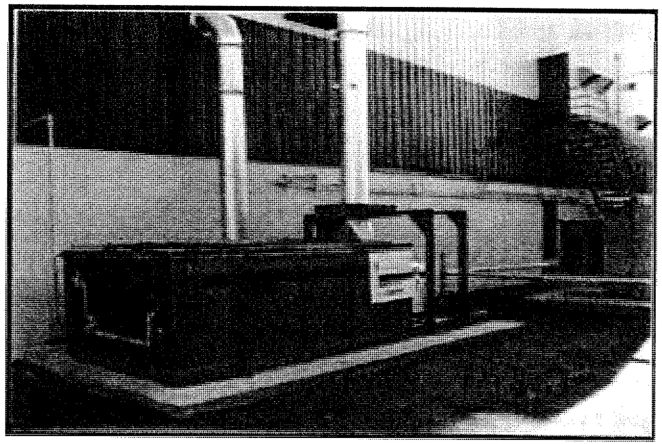
Appendix E: Anguil Self Cleaning Ceramic Filter Submittal (Option 5)

ANGUIL
Budget Proposal for Self Cleaning Ceramic Filter With Economizer

Prepared for:

Mr. Ruwan Jayaweera
PAE Consulting Engineers
808 SW 3rd Avenue, Suite 300
Portland, OR 97204
Ph: (503) 226-2921
Fx: (503) 226-2930
Em:

RE: Stumptown Coffee Roasters



Submitted by:

Mr. Christopher A. Anguil
Vice President – Sales

Ph: (414) 365-6400
Fx: (414) 365-6410
Em: chris.anguil@anguil.com

Local Representative:

Mr. Derek MacKenzie
KJ Barnett Company
Redmond, WA
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ANGUIL ENVIRONMENTAL SYSTEMS, INC.
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http://www.anguil.com

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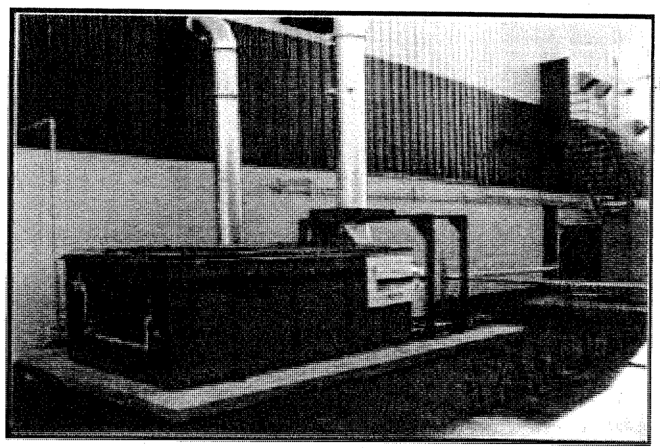

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Table of Contents

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Section I - Design Considerations

APPLICATION DATA AND DESIGN PARAMETERS

• Process Producing Emissions:	Coffee Roasting
• Max Process Stream Flow Rate:	650 ACFM
• Max Process Temperature:	450 °F
• Contaminant Breakdown:	Not provided
• System Location:	Outside
• Required Fuel:	Natural Gas at 2-5 psig
• Required Power:	480V / 60 Hz / 3 Ph

DESIRED RESULTS

- Compliance with the local regulatory agency by eliminating odors, visible plume and providing 95% non methane VOC destruction efficiency
- Keep the overall cost of the project to a minimum
- Minimize yearly operational cost of the system
- Create no adverse effects on the operation of the current process
- Minimize equipment maintenance

EQUIPMENT RECOMMENDATION

- One (1) Anguil Model 5 (500 SCFM) Self Cleaning Ceramic Filter (SCCF)
- One (1) Anguil Model 5 (500 SCFM) Economizer Package

EQUIPMENT BENEFITS

- Fully automated PLC based control system
- Variable Frequency Drive (VFD) to control system fan reduces operating costs
- Phone modem for remote diagnostics
- Field tested and proven technology
- Full equipment warranty
- Full factory test prior to shipment
- 24-hour service support

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One Anguil Model 5 Self Cleaning Ceramic Filter will process up to 500 SCFM of VOC and particulate laden air, providing odor and opacity control and 95% non-methane VOC destruction efficiency.

During the system operation, the air will be exhausted from the process directly into the burner/reactor section where the air is raised to a temperature of typically 600 to 750 F. Additionally, a ceramic filter matrix is located in near proximity to the burner flame. This is meant to trap and volatilize any organic particulate that enters the system.

After leaving the burner section, the heated exhaust air passes through a catalyst bed. When the process air passes through the catalyst an exothermic reaction will take place as the organic vapors are oxidized to carbon dioxide and water. The hot purified air will then be drawn into the induced draft system fan and from there it is forced into the economizer section.

One Anguil Model 5 Economizer will transfer heat from a purified exhaust airstream (650 up to 1100 F typical) to a water loop. Anguil's Economizer package typically includes stainless steel tubes and fins, an internal exhaust gas bypass, stainless steel inner and outer skins with internal insulation, service access doors and a condensate drain.

The equipment will be assembled, factory pre-wired and supplied per the following specifications:

SYSTEM

- Approximate Footprint: 15' L x 9' W
- Approximate Weight: 5,500 lbs.

REACTOR

- 304L stainless steel interior reactor shell
- Aluminized steel exterior reactor shell
- High density mineral wool placed between reactor shells
- Exterior shell painted with 2 coats of UV resistant polyurethane paint
- Access door allows for service and inspection of filter, catalyst, and reactor.

INDUCED DRAFT SYSTEM FAN

- New York Blower high performance, industrial grade fan,
- 460V/60Hz/3PH TEFC (Totally Enclosed Fan Cooled) motor
- Fresh air for startup shall be provided from the process ductwork

VARIABLE FREQUENCY DRIVE

- Allen Bradley Powerflex Variable Frequency Drive (VFD) in a NEMA 12 enclosure (located in the control panel) to regulate airflow through the system
- VFD controlled by a pressure transducer located up-stream of the system in the ductwork
- Provides maximum turn-down ratio of 4:1

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- Provides maximum turn-down ratio of 4:1

BURNER/GAS TRAIN

- Fuel source – Natural Gas
- Approximate burner capacity – 1.0 MMBTU/hr
- Fabricated to FM/IRI specifications
- 20:1 maximum turndown
- Burner mounted in horizontal plane to allow the flame to fire in the same direction as the airflow
- Burner selected to bring reactor up to catalyst-ready temperature with ambient air during start-up
- Burner will have capacity to maintain system operating temperature during VOC free, full air flow conditions
- Expected system heat up time from cold start is 30 minutes

SELF CLEANING CERAMIC FILTER

- Anguil Environmental Systems U.S. Patent No. 5,143,700
- 1" ceramic matrix filter, 400 cpsi
- Burner shall fire on ceramic filter to volatilize organic particulate and aerosols
- Stainless steel filter rack

CATALYST

• Catalyst Type:	Precious Metal Monolith
• Gas Hourly Space Velocity:	45,000 hrs^{-1}
• Volume of Catalyst:	2 ft^3
• Catalyst Inlet Temp:	600 to 750^0 F
• Maximum Catalyst Outlet Temp:	$1,200^0$ F

ECONOMIZER/AIR-TO-WATER HEAT EXCHANGER

- Individually removable type 316 stainless steel tubes with 304 stainless steel fins
- Internal stainless steel exhaust gas bypass
- 304 stainless steel internal and exterior shell
- 2 to 4 inches of factory insulation
- A hinged, full-face access door for inspecting and/or cleaning the finned tubes
- Condensate drain

EXHAUST STACK

- Constructed of aluminized steel
- Guy wired, no-loss type
- Stack height will be up to 10' above oxidizer base
- Sampling ports are provided

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CATALYST

- Catalyst Type: Precious Metal Monolith
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Equipment Specifications (cont)

SYSTEM CONTROLS

- Fully automated PLC (Programmable Logic Controller) controls
- **Allen Bradley or equivalent**
- NEMA 12 panel enclosure
- **First out shutdown detector: AB PanelView HMI will indicate cause of system shutdown via a digital message in English**
- **Yokagawa three-trace digital chart recorder to monitor the catalyst inlet and outlet temperatures and stack temperature**
- Phone modem for remote diagnostics

Control Panel

SAFETY SHUTDOWNS

- Loss of proper airflow
- Loss of electrical power
- Loss of gas pressure
- High catalyst outlet temperature
- Low catalyst inlet temperature
- High pressure drop across ceramic filter

START-UP AND TRAINING SERVICES (QUOTED AS LINE ITEM)

- Service technician can be provided to start-up and balance the SCCF
- Operator training will be conducted during start-up

ADDITIONAL ITEMS

- Two sets of Operation and Maintenance Manuals (O&M) containing the sequence of operations and drawings will be provided
- All vendor bulletins will be provided on CD-Rom
- Thorough factory quality run and test

ITEMS NOT INCLUDED AS PART OF THIS PROPOSAL

- All compliance testing of system
- Power wiring to control panel
- Interconnecting wiring from control panel to equipment
- Natural gas service connection to equipment fuel train at required pressure
- All local and regulatory permits
- Mechanical and electrical installation
- Sales tax, freight charges, crating, insurance and duties

*Note: All weights, dimensions, horsepower ratings, burner sizing, and specific engineering details within the proposal are approximate and will be confirmed by Anguil Environmental following order placement.

Equipment Specifications (cont)

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SYSTEM BUDGET PRICE, Ex Works Fabrication Facility: $95,000.00

One (1) Anguil Model 5 Economizer will transfer heat from a purified exhaust airstream (650 up to 1100 F typical) to a water loop.

SYSTEM BUDGET PRICE, Ex Works Fabrication Facility: $47,000.00

START UP AND TRAINING
$930 / 8 hour day + travel and living expenses

SHIPMENT: 10-12 WEEKS AFTER RECEIPT OF ORDER (TYPICAL)

EXPEDITED DELIVERY OPTIONS AVAILABLE

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