ITS Intertek Testing Services
ETL SEMKO
8431 Murphy Drive
Middleton, WI 53562

ITS TEST REPORT #J99031218-231
TEST OF A WOOD BURNING STOVE
FOR EMISSIONS & EFFICIENCY USING
EPA METHOD 28 AND 5G-3
MODEL: SQUIRREL
WOOD BURNING STOVE
FOR
MORSO JERNSTOBERI A/S
FURVEJ 6 7900 NYKOBING
MORS, DENMARK

TEST OF A WOOD BURNING STOVE
FOR

EMISSIONS AND EFFICIENCY

PER

EPA METHODS 28 AND 5G-3
FOR
MORSO JERNSTOBERI A/S
FURVEJ 6 7900 NYKOBING
MORS, DENMARK 7900

TESTED BY:

INTERTEK TESTING SERVICES NA INC.
8431 MURPHY DRIVE
MIDDLETON, WISCONSIN 53562

TEST DATES: FEBRUARY 3-8, 2000
REPORT DATE: FEBRUARY 11,2000

VI. QUALITY ASSURANCE

I. INTRODUCTION

I.A. GENERAL

From February 3 through 8, 2000 Intertek Testing Services NA Inc. (ITS) conducted tests on Morso Jernstoberi's model 1410 (Squirrel) wood burning stove to determine compliance with U.S. EPA emissions regulations.

Tests were conducted by Rick Armstrong. Present, as an observer for tests was Karsten Aagaard, a representative of Morso. 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

The Morso Squirrel model 1410 wood burning stove is rectangular in shape and sits on four legs. The Unit is constructed from cast iron with a glass and cast iron door that is hinged on the left. The air control consists of a spin type damper located on the door above the glass. The air is directed down the glass as air wash. The firebox is lined on the sides with cast refractory. Under the firebox is an ash-pan.

I.C. RESULTS

The unit as tested produced a weighted-average emissions rate of 3.313 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.

I.D. PRETEST INFORMATION

The test unit was received at Intertek Testing Services NA Inc. in Middleton, Wisconsin on December 29,1999 via KLM. 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 located centrally on the top, back, left, right, and bottom. 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 13 plus hours of pre-burning was conducted on January 31 and February 1, 2000. 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 February 3, 2000, 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.

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	2/3/00	0.795	4.523	6.369	70.61
2	2/4/00	0.986	1.390	2.392	65.52
3	2/7/00	1.395	0.718	1.383	65.52
4	2/8/00	1.826	2.831	4.317	66.79

**Calculated as specified in CSA B-415

II.B. WEIGHTED AVERAGE CALCULATION

Run Number	Burn Rate	(E) Adjusted Emission Rate g/hr	(OHE)*	Output (BTU/HR)	Prob	(K) Weighting Factor	(KxE)	(KxOHE)
1	0.795	6.369	70.61	9586.27	.2165	.3654	2.3275	25.80
2	0.986	2.392	65.37	11889.39	.3654	.4744	1.1348	31.01
3	1.395	1.383	65.52	16821.19	.6909	.5132	.7098	33.62
4	1.826	4.317	66.79	22018.27	.8786	.3091	1.3344	20.64
					Sums:	1.66214	5.5064	111.08

Weighted Average Emissions Rate: 5.5064÷1.66214= 3.3128

Weighted Average Overall Heating Efficiency: 111.08 ÷1.66214 = 66.83%

*Calculated as specified in CSA B-415

II.C. TEST FACILITY CONDITIONS

Run Number	Room Temperature Before (F)	Room Temperature After (F)	Barometric Pressure Before (in. Hg)	Barometric Pressure After (in. Hg)	Relative Humidity Before (%)	Relative Humidity After (%)	Air Velocity Before (ft/min)	Air Velocity After (ft/min)
1	73	74	28.73	28.78	33	34	0	0
2	73	74	29.22	29.28	35	28	0	0
3	68	75	29.34	29.40	41	30	0	0
4	71	75	29.40	29.38	32	25	0	0

II.D. FUEL QUALITIES

Run Number	Pre-Test Load Loading Weight Wet Basis (lb.)	Pre-Test Load Moisture Content Dry Basis (%)	Pre-Test Load Coal Bed Weight (lb.)	Test Load Weight Wet Basis (lb.)	Test Load Density Wet Basis (lbs/ft^3)	Test Load Moisture Content Dry Basis (%)	Test Load Piece Length (in.)	Number of 2x4's	Number of 4x4's
1	4.89	24.54	1.1	5.1	6.929	22.03	10.00	3	0
2	5.08	21.24	1.1	5.22	7.090	23.18	10.00	3	0
3	5.15	20.85	1.1	5.16	7.011	22.79	10.00	3	0
4	5.31	19.31	1.1	5.36	7.283	22.92	10.00	3	0

.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) 1	Sample Volume (dscf) 2	Particulate Catch (mg) 1	Particulate Catch (mg) 2
1	143	13.51	142.99	542.00	32.73	33.29	17.3	17.5
2	117	13.38	143.89	542.38	27.58	27.70	4.3	4.6
3	82	13.57	143.97	552.20	19.15	19.34	1.6	1.6
4	65	13.46	142.50	553.50	15.25	15.55	5.1	5.1

I.F. DILUTION TUNNEL DUAL TRAIN PRECISION

Run Number	Sample Ratios Train 1	Sample Ratios Train 2	Total Emissions (grams) Train 1	Total Emissions (grams) Train 2	% Deviation
1	624.81	614.28	10.81	10.75	0.46
2	610.33	607.88	2.62	2.80	5.26
3	616.41	610.53	0.99	0.98	0.79
4	607.23	595.58	3.10	3.04	1.61

I.G. **GENERAL SUMMARY OF RESULTS**

Run Number	Burn Rate (kg/hr)	Average Temperature (F) Combustion	Surface	Change In Surface Temperature (F)	Initial Draft (in. H2O)	Primary Air Setting	Run Time (min)	Average Draft (in. H_2O)
1	0.795	772.38	441.43	-113.80	.045	1 turn open	143	.043
2	0.986	828.54	482.02	-65.40	.040	1¼ turns	117	.049
3	1.395	957.50	544.10	-18.6	.072	2 1/2 turns	82	.067
4	1.826	1063.13	580.40	+ 30.80	.053	full open	65	.073

III. PROCESS DESCRIPTION

III.A. DISCUSSION

RUN #1 (February 3, 2000) the air control was set at one turn from full closed. The test was loaded in 35 seconds. The door was open for 3 minutes and the air control was open for 5 minutes. Burn time was 143 minutes making the burn rate 0.795 kg/hour, a category 1-burn rate. At 13:52 the fire was stirred and the door was open for 15 seconds. See sec. 6.4.3

RUN #2 (February 4, 2000) the air control was set at 1¼ turns from closed. The test was loaded in 25 seconds. The door was open for 5 minutes. The air control was not adjusted during start-up. Burn time was 117 minutes for a category 2-burn rate of .986 kg/hr.

RUN #3 (February 7, 2000) the air control was set to 2 ½ turns from closed. The test was loaded in 30 seconds, the door was open for 5 minutes. The air was not adjusted during start up. Burn time was 82 minutes for a category 3-burn rate of 1.395 kg/hr.

RUN #4 (February 8, 2000) the primary air control was set at full open. The test was loaded in 15 seconds. The door was open for 3 minutes. Burn time was 65 minutes for a category 4-burn rate of 1.826 kg/hr.

III.B. UNIT DIMENSIONS

28.25" high, 22.5" wide and 19.5" deep.

III.C. AIR SUPPLY SYSTEM

Primary combustion air enters the unit through a spin type damper centrally located on the door above the glass. This air is directed down across the glass as air wash. Secondary air is channeled uncontrolled up the rear of the firebox and forward in the baffle where it spills out **through 48 holes**. Combustion products then exit the unit through a six-inch flue collar located centrally at the rear of the stovetop.

III.D. OPERATION DURING TEST

The stove and all lab equipment operated as they should during all tests.

III.E. START-UP OPERATION

Each test was started with a clean firebox and the scale zeroed. A fire was started using newspaper and Douglas Fir scraps for kindling. For all tests the fire was started with two to three pounds of kindling and then a warm-up pre-test load of fuel was put in. This was allowed to burn until there was about one to two lbs. of fuel was left. At this point, the stove was cleaned out the scale was zeroed. Approximately 1 lb. of hot coals from the warm-up fire was put back in to start the pre-burn fuel. Pretest loads were fired on high until burning well. Stirring was done as required to insure uniform charcoalization. At least one hour prior to reloading the air controls was set to the approximate position used during the test. Stirring was limited to less than 1 minute during the last 15 minutes of the pre-test.

IV. SAMPLING SYSTEMS

IV.A. SAMPLING LOCATIONS

Particulate samples are collected from the dilution tunnel at a point 20 feet from the tunnel entrance. The tunnel has two elbows and two mixing baffles in the system ahead of the sampling section. (See Figure 3.) The sampling section is a continuous 13 foot section of 6 inch diameter pipe straight over its entire length. Tunnel velocity pressure is determined by a standard Pitot tube located 60 inches from the beginning of the sampling section. The dry bulb thermocouple is located six inches downstream from the Pitot tube. Tunnel samplers are located 60 inches downstream of the Pitot tube and 36 inches upstream from the end of this section. (See Figure 1.)

Stack gas samples are collected from the steel chimney section 8 feet ± 6 inches above the scale platform. (See Figure 2.)

IV.A.(1) DILUTION TUNNEL

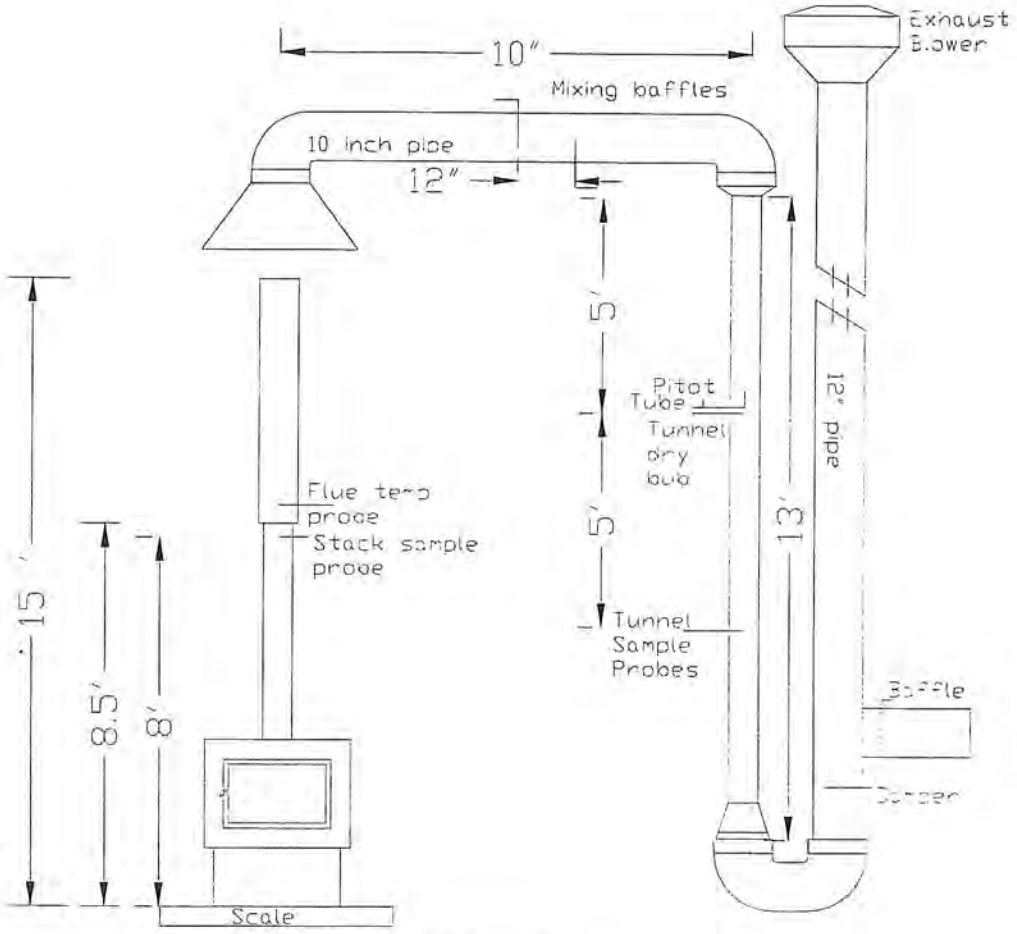
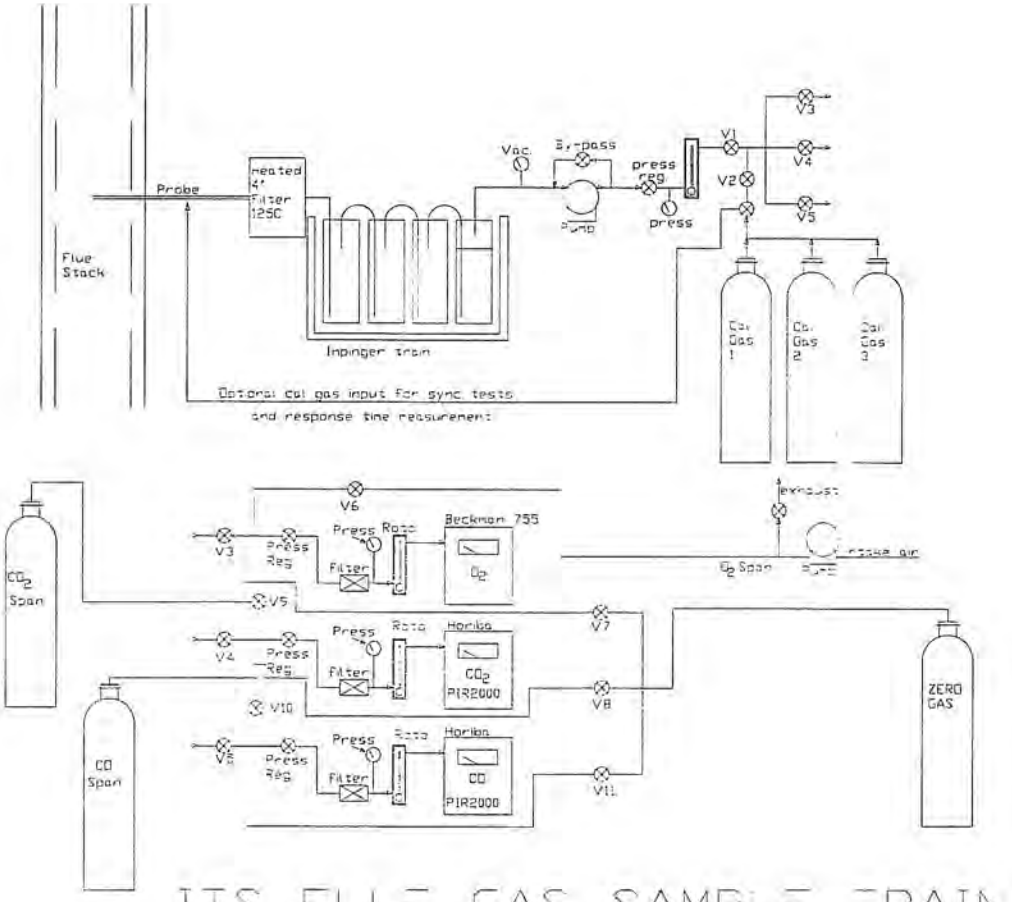


FIGURE 1

IV.B. OPERATIONAL DRAWINGS

IV.B.(1) STACK GAS SAMPLE TRAIN



ITS FLUE GAS SAMPLE TRAIN

FIGURE 2

IV.B.(2). DILUTION TUNNEL SAMPLE SYSTEMS

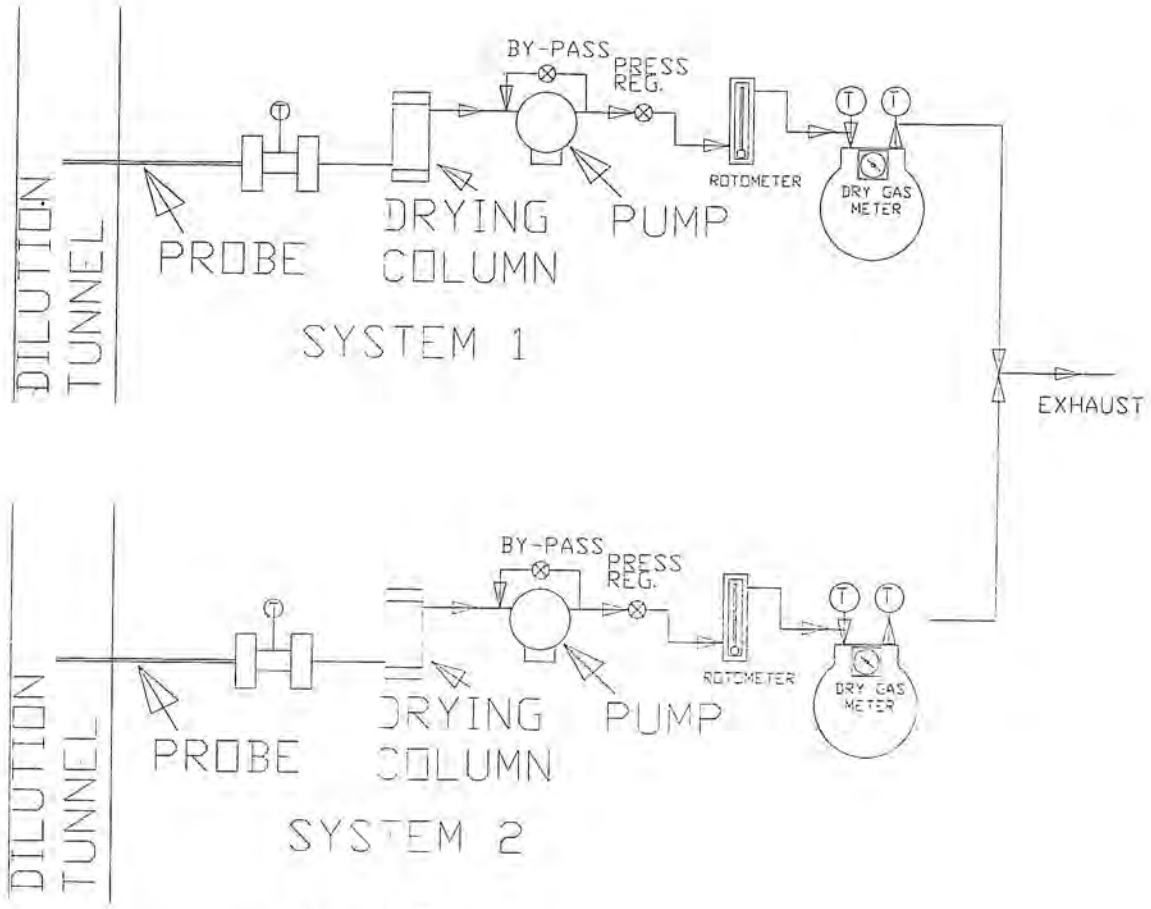


Figure 3

IV.B. EMISSION AND EFFICIENCY EQUIPMENT LIST

ITEM DESCRIPTION	MANUFACTURER	MODEL	SERIAL #
1. CO2 Analyzer (WHI#010)	HORIBA	PIR-2000	607023
2. CO Analyzer (WHI #009)	HORIBA	PIR-2000	6110019
3. O2 Analyzer (WHI #011)	BECKMAN	755	1001926
4. Dry Gas Meter (WHI #012)	Rockwell	T-110	26866
5. Dry Gas Meter (WHI #013)	Rockwell	T-ll0	26873
6. Rotometer (WHI # 015)	Matheson	602 Tube	
7. Rotometer (3) (WHI # 016)	Matheson	603 Tube	
8. Rotometer (2) (WHI # 019)	Matheson	604 Tube	
9. Hot Wire Anemometer (WHI #021)	Alnor	8525	MD 1057
10. Inclined Manometer (WHI #022)	Dwyer	125-AV	
11. Pitot Tube (WHI # 044)			
12. Manometer 0-10" (WHI #024)	Dwyer	400-10	
13. Mercury Barometer (WHI # 142)	Meriam	310EC10WM	184550-X1
14. Draft Indicator (WHI #027)	Dwyer	2000-00	R60825 M29
15. Scale, 1000# Cap./Record.(WHI #025)	Toledo Masstron	ML222	8013
16. Readout for 1000# Scale (WHI #007)	NCI	5780	C800174
17. Scale, 75# Capacity (WHI #006)	NCI	3824-100	762117
18. Readout for 75# Scale (WHI #008)	NCI	5780	G800082
19. Analytical Balance (WHI #028)	OHAUS	G-110	5336
20. Dial-o-gram Balance 2610 g (WHI # 031)	OHAUS	1650	
21. Audit Weights 1 mg-100 g/Class-S (WHI # 029)	Ainsworth	4254-S	39392
22. Diaphragm Pumps (4) (WHI # 032 - 035)	Dayton	ZO24 (1) 2Z866 (3)	
23. Method 5H Glassware (WHI # 036)	Andersen	4" Filter, 4-250 ml Impingers	
24. Gases; Calibration, Zero, Span	Matheson		
25. Regulators for Gases (6) (WHI # 037 - 043)	Matheson	8-(XXXX)	
26. High Accuracy Needle Valves (9)	Matheson		
27. Solenoid Valves (12) (WHI # 045)	Dayton		
28. Switches (Misc.) (WHI # 045)	Dayton		
29. ORSAT Gas Analyzer (WHI # 048)	Fisher	D	
30. Oxygen Bomb Calorimeter (WHI # 047)	Parr	1341	4514
31. Moisture Meter (WHI #049)	Delmhorst	RC-1C	14356
32. Humidity Chamber (WHI # 050)	Lab Built		
33. Dilution Tunnel (WHI # 046)	Lab Built		
34. Spirometer (WHI # 51)	Lab Built		
35. Data Acquisition System (WHI # 052)	Lab Built		
36. Drying Oven (WHI # 002)	Blue-M	SW-11TA-1	SW-291
37. Filter Holders, 47-mm (8) (WHI # 053)	Nalgene		
38. Type-K Meter (WHI #054)	Omega	199	21662
39. Digital Voltmeter (WHI # 055)	Newport	2004-3	6090022-3
40. Type K Thermocouple Wire 24 Ga.	Gordon	Special Limits of Error	
41. Type K T/C Plugs	Gordon	K-901/900	
42. Dry Gas Meter (WHI #014)	Rockwell	T-110	27002
43. Audit Weights; 5#, 10# (WHI # 160)	Rice Lake Weighing System		Class-F
44. Sling Psychrometer (WHI # 126)	Taylor		
45. Chart Recorder (WHI # 056)	Cole-Palmer	2030-0000	221063
46. Infrared Pyrometer (WHI #102)	Omega	OS-2000A	A4048T
47. Class C Weights 1-500 g (WHI # 161)	Ohaus		
48. Bomb Calorimeter Thermometer (WHI # 162)	Parr	1603	3K9347
49. Microtector Gauge (WHI # 103)	Dwyer	1430	
50. Bubble flow meter (WHI # 415)	Humonics	650	570192
51. Soxhlet extractor (WHI # 413)	Fisher Scientific		
52. ESS Unit (WHI # 416)	Omni		
53. Unimantle (WHI # 413)			
54. Magnehelic (WHI #027)			

Prepared January 1988 by Rick Curkeet / Rev. May1997 by Rick Armstrong

V. SAMPLING METHODS

V.A. PARTICULATE SAMPLING

Particulates were sampled in strict accordance with EPA Method 5G-3. This method uses two identical sampling systems with Gelman A/E 61631 binder free, 47-mm diameter filters. The dryers used in the sample systems are filled with "Drierite" before each test run.

V.B. EFFICIENCY

Efficiencies reported were based on Method CSA-B415 (calculation). Stack gas analysis for oxygen, carbon dioxide and carbon monoxide was performed in accordance with EPA Method 5H.

VI. QUALITY ASSURANCE

VI.A. INSTRUMENT CALIBRATION

VI.A.(1). DRY GAS METERS

At the conclusion of each test program the dry gas meters are checked against our standard dry gas meter. Three runs are made on each dry gas meter used during the test program. The average calibration factors obtained are then compared with the six-month calibration factor and, if within 5%, the six-month factor is used to calculate standard volumes. Results of this calibration are contained in Appendix D.

An integral part of the post test calibration procedure is a leak check of the pressure side by plugging the system exhaust and pressurizing the system to 10" W.C. The system is judged to be leak free if it retains the pressure for at least 10 minutes.

The standard dry gas meter is calibrated every 6 months using a Spirometer designed by the EPA Emissions Measurement Branch. The process involves sampling the train operation for 1 cubic foot of volume. With readings made to .001 ft^3, the resolution is .1%, giving an accuracy higher than the ±2% required by the standard.

VI.A.(2). STACK SAMPLE ROTAMETER

The stack sample rotometer is checked by running three tests at each flow rate used during the test program. The flow rate is checked by running the rotometer in series with one of the dry gas meters for 10 minutes with the rotometer at a constant setting. The dry gas meter volume measured is then corrected to standard temperature and pressure conditions. The flow rate determined is then used to calculate actual sampled volumes.

VI.A.(3). GAS ANALYZERS

The continuous analyzers are zeroed and spanned before each test with appropriate gases. A mid-scale multi-component calibration gas is then analyzed (values are recorded). At the conclusion of a test, the instruments are checked again with zero, span and calibration gases (values are recorded only). The drift in each meter is then calculated and must not exceed 5% of the scale used for the test.

At the conclusion of each unit test program, a five-point calibration check is made. This calibration check must meet accuracy requirements of the applicable standards. Consistent deviations between analyzer readings and calibration gas concentrations are used to correct data before computer processing. Data is also corrected for interferences as prescribed by the instrument manufacturers instructions. Calibration gases are checked by ORSAT analysis when received to verify suppliers analysis.

VI.B. TEST METHOD PROCEDURES

VI.B.(1). LEAK CHECK PROCEDURES

Before and after each test, each sample train is tested for leaks. Leakage rates are measured and must not exceed 0.02 CFM or 4% of the sampling rate. Leak checks are performed checking the entire sampling train, not just the dry gas meters. Pre-test and post-test leak checks are conducted with a vacuum of 10 inches of mercury. Vacuum is monitored during each test and the highest vacuum reached is then used for the post test vacuum value. If leakage limits are not met, the test run is rejected. During, these tests the vacuum was typically less than 2 inches of mercury. Thus, leakage rates reported are expected to be much higher than actual leakage during the tests.

VI.B.(2). TUNNEL VELOCITY/FLOW MEASUREMENT

The tunnel velocity is calculated from a center point pitot tube signal multiplied by an adjustment factor. This factor is determined by a traverse of the tunnel as prescribed in EPA Method 1. Final tunnel velocities and flow rates are calculated from EPA Method 2, Equation 6.9 and 6.10. (Tunnel cross sectional area is the average from both lines of traverse.)

Pitot tubes are cleaned before each test and leak checks are conducted after each test.

VI.B.(3). PM SAMPLING PROPORTIONALITY (5G-3)

Proportionality was calculated in accordance with EPA Method 5G-3. The data and results are included in Appendix C.

All tests were conducted, analyzed, and reported on by:

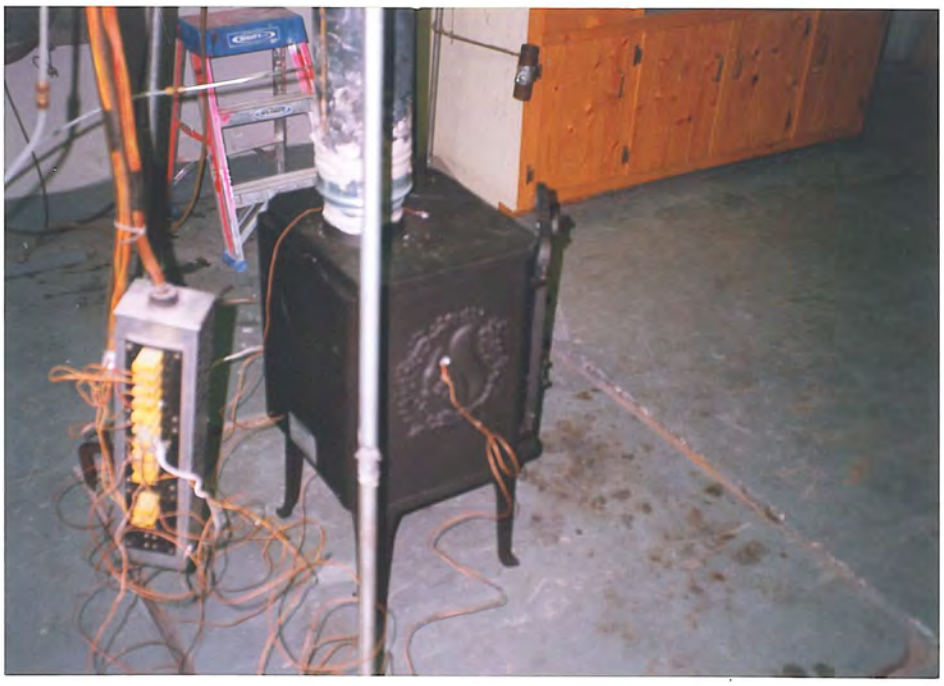
Rick Armstrong, Engineering Technician

Reviewed By:

Edwin Hodgson, Project Manager

William Keen, Engineering Technician

Intertek Testing Services

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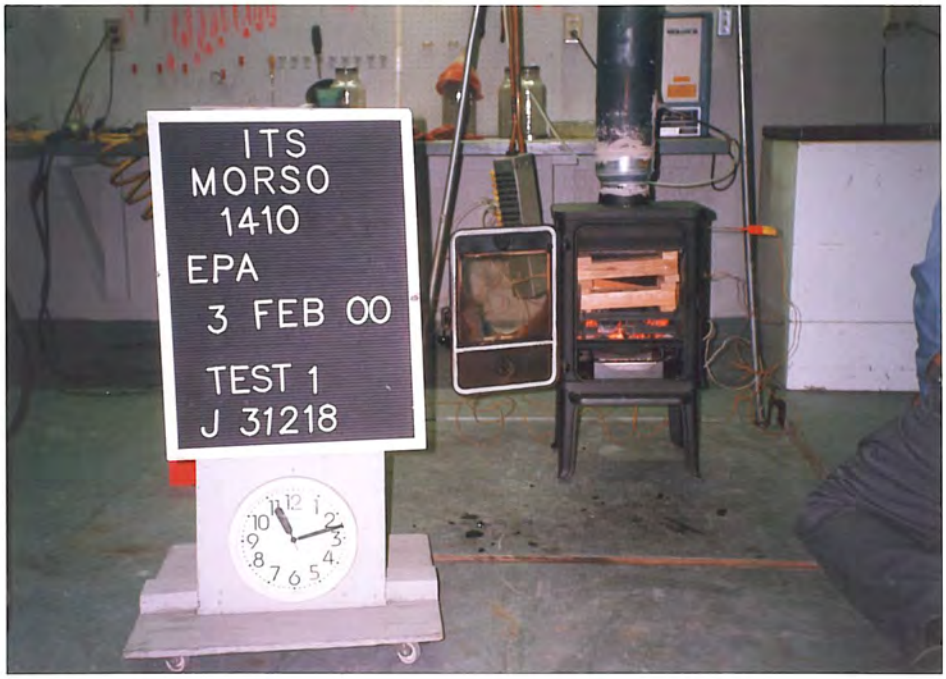
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APPENDIX A

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SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Morso		RESULTS		
Model:	1410				
Date:	02/03/00		AVERAGE ADJUSTED EMISSION R		6.369
Run:	1				
Project #:	31218		Burn Rate (Dry kg/hr):		0.795
Test Duration: (minutes)	143				
PRESSURE FACTOR:		0.96106	BAROMETRIC PRESSURE		
				Average:	28.755
TEMPERATURE FACTORS				Start:	28.73
	DGM #1:	0.97772		End:	28.78
	DGM #2:	0.98022			
			DRY GAS METER VALUES		
VOLUMES SAMPLED			DGM #1	Final:	140.757
	DGM #1:	32.72651		Initial:	106.467
	DGM #2:	33.28749			
			DGM #2	Final:	518.210
TOTAL TUNNEL VOLUME (scf):		20447.986		Initial:	484.106
SAMPLE RATIOS			TEMPERATURES (DEG. RANKIN)		
Sample Train 1:		624.814		DGM #1:	540.031
Sample Train 2:		614.284		DGM #2:	538.656
TOTAL EMISSIONS			CALIBRATION FACTORS		
Sample Train 1 (g):		10.8093		DGM #1:	1.0157
Sample Train 2 (g):		10.7500		DGM #2:	1.0361
EMISSION RATES			TUNNEL FLOW RATE:		142.993
Sample Train 1 (g/hr):		4.5354			
Sample Train 2 (g/hr):		4.5105	PARTICULATE CATCH (mg)		
				Sample Train 1:	17.3
ADJUSTED EMISSION RATES				Sample Train 2:	17.5
Sample Train 1 (g/hr):		6.3835			
Sample Train 2 (g/hr):		6.3544			
DEVIATION:		0.46%			

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SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Morso	RESULTS	
Model:	1410		
Date:	02/04/00	AVERAGE ADJUSTED EMISSION R/	2.392
Run:	2		
Project #:	31218	Burn Rate (Dry kg/hr):	0.986
Test Duration: (minutes)	117		
PRESSURE FACTOR:	0.97761	BAROMETRIC PRESSURE	
		Average:	29.25
TEMPERATURE FACTORS		Start:	29.22
DGM #1:	0.98522	End:	29.28
DGM #2:	0.98226		
		DRY GAS METER VALUES	
VOLUMES SAMPLED		DGM #1 Final:	168.970
DGM #1:	27.58444	Initial:	140.773
DGM #2:	27.69573		
		DGM #2 Final:	546.063
TOTAL TUNNEL VOLUME (scf):	16835.692	Initial:	518.226
SAMPLE RATIOS		TEMPERATURES (DEG. RANKIN)	
Sample Train 1:	610.333	DGM #1:	535.923
Sample Train 2:	607.880	DGM #2:	537.538
TOTAL EMISSIONS		CALIBRATION FACTORS	
Sample Train 1 (g):	2.6244	DGM #1:	1.0157
Sample Train 2 (g):	2.7963	DGM #2:	1.0361
EMISSION RATES		TUNNEL FLOW RATE:	143.895
Sample Train 1 (g/hr):	1.3459		
Sample Train 2 (g/hr):	1.4340	PARTICULATE CATCH (mg)	
		Sample Train 1:	4.3
ADJUSTED EMISSION RATES		Sample Train 2:	4.6
Sample Train 1 (g/hr):	2.3289		
Sample Train 2 (g/hr):	2.4547		
DEVIATION:	5.26%		

Intertek Testing Services

SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Morso		RESULTS		
Model:	1410				
Date:	02/07/00		AVERAGE ADJUSTED EMISSION RA		1.383
Run:	3				
Project #:	31218		Burn Rate (Dry kg/hr):		1.395
Test Duration: (minutes)	82				
	PRESSURE FACTOR:	0.98162	BAROMETRIC PRESSURE		
				Average:	29.37
TEMPERATURE FACTORS				Start:	29.34
	DGM #1:	0.97841		End:	29.4
	DGM #2:	0.98178			
			DRY GAS METER VALUES		
VOLUMES SAMPLED			DGM #1	Final:	188.630
	DGM #1:	19.15209		Initial:	168.997
	DGM #2:	19.33636			
			DGM #2	Final:	565.450
TOTAL TUNNEL VOLUME (scf):		11805.486		Initial:	546.085
SAMPLE RATIOS			TEMPERATURES (DEG. RANKIN)		
	Sample Train 1:	616.407		DGM #1:	539.650
	Sample Train 2:	610.533		DGM #2:	537.800
TOTAL EMISSIONS			CALIBRATION FACTORS		
	Sample Train 1 (g):	0.9863		DGM #1:	1.0157
	Sample Train 2 (g):	0.9769		DGM #2:	1.0361
EMISSION RATES			TUNNEL FLOW RATE:		143.969
	Sample Train 1 (g/hr):	0.7216			
	Sample Train 2 (g/hr):	0.7148	PARTICULATE CATCH (mg)		
				Sample Train 1:	1.6
ADJUSTED EMISSION RATES				Sample Train 2:	1.6
	Sample Train 1 (g/hr):	1.3883			
	Sample Train 2 (g/hr):	1.3773			
	DEVIATION:	0.79%			

SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Morso
Model:	1410
Date:	02/08/00
Run:	4
Project #:	31218
Test Duration: (minutes)	65

RESULTS

AVERAGE ADJUSTED EMISSION RA	4.317
Burn Rate (Dry kg/hr):	1.826

PRESSURE FACTOR:	0.98229

TEMPERATURE FACTORS

DGM #1:	0.98599
DGM #2:	0.99015

VOLUMES SAMPLED

DGM #1:	15.25379
DGM #2:	15.55224
TOTAL TUNNEL VOLUME (scf):	9262.571

SAMPLE RATIOS

Sample Train 1:	607.231
Sample Train 2:	595.578

TOTAL EMISSIONS

Sample Train 1 (g):	3.0969
Sample Train 2 (g):	3.0374

EMISSION RATES

Sample Train 1 (g/hr):	2.8587
Sample Train 2 (g/hr):	2.8038

ADJUSTED EMISSION RATES

Sample Train 1 (g/hr):	4.3520
Sample Train 2 (g/hr):	4.2825
DEVIATION:	1.61%

BAROMETRIC PRESSURE

Average:	29.39
Start:	29.4
End:	29.38

DRY GAS METER VALUES

DGM #1	Final:	204.157
	Initial:	188.651
DGM #2	Final:	580.903
	Initial:	565.470

TEMPERATURES (DEG. RANKIN)

DGM #1:	535.500
DGM #2:	533.250

CALIBRATION FACTORS

DGM #1:	1.0157
DGM #2:	1.0361

TUNNEL FLOW RATE:	142.501

PARTICULATE CATCH (mg)

Sample Train 1:	5.1
Sample Train 2:	5.1

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date

Job # 31218 Run Tech RA

Emissions Testing Initial Stove Check Out

Date received: 12-29-99 Carrier: KLM

Shipping damage? X No Yes Describe damage

If damaged, repairable? No Yes

Repairs affected by: Date:

Client notified about
irreparable damage by: Date:

Disposition:

Safety Certified by: Safety Control#

Overall Unit Dimensions: High Wide Deep

Comments:

Initialed:

ITS Intertek Testing Services

Manufacturer Morso Model 1410 Date 2-1-00

Job # 31218 Run _____ Tech RA

EMISSIONS TESTING UNIT PREPARATION

Unit description (check all that apply)

X Stove	X Top Vent	____ Manual Draft
____ Insert	____ Rear Vent	____ Bimetal Spring
____ Catalytic	X Grate	____ Remote Thermostat
X Non-catalytic	X Ashpan	____ 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: _____

Unit net weight with all components: _____ lbs. _____ Kg.
Unit fire box volume: .736 Ft^3 (attach fire box volume calculations and drawings)
Ideal Load Weight: 5.15 lbs. (Volume x 7)
Load Weight Range: (±10% of ideal weight) 4.64 lbs. to 5.67 lbs.
Ideal piece length specification: 10 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)

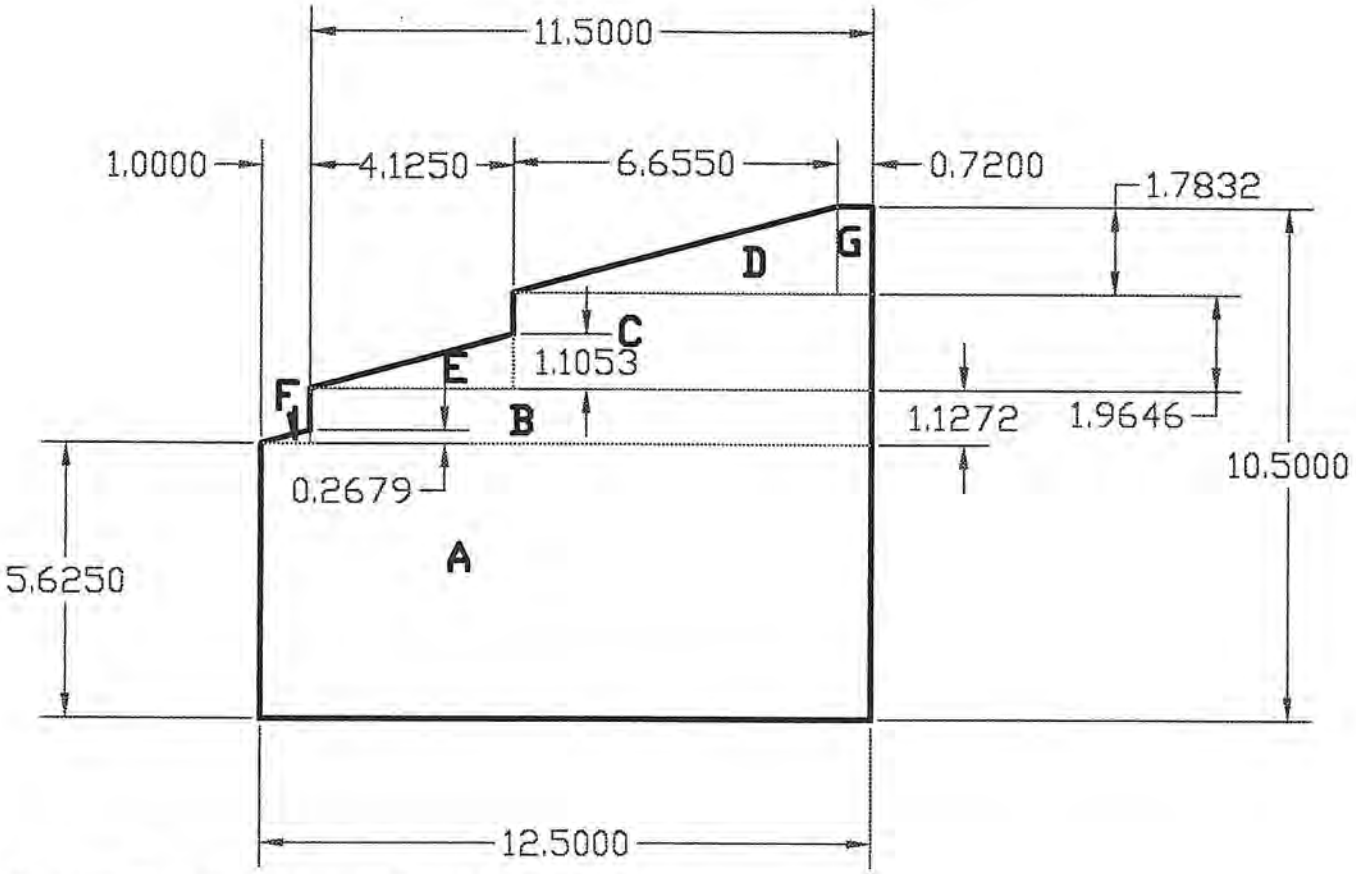
Date started: 1-31-00 Date completed: 2-1-00
Catalyst manufacturer: _____
Serial number: _____ Dimensions: _____ Cell size: _____ $cells/in.^2$
Unit ready for testing (date): _____ **Initialed:** _____

Manufacturer MORSO Model 1410 Date 2-1-00

Job # 31218 Run _____ Tech RA

Measurements By: RA Checked By: _____

FIRE BOX VOLUME CALCULATION



Firebox width = 12 inches

Volume = A+B+C+D+E+F+G

A = 12.5*12*5.625 = 843.75
B = 11.5*1.1272*12 = 155.55
C = 1.9646*6.6550*12 = 156.899
D = .5(6.655*1.7832*12) = 71.20
E = .5(4.125*1.1053*12) = 27.36
F = .5(1*.2679*12) = 1.61
G = .72*1.7832*12 = 15.40

Volume = 1271.769 cubic inches or
.736 cubic feet

Manufacturer MORSO Model 1410 Date 2-1-00

Job # 31218 Run _____ Tech RA

Thermocouple Location

THEROCOUPLES WERE PLACED CENTRALLY ON THE LOCATION LISTED BELOW.

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

ITS Intertek Testing Services

Manufacturer Morso Model 1410 Date 2-3-00

Job # 31218 Run 1 Tech RA

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 28.73 (inches Hg.) Static pressure (P_q) .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_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.040	85	.2000
B-Centroid	3.00	.040	84	.2000
A-1	0.40	.037	85	.1920
A-2	1.50	.040	85	.2000
A-3	4.50	.040	85	.2000
A-4	5.60	.036	85	.1897
B-1	0.40	.036	84	.1897
B-2	1.50	.040	84	.2000
B-3	4.50	.040	84	.2000
B-4	5.60	.035	84	.1871
		AVERAGE	84.5	.1959

Adjustment factor application

$$V_s = K_p C_p F_p \left(\sqrt{\Delta_p}\right) AVG \sqrt{\frac{T_s}{P_s M_s}} \qquad V_s = K_p C_p \left(\sqrt{\Delta_p}\right) avg. \sqrt{\frac{T_s}{P_s M_s}}$$

Pitot correction .9795

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 (°F + 460)

P_s = absolute dilution tunnel gas pressure or Pbar + P_g

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

P_g = static pressure $\frac{inches H_2O}{13.6}$

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

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

$\left(\sqrt{\Delta_p}\right) centroid$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-3-00

Job # 31218 Run 1 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:	Time: 8:00	X: ✓	Y: ✓	12: ✓	22: ✓

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	0 fpm	fpm
Smoke Capture Check	✓	
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	2-2-00	
Date Dilution Tunnel Cleaned	2-2-00	
Induced Draft Check	0	
Tunnel Velocity	040	
Flow Rate 140-cfm ±10%		142.931
Pitot Leak Check:		
Side A		
Side B		
Temperature System:		
Ambient (65°- 90°F)		°F
Wood Heater Surface (±125°F)		°F
Proportional Checks:		
CO Analyzer Drift Check		
CO_2 Analyzer Check		
O_2 Analyzer Check		
Thermocouple check		

Sampling Train ID Numbers:	Train 1	Train 2
Probe	3	4
Filter Front	25	27
Filter Back	26	28
Filter Thermocouple	19	22
Filter 5G-3 (<90°F)		

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

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-3-00

Job # 31218 Run 1 Tech RA

Pre-Test Scale Audit

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

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-3-00

Job # 31718 Run 1 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

	SYSTEM 1		SYSTEM 2	
Unplugged Flow Rate = .25cfm	Pre-Test	Post-Test	Pre-Test	Post-Test
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1minute DGM (ft^3)	106.467	140,768	484,106	518,222
Initial 1minute DGM (ft^3)	106.465	140,765	484,104	518,221
Change (C) (ft^3)	.002		.002	
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 MORSO Model 1410 Date 2-3-00

Job # 31218 Run 1 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	9.99	9.99	.96	.991
CO_2	0	0	24.65	24.65	9.65	10.02
O_2	0	0	20.93	20.93	10.14	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	10.01	.96	0	.02	0	✓	
CO_2	.01	24.68	9.65	.01	.03	0	✓	
O_2	03	20.83	10.16	.03	.10	.02		

* Greater than ± 5% of the range used.

ITS Intertek Testing Services

Manufacturer Morso Model 1410 Date 2-3-00

Job # 31218 Run 1 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE Gelman 47mm A/E

Samples in Desecrator. Date: 2-3-00 Time: 14:00

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing #	Filter Numbers	Probe and Front Half Housing #	Filter Numbers
Post Test Weight:	93,1198 grams	,2568 grams	89.9725 grams	,2571 grams
Pre Test Weight:	93,1188 grams	,2395 grams	89,9725 grams	,2396 Grams
Gain:	0 grams	.0173 grams	0 grams	.0175 Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = ,0173 grams a2 + b2 = ,0175 grams

		SYSTEM 1			SYSTEM 2				
Pre-test Weight Record		Probe & Housing Number	Front Filter Number	Back Filter Number	Probe & Housing Number	Front Filter Number	Back Filter Number	TEMP	HUMID
Date	Time	3	25	24	4	27	28	°F	%
2-2-00	7:40	93.1195	.1197	.1203	89,9722	.1200	.1201	66	24
2-3-00	7:00	93,1198	.1196	.1199	89.9725	.1196	.1200	65	26
		Total	,2395		Total	,2396			

		SYSTEM 1		SYSTEM 2			
Pre-test Weight Record		Probe & Housing Number	Combined Filter Weight Number	Probe & Housing Number	Combined Filter Weight Number	TEMP	HUMID
Date	Time	3		4		°F	%
2-3-00	14:06	93,1225	,2590	89,9752	,2590	78	26
2-4-00	7:05	93,1204	,2569	89,9725	,2571	65	26
2-7-00	7:00	93,1198	,2568	89,9725	2571	65	25

Manufacturer MORSO Model 1410 Date 2-3-00

Job # 31218 Run 1 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft^3)	140.757	518.210
Initial (ft^3)	106.467	484.106

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	28.73	28.78
Wet Bulb (°F)	56	59
Dry Bulb (°F)	73	78
Humidity (%)	33	34

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-3-00

Job # 31218 Run 1 Tech RA

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:

Kindling weight: 2.4 lbs. Consisting of: Scrap and paper Fire lit Time: 8:07

Pre-test load weight: 4.89 lbs. Consisting of: 2X4X 10 inches Time loaded: _____

Pre-test moisture content: Uncorrected: 22.73 % Corrected Dry: 24.54 % Wet: 19.71 %

Test Air Control Settings: _____ Time: _____

Test Unit Fan Settings: NO FAN Time: _____

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	4.64 Lbs.	5.15 lbs.	5.67 Lbs.

Fire Box Volume:	.736 Ft.^{3}	Ideal Length:	10 Inches
Load Volume:	.1302 Ft.^{3}	Loading Density:	6.929 lbs/ft^3
Number of Spacers	12 ¾x1½x5	Load Density:	lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 10 in.	1.74 lbs.	21.9 %	22.2 %	19.2 %
2 x 4 x 10 in.	1.84 lbs.	23. %	19.5 %	23 %
2 x 4 x 10 in.	1.55 lbs.	18.3 %	19.2 %	18.6 %
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%

*Uncorrected range = 17.9% to 23.1%

TEST LOAD WEIGHT: 5.10 lbs. **DRY WEIGHT:** 1.90 kg.

AVERAGE MOISTURE CONTENT:

(DRY) 20.5% CORRECTED TO TWO PIN: (DRY) 22.03% (WET) 18.05%

COAL BED RANGE:

1.1 lbs. to 1.2 lbs. (20% to 25% of test load)

TEST CHARGE:

Time loaded: 1114 Coal bed weight: 1.1 lbs. Coal bed weight = 21.6 % of test load weight

CHARCOALIZATION: good |--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--| poor

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2.3.00

Job # 31218 Run 1 Tech RA

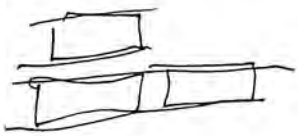
COMMENTS

8:07 FIRE LIT

8:41 5.0 lbs WOOD ADDED 20.90% CORRECTED

AIR CONTROL IS SPIN TYPE. CLOSED POSITION WILL BE DETERMINED AT LAB DEPENDING ON BURN RATE.

TEST LOAD CONFIGURATION



Manufacturer MORSO Model 1410 Date 2-3-00

Job # 31218 Run 1 Tech RA

AIR CLOSED TO 1 TURN 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	9:56	0	4,70	336	71	93	69	596	601	391	412	460	786	,035	,063	H
1		10	4,00	307	71	88	69	607	577	380	406	484	914	,041	,061	M
2		20	3,40	215	72	84	70	509	580	374	396	482	862	,040	,051	H
3		30	2,70	310	72	87	70	647	560	368	391	467	1310	,039	,060	T
4		40	2,00	249	73	84	70	692	538	398	428	455	1147		,053	C
5		50	1,70	253	73	85	71	594	542	404	430	433	1121	,039	,051	C
6		60	1,40	248	73	84	70	556	600	401	429	430	801	,040	,049	C
7		70	1,20	225	73	83	71	495	618	393	426	439	712	,040	,046	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:
10:30 FIRE STIRRED 11:12 FIRE STIRRED DOOR OPEN 1 min
10:42 FIRE STIRRED

WHI LTO#: 31218 AIR CLOSED TO 1 TURN OPEN page 15 of 48

MANUFACTURER: MODESO MODEL: 1410 FIRE SIZE: LOW DATE: 2-3-00 RUN#: 1 TECHNICIAN: RA

SWITCH NUMBER: 1 2 3 4 5 6 7 8 9 10 11 12 13 17 18 19 20 21 22

READING#	REAL TIME	ELAPSED TIME	WEIGHT REMAIN.	CO	CO_2	O_2	FLUE GAS TEMP	ROOM TEMP	TUNNEL TEMP	TUNNEL WET BULB	UNIT TOP	UNIT BACK	UNIT RT. SIDE	UNIT LEFT SIDE	UNIT BOTTOM	CAT UNIT	CAT CENTER			GAS SAMPL. ROTO.	DGM #1 READING	ROTO 1 READING	DGM TEMP INLET	DGM TEMP OUTLET	FILTER TEMP	DGM #2 READING	ROTO 2 READING	DGM TEMP INLET	DGM TEMP OUTLET	FILTER TEMP	TUNNEL VELOCITY	DNA/P	SMOKE	MAN DGM PRESS
0	11:14	0	5.10	175	7.81	11.51	224	73	83	71	491	612	387	423	442	697				135	106.4	120	77	77	74	484.1	120	74	74	74	.040	.045	H	2
1		10	4.20	1.41	9.89	10.24	251	74	86	70	510	594	386	409	498	697				135	108.8	120	77	78	79	486.4	120	75	74	79	.040	.056	H	2
2		20	3.50	1.26	12.52	6.38	257	75	85	70	525	569	384	394	493	1055				135	111.2	120	78	78	79	488.8	120	76	75	79	.040	.057	L	2
3		30	2.70	.38	16.18	3.84	288	75	85	71	641	526	396	394	480	1295				135	113.6	120	79	78	79	491.2	120	77	76	80	.041	.060	T	2
4		40	1.90	1.63	18.36	1.53	305	75	86	71	737	511	416	414	462	1280				135	116.0	120	79	79	80	493.6	120	77	76	80	.039	.062	T	2
5		50	1.10	1.43	16.93	2.75	288	76	87	71	766	543	444	440	443	1289				135	118.4	120	80	79	80	496.0	120	78	77	81	.041	.061	T	2
6		60	.70	.49	12.52	7.10	230	76	85	71	668	570	441	456	431	954				135	120.8	120	80	80	80	498.3	120	79	78	80	.040	.050	C	2
7		70	.60	1.73	9.01	10.12	187	75	82	72	552	570	419	444	419	730				135	123.2	120	81	80	80	500.7	120	80	78	80	.041	.042	C	2
8		80	.30	2.60	6.90	11.60	167	74	81	72	465	545	391	418	407	656				135	125.6	120	81	81	80	503.1	120	80	79	80	.040	.039	C	2
9		90	.40	3.00	7.45	10.83	155	75	81	72	416	530	366	395	396	594				135	128.0	120	81	81	80	505.5	120	81	80	80	.041	.035	C	2
10		100	.30	2.78	7.40	10.97	147	75	80	72	389	516	347	375	388	560				135	130.4	120	81	81	80	507.8	120	81	81	80	.041	.032	C	2
11		110	.20	2.72	7.22	11.23	140	75	79	72	368	501	332	359	381	541				135	132.8	120	82	81	80	510.3	120	81	81	80	.040	.030	C	2
12		120	.20	2.73	6.93	11.57	135	75	79	72	354	486	321	347	371	513				135	135.2	120	81	81	79	512.6	120	81	81	79	.040	.029	C	2
13		130	.10	1.85	7.86	15.03	147	75	79	71	345	488	320	337	368	502				135	137.6	120	82	81	79	515.0	120	81	81	79	.040	.028	C	2
14		140	.10	2.11	7.12	11.81	129	74	77	71	340	478	299	329	359	503				135	140.0	120	81	82	79	517.4	120	81	81	82	.040	.027	C	2
15	~~14~~	~~150~~ 0	2.10	6.82	12.16	128	74	77	71	335	476	298	325	352	492					135	140.7	120	82	82	78	518.2	120	81	82	79	.040	.026	C	2
16		160																															
17		170																															
18		180																															
19		190																															
20		200																															
21		210																															
22		220																															
23		230																															
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32		320																															
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34		340																															
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																															

.31 RA

7.93 Kg/Hr

1.43 m/s

COMMENTS:

TEST LOADED IN 55 SECONDS DOOR OPEN 3 MIN AIR CONTROL SET AT 5 MIN @ 13:22 FIRE STIRRED DOOR OPEN 15 SEC RA

SEE SEL 6.43

ITS Intertek Testing Services

Manufacturer MONSO Model 1410 Date 2-4-00

Job # 31218 Run 2 Tech RA

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.22 (inches Hg.) Static pressure (P_q) +.128 (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_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.041	86	.2025
B-Centroid	3.00	.041	87	.2025
A-1	0.40	.038	86	.1949
A-2	1.50	.041	86	.2025
A-3	4.50	.039	86	.1975
A-4	5.60	.038	86	.1949
B-1	0.40	.038 ~~.041~~ RA	87	.1949
B-2	1.50	.041	87	.2025
B-3	4.50	.041	87	.2025
B-4	5.60	.038	87	.1949
		AVERAGE	86.5	.1990

Adjustment factor application

$$V_s = K_p C_p F_p \left(\sqrt{\Delta_p}\right) AVG \sqrt{\frac{T_s}{P_s M_s}} \qquad V_s = K_p C_p \left(\sqrt{\Delta_p}\right) avg. \sqrt{\frac{T_s}{P_s M_s}}$$

Pitot correction .9826

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 (°F – 460)

P_s = absolute dilution tunnel gas pressure or Pbar + P_g

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

P_g = static pressure $\frac{inches H_2O}{13.6}$

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:

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

$\left(\sqrt{\Delta_p}\right) centroid$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

Manufacturer Morso Model 1410 Date 2-4-00

Job # 31218 Run 2 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:

Time: 9:00	X: ✓	Y: ✓	12: ✓	22: ✓

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	0 fpm	0 fpm
Smoke Capture Check	✓	✓
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	2-2-00	
Date Dilution Tunnel Cleaned	2-2-00	
Induced Draft Check	✓	✓
Tunnel Velocity	.039	
Flow Rate 140-cfm ±10%		143.895
Pitot Leak Check:		
Side A	✓	✓
Side B	✓	✓
Temperature System:		
Ambient (65°- 90°F)		°F
Wood Heater Surface (±125°F)		-65.4 °F
Proportional Checks:		
CO Analyzer Drift Check		✓
CO_2 Analyzer Check		✓
O_2 Analyzer Check		✓
Thermocouple check		✓

Sampling Train ID Numbers:	Train 1	Train 2
Probe		
Filter Front		
Filter Back		
Filter Thermocouple	19	22
Filter 5G-3 (<90°F)		

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

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-4-00

Job # 31218 Run 2 Tech RA

Pre-Test Scale Audit

Scale Type	Audit Weight	Measured Weight
Platform	10 lbs., Class F	10.0 lbs.
Wood	10 lbs., Class F	10.00 lbs.
Analytical	100 Grams 100 mg, Class S	100 Grams 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 MORSO Model 1410 Date 2-4-00

Job # 31218 Run 2 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

	SYSTEM 1		SYSTEM 2	
Unplugged Flow Rate = .25cfm	Pre-Test	Post-Test	Pre-Test	Post-Test
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1minute DGM (ft^3)	140.773	168,980	518,226	546.072
Initial 1minute DGM (ft^3)	140,772	168,979	518,225	546.072
Change (C) (ft^3)	.001	.001	.001	
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 Moreso Model 1410 Date 2-4-00

Job # 31218 Run 2 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	9.99	9.99	.97	.991
CO_2	0	0	24.65	24.65	9.71	10.02
O_2	0	0	20.93	20.93	10.09	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	10.04	.98	0	.05	.01	✓	
CO_2	02	24.95	9.85	.02	.30	.14	✓	
O_2	.104	20.83	10.12	.04	.10	.103	✓	

* Greater than ± 5% of the range used.

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-4-00

Job # 31218 Run 2 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Samples in Desecrator. Date: 2-4-00 Time: 13:08

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing #	Filter Numbers	Probe and Front Half Housing #	Filter Numbers
Post Test Weight:	91.0642 grams	.2438 grams	91.5732 grams	.2449 grams
Pre Test Weight:	91.0642 grams	.2395 grams	91.5731 grams	.2404 Grams
Gain:	0 grams	.0043 grams	.0001 grams	.0045 Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0043 grams a2 + b2 = .0046 grams

Pre-test Weight Record		SYSTEM 1 Probe & Housing Number	SYSTEM 1 Front Filter Number	SYSTEM 1 Back Filter Number	SYSTEM 2 Probe & Housing Number	SYSTEM 2 Front Filter Number	SYSTEM 2 Back Filter Number	TEMP	HUMID
Date	Time	5	29	30	6	31	32	°F	%
2-3-00	7:00	91.0642	.1199	.1194	91.5729	.1199	.1201	65	26
2-4-00	7:05	91.0642	.1200	.1195	91.5731	.1200	.1204	65	26
		Total	.2395		Total	.2404			

Pre-test Weight Record		SYSTEM 1 Probe & Housing Number	SYSTEM 1 Combined Filter Weight Number	SYSTEM 2 Probe & Housing Number	SYSTEM 2 Combined Filter Weight Number	TEMP	HUMID
Date	Time	5	29+30	6	31+32	°F	%
2-4-00	13:08	91.0659	.2459	91.5747	.2453	77	25
2-7-00	7:00	91.0642	.2438	91.5732	.2449	65	25
2-8-00	7:00	91.0642	.2438	91.5732	.2449	65	23
2-9-00	7:00	91.0642	.2438	91.5732	.2449	65	25

Manufacturer MORSO Model 1410 Date 2-4-~~05~~

Job # 31218 Run 2 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft^3)	168,970	546.063
Initial (ft^3)	140,773	518,226

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.22	29.28
Wet Bulb (°F)	56	58
Dry Bulb (°F)	72	78
Humidity (%)	35	28

Manufacturer MORSO Model 1410 Date 2-4-00

Job # 31218 Run 2 Tech RK

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:

Kindling weight: 3.00 lbs. Consisting of: Scrap and paper Fire lit Time: 8:11

Pre-test load weight: 5.08 lbs. Consisting of: 2X4X inches Time loaded: ~~9:25~~ RA 9:31

Pre-test moisture content: Uncorrected: 19.86 % Corrected Dry: 21.24 % Wet: 17.52 %

Test Air Control Settings: 1 1/4 TURN OPEN Time: 9:36

Test Unit Fan Settings: NO FAN Time:

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	4.64 Lbs.	5.15 lbs.	5.67 Lbs.

Fire Box Volume:	.736 $Ft.^3$	Ideal Length:	10 Inches
Load Volume:	.1302 $Ft.^3$	Loading Density:	7.092 lbs/ft^3
Number of Spacers	12 ¾x1½x5	Load Density:	40.090 lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 10 in.	1.69 lbs.	21.5 %	23 %	21.5 %
2 x 4 x 10 in.	1.74 lbs.	23 %	19 %	22 %
2 x 4 x 10 in.	1.79 lbs.	23 %	19 %	21.9 %
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%

*Uncorrected range = 17.9% to 23.1%

TEST LOAD WEIGHT: 5.22 lbs. **DRY WEIGHT:** 1.92 kg.

AVERAGE MOISTURE CONTENT:

(DRY) 21.4 % CORRECTED TO TWO PIN: (DRY) 23.18 % (WET) 18.82 %

COAL BED RANGE:

1.1 lbs. to 1.3 lbs. (20% to 25% of test load)

TEST CHARGE:

Time loaded: 10:56 Coal bed weight: 1.1 lbs. Coal bed weight = 21 % of test load weight

CHARCOALIZATION: good X-- |--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--| poor

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-4-10

Job # 31218 Run 2 Tech RA

COMMENTS

8:11 FIRE LIT 3.0 lbs KINDLING

8:32 5.38 lbs LOADED

9:31 STOVE CLEANED OUT SCALE ZEROED 1.0 lb

COALS PUT BACK IN WITH PRE-TEST LOAD 5.08 lbs

TEST LOAD CONFIGURATION

Manufacturer MORSO Model 1410 Date 2-4-00

Job # 31218 Run 2 Tech RA

AIR CONTROL 1 1/4 TURNS FROM CLOSED

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	9:37	0	4.90	501	71	118	64	714	746	444	478	557	1165	.040	.078	C
1		10	4.10	311	70	88	65	700	633	441	480	549	1110	.045	.068	C
2		20	3.30	303	71	86	66	751	593	436	483	510	1268	.040	.065	C
2.50		30	~~2.55~~	290	72	86	67	761	579	438	486	476	1294.		.062	C
4		40	1.90	268	73	85	67	748	576	449	490	450	1076	.040	.057	C
5		50	1.60	236	72	83	68	640	581	434	474	435	993	.039	.050	C
6		60	1.40	207	73	81	68	543	612	414	456	430	720	.039	.045	C
7		70	1.20	186	73	79	68	470	611	388	430	431	672	.039	.040	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:

10:30 FIRE STIRRED 10:54 FIRE STIRRED DOOR OPEN 55SEC

WHI LTO#: 31218 AIR CONTROL 1¼ TURNS FROM CLOSED

page 26 of 48

MANUFACTURER: MORSO MODEL: 1410 FIRE SIZE: MLOW DATE: 2-4-00 RUN#: 2 TECHNICIAN: RM

SWITCH NUMBER:

READING#	REAL TIME	ELAPSED TIME	WEIGHT READING	CO	CO_2	O_2	1 FLUE GAS TEMP	2 ROOM TEMP	3 TUNNEL TEMP	4 TUNNEL WET 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	GAS SWIVL ROTO.	DGM #1 READING	ROTO 1 READING	17 DGM TEMP INLET	18 DGM TEMP OUTLET	19 FILTER TEMP	DGM #2 READING	ROTO 2 READING	20 DGM TEMP INLET	21 DGM TEMP OUTLET	22 FILTER TEMP	DRAFT VARIABILITY	DRAFT	SMOKE	MAX DGM PRESS
0	10:56	0	5.22	1.40	8.63	10.80	280	73	71		409	610	369	404	448	552				135	140.773	120	77	76	74	518.226	120	74	72	74	.034	.040	C	2
1		10	3.80	1.58	14.91	4.48	335	74	93	69	668	666	397	429	518	1073				135	143.1	120	77	77	81	520.5	120	74	73	80	.039	.070	T	2
2		20	.790	1.36	18.64	2.08	307	74	88	69	739	623	411	453	509	1158				135	145.5	120	77	77	80	522.9	120	75	74	80	.039	.068	C	2
3		30	.200	.85	18.78	1.91	296	74	87	70	770	606	426	463	486	1227				135	147.9	120	79	78	80	525.3	120	77	75	80	.041	.055	C	2
4		40	1.30	1.53	18.95	1.11	289	75	87	70	808	594	441	471	474	1295				135	150.3	120	78	78	80	527.7	120	77	76	80	.041	.044	T	2
5		50	.170	.36	13.89	6.69	255	76	85	70	741	597	452	480	443	948				135	152.7	120	79	78	80	530.1	120	79	78	80	.040	.054	C	2
6		60	.160	2.24	8.74	10.13	214	76	83	70	590	598	434	465	432	767				135	155.1	120	79	78	80	532.5	120	79	79	80	.040	.047	C	2
7		70	.150	2.55	8.56	10.12	191	75	81	70	499	588	405	439	426	714				135	157.5	120	79	79	80	534.8	120	79	79	79	.040	.043	C	2
8		80	.40	2.46	7.96	10.83	177	74	80	70	455	581	382	415	422	667				135	160.0	120	80	80	80	537.2	120	79	79	79	.040	.040	C	2
9		90	.30	2.58	7.72	10.97	168	74	77	70	423	569	365	398	415	645				135	162.4	120	80	80	79	539.6	120	79	79	79	.040	.038	C	2
10		100	.20	2.48	7.20	11.64	160	74	79	70	399	556	351	383	406	598				135	164.8	120	80	80	79	542.0	120	80	80	79	.040	.035	C	2
11		110	.10	2.32	6.69	12.24	155	75	78	70	381	535	341	369	395	574				135	167.2	120	80	80	79	544.3	120	80	80	79	.040	.035	C	2
12	117	~~120~~	0	2.29	6.47	12.46	151	74	78	70	369	522	334	359	386	558				135	168.9	120	80	80	79	546.0	120	80	80	78	.039	.034	C	2
13		130																																
14		140																																
15		150																																
16		160																																
17		170																																
18		180																																
19		190																																
20		200																																
21		210																																
22		220																																
23		230													.486 Kg/HR																			
24		240																																
25		250																																
26		260																																
27		270													117 MIN																			
28		280																																
29		290																																
30		300																																
31		310																																
32		320																																
33		330																																
34		340																																
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																																

COMMENTS:

TEST LOADED IN 25 SECONDS DOOR CLOSED AT 5 MIN AIR CONTROL NOT ADJUSTED

ITS Intertek Testing Services

Manufacturer Marso Model 1410 Date 2-7-00

Job # 31218 Run 3 Tech RA

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.34 (inches Hg.) Static pressure (P_q) .128 (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_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.040	103	.2000
B-Centroid	3.00	.039	99	.1975
A-1	0.40	.036	102	.1897
A-2	1.50	.041	102	.2025
A-3	4.50	.040	103	.2000
A-4	5.60	.037	102	.1924
B-1	0.40	036	101	.1897
B-2	1.50	.040	100	2000
B-3	4.50	.040	99	.2000
B-4	5.60	.035	101	.1871
		AVERAGE	101.2	.1959

Adjustment factor application

$$V_s = K_p C_p F_p \left(\sqrt{\Delta_p}\right) AVG \sqrt{\frac{T_s}{P_s M_s}} \qquad V_s = K_p C_p \left(\sqrt{\Delta_p}\right) avg. \sqrt{\frac{T_s}{P_s M_s}}$$

Pitot correction .9856

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 (°F + 460)

P_s = absolute dilution tunnel gas pressure or Pbar – P_g

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

P_g = static pressure $\frac{inches H_2O}{13.6}$

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:

$\left(\sqrt{\Delta_p}\right) avg.$ = Average of the square roots of the velocity heads (l_2) measured at each traverse point.

$\left(\sqrt{\Delta_p}\right) centroid$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

ITS Intertek Testing Services

Manufacturer Morso Model 1410 Date 2-7-00

Job # 31218 Run 3 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:

Time: 8:15	X: ✓	Y: ✓	12: ✓	22: ✓

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	0 fpm	0 fpm
Smoke Capture Check	✓	✓
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	2-2-00	
Date Dilution Tunnel Cleaned	2-2-00	
Induced Draft Check	0	0
Tunnel Velocity	.039	
Flow Rate 140-cfm ±10%		143.969
Pitot Leak Check:		
Side A	✓	✓
Side B	✓	✓
Temperature System:		
Ambient (65°- 90°F)	✓ °F	
Wood Heater Surface (±125°F)	-18.6 °F	
Proportional Checks:		
CO Analyzer Drift Check	✓	
CO_2 Analyzer Check	✓	
O_2 Analyzer Check	✓	
Thermocouple check	✓	

Sampling Train ID Numbers:	Train 1	Train 2
Probe	7	8
Filter Front	33	35
Filter Back	34	36
Filter Thermocouple	19	22
Filter 5G-3 (<90°F)	✓	✓

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

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-7-00

Job # 7/2.18 Run 3 Tech RA

Pre-Test Scale Audit

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

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-7-00

Job # 3128 Run 3 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

	SYSTEM 1		SYSTEM 2	
Unplugged Flow Rate = .25cfm	Pre-Test	Post-Test	Pre-Test	Post-Test
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1minute DGM (ft^3)	168,997	188,644	546.085	565,463
Initial 1minute DGM (ft^3)	168,995	188,643	546.081	565,460
Change (C) (ft^3)	,003	,001	,004	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 (mm)	0	0
Flow Rate (CFM)	0	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

ITS Intertek Testing Services

Manufacturer Monso Model 1410 Date 2-7-00

Job # 31218 Run 3 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	9.99	9.99	.97	.991
CO_2	0	0	24.65	24.65	9.72	10.02
O_2	0	0	20.93	20.93	10.09	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	10.00	.97	0	.01	0	✓	
CO_2	.04	24.78	9.79	.04	.13	.07	✓	
O_2	.06	20.73	10.14	.06	20	.05	✓	

* Greater than ± 5% of the range used.

Manufacturer Morso Model 1410 Date 2-7-00

Job # 21218 Run 3 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Samples in Desecrator. 2-7-00 Date: 12:10 Time:

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing #	Filter Numbers	Probe and Front Half Housing #	Filter Numbers
Post Test Weight:	90,9536 grams	,2414 grams	92.1914 grams	,2409 grams
Pre Test Weight:	90,9536 grams	,2398 grams	92,1914 grams	,2393 Grams
Gain:	0 grams	,0016 grams	0 grams	0016 Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = ,0016 grams a2 + b2 = ,0016 grams

Pre-test Weight Record		SYSTEM 1			SYSTEM 2				
		Probe & Housing Number	Front Filter Number	Back Filter Number	Probe & Housing Number	Front Filter Number	Back Filter Number	TEMP	HUMID
Date	Time	7	33	34	8	35	36	°F	%
2-4-00	7:05	90.9534	.1199	,1200	92.1913	,1197	,1196	65	24
2-7-00	7:00	90.9534	.1198	,1200	92,1914	,1198	,1195	65	25
		Total	,2398		Total	,2393			

Pre-test Weight Record		SYSTEM 1		SYSTEM 2			
		Probe & Housing Number	Combined Filter Weight Number	Probe & Housing Number	Combined Filter Weight Number	TEMP	HUMID
Date	Time	7	33+34	8	35+36	°F	%
2-7-00	12:10	90.9547	,2423	92.1922	,2417	77	75
2-8-00	7:20	909536	,2420	92.1914	,2414	66	23
2-9-00	10:15	90.9534	,2414	92.1914	,2409	71	30
2-10-00	7:30	90,9536	,2414	92,1914	,2409	65	35

Manufacturer MORSO Model 1410 Date 2-7-00

Job # 31218 Run 3 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft^3)	188,630	585.450
Initial (ft^3)	168,997	546.085

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.34	29.40
Wet Bulb (°F)	56	59
Dry Bulb (°F)	70	80
Humidity (%)	41	30

Manufacturer MORSO Model 1410 Date 2-7-00

Job # 31218 Run 3 Tech RA

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:

Kindling weight: 4.10 lbs. Consisting of: Scrap and paper Fire lit Time: 7:42

Pre-test load weight: 5.15 lbs. Consisting of: 2X4X 10 inches Time loaded: 9:05

Pre-test moisture content: Uncorrected: 19.50 % Corrected Dry: 20.85 % Wet: 17.25 %

Test Air Control Settings: 2 1/2 TURNS OPEN Time: 9:20

Test Unit Fan Settings: NO FAN Time:

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	4.64 Lbs.	5.15 lbs.	5.67 Lbs.

Fire Box Volume:	.736 Ft.^{3}	Ideal Length:	10 Inches
Load Volume:	.1302 Ft.^{3}	Loading Density:	7.011 lbs/ft^3
Number of Spacers	12 ¾x1½x5	Load Density:	39.629 lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 10 in.	1.62 lbs.	22.2 %	18.4 %	22.5 %
2 x 4 x 10 in.	1.83 lbs.	19.6 %	22.2 %	22.6 %
2 x 4 x 10 in.	1.73 lbs.	21.8 %	22.8 %	18.8 %
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%
x x in.	lbs.	%	%	%

*Uncorrected range = 17.9% to 23.1%

TEST LOAD WEIGHT: 5.16 lbs. **DRY WEIGHT:** 1.91 kg.

AVERAGE MOISTURE CONTENT:

(DRY) 21.21 % CORRECTED TO TWO PIN: (DRY) 22.79 % (WET) 18.56 %

COAL BED RANGE:

1.1 lbs. to 1.2 lbs. (20% to 25% of test load)

TEST CHARGE:

Time loaded: 10:36 Coal bed weight: 1.1 lbs. Coal bed weight = 21.3 % of test load weight

CHARCOALIZATION: good |X|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--| poor

ITS Intertek Testing Services

Manufacturer MORSO Model 1410 Date 2-7-00

Job # 31218 Run 3 Tech RA

COMMENTS

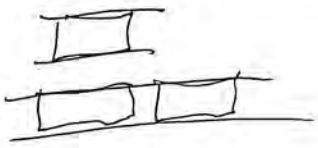
7:42 FIRE LIT 4.1 lbs KINDLING

8:27 5.06 lbs ADDED 21.48% COR 17.68 WET

9:15 STOVE CLEANED OUT SCALE ZEROED

1.1 lbs COALS PUT BACK IN WITH PRELOAD

TEST LOAD CONFIGURATION



Manufacturer MOKSO Model 1410 Date 2-7-00

Job # 31218 Run 3 Tech RA

AIR CONTROL 2½ TURNS FROM CLOSED

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		0	5,10	460	67	103	69	850	631	450	495	530	1424	,039	,082	C
1		10	3,70	457	71	103	70	927	641	466	504	527	1417	,039	,081	C
2		20	2,50	431	73	101	71	927	661	502	537	535	1348		,080	C
3		30	1,80	341	73	94	71	797	662	513	553	549	1055	,039	,068	C
4		40	1,60	278	72	89	72	624	646	486	521	548	798	,038	,059	C
5		50	1,40	271	71	87	71	540	632	442	475	537	817	,040	,056	C
6		60	1,30	267	70	86	71	523	623	416	446	532	802	,040	,055	C
7		70	1,10	254	70	84	71	494	605	401	426	526	731	,038	,054	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:

10:35 FIRE STIRRED DOOR OPEN 30SEC

WHI LTO#: 31218 AIR CONTROL 2½ TURNS FROM CLOSED page 37 of 48

MANUFACTURER: MORSO MODEL: 1410 FIRE SIZE: DATE: 2-7-00 RUN#: 3 TECHNICIAN: BA

SWITCH NUMBER:

READING#	REAL TIME	ELAPSED TIME	WEIGHT REMARK	CO	CO_2	O_2	1 FLUE GAS TEMP	2 ROOM TEMP	3 TUNNEL TEMP	4 TUNNEL WET 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	GAS SAMPL ROTO.	DGM #1 READING	ROTO 1 READING	17 DGM TEMP INLET	18 DGM TEMP OUTLET	19 FILTER TEMP	DGM #2 READING	ROTO 2 READING	20 DGM TEMP INLET	21 DGM TEMP OUTLET	22 FILTER TEMP	TUNNEL VELOCITY	DRAFT	SMOKE	MAX DGM PRESS
0	10:34	0	5.16	1.27	6.66	13.19	252	68	85	71	486	605	401	425	525	716				135	168.997	120	76	76	74	546.085	120	73	73	73	.039	.072	C	0
1		10	3.70	.46	18.55	1.25	438	70	102	73	804	547	413	440	579	1388				135	171.3	120	77	77	83	548.4	120	75	74	83	.039	.082	C	2
2		20	2.50	.46	17.84	2.44	417	72	99	72	878	593	444	490	558	1390				135	173.7	120	78	78	84	550.7	120	76	74	83	.041	.081	C	2
3		30	1.50	.99	17.70	2.39	393	75	97	72	881	620	480	527	544	1370				135	176.1	120	78	78	84	553.1	120	76	75	83	.040	.075	C	2
4		40	.90	.16	12.59	7.83	357	76	96	73	785	640	497	541	536	1109				135	178.5	120	79	78	84	555.4	120	78	76	84	.040	.071	C	2
5		50	.50	.80	8.85	11.05	311	76	93	73	644	644	488	520	527	903				135	180.9	120	81	80	84	557.8	120	79	77	84	.040	.064	C	2
6		60	.40	1.53	6.54	13.04	279	75	90	73	559	642	457	489	521	751				135	183.3	120	81	80	84	560.2	120	80	80	84	.041	.060	C	2
7		70	.20	2.27	5.17	14.08	257	75	88	73	498	613	426	457	508	687				135	185.7	120	83	82	83	562.6	120	82	80	83	.040	.056	C	2
8		80	.10	2.28	4.75	14.59	239	75	86	73	454	606	397	429	468	682				135	188.1	120	83	83	82	564.9	120	83	81	82	.041	.053	C	2
9	82	90	0	2.45	4.50	14.73	236	75	86	73	446	605	393	424	481	624				135	188.6	120	83	82	82	565.4	120	82	82	82	.041	.053	C	2
10		100																																
11		110																																
12		120																																
13		130																																
14		140																																
15		150																																
16		160																																
17		170																																
18		180																																
19		190										82 MIN																						
20		200																																
21		210																																
22		220																																
23		230										1.395 Kg/HR																						
24		240																																
25		250																																
26		260																																
27		270																																
28		280																																
29		290																																
30		300																																
31		310																																
32		320																																
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34		340																																
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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																																

COMMENTS:

TEST LOADED IN 30 SECONDS DOOR CLOSED AT 5:00 AIR NOT ADJUSTED

ITS Intertek Testing Services

Manufacturer Moreso Model 1410 Date 2-8-00

Job # 31218 Run 4 Tech RA

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.40 (inches Hg.) Static pressure (P_q) .137 (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_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.041	103	.2025
B-Centroid	3.00	.042	100	.2049
A-1	0.40	038	99	.1949
A-2	1.50	.042	102	.2049
A-3	4.50	042	102	.2049
A-4	5.60	.040	101	.2000
B-1	0.40	.038	102	.1949
B-2	1.50	.042	102	.2049
B-3	4.50	041	101	.2025
B-4	5.60	.038	102	.1949
		AVERAGE	101.4	.2010

Adjustment factor application

$$V_s = K_p C_p F_p \left(\sqrt{\Delta_p}\right) AVG \sqrt{\frac{T_s}{P_s M_s}} \qquad V_s = K_p C_p \left(\sqrt{\Delta_p}\right) avg \sqrt{\frac{T_s}{P_s M_s}}$$

Pitot correction .9865

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 (°F + 460)

P_s = absolute dilution tunnel gas pressure or Pbar - P_g

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

P_g = static pressure $\frac{inches H_2O}{13.6}$

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:

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

$\left(\sqrt{\Delta_p}\right) centroid$ = Average of the square roots of the velocity heads measured at the tunnel centroid (inches of H_2O)

Manufacturer Morso Model 1410 Date 2-8-00

Job # 31218 Run 4 Tech RA

Pre/Post Checks

Moisture Meter Calibration Check:

Time: 8:15	X: ✓	Y: ✓	12: ✓	22: ✓

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	0 fpm	0 ✓ fpm
Smoke Capture Check	✓	✓
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	2-2-00	
Date Dilution Tunnel Cleaned	2.2.00	
Induced Draft Check	0	0
Tunnel Velocity	.039	142
Flow Rate 140-cfm ±10%		142.501
Pitot Leak Check:		
Side A	✓	
Side B	✓	
Temperature System:		
Ambient (65°- 90°F)	✓ °F	
Wood Heater Surface (±125°F)	+30.8 °F	
Proportional Checks:		
CO Analyzer Drift Check	✓	
CO_2 Analyzer Check	✓	
O_2 Analyzer Check	✓	
Thermocouple check	✓	

Sampling Train ID Numbers:	Train 1	Train 2
Probe	9	10
Filter Front	37	39
Filter Back	38	40
Filter Thermocouple	19 ✓	22 ✓
Filter 5G-3 (<90°F)	✓	✓

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

ITS Intertek Testing Services

Manufacturer MOR50 Model 1410 Date 2-8-00

Job # 31218 Run 4 Tech RA

Pre-Test Scale Audit

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

ITS Intertek Testing Services

Manufacturer MODESO Model 1410 Date 2-8-05

Job # 31218 Run 4 Tech RA

SAMPLING EQUIPMENT CHECK OUT

Leakage Checks Tunnel Samplers

	SYSTEM 1		SYSTEM 2	
Unplugged Flow Rate = .25cfm	Pre-Test	Post-Test	Pre-Test	Post-Test
Vacuum (inches Hg.)	10"	10"	10"	10"
Final 1minute DGM (ft^3)	188,651	204,164	565,470	580,920
Initial 1minute DGM (ft^3)	188,650	204,162	565,468	580,916
Change (C) (ft^3)	.001	.002	.002	.004
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 Monitor Model 1410 Date 2-8-00

Job # 31218 Run 4 Tech RA

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	9.99	9.99	.97	.991
CO_2	0	0	24.5	24.65	9.71	10.02
O_2	0	0	20.93	20.93	10.07	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	9.99	.96	0	0	.01	✓	
CO_2	.02	24.73	9.78	.02	.08	.07	✓	
O_2	.08	20.61	10.07	.08	.32	0	✓	

* Greater than ± 5% of the range used.

Manufacturer Morso Model 1410 Date 2-8-00

Job # 31218 Run 4 Tech RA

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Samples in Desecrator. Date: 2-8-00 Time: 11:20

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing #	Filter Numbers	Probe and Front Half Housing #	Filter Numbers
Post Test Weight:	92.2243 grams	.2453 grams	92.0556 grams	.2452 grams
Pre Test Weight:	92.2243 grams	.2402 grams	92.0556 grams	.2401 Grams
Gain:	0 grams	.0051 grams	0 grams	.0051 Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0051 grams a2 + b2 = grams

Pre-test Weight Record		SYSTEM 1			SYSTEM 2				
Date	Time	Probe & Housing Number	Front Filter Number	Back Filter Number	Probe & Housing Number	Front Filter Number	Back Filter Number	TEMP	HUMID
		9	37	38	10	39	40	°F	%
2-7-00	7:10	92.2243	.1202	.1201	92.0552	.1202	.1200	66	26
2-8-00	7:25	92.2243	.1200	.1202	92.0556	.1201	.1200	66	23
		Total	.2402		Total	.2401			

Pre-test Weight Record		SYSTEM 1		SYSTEM 2			
Date	Time	Probe & Housing Number	Combined Filter Weight Number	Probe & Housing Number	Combined Filter Weight Number	TEMP	HUMID
		9	37+38	10	39+40	°F	%
2-8-00	11:20	92.2260	.2466	92.0570	.2463	73	24
2-9-00	10:15	92.2245	.2455	92.0558	.2452	71	30
2-10-00	7:15	92.2245	.2453	92.0558	.2452	65	30
2-10-00	12:00	92.2243	.2453	92.0554	.2452	74	30

ITS Intertek Testing Services

Manufacturer Mobile Model 1410 Date 2-8-08

Job # 31218 Run 4 Tech RA

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft^3)	204.157	580.903
Initial (ft^3)	188.651	565.470

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.40	29.38
Wet Bulb (°F)	52	56
Dry Bulb (°F)	68	76
Humidity (%)	32	25

ITS Intertek Testing Services

Manufacturer: Morso Model: 1410 Date: 2-8-00

Job #: 31218 Run: 4 Tech: RA

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:

Kindling weight: ~~8.04~~ lbs. Consisting of: Scrap and paper Fire lit Time: 8.04

Pre-test load weight: 5.31 lbs. Consisting of: 2X4X 10 inches Time loaded: ______

Pre-test moisture content: Uncorrected: 18.1 % Corrected Dry: 19.31 % Wet: 16.18 %

Test Air Control Settings: FULL OPEN Time: 8:04

Test Unit Fan Settings: NO FAN Time: ______

TEST LOAD

	Lower Limit		Ideal		Upper Limit	
Test Load Weight:	4.64	Lbs.	5.15	lbs.	5.67	Lbs.

Fire Box Volume:	.736 Ft.^{3}	Ideal Length:	10 Inches
Load Volume:	.1302 Ft.^{3}	Loading Density:	7.283 lbs/ft^3
Number of Spacers	12 ¾x1½x5	Load Density:	~~58.807~~ RA 41.165 lbs/ft^3

Piece Size		Weight		Meter Moisture Content (% dry)*					
2 x 4 x 10	in.	1.86	lbs.	21	%	22.5	%	21.8	%
2 x 4 x 10	in.	1.87	lbs.	22.5	%	23	%	18.5	%
2 x 4 x 10	in.	1.69	lbs.	20.5	%	20.1	%	22	%
x x	in.		lbs.		%		%		%
x x	in.		lbs.		%		%		%
x x	in.		lbs.		%		%		%
x x	in.		lbs.		%		%		%

*Uncorrected range = 17.9% to 23.1%

TEST LOAD WEIGHT: 5.36 lbs. **DRY WEIGHT:** 1.98 kg.

AVERAGE MOISTURE CONTENT:

(DRY) 21.32 % CORRECTED TO TWO PIN: (DRY) 22.92 % (WET) 18.65 %

COAL BED RANGE:

1.1 lbs. to 1.3 lbs. (20% to 25% of test load)

TEST CHARGE:

Time loaded: 10:09 Coal bed weight: 1.1 lbs. Coal bed weight = 20.5 % of test load weight

CHARCOALIZATION: good |X|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--| poor

Manufacturer MORSO Model 1410 Date 2-8-00

Job # 31218 Run 4 Tech RA

COMMENTS

8:04 FIRE LIT 2.7 lbs KINDLING
8:25 4.60 lbs ADDED 21.22% DRY 17.50% WET
9:04 STOVE CLEANED OUT SCALE ZEROED
1.3 lbs COALS PUT BACK IN TO START 5.31 lbs
PRE-LOAD FUEL

TEST LOAD CONFIGURATION

Manufacturer MADRID Model 1410 Date 2-8-00

Job # 31718 Run 4 Tech RA

AIR CONTROL FULL OPEN 3¾ TURNS

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	9:06	0	6.10	476	67	112	62	751	630	439	481	410	1316			
1		10	4.50	516	67	103	63	942	580	465	600	423	1422	.043	.081	C
2		20	3.00	492	72	99	65	939	615	501	528	437	1346		.081	C
3		30	1.90	462	71	99	64	932	624	515	559	462	1367	.040	.082	C
4		40	1.40	318	72	87	65	745	696	506	564	478	967	.039	.065	C
5		50	1.30	235	70	82	66	593	685	473	525	478	751	.038	.051	C
6		60	1.20	247	71	80	65	508	679	434	480	477	697	.041	.052	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:

10:08 FIRE STIRRED DOOR OPEN 15 SEC

WHI LTO#: 31218 AIR CONTROL FULL OPEN

MANUFACTURER: MORSO MODEL: 1410 FIRE SIZE: HIGH DATE: 2-8-00 RUN#: 4

SWITCH NUMBER: TECHNICIAN: RA

READINGS	REAL TIME	ELAPSED TIME	WEIGHT REMAIN.	CO	CO_2	O_2	1 FLUE GAS TEMP	2 ROOM TEMP	3 TUNNEL TEMP	4 TUNNEL WET 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	GAS SAMPL ROTO.	DGM #1 READING	ROTO 1 READING	17 DGM TEMP INLET	18 DGM TEMP OUTLET	19 FILTER TEMP	DGM #2 READING	ROTO 2 READING	20 DGM TEMP INLET	21 DGM TEMP OUTLET	22 FILTER TEMP	TUNNEL VELOCITY	DRAFT	SMOKE	MAX DGM PRESS
0	10:09	0	5.36	2.04	6.07	12.99	346	71	80	65	505	678	481	477	477	683				135	188.6	120	72	72	70	565.4	120	69	69	70	.039	.053	C	0
1		10	3.80	1.83	18.29	.97	478	72	98	66	865	664	420	467	516	1432				135	191.0	120	73	73	79	567.8	120	71	69	78	.039	.085	C	2
2		20	2.40	.65	18.10	1.84	482	73	99	67	948	642	452	525	510	1433				135	193.4	120	74	74	82	570.2	120	72	70	81	.041	.086	C	2
3		30	1.20	.34	17.64	2.62	463	75	101	68	966	650	492	564	510	1420				135	195.7	120	75	74	83	572.5	120	73	71	82	.040	.084	C	2
4		40	.60	.15	10.38	10.03	407	75	96	68	806	660	523	569	514	1006				135	198.1	120	76	75	83	574.9	120	75	73	82	.040	.075	C	2
5		50	.40	.57	8.13	11.60	356	75	93	69	667	669	503	537	518	888				135	200.5	120	78	77	83	577.3	120	77	74	82	.039	.071	C	2
6		60	.10	1.00	7.60	12.32	330	74	91	69	600	668	469	501	531	824				135	202.9	120	79	78	82	579.7	120	78	76	82	.039	.067	C	2
7	65	65	0	1.11	7.12	12.73	320	75	90	69	574	672	456	486	534	809				135	204.1	120	80	78	82	580.9	120	78	77	81	.038	.064	C	2
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																																
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24		240																																
25		250																																
26		260																																
27		270																																
28		280																																
29		290																																
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34		340																																
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																																

65 MIN

1,826 Kg/HR

COMMENTS:

TEST LOADED IN: 15 SECONDS DOOR OPEN 3:00 AIR LEFT FULL OPEN

APPENDIX B

INTRODUCTION

This document provides a step by step guide for the technician conducting tests to EPA standard requirements. Procedures outlined here, when followed, will result in tests in conformance with EPA Methods 28 and 5G-3. This guide cannot cover every possible contingency that may develop during a particular test program. Many questions that may arise can be answered by a complete understanding of the test standards and their intent. When in doubt on any detail check with the laboratory manager and be sure you understand the procedures involved.

The primary measurements to be obtained are particulate emission data and efficiency data. The technician's duties include the following steps. It is critical that all spaces on the data forms be properly filled in. Each test must be represented by a complete record of what was done and when.

I. APPLIANCE INSPECTION AND SET-UP
   - A. Incoming Inspection
   - B. Unit Set-Up

II. SAMPLING SYSTEMS - SET-UP
   - A. Gas Analysis
   - B. Dilution Tunnel

III. TEST CONDUCT
   - A. Pre-Test Fuel Load
   - B. Test Fuel Load
   - C. Unit Start - up
   - D. Test Run

IV. POST TEST PROCEDURE
   - A. Leak Checks
   - B. Particulate Sample Recovery

The technician running this test must be familiar with the following EPA documents that are to be kept in the laboratory at all times.

1. Method 28
2. Method 28A
3. Method 5G-3
4. Method 5H

I. APPLIANCE INSPECTION AND SET-UP

A. Incoming Inspection

1. Check for completeness of unit including parts, accessories, installation and operating instructions, drawings and specifications, etc. Note any discrepancies or missing parts.
2. Check for shipping damage. If damage has occurred, notify the laboratory manager. In some cases repairs may be made, provided the manufacturer and laboratory manager concur that repairs will not affect the units performance. If damage is irreparable, a new unit will need to be obtained.
3. Note whether unit is catalytic or non-catalytic.
4. Mark unit with manufacturer's name, model number, work order number and date received.
5. If unit is safety listed, note label data including listing agency and serial number.

B. Unit Set-Up

1. All units must be operated in-house for a break-in period as follows (the unit may be connected to a lab chimney). NOTE: Inserts are tested as if they are freestanding stoves.

    a. Non-catalytic units: 10 hours minimum burn time with a stack temperature of at least 2501 Fahrenheit (medium burn rate, Douglas Fir scrap or cordwood.) A stack thermocouple must be installed and stack temperature recorded at 1-hour intervals or on chart recorder.

    b. Catalytic units: 50 hours minimum burn time with catalyst temperature in excess of 8001 Fahrenheit (medium burn rate, Douglas Fir scraps or cordwood). Record catalyst temperature at 1-hour intervals or on chart recorder.

2. Once break-in is completed, allow unit to cool then clean unit thoroughly.

3. Thermocouples must be attached to surfaces of unit prior to testing. EPA requires a thermocouple on the outside bottom of the firebox. This must be installed prior to putting the unit on the scale. In some cases the required thermocouple locations will be inaccessible on finished units. Check with the laboratory manager if problems are encountered in proper thermocouple attachment.
4. Prior to placing unit on scale, the scale must be turned on and allowed to warm up for 1-hour minimum.
5. Place unit on scale and align so chimney will be centered in hood. Record the weight of the unit and all accessories. (Do not weight with chimney attached.)
6. Chimney and connector should be cleaned with a wire brush prior to mounting. Attach chimney and connector then seal all joints. Be sure single wall stove pipe terminates and insulated pipe starts at proper level above scale platform. Chimney must be supported from scale so that it does not touch test enclosure or hood walls.
7. Measure firebox dimensions and record on appropriate data form. Make a three dimensional sketch of the firebox including firebrick, baffles, and obstructions. Calculate firebox volume in cubic feet. See Section 6.2.4 of EPA Method 28 for details.
8. If unit is equipped with a catalyst additional thermocouples must be installed downstream of, and inside catalyst (upstream optional).
9. Plug thermocouples into data acquisition system jacks and verify that all instrumentation is working properly.
10. Dilution tunnel must be cleaned prior to each certification test series, and at anytime a higher burn rate follows a lower burn rate.

II. SAMPLING SYSTEMS SET-UP

A. Gas Analysis

1. All instruments should be turned on and allowed to warm up for 1-hour minimum.
2. Prior to calibrating, make sure that the outlet pressure on each calibration gas bottle reads 10 PSI. Adjust flow meters at each gas analyzer to required flow.

   All gas analyzers (CO_2, CO, O_2) are zeroed on nitrogen. The O_2 analyzer is spanned on air and set for 20.93%. CO_2 and CO analyzers are spanned with their respective gases.

   Calibrate analyzers as follows:

   a. With calibration switch at "SPAN", adjust all span controls to values specified on span gas label.
   b. Switch to "ZERO" and adjust zero controls to provide 0.00 readout on all analyzers.
   c. Repeat a. and b. until no further adjustment is required.
   d. Record these values on the appropriate data sheet.
   e. Switch to "CAL." and record all analyzer values.

3. Response time synchronization check.

   a. With switch at "SAMPLE" and no fire in unit, allow readings to stabilize (O_2 analyzer should read 20.93, CO and CO_2 should read 0.00).
   b. Switch to "CAL" setting and start the stopwatch. Note the time required for each unit to reach the calibration gas bottle value. If all three analyzers reach this value within 5 seconds of each other, synchronization is adequate. If not, contact the laboratory manager. Synchronization is adjusted by either internal instrument setting or adjustment of sample line length.
   c. Use EPA Method 5H 6.7-6.9 procedures to check calibration of instruments.

4. Sample clean-up train.

   a. Load a new filter in 4-inch glass filter holder.
   b. Load four Impingers as follows.

      #1: 100 ml. distilled water and 5 ml. H_2SO_4
      #2: 100 ml. distilled water and 5 ml. H_2SO_4
      #3: Empty
      #4: 200-300 grams Drierite.

   c. Place Impingers in container and connect with greased "U TUBES". (Grease carefully on bottom half of ball joint so that grease will not get into tubes.)
   d. Connect filter to impinger #1 and sample line to impinger #4.
   e. Connect stack probe to filter.
   f. Leak check system as follows.

      1) Plug probe.
      2) Turn on sample system and increase flow rate slowly.
      3) Set vacuum adjust valve to obtain a vacuum of 10 inches mercury.
      4) If sapphire float in rotometer does not stabilize below 10 on scale, system must be resealed.
      5) Repeat leak check procedure until satisfactory results are obtained.
      6) Unplug probe slowly, then decrease flow rate slowly before shutting off system.

   g. Just prior to starting test, fill impinger container with ice.

B. Dilution Tunnel Sample Train Set-Up:

1. Filters and holders.

   a. Clean probes and filter holder front housings carefully and desiccate to a constant weight prior to use.
   b. Filters and filter probe combinations should be numbered and labeled prior to use.
   c. Weigh desiccated filters and probe filter units on analytical balance. Record weights on appropriate form. Note that probe and front half of front filter holder is to be weighed as a unit.
   d. Carefully assemble filter holder units and connect to sampling systems.
   e. Check Silica gel columns for adequate dry absorbent (blue color).

2. Leak checking.

   a. Each sample system is to be checked for leakage prior to inserting probes in tunnel.
   b. Plug probes and start samplers. Adjust pump bypass valve to produce a vacuum reading of 10 inches mercury. NOTE: During test, highest vacuum recorded is required for posttest leak check.
   c. Allow vacuum indication to stabilize at 10" mercury, record dry gas meter readings, (DGM_1, DGM_2). At a convenient DGM value start stopwatch. Time for 1 minute then stop vacuum pumps. Record dry gas meter readings again, (DGM_3, DGM_4). NOTE: If rotometer ball is floating above the 5-mm mark, system is leaking too much and all seals should be checked.

   d. Calculate leakage rate as follows.

      System 1: $DGM_3 - DGM_1 = CFM_1$

      System 2: $DGM_4 - DGM_2 = CFM_2$

      If CFM_1 or CFM_2 is greater than 0.02 cfm, or ,S greater than 0.04 x Sample Rate, leakage is unacceptable and system must be resealed.
      For most tests the sample rate will be 0.25 cfm, thus leakage rates in excess of 0.04 x 0.25 = 0.010 cfm are not acceptable.
   e. To prevent contamination, do not insert probes in tunnel until the start of the test run.

III. TEST CONDUCT

A. Pre-Test Fuel Load

1. Using 2x4 Douglas Fir cut enough pieces to approximate test load weight. (Piece length must be greater than 1/3 of the test load length.)
2. Measure percent moisture content using Delmhorst moisture meter. The average percent moisture must be within 19 to 25 percent.

B. Test Fuel Load

1. Determine optimum load weight by multiplying firebox volume (cubic feet) by 7. This is the ideal load weight.
2. Determine piece size mix i.e. <1.5 cubic feet volume use 2x4's only; 1.5 ft^3 to 3.0 ft^3 use a mix of 2.4's and 4x4's; >3.0 ft_3 use only 4x4's. Ideal length is 5/6 of the longest firebox dimension.
3. Weigh out test load and appropriate number of spacers and adjust weight by shortening or lengthening all pieces equally if necessary.
4. Construct test loads by attaching spacers as shown in EPA Method 28.
5. Measure and record moisture content of each fuel piece (use three sides). Determine if fuel load moisture content is within required range (19-25%). If not, construct new fuel pieces using wood with required moisture content.
   All wood in the humidity chamber is Douglas Fir and should be within range. Contact laboratory manager if you cannot find suitable pieces.

C. Unit Start-Up

1. With all doors and air controls closed, zero draft Magnehelic using screw located at bottom of meter.
2. Before lighting a fire, turn on dilution tunnel and set flow rate to 140 scfm (approximately 715 fpm) if burn rate is to be less than 3 kg/hr. For higher burn rates set flow for a 150:1 air fuel ratio (see chart for approximate values).
3. Check draft imposed on cold stove. All inlets must be closed and a draft gauge in the chimney. If draft is greater than 0.005 inches water column, adjust tunnel to stack gap until draft is less than 0.005 inches water column.

4. With hot wire anemometer check for ambient airflow around unit (must be less than 50 ft/min).
5. Zero scale and start fire with newspaper and Douglas Fir kindling. (Make sure stack sample probe is on the unit.)
6. Once kindling is burning well, add preload fuel. Operate at high fire for sufficient time to get fuel load burning well. Then adjust settings to intended test run levels.
7. Perform the dilution tunnel traverse as prescribed in Method 28, Section 6.3. (Pitot tube should be carefully cleaned prior to each test.)
8. Pretest load must burn for a minimum of 1 hour. Record stove surface, catalyst, room and flue temperatures.
9. Stir fire often during preburn (after a reading) to get a good coal bed. Fire can only be raked once (door open 1 minute or less) during the 15 minutes prior to the start of the test.

D. Test Run

1. Stack gas analyzers should be on and in the sample mode.
2. When the fuel bed is between 20-25% of the test load weight the test is to be started.

a. Insert the sample probes into the tunnel being careful not to hit sides of tunnel with probe tip.
b. Check tunnel Pitot tube for proper position.
c. Record initial readings.
d. Turn on probe sample systems and start timing test.
e. Tare platform scale.
f. Open stove doors and load stove. Close door or follow manufacturer's start-up procedures. Five minutes is the maximum time before all doors and controls must be set to final positions for duration of test.
g. Record length of time door and bypass are open, include any air control setting adjustments.
h. Every 10 minutes record the following:

1) Dry gas meter readings.
2) Weight remaining.
3) All thermocouple temperatures.
4) Tunnel Pitot tube reading.
5) Draft reading.
6) Rotometer readings.

i. Filter temperatures shall not exceed 901F anytime during the test. If approaching 901F turn on cooling pump. Filters must be kept above the dilution tunnel wet bulb temperature in order to prevent condensation.
j. Regularly check impinger for ice level during test.
k. After 30 seconds of 0.00 lbs. weight, and on the minute, shut off sample trains and record last reading.
l. Record final dry gas meter values.

IV. POST TEST PROCEDURES

A. LEAK CHECKS

1. Dilution Tunnel

   a. Remove both sample probes from tunnel and plug with rubber stopper.
   b. Turn on sample system and set vacuum to 10" mercury or to the highest value reached during the test.
   c. At a convenient value start stop watch. Record DGM starting value.
   d. After 1 minute stop sample system and record ending DGM value.
   e. Calculate leakage rate per pre-test description (see II.B.2.c.).

2. Gas Analyzers

   a. Set stack sample flow to about 75 mm on the rotometer.
   b. Plug with rubber stopper.
   c. Adjust vacuum to 10" mercury.
   d. Let system stabilize then record rotometer readings.
   e. If rotometer readings do not equal zero check with laboratory manager.
   f. SLOWLY unplug probe and decrease flow rate to zero.
   g. Turn off stack sampling system.
   h. Zero, span and calibrate the analyzers (see Gas Analysis). RECORD ONLY these meter values.

B. Particulate Sample Recovery

1. Disassemble filter holder and scrape gasket with scalpel. Collect all loose material on filters.
2. Weigh and record probes and filters for each train. NOTE: 24 hours of desiccation must pass before final "no change" weight values can be recorded.
3. Weigh and record probes and fillers at 2-hour intervals until weight change between weighing is less than 0.5 mg.
4.

In order to meet the requirements of section 60.535(g) of the EPA's 40CFR Part 60 Standards of Performance for New Stationary Sources; New Residential Wood Heaters, Intertek Testing Services seals certified wood heaters by strapping the unit to a pallet and covering the unit with stretch wrap. A copy of the EPA certificate is attached and our G mark stamped on the stretch wrap in various positions and then another layer of stretch wrap is used to cover the markings and copy of the certificate. Any breaking of the stretch wrap seal will be easily noticeable. The unit is then shipped back to the manufacturer.

APPENDIX C

		Manufacturer:			Morso				
		Model:			1410				
		Date:			02/03/00				
		Run:			1				
		Project #:			31218				
		Test Duration:			143				
	Total Gas Volume (DGM 1):				32.71623				
	Total Gas Volume (DGM 2):				33.25849				
	Average Barometric Pressure:				28.755				
		Molecular Weight:			28.56				
		Pitot Correction:			0.9795				
	Calibration Factor (DGM #1):				1.0157				
	Calibration Factor (DGM #2):				1.0361				
				(1) VS:	0.045724				
				(2) VS:	0.044979			Filter	Filter
								Face	Face
Elapsed	DGM 1	DGM 1	DGM 1	DGM 2	DGM 2	DGM 2	Tunnel	Velocity	Velocity
Time	Reading	Inlet T	Outlet T	Reading	Inlet T	Outlet T	Dry Bulb	DGM 1	DGM 2
0	106.4	77	77	484.1	74	74	83		
10	108.8	77	78	486.4	75	74	86	19.83	19.50
20	111.2	78	78	488.8	76	75	85	19.81	20.31
30	113.6	79	78	491.2	77	76	85	19.79	20.27
40	116.0	79	79	493.6	77	76	86	19.78	20.27
50	118.4	80	79	496.0	78	77	87	19.76	20.23
60	120.8	80	80	498.3	79	78	85	19.74	19.35
70	123.2	81	80	500.7	80	78	82	19.72	20.17
80	125.6	81	81	503.1	80	79	81	19.70	20.15
90	128.0	81	81	505.5	81	80	81	19.70	20.12
100	130.4	81	81	507.8	81	81	80	19.70	19.26
110	132.8	82	81	510.3	81	81	79	19.68	20.94
120	135.2	81	81	512.6	81	81	79	19.70	19.26
130	137.6	82	81	515.0	81	81	79	19.68	20.10
140	140.0	81	82	517.4	81	81	77	19.68	20.10
143	140.7	82	82	518.2	81	82	77	19.12	22.31

Proportional Rate Calculations (EPA Formulas from PR5G)

Stack area (ft2):	0.1963	Manufacturer:		Morso
Wood moisture (% wet):	18.05	Model:		1410
Load Weight (lbs wet):	5.1	Date:		02/03/00
Burn Rate (Dry kg/hr):	0.794	Run:		1

Final Temperature (DGM #1) Degrees Rankin:	540.031
Final Temperature (DGM #2) Degrees Rankin:	538.656
Final Tunnel Temperature Degrees Rankin:	542.000
Final Tunnel Velocity (feet per second):	13.5132264
Standardized Tunnel Flow (dscfm):	142.992909

Tunnel Velocity	Tunnel Velocity Ft/Sec	Average Inlet + Outlet Temp. Meter 1 Deg. R	Average Inlet + Outlet Temp. Meter 2 Deg. R	PR1	PR2	#1 dDGM Vol.Std. (ft3)	#2 dDGM Vol.Std. (ft3)	Time
0.040	13.484	537.0	534.0					0
0.040	13.521	537.5	534.5	101.21	98.03	2.300	2.261	10
0.040	13.509	538.0	535.5	101.02	102.01	2.298	2.355	20
0.041	13.677	538.5	536.5	99.69	100.57	2.296	2.351	30
0.039	13.351	539.0	536.5	102.21	103.21	2.294	2.351	40
0.041	13.702	539.5	537.5	99.69	100.57	2.292	2.347	50
0.040	13.509	540.0	538.5	100.65	97.22	2.290	2.245	60
0.041	13.639	540.5	539.0	99.05	99.83	2.288	2.340	70
0.040	13.459	541.0	539.5	100.09	100.88	2.286	2.338	80
0.041	13.626	541.0	540.5	98.86	99.46	2.286	2.334	90
0.041	13.614	541.0	541.0	98.77	95.14	2.286	2.234	100
0.040	13.434	541.5	541.0	99.81	104.60	2.283	2.429	110
0.040	13.434	541.0	541.0	99.91	96.23	2.286	2.234	120
0.040	13.434	541.5	541.0	99.81	100.42	2.283	2.331	130
0.040	13.409	541.5	541.0	99.63	100.23	2.283	2.331	140
0.040	13.409	542.0	541.5	98.11	104.31	0.720	0.776	143

		Manufacturer:		Morso					
		Model:		1410					
		Date:		02/04/00					
		Run:		2					
		Project #:		31218					
		Test Duration:		117					
	Total Gas Volume (DGM 1):			27.52174					
	Total Gas Volume (DGM 2):			27.60526					
	Average Barometric Pressure:			29.25					
		Molecular Weight:		28.56					
		Pitot Correction:		0.9826					
	Calibration Factor (DGM #1):			1.0157					
	Calibration Factor (DGM #2):			1.0361					
			(1) VS:	0.053772					
			(2) VS:	0.053609				Filter	Filter
								Face	Face
Elapsed	DGM 1	DGM 1	DGM 1	DGM 2	DGM 2	DGM 2	Tunnel	Velocity	Velocity
Time	Reading	Inlet T	Outlet T	Reading	Inlet T	Outlet T	Dry Bulb	DGM 1	DGM 2
0	140.8	77	76	518.2	74	72	73		
10	143.1	77	77	520.5	74	73	93	19.58	19.64
20	145.5	77	77	522.9	75	74	88	20.19	20.69
30	147.9	79	78	525.3	77	75	87	20.14	20.64
40	150.3	78	78	527.7	77	76	87	20.15	20.62
50	152.7	79	78	530.1	79	78	85	20.14	20.54
60	155.1	79	78	532.5	79	79	83	20.14	20.52
70	157.5	79	79	534.8	79	79	81	20.12	19.67
80	160.0	80	80	537.2	79	79	80	20.92	20.52
90	162.4	80	80	539.6	79	79	79	20.08	20.52
100	164.8	80	80	542.0	80	80	79	20.08	20.48
110	167.2	8	80	544.3	80	80	78	21.51	19.63
117	168.9	80	80	546.0	80	80	78	20.32	20.73

	Proportional Rate Calculations				(EPA Formulas from PR5G)			
	Stack area (ft2):	0.1963			Manufacturer:	Morso		
	Wood moisture (% wet):	18.82			Model:	1410		
	Load Weight (lbs wet):	5.22			Date:	02/04/00		
	Burn Rate (Dry kg/hr):	0.986			Run:	2		
Final Temperature (DGM #1) Degrees Rankin:					535.923			
Final Temperature (DGM #2) Degrees Rankin:					537.538			
Final Tunnel Temperature Degrees Rankin:					542.385			
Final Tunnel Velocity (feet per second):					13.3778163			
Standardized Tunnel Flow (dscfm):					143.8948			

Tunnel Velocity	Tunnel Velocity Ft/Sec	Average Inlet + Outlet Temp. Meter 1 Deg. R	Average Inlet + Outlet Temp. Meter 2 Deg. R	PR1	PR2	#1 dDGM Vol.Std. (ft3)	#2 dDGM Vol.Std. (ft3)	Time
0.039	13.121	536.5	533.0					0
0.039	13.364	537.0	533.5	98.53	98.57	2.271	2.279	10
0.039	13.304	537.0	534.5	101.16	103.36	2.342	2.400	20
0.041	13.628	538.5	536.0	98.30	100.44	2.336	2.394	30
0.041	13.628	538.0	536.5	98.39	100.34	2.338	2.391	40
0.040	13.436	538.5	538.5	99.34	101.03	2.336	2.383	50
0.040	13.412	538.5	539.0	99.16	100.75	2.336	2.380	60
0.040	13.387	539.0	539.0	98.88	96.37	2.334	2.281	70
0.040	13.375	540.0	539.0	102.72	100.47	2.426	2.380	80
0.040	13.362	540.0	539.0	98.52	100.38	2.329	2.380	90
0.040	13.362	540.0	540.0	98.52	100.19	2.329	2.376	100
0.040	13.350	504.0	540.0	105.45	95.93	2.496	2.277	110
0.039	13.182	540.0	540.0	100.86	102.58	1.650	1.683	117

Manufacturer:	Morso
Model:	1410
Date:	02/07/00
Run:	3
Project #:	31218
Test Duration:	82
Total Gas Volume (DGM 1):	19.108958
Total Gas Volume (DGM 2):	19.27223
Average Barometric Pressure:	29.37
Molecular Weight:	28.56
Pitot Correction:	0.9856
Calibration Factor (DGM #1):	1.0157
Calibration Factor (DGM #2):	1.0361
(1) VS:	0.0771683
(2) VS:	0.0765145

Elapsed Time	DGM 1 Reading	DGM 1 Inlet T	DGM 1 Outlet T	DGM 2 Reading	DGM 2 Inlet T	DGM 2 Outlet T	Tunnel Dry Bulb	Filter Face Velocity DGM 1	Filter Face Velocity DGM 2
0	169.0	76	76	546.1	73	73	85		
10	171.3	77	77	548.4	75	74	102	19.45	20.04
20	173.7	78	78	550.7	76	74	99	20.24	19.89
30	176.1	78	78	553.1	76	75	97	20.24	20.74
40	178.5	79	78	555.4	78	76	96	20.22	19.82
50	180.9	81	80	557.8	79	77	93	20.14	20.64
60	183.3	81	80	560.2	80	80	90	20.14	20.57
70	185.7	83	82	562.6	82	80	88	20.07	20.53
80	188.1	83	83	564.9	83	81	86	20.05	19.64
82	188.6	83	82	565.4	82	82	86	20.91	21.34

	Proportional Rate Calculations			(EPA Formulas from PR5G)				
	Stack area (ft2):	0.1963		Manufacturer:		Morso		
	Wood moisture (% wet):	18.56		Model:		1410		
	Load Weight (lbs wet):	5.16		Date:		02/07/00		
	Burn Rate (Dry kg/hr):	1.395		Run:		3		
Final Temperature (DGM #1) Degrees Rankin:				539.650				
Final Temperature (DGM #2) Degrees Rankin:				537.800				
Final Tunnel Temperature Degrees Rankin:				552.200				
Final Tunnel Velocity (feet per second):				13.57128963				
Standardized Tunnel Flow (dscfm):				143.9693444				

Tunnel Velocity	Tunnel Velocity Ft/Sec	Average Inlet + Outlet Temp. Meter 1 Deg. R	Average Inlet + Outlet Temp. Meter 2 Deg. R	PR1	PR2	#1 dDGM Vol.Std. (ft3)	#2 dDGM Vol.Std. (ft3)	Time
0.039	13.281	536.0	533.0					0
0.039	13.486	537.0	534.5	99.18	101.31	2.257	2.325	10
0.041	13.791	538.0	535.0	100.35	97.82	2.347	2.308	20
0.040	13.597	538.0	535.5	101.42	103.06	2.347	2.406	30
0.040	13.585	538.5	537.0	101.23	98.40	2.345	2.299	40
0.040	13.548	540.5	538.0	100.58	102.21	2.337	2.395	50
0.041	13.679	540.5	540.0	99.08	100.31	2.337	2.386	60
0.040	13.487	542.5	541.0	99.76	101.18	2.328	2.381	70
0.041	13.629	543.0	542.0	98.26	95.42	2.326	2.278	80
0.041	13.629	542.5	542.0	102.45	103.72	0.485	0.495	82

		Manufacturer:		Morso					
		Model:		1410					
		Date:		02/08/00					
		Run:		4					
		Project #:		31218					
		Test Duration:		65					
	Total Gas Volume (DGM 1):			15.23412					
	Total Gas Volume (DGM 2):			15.60403					
	Average Barometric Pressure:			29.39					
		Molecular Weight:		28.56					
		Pitot Correction:		0.9865					
	Calibration Factor (DGM #1):			1.0157					
	Calibration Factor (DGM #2):			1.0361					
			(1) VS:	0.095744					
			(2) VS:	0.093474				Filter	Filter
								Face	Face
Elapsed	DGM 1	DGM 1	DGM 1	DGM 2	DGM 2	DGM 2	Tunnel	Velocity	Velocity
Time	Reading	Inlet T	Outlet T	Reading	Inlet T	Outlet T	Dry Bulb	DGM 1	DGM 2
0	188.6	72	72	565.4	69	69	80		
10	191.0	73	73	567.8	71	69	98	20.44	20.97
20	193.4	74	74	570.2	72	70	99	20.40	20.93
30	195.7	75	74	572.5	73	71	101	19.53	20.02
40	198.1	76	75	574.9	75	73	96	20.34	20.81
50	200.5	78	77	577.3	77	74	93	20.27	20.75
60	202.9	79	78	579.7	78	76	91	20.23	20.70
65	204.1	80	78	580.9	78	77	90	20.21	20.68

	Proportional Rate Calculations			(EPA Formulas from PR5G)				
	Stack area (ft2):	0.1963		Manufacturer:		Morso		
Wood moisture (% wet):		18.65		Model:		1410		
Load Weight (lbs wet):		5.36		Date:		02/08/00		
Burn Rate (Dry kg/hr):		1.826		Run:		4		
Final Temperature (DGM #1) Degrees Rankin:				535.500				
Final Temperature (DGM #2) Degrees Rankin:				533.250				
Final Tunnel Temperature Degrees Rankin:				553.500				
Final Tunnel Velocity (feet per second):				13.4553456				
Standardized Tunnel Flow (dscfm):				142.501089				
		Average	Average					
		Inlet +	Inlet +					
		Outlet	Outlet			#1	#2	
	Tunnel	Temp.	Temp.			dDGM	dDGM	
Tunnel	Velocity	Meter 1	Meter 2			Vol.Std.	Vol.Std.	
Velocity	Ft/Sec	Deg. R	Deg. R	PR1	PR2	(ft3)	(ft3)	Time
0.039	13.227	532.0	529.0					0
0.039	13.446	533.0	530.0	102.06	102.22	2.371	2.432	10
0.041	13.799	534.0	531.0	99.44	99.60	2.367	2.428	20
0.040	13.654	534.5	532.0	96.57	96.62	2.266	2.322	30
0.040	13.593	535.5	534.0	100.13	100.00	2.360	2.414	40
0.039	13.386	537.5	535.5	100.75	100.71	2.351	2.407	50
0.039	13.361	538.5	537.0	100.38	100.25	2.347	2.401	60
0.038	13.177	539.0	537.5	101.51	101.38	1.172	1.199	65

APPENDIX D

Intertek Testing Services

Warnock Hersey

Middleton, Wisconsin

Post Test Dry Gas Meter Calibration Data

Manufacturer: Morso Model: 1410 Job Numbe 31218 Date: 02/08/00 Tech: RA

Barometric Press: 29.29 Calibration Factors: DGM#1: 1.0157 DGM#2: 1.0361 Std.Meter DGM#3: 1.0212

	Standardized Meter # 3						System # 1					
Trial No.	Press Drop	Initial Ft.^{3}	Final Ft^3	Change Ft.^{3}	Temp °F	Std. Ft^3	Initial Ft.^{3}	Final Ft.^{3}	Change Ft.^{3}	Temp °F	Std Ft.^{3}	Cal Factor
1	0.055	317.491	319.78	2.2890	72	2.2711	205.137	207.58	2.443	77	2.3884	0.9509
2	0.055	319.78	322.139	2.359	72	2.3406	207.58	209.972	2.392	77	2.3385	1.0009
3	0.055	322.139	324.458	2.319	72	2.3009	209.972	212.45	2.478	77	2.4226	0.9497
											Average:	0.9672

Previous Cal Factor:	Minus -	Avg. Cal. Factor	divided by /	Previous Cal Factor	Times 100 *	equals =	Precent Deviation
1.0157		0.9672		1.0157			4.7783

	Standardized Meter #3						System # 2					
Trial No.	Press Drop	Initial Ft.^{3}	Final Ft^3	Change Ft.^{3}	Temp °F	Std. Ft^3	Initial Ft.^{3}	Final Ft.^{3}	Change Ft.^{3}	Temp °F	Std Ft.^{3}	Cal Factor
1	0.055	325.815	328.283	2.4680	72	2.4487	582.135	584.578	2.443	75	2.4455	1.0013
2	0.055	328.283	330.771	2.4880	72	2.4685	584.578	587.029	2.451	76	2.4489	1.0080
3	0.055	330.771	333.262	2.4910	72	2.4715	587.029	589.475	2.446	76	2.4439	1.0113
											Average:	1.0069

Previous Cal Factor:	Minus -	Avg. Cal. Factor	divided by /	Previous Cal Factor	Times 100 *	equals =	Precent Deviation
1.0361		1.00688		1.0361			2.82020

Intert Testing Services

Page___of___

Manufacturer_____ Model_____ Date_____

Job #_____ Run_____ Tech_____

POST TEST DRY GAS METER CALIBRATION DATA

MANUFACTURER: Morso MODEL: 1410 LTO: 31218 DATE: 2-8-00 TECHNICIAN: RA

BAROMETRIC PRESSURE: 29.29 CALIBRATION FACTOR DGM#1: 1.0157 DGM#2: 1.0361 STANDARDIZED DGM#3: 1.0212

	STANDARD METER						METER #1					
TRAIL NO.	PRESS DROP	FINAL FT.³	INITIAL FT.³	CHANGE FT.³	TEMP °F	STD FT.³	FINAL FT.³	INITIAL FT.³	CHANGE FT.³	TEMP °F	STD. FT.³	CAL. FACTOR
1	.055	319.780	317.491	2.2890	72	2.2711	207.580	205.137	2.443	77	2.3884 2.400	0.9509
2	.055	322.139	319.780	2.359	72	2.3406	209.972	207.580	2.392	77	2.3385 2.3	1.0009
3	.055	324.580	322.139	2.319	72	2.6495	212.450	209.972	2.478	77	2.4224	.9677 1.9497
						2.3009						

AVERAGE CALIBRATION FACTOR: .9672

PREVIOUS CAL. FACTOR	MINUS	AVERAGE CAL.FACTOR	DIVIDED BY	PREVIOUS CAL.FACTOR	MULTIPLIED *100	EQUALS	DEVIATION PERCENT
1.0157	-	.9672	1	1.0157	*100	=	4.7783 %

	STANDARD METER						METER #2					
TRAIL NO.	PRESS DROP	FINAL FT.³	INITIAL FT.³	CHANGE FT.³	TEMP °F	STD. FT.³	FINAL FT.³	INITIAL FT.³	CHANGE FT.³	TEMP °F	STD. FT.³	CAL. FACTOR
1	.055	328.283	325.815	2.4680	72	2.4487	584.578	582.135	2.443	75	2.4455	1.0093
2	.055	330.771	328.283	2.488	72	2.4685	587.029	584.578	2.451	76	2.4489	1.0080
3	.055	333.262	330.771	2.491	72	2.4715	589.475	587.029	2.446	76	2.4439	1.0113

AVERAGE CALIBRATION FACTOR:_____

PREVIOUS CAL. FACTOR	MINUS	AVERAGE CAL. FACTOR	DIVIDED BY	PREVIOUS CAL. FACTOR	MULTIPLIED *100	EQUALS	DEVIATION %
1.0361	-	1.0069	1	1.0361	*100	=	2.820 %

PERCENT OF DEVIATION MUST BE LESS THAN 5 %. IF DEVIATION IS MORE THAN 5 %, THE UPDATED CALIBRATION FACTOR MUST BE USED.

APPENDIX E

ITS Intertek Testing Services

Manufacturer Morso Model 1410 Date 2-8-00

Job # 31218 Run POST TEST Tech RA

POST TEST 5-POINT GAS ANALYZER CHECK

	CO		CO_2		O_2	
	Actual	Should Be	Actual	Should Be	Actual	Should Be
Zero Gas		0		0		0
Span Gas		9.99		24.65		20.93
Cal Gas #1		.991		10.02		10.01
Deviation	.97	2.12	9.69	3.29	10.13	1.20
Cal Gas #2	2.35	2.36	5.78	5.88	5.68	5.55
Deviation		.42		1.70		2.52
Cal Gas #3		7.68		19.86		17.16
Deviation	7.66	1.04	19.28	2.97	17.36	2.80
Average Deviation		1.19		2.65		2.17

ıanufacturer: Morso
Project No: 31218
Model: 1410
Date: 02/08/00

	CO		CO2		O2	
	Actual	Should be	Actual	Should be	Actual	Should be
Zero Gas	0	0	0	0	0	0
Span Gas	9.99	9.99	24.63	24.63	20.93	20.93
Cal GAS #1	0.97	0.991	9.69	10.02	10.13	10.01
Deviation		2.12%		3.29%		1.20%
Cal GAS #2	2.35	2.36	5.78	5.88	5.69	5.55
Deviation		0.42%		1.70%		2.52%
Cal GAS #3	7.6	7.68	19.27	19.86	17.64	17.16
Deviation		1.04%		2.97%		2.80%
Average Deviation		1.19%		2.65%		2.17%

ITS EQUIPMENT CALIBRATION RECORD

ITS# 56

DESCRIPTION: Chart Recorder

MANUFACTURER: Cole Parmer

SERIAL #: 221068 MODEL: 8376-XX

EQUIPMENT LOCATION: E & E

PURPOSE & ACCURACY: ± 0.2 °C

CALIBRATION SPECIFICATIONS/INTERVAL: 1 yr.

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
11/24/98	11/24/99	Cal Lab		
11/22/99	11/22/00	"		

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

CAL LAB

CERTIFICATE OF CALIBRATION

Cert. No. 1041317

Customer	Equipment
Intertek Testing Services	Manufact: Cole Parmer
8431 Murphy Dr.	Descript: Chart Recorder
Middleton, WI 53562	Model #: 8376-XX
	Serial #: 221068
	I.D. #: 000056

Calibration Date: 11/22/1999 Recalibration Date: 11/22/2000

Received Condition: Fully operational and within tolerance

Work Performed: No adjustments required and calibrated to manufacturers specifications using manufacturers procedure

Test Conditions: Temperature: 68°F Humidity:45% Technician:Jim Goff On site

Standards Used

1239 Datron 4800 Multifunction Calibrator 01/31/2000 1330 Fluke 743B Process Calibrator 01/31/2000

This instrument was calibrated with a minimum 4:1 TUR/TAR unless otherwise stated. These represent test uncertainties. Actual uncertainties are available upon request.

Best Measurement Uncertainty

DC Voltage ±8.5ppm Temperature ±0.2°C

Reviewed and approved by Mike Boothe
Quality Team Member
Issue Date:11/23/1999

This Report Certifies that all Calibration Equipment used in the test is traceable to the NIST, and the test was performed in accordance to ANSI/NCSL Z540-1-1994 (FORMERLY MIL-STD 45662A)

ITS EQUIPMENT CALIBRATION RECORD

ITS# 54

DESCRIPTION: Digital Type K Thermocouple Meter

MANUFACTURER: Omega

SERIAL #: 21662 MODEL: 199-KF-A-X

EQUIPMENT LOCATION: E+E

PURPOSE & ACCURACY: ~~±2°F~~ ±2°F (with)

CALIBRATION SPECIFICATIONS/INTERVAL: 6 months

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
12/11/98	6/11/99	In house	RA	
6/1/99	12/1/99	"	RA	
1/14/00	7/14/00	"	RA	

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

ITS Intertek Testing Services NA Inc.

Middleton, Wisconsin

CALIBRATION DATE: 11-14-00 **CALIBRATED BY:** RA
REVIEWED BY: [signature]

DESCRIPTION: K-Meter (Omega) **MODEL:** 199

SERIAL NUMBER: 21662 **WHI INVENTORY #054**
(located in E&E Lab)

USING: OMEGA CL 6503 CALIBRATOR
BK 2816 VOLTMETER

	CALIBRATOR	METER	VOLTMETER
SET AT	———	UNADJUSTED	———
	———	———	———

Calibrator	Voltmeter	Meter	Dev. °F	Calibrator	Voltmeter	Meter	Dev. °F
31.4	30	31	.4	912.6	912	912	.6
115.1	113	113	2.1	~~912~~			
196.9	196	196	.9	1051.6	1051	1051	.6
278.5	279	279	.5	1111.7	1111	1111	.7
446.8	446	446	.8	1211.3	1212	1211	.3
530.0	528	528	2.	1372.5	1373	1373	.5
611.4	610	611	.4	1433.7	1436	1434	.7
712.8	711	711	.2	1516.6	1517	1515	1.6
832.6	831	831	1.6	1748.6	1749	1748	.6

AVERAGE .852 °F

ITS EQUIPMENT CALIBRATION RECORD

ITS# 28

DESCRIPTION: Analytical Balance

MANUFACTURER: Ohaus

SERIAL #: 5336 MODEL: G110

EQUIPMENT LOCATION: E & E

PURPOSE & ACCURACY: ±.0001

CALIBRATION SPECIFICATIONS/INTERVAL: 6 months

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
6-2-97	12-2-97	In-house	RA	
6/25/98	12-25-98	"	WK	
12/11/98	6/11/98	"	RA	
6/1/99	12/1/99	"	RA	
1/14/00	7/14/00	"	RA	

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

ITS Intertek Testing Services NA Inc.

Middleton, Wisconsin

CALIBRATION DATE: 1-14-99 **CALIBRATED BY:** RA
REVIEWED BY: [signature]

DESCRIPTION: Analytical Balance **MODEL:** (Ohaus) Galaxy 110

SERIAL NUMBER: 5336 **WHI INVENTORY #028**

Ainsworth Class S Weight

WEIGHT	MEASURED	DEVIATION (g)
2 mg		
5 mg	.0050G 5 MG	0
10 mg	.0099 G	.0001
20 mg	0200 G	0
50 mg	.0501 G	.0001
100 mg	.1001 G	.0001
1 g	.9998 G	.0002
20 g	20.0003	.0003
50 g	50.0002	.0002
100 g	100.0001	.0001

AVERAGE DEVIATION = .00012 grams

ITS EQUIPMENT CALIBRATION RECORD

ITS# 22

DESCRIPTION: Manometer 0-1" Inclined

MANUFACTURER:

SERIAL #: 882 MODEL: 125 AV

EQUIPMENT LOCATION: Emissions Lab

PURPOSE & ACCURACY: ± 1% of FS (0.01 in)

CALIBRATION SPECIFICATIONS/INTERVAL: 6 mos.

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
3/17/94	9/17/94	Inhouse	WK	
10/1/94	4/1/95	"	WK	
4/11/95	10/11/95	"	RA	
10/16/95	4/16/96	"	RA	
4/19/96	10/19/96	"	WK	
10/9/96	4/9/97	"	RB	
5/14/97	11/14/97	"	RA	
12/16/97	6/16/98	"	RA	
8/12/98	2/12/99	"	RA	
1-22-99	7-22-99	"	RA	
7/16/99	1/16/00	"	RA	
1/14/00	7/14/00	"	RA	

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

ITS Intertek Testing Services NA Inc.

Middleton, Wisconsin

CALIBRATION DATE: 11-14-00 **CALIBRATED BY:** RH
REVIEWED BY: [illegible]

DESCRIPTION: Manometer Inclined 0-1" **MODEL: 125 AV**
Located in EE lab

SERIAL NEMBER: 8 82 **WHI INVENTORY #022**

CHANGE THIS TO 1 TIME PER YEAR

MICROTECTOR	MANOMETER	DEVIATION IN.
.022	.034.05	.002
.051	.084	.018
.086	.166	006
.113	.214	.012
.138	.262	.014
.165	.317	.013
191	.364	.018
.239	.462	.016

AVERAGE DEVIATION = .0124 **INCHES**

Note: Microtector reading is exactly ½ of the manaometer reading

ITS EQUIPMENT CALIBRATION RECORD

ITS# 021

DESCRIPTION: Alnor Velometer

MANUFACTURER: Alnor

SERIAL #: MD1057 MODEL: 8525

EQUIPMENT LOCATION: Calibrated - In-house

PURPOSE & ACCURACY: ±3% -75-79° / ±4% -68-86° / ±9% -32-122°

CALIBRATION SPECIFICATIONS/INTERVAL: 6 months

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
10-30-96	4-30-97	Alnor Instruments		Was broken - repaired 10/96
12-4-96	6-4-97	In-house	RA	
6-2-97	12-2-97	"	RA	
12/12/97	6/12/98	"	RA	
8/11/98	2/11/99	"	RA	
1-22-99	7-22-99	"	RA	
7/16/99	1/16/00	"	RA	
1/14/00	7/14/00	"	RA	

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

ITS Intertek Testing Services NA Inc.

Middleton, Wisconsin

CALIBRATION DATE: 1-14-00 **CALIBRATED BY:** RA
REVIEWED BY:

DESCRIPTION: Alnor Hot Wire Anemoter **MODEL: 8525**
Located in EE lab
SERIAL NUMBER: MD 1057 **WHI INVENTORY #021**

PITOT TUBE IN TUNNEL CENTER.

Barometric Pressure:

Manometer Reading	Tunnel Temp	Static Pressure	Velocity ft/sec	ft/min	Velometer ft/min	Deviation
.056	69	.168	15.89	953.1	810	15.02%
.041	68	.111	13.57	814.0	730	10.32%
.026	68	.084	10.80	647.9	640	1.22%
.115	66	.353	22.77	1366.3	1170	14.37
.262	66	.8	34.64	2078.2	1750	15.79
.28	66	.89	35.82	2151.8	1840	14.49

AVG. DEV 11.877%

$K_p = 85.49$
$C_p = .99$
$T_s = °F + 460$
$P_s = P_{Bar} + (P_g \text{ (static)})$ (a negative number)
$M_s = 28.56$

$$V_s = K_{pCp(AP)} \frac{T_s}{P_s + M_g}$$

Excel program is located: K:\groups\test\dept\misc\ee\calibrat\velomete

EQUIPMENT CALIBRATION RECORD
WARNOCK HERSEY, INC.
MIDDLETON, WISCONSIN 53562

A. IDENTFICATION:

1. TYPE AND MODEL DESIGNATION - Dry Gas Meter Calibration

2. MANUFACTURER/SUPPLIER - ① Rockwell T-110 #26866 WHI #12
② Rockwell T-110 #26873 WHI #13
③ Rockwell T-110 #27002 WHI #14

3. SERIAL NO./WH DESIGNATION NO.

B. EQUIPMENT LOCATION:

1. PURPOSE & ACCURACY - ±.05 CFH

2. CALIBRATION INTERVAL - 6 Months

C. CALIBRATIONS: DONE BY-

CALIBRATION DATE	CALIBRATION DUE NEXT	CALIBRATION AGENCY	ACCEP	CALIBRATION RESULTS ADJUSTMENTS REQUIRED
1/3/96	7/3/96	In house	[illegible]	
7/9/96	1/9/97	In-house	[illegible]	
12-4-96	6-4-97	In house	RA	
6-2-97	12-2-97	"	RA	
12/12/97	6/12/98	"	RA	
6/22/98	12/22/98	"	WK	
1/19/99	7/19/99	"	RA	
5/3/99	11/3/99	MG + E	—	
1/12/00	7/12/00	In-house	RA	

D. MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR OR MAINTENCANCE

ITS EQUIPMENT CALIBRATION RECORD

ITS# 12, 13, 14

DESCRIPTION: Dry Gas Meter Calibration

MANUFACTURER: ① Rockwell T-110 #26866 #12
② Rockwell T-110 #26873 #13

SERIAL #: ③ Rockwell T-110 # 27602 MODEL: #14

EQUIPMENT LOCATION:

PURPOSE & ACCURACY: ± .05 CFH

CALIBRATION SPECIFICATIONS/INTERVAL: 6 months

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

ITS Interte. esting Services

Page ___ of ___

Manufacturer ROCKWELL Model T110 Date 1/2-99

Job # _____ Run _____ Tech RA

SPIROMETER (Six Month Dry Gas Meter Calibration)

SN 27002 Meter Number 3 Inventory Number 014

Run Number	Meter Initial	Barometric Pressure	Spirometer Temperature	Vapor Press (H2O)	Meter Temperature	Meter Pressure	Measurement Inches	Spirometer Volume	Meter Final	Y
1	294.005	29.22	66	.6380	65.5	.47	23.03125	~~295.005~~	295,005	1.0230
2	295.005	29.19	65	.6160	65.5	.47	23.125	~~296.000~~ 1.0469	296.008	1.0269
3	296.608	29.19	66.5	.6495	65	.47	23.5625	1.0710	297.032	1.0197
4	298.083	29.19	66	~~.6380~~	65.5	.47	22.9375	1.0426	299.082	1.0195
5	~~299.082~~	29.19	66	.6380	65	.47	23.125	1.0511	~~300.328~~	1.0206
6	300.328	29.19	65	.6160	65	.47	22.875	1.0398	301.329	1.0168
7										
									AVERAGE	1.0212

99.3225 ~~255.8407~~

SN 26864 Meter Number 1 Inventory Number 012

1.0469

1	902.825	29.22	66	.6380	68	.47	23.03125	~~903.833~~	903.833	1.0198
2	903.833	29.19	65	.6160	68.5	.47	23.125	1.0511	904.848	1.0205
3	904.848	29.19	66.5	.6495	69	.47	23.5625	1.0710	905.893	1.0069
									AVERAGE	1.0157

SN 26873 Meter Number 2 Inventory Number 013

84.436 ~~164.211~~

1	283.205	29.19	66	.6380	67	.47	22.9375	1.0426	284.197	1.0300
~~2~~	~~284.197~~	29.19	66	.6380	67	.47	23.125	1.0511	~~300~~ 285.428	~~1.0384~~
3	285.428	29.19	65	.6140	67		22.875	1.0398	286.4105	1.0399
									AVERAGE	1.0361

$$Y = \left[\frac{V_{SPR}}{MR_F - MR_I}\right]\left[1 - \frac{P_{H2O}}{P_{BAR}}\right]\left[\frac{T_M + 460}{T_{SPR} + 460}\right]$$

SPIROMETER

1.003

01/12/00	Barometer:	29.1		Meter Number	13	Inventory Numbe	14		
Meter Initial	Barometric Pressure	Spirometer Temperature	Vapor Press (H2O)	Meter Temperature	Meter Pressure	Measurement Inches	Spirometer Volumn	Meter Final	Y
294.005	29.22	66	0.6380	65.5	0.47	23.03125	1.0469	295.005	1.0230
295.005	29.19	65	0.6160	65.5	0.47	23.125	1.0511	296.008	1.0269
296.008	29.19	66.5	0.6495	65	0.47	23.5625	1.0710	297.032	1.0197
298.083	29.19	66	0.6380	65.5	0.47	22.9375	1.0426	299.082	1.0199
299.3225	29.19	66	0.6380	65	0.47	23.125	1.0511	300.328	1.0206
300.328	29.19	65	0.6160	65	0.47	22.875	1.0398	301.329	1.0168
								AVERAGE	1.0212
				Meter Number	1	Inventory Numbe	12		
Meter Initial	Barometric Pressure	Spirometer Temperature	Vapor Press (H2O)	Meter Temperature	Meter Pressure	Measurement Inches	Spirometer Volumn	Meter	Y
902.825	29.22	66	0.6380	68	0.47	23.03125	1.0469	903.833	1.0198
903.833	29.19	65	0.6160	68.5	0.47	23.125	1.0511	904.848	1.0205
904.848	29.19	66.5	0.6495	69	0.47	23.5625	1.0710	905.893	1.0069
								AVERAGE	1.0157
				Meter Number	2	Inventory Numbe	13		
Meter Initial	Barometric Pressure	Spirometer Temperature	Vapor Press (H2O)	Meter Temperature	Meter Pressure	Measurement Inches	Spirometer Volumn	Meter Final	Y
283.205	29.19	66	0.6380	67	0.47	22.9375	1.0426	284.197	1.0300
284.436	29.19	66	0.6380	67	0.47	23.125	1.0511	285.428	1.0384
285.428	29.19	65	0.6160	67	0.47	22.875	1.0398	286.4105	1.0399
								AVERAGE	1.0361

ITS EQUIPMENT CALIBRATION RECORD

ITS# #9, 10, 11

DESCRIPTION: CO, CO2, O2 Analyzers

MANUFACTURER: Horiba & Beckman

#9 #10 #11

SERIAL #: CO PIR-2000 6110019 MODEL: CO2 PIR-2000 607023 O2 755 1001926

EQUIPMENT LOCATION:

PURPOSE & ACCURACY: ± 1% of FS

CALIBRATION SPECIFICATIONS/INTERVAL: 6 mos.

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
7/16/99	1/16/00	In House	RA	
1/17/00	7/17/00	"	RA	

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

ITS Intertek Testing Services NA Inc.

Middleton, Wisconsin

CALIBRATION DATE: 1-17-00 **CALIBRATED BY:** RA
REVIEWED BY:

DESCRIPTION: Gas Analyzers
Located in EE console

SERIAL NUMBER: 6110019 CO **WHI INVENTORY #009**
SERIAL NUMBER: 607023 CO_2 **WHI INVENTORY #010**
SERIAL NUMBER: 1001926 O_2 **WHI INVENTORY #011**

GAS ANALYZER RESPONSE TIME
CALIBRATION GAS USED

	CO	CO_2	O_2
Analysis:	.991	10.02	10.01
Meter Reading Direct Connection:	.98	9.74	10.08
90% of Analysis:	.892 ~~.891~~ RA	9.02	9.01

- Meters set with zero gas and span gas.
- Calibration gas routed through impinger train.
- Zero gas was introduced after each time trial to return meter to zero.

		Trial	Time		Trial	Time
CO	90% (.892)	1.	5 sec	100% (.95)	1.	11 sec
		2.	5 sec		2.	10 sec
		3.	5 sec		3.	10 sec
		Average	5 sec		Average	10.33 sec
CO_2	90% (9.02)	1.	5 sec	100% (9.43)	1.	11 sec
		2.	5 sec		2.	11 sec
		3.	6 sec		3.	11 sec
		Average	5.33 sec		Average	11 sec
O_2	90% (9.01)	1.	14 sec	100% (10.16)	1.	30 sec
		2.	16 sec		2.	30 sec
		3.	16 sec		3.	32 sec
		Average	15.33 sec		Average	30.67 sec

ITS EQUIPMENT CALIBRATION RECORD

ITS# ~~EB~~ 500

DESCRIPTION: THERMOCOUPLES

MANUFACTURER: OMEGA

SERIAL #: — MODEL: —

EQUIPMENT LOCATION: E+E CAB

PURPOSE & ACCURACY:

CALIBRATION SPECIFICATIONS/INTERVAL: BOILING WATER ICE BATH 6 MONTHS

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
6-4-97	12-4-97	IN HOUSE	RA	
12-12-97	6-12-98	"	RA	
6-26/98	12-26-98	"	WK	
12-11-98	6-11-99	"	RA	
6/1/99	12/1/99	"	RA	

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

ITS Intertek Testing Services NA Inc.

Middleton, Wisconsin

CALIBRATION DATE: 6-1-99 **CALIBRATED BY:** RA

REVIEWED BY: [illegible]

500

ITS # TC

ROOM TEMPERATURE 74

Thermocouple number and location	Thermocouple immersed in boiling water	Thermocouple immersed in ice bath
1) Flue Gas	212	34
2) Room Temperature	212	34
3) Dry Bulb (in tunnel)	212	34
4) Wet Bulb (in tunnel)	211	33
5) Unit Top	212	34
6) Unit Back	211	33
7) Unit Right Side	212	34
8) Unit Left Side	212	33
9) Unit Bottom	212	34
10) Catalyst Downstream	212	34
11) Catalyst Center	212	34
12)	212	34
13)	212	34
14)	212	34
15)	212	34
16)	212	34
17) DGM (in)	212	34
18) DGM (out)	212	34
19) Filter (1)	212	34
20) DGM (in)	212	34
21) DGM (out)	212	34
22) Filter (2)	212	34

ITS EQUIPMENT CALIBRATION RECORD

ITS# 8 & 259

DESCRIPTION: Weigh

MANUFACTURER: Tronix

SERIAL #: (8) 6800082 (259) 03082 MODEL: (8) NCI 5780 (259) WI 110

EQUIPMENT LOCATION:

PURPOSE & ACCURACY: .1 lb

CALIBRATION SPECIFICATIONS/INTERVAL: 6 Months

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
8-11-98	2-11-99	In-house.	RA	
5-19-98	11-19-98	Cream City	—	
11-98	5-99	CREAM CITY	JEFF	
5/21/99	11/21/99	" "	CC	
11/99	5/00	Cream City	Jeff	

MAINTENANCE AND REPAIR:

DATE OUT OF SERVICE	DATE BACK IN SERVICE	REPAIR AGENCY	DESCRIPTION OF REPAIR

*6

Certificate of Calibration

CREAM CITY SCALE, CO INC.

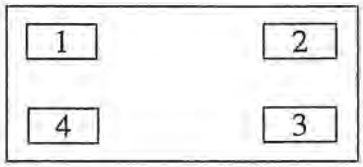
2009 S. Stoughton Rd., Madison, WI 53716 (608) 222-9427 or (888) 934-4448

CUSTOMER ITS. DATE 11/99
ADDRESS 8931 Murphy DR
CITY, STATE & ZIP Middleton WI 53562

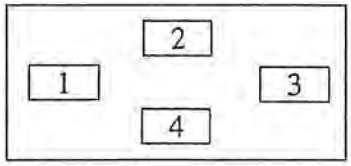
INDICATOR MFG.	GSE	CAPACITY	1000 Lb	CLASS	III
MODEL	450	DIVISIONS	.01	ACCURACY	1/0
SERIAL NO.	10122	LOCATION	E&E	TOLERANCES USED	HB44
BASE MFG.	NCI	I.D. #			
MODEL	3220	CALIBRATION INTERVAL		Semi Annual	
SERIAL NO.	790193	NEXT CALIBRATION DUE		5/00	

SHIFT TEST

FLOOR SCALE



BENCH SCALE



SECTION	LOAD	READING	ERROR
1	50.00	50.00	0
2	50.00	50.00	0
3	50.00	50.00	0
4	50.00	50.00	0

IS SHIFT TEST WITHIN TOLERANCE (X) YES ( ) NO ( ) ADJUSTED

INCREASING LOAD TEST

PRELIMINARY LOAD TEST

SUBSTITUTION WEIGHT	TEST WEIGHT	READING	ERROR
	5.00	5.00	0
	10.00	10.00	0
	15.00	15.00	0
	20.00	20.00	0
	25.00	25.00	0
	50.00	50.00	0
	75.00	75.00	0

IS SCALE WITHIN MAINTENANCE TOLERANCE (X) Y ( ) N
(if no, see final load test)

FINAL LOAD TEST AFTER ADJUSTMENT

SUBSTITUTION WEIGHT	TEST WEIGHT	READING	ERROR

IS SCALE WITHIN ACCEPTANCE TOLERANCE ( ) Y ( ) N

WAS SCALE WITHIN CUSTOMERS REQUIRED ACCURACY? (X) Y ( ) N

COMMENTS:

TEST WEIGHT CLASSIFICATION F
NIST TRACEABILITY CERTIFICATE NO. W45-206
LIST TEST WEIGHTS USED BY SERIAL NO. K75, 71

SCALES WERE CALIBRATED WITH THE CERTIFIED TEST WEIGHTS, ADJUSTMENTS TO RESTORE AND/OR MAINTAIN THE ACCURACY OF THE SCALE CONFORM TO THE TOLERANCES ESTABLISHED BY THE NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY AS SPECIFIED IN HANDBOOK 44.

TECHNICIAN

White - Customer Copy Canary - Office Copy

#25

Certificate of Calibration

CREAM CITY SCALE, CO INC.

2009 S. Stoughton Rd., Madison, WI 53716 (608) 222-9427 or (888) 934-4448

CUSTOMER I.T.S. DATE 11/99

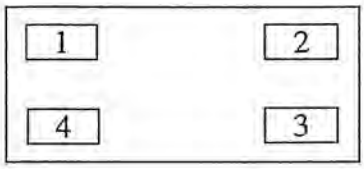
ADDRESS 8431 Murphy DR

CITY, STATE & ZIP Middleton WI 53562

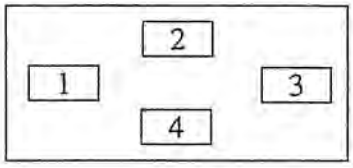
INDICATOR MFG.	Weigh-Tronix	CAPACITY	980#	CLASS	III
MODEL	WI 110	DIVISIONS	.1	ACCURACY	1%
SERIAL NO.	30821	LOCATION	E+E	TOLERANCES USED	
BASE MFG.	Toledo	I.D. #	259		HB 44
MODEL	Dormant	CALIBRATION INTERVAL		Semi Annual	
SERIAL NO.	N/A	NEXT CALIBRATION DUE		5/00	

SHIFT TEST

FLOOR SCALE



BENCH SCALE



SECTION	LOAD	READING	ERROR
1	500	500	0
2	500	500	0
3	500	500	0
4	500	500	0

IS SHIFT TEST WITHIN TOLERANCE (X) YES ( ) NO ( ) ADJUSTED

INCREASING LOAD TEST

PRELIMINARY LOAD TEST

SUBSTITUTION WEIGHT	TEST WEIGHT	READING	ERROR
	50.0	50.0	0
	100.0	100.0	0
	200.0	200.0	0
	400.0	400.0	0
	600.0	600.0	0
	800.0	800.0	0
	900.0	900.0	0

FINAL LOAD TEST AFTER ADJUSTMENT

SUBSTITUTION WEIGHT	TEST WEIGHT	READING	ERROR

IS SCALE WITHIN MAINTENANCE TOLERANCE (X) Y ( ) N
(if no, see final load test)

IS SCALE WITHIN ACCEPTANCE TOLERANCE ( ) Y ( ) N

WAS SCALE WITHIN CUSTOMERS REQUIRED ACCURACY? (X) Y ( ) N

COMMENTS:

TEST WEIGHT CLASSIFICATION F

NIST TRACEABILITY CERTIFICATE NO. 4198-206

LIST TEST WEIGHTS USED BY SERIAL NO. 71, 72, 73, 74, 75, 76, 77, 78, M685

SCALES WERE CALIBRATED WITH THE CERTIFIED TEST WEIGHTS, ADJUSTMENTS TO RESTORE AND/OR MAINTAIN THE ACCURACY OF THE SCALE CONFORM TO THE TOLERANCES ESTABLISHED BY THE NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY AS SPECIFIED IN HANDBOOK 44.

TECHNICIAN

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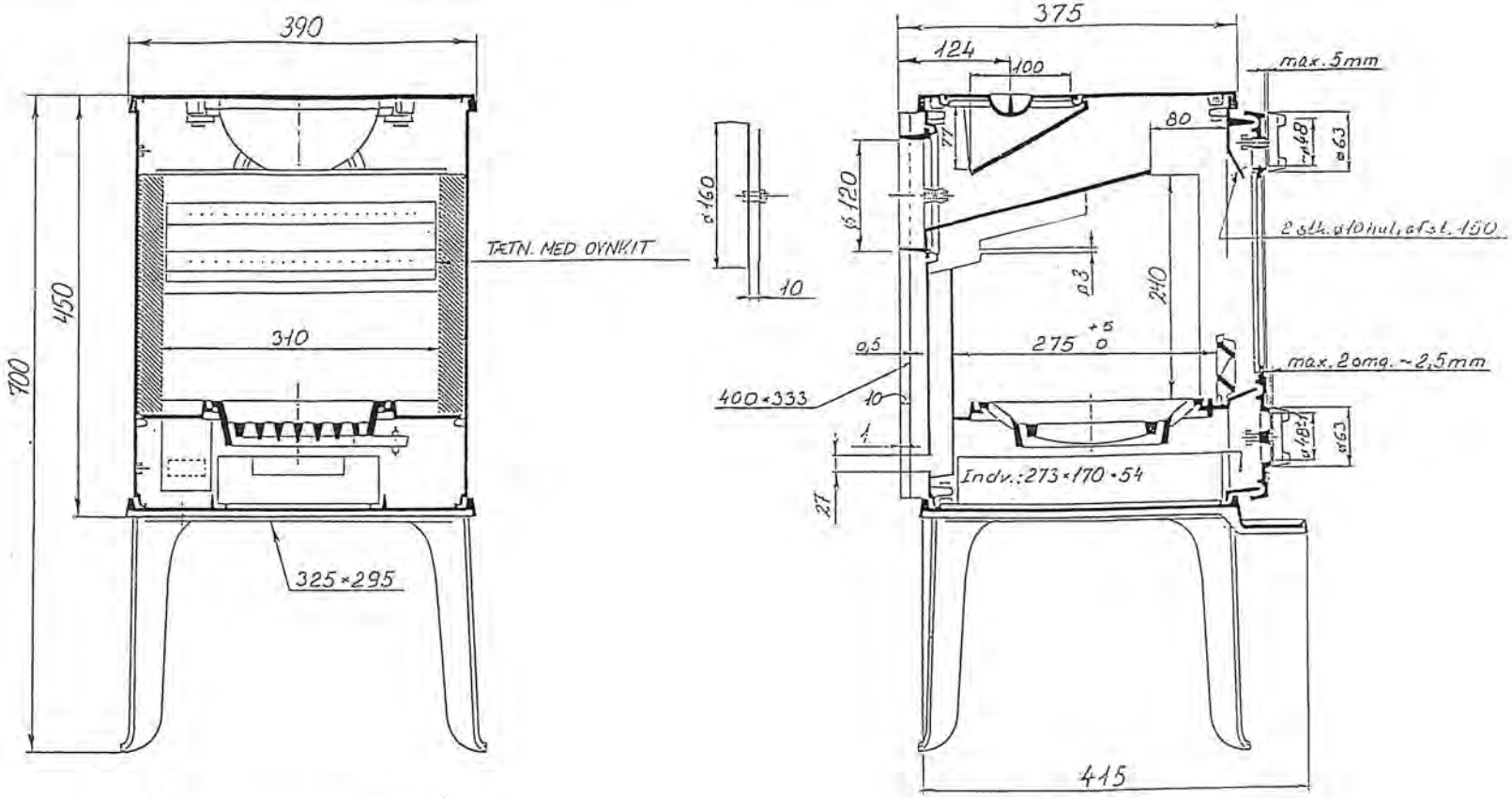
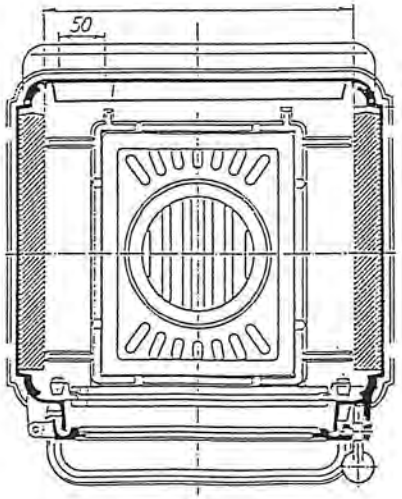
APPENDIX F

Specifications for Morsø 1410 N

Dimensions:	Height: 700 mm, Width: 390 mm, Depth: 395 mm
Cast items:	GG 15-20, thickness 5 mm
Pipe connection:	Rear or top, Ø 120 mm
Brick:	Refractory chamotte bricks, thickness 25 mm
Glass:	5 mm high-temperature resistant, laid in 2 mm ceramic paper
Glass frame:	1.5 mm stainless steel
Sealing strip:	5 mm and 8 mm ceramic glass cord
Internal plate sections:	3 mm high-temperature resistant plates
Ash pan:	1 mm SPD plate
Rear convection plate:	1 mm SPD plate
Heat shield:	0.5 mm galvanised plate
Spacing bushes:	Ø 20 x 1 mm galvanised pipe
Screws:	M6, no special strength requirements
Surface:	Coated with senotherm
Accessories:	Poker, ceramic sealing cord for assembling pipe sections, and Morsø glove

26th January 1999 - Sign.: Rita Svenningsen
Morsø Jernstøberi A/S - DK-7900 Nykøbing Mors

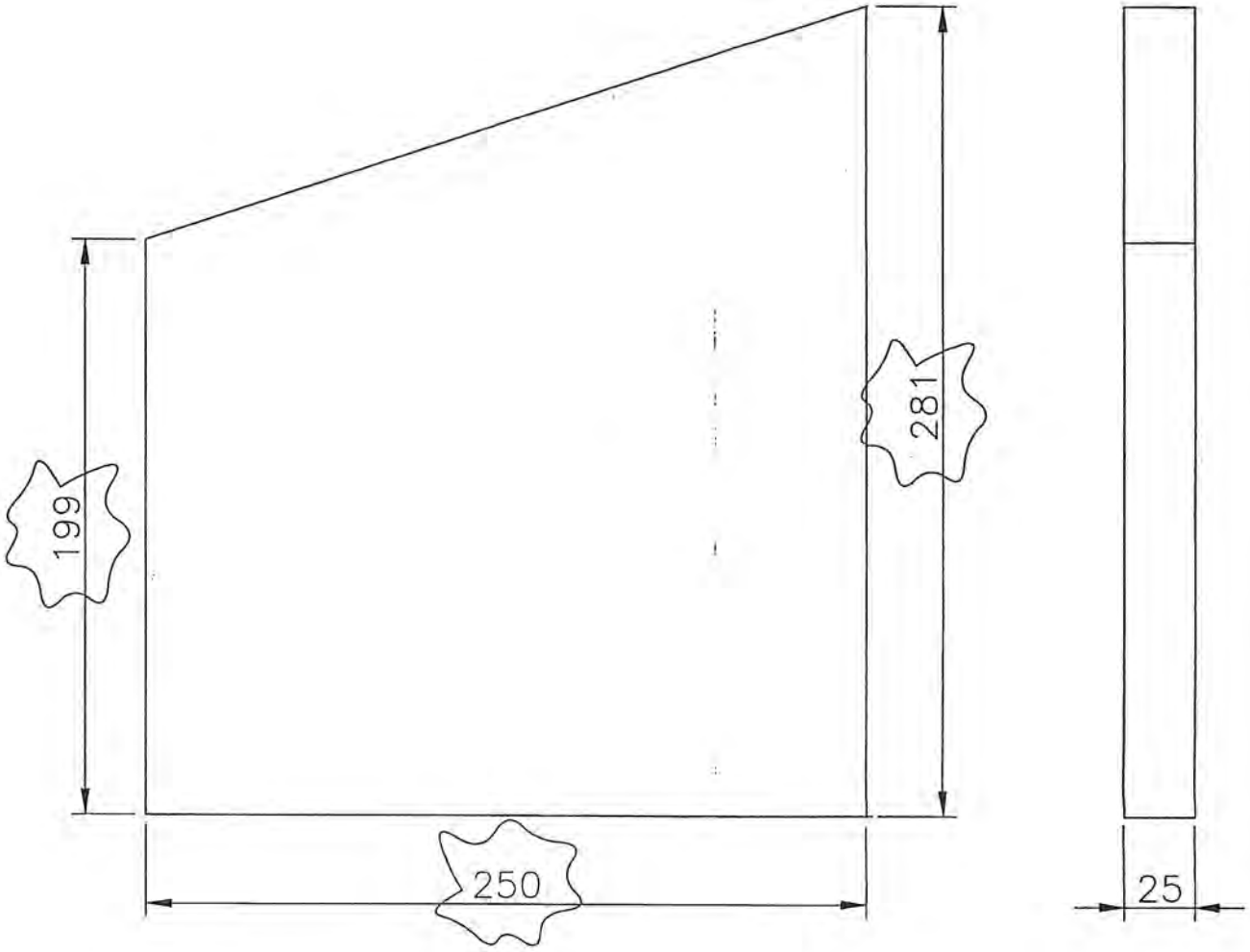




LEVERANDØR TIL
DET KGL. DANSKE HOF
morsø
AKTIESELSKABET
N. A. CHRISTENSEN & CO.
DK-7900 NYKØBING MORS
TLF. 07-72 1300

MORSØ 1410/1415

DATO 27/10-1997	SIGN. KAA
MÅL 1:5	ÆNDRET
	MODELNR.
TEGNINGSNR. 1400-180-3	



Tolerance: + 0 %
− 2 %

Matr. Ildfast sten

Rev.	Revision	Sign.	Dato
b	Mål ændret	RSV	11.02.98
c	Mål ændret	RSV	17.04.98

Titel:
Sidesten
Morsø 1440 N

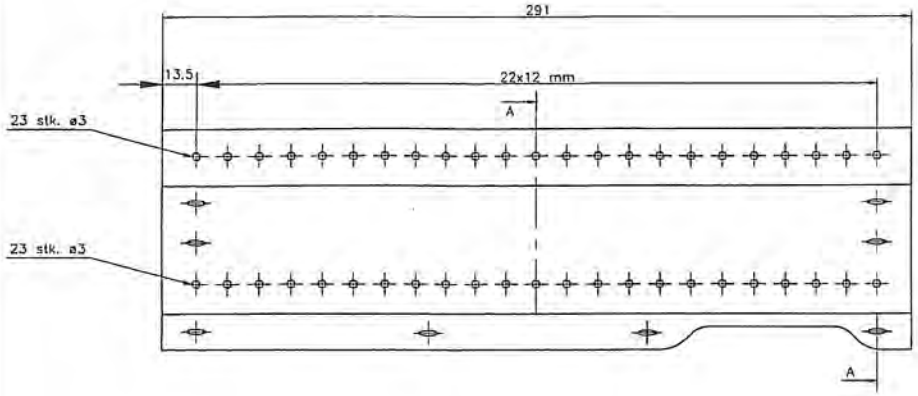
Filnavn:
1400−189

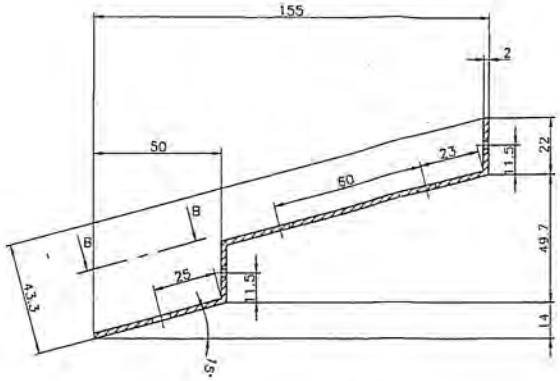
morsø
Jernstøberi A/S

Sign.:	Dato:
RS	980205
Tegn.form.:	Målforhold
A4	1:2.5

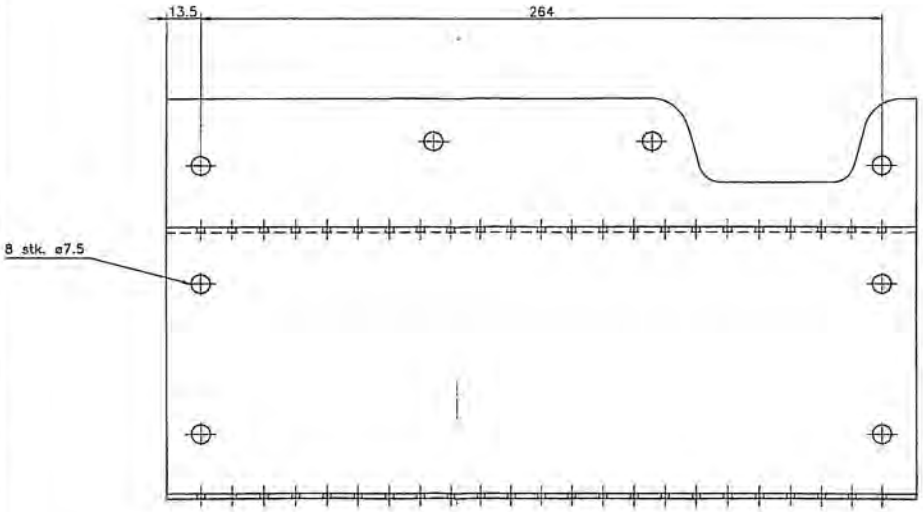
Varenummer:
79094700

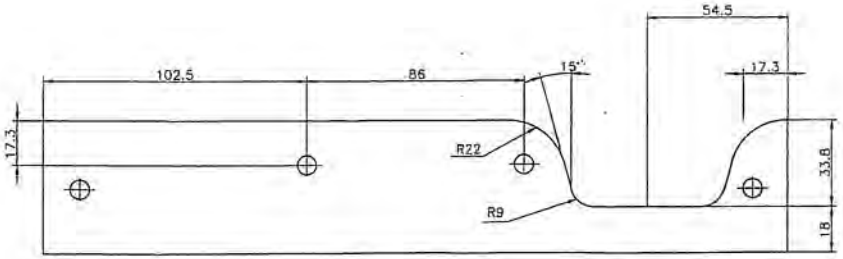
Tegningsnummer:
1400−189 c





Snit A-A





Snit B-B

Generelle tolerancer ± 0.5mm

Matr.: Mo 3 (Rustfast stål)

Revision	Sign.	Dato
Ændret	RS	09.02.98
Tilføjet mål	RS	10.02.98
Tilføjet huller+mål	RS	13.02.98
Ændret mål+radie	RS	18.02.98

Titel:
Røgledeplade stål
Morsø 1440 N

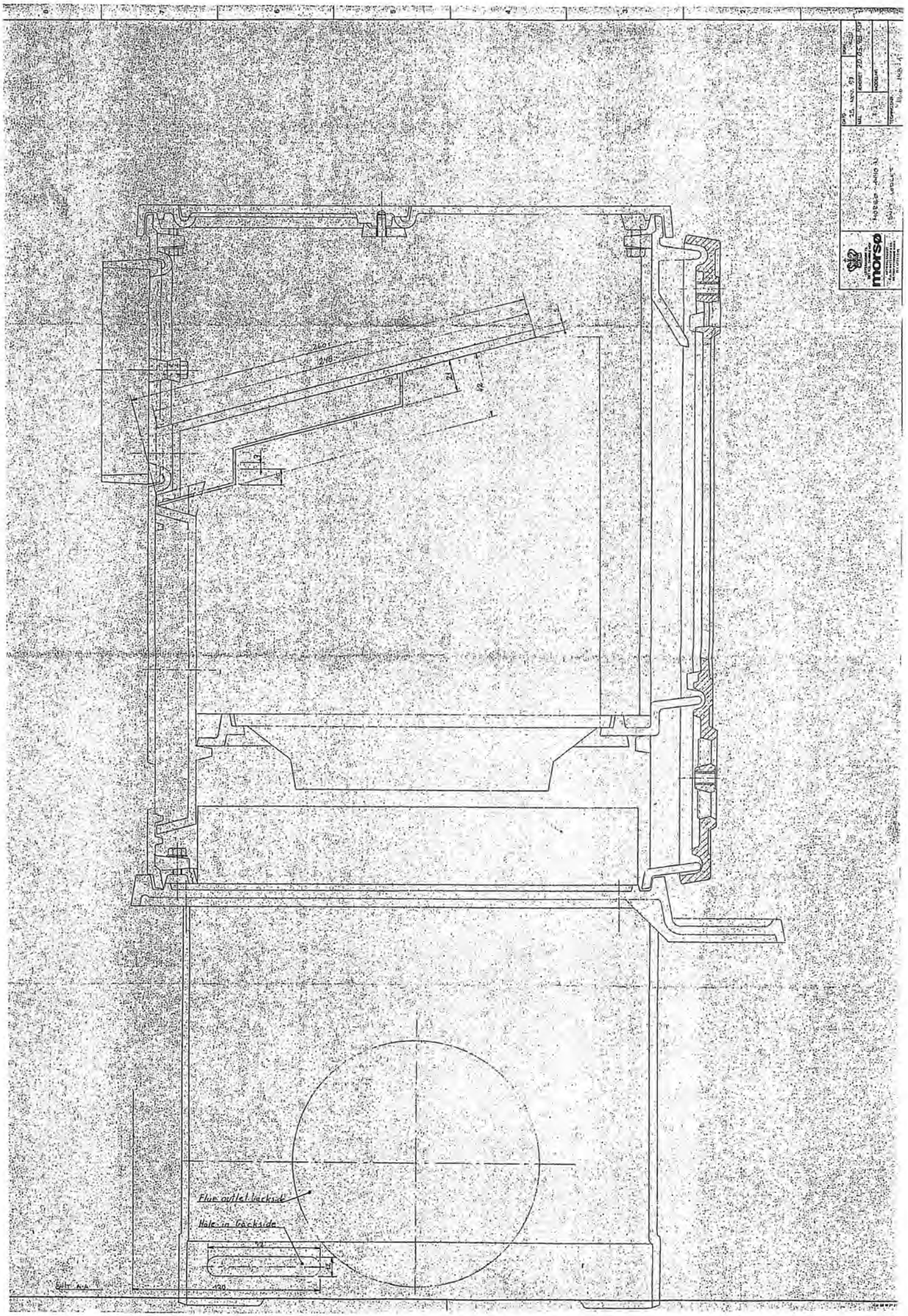
Filnavn:
1400-187

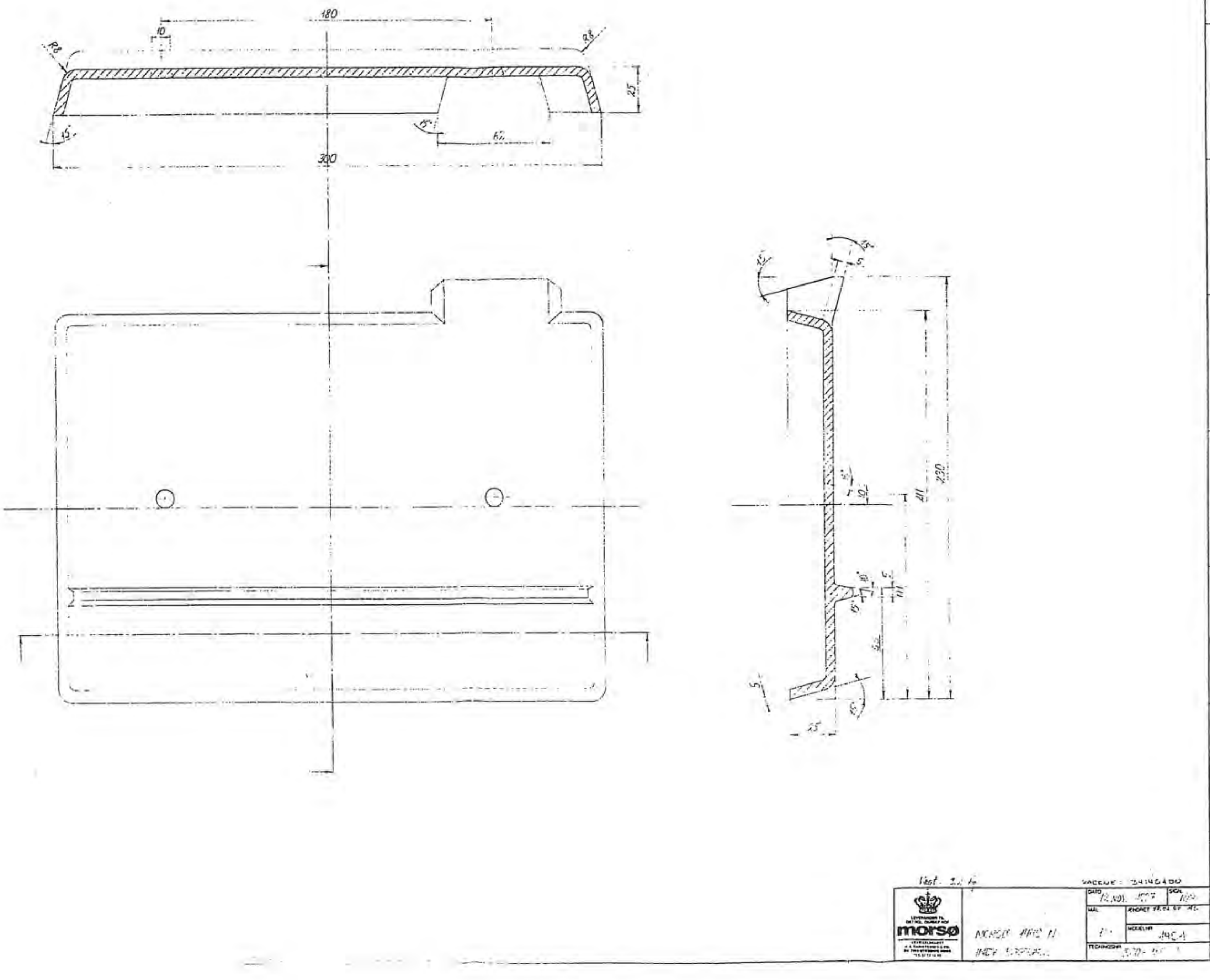
morsø
Jernstaberi A/S

Sign.:	Dato:
RS	09.02.98
Tegn.form.:	Målforhold
A3	1:2.5

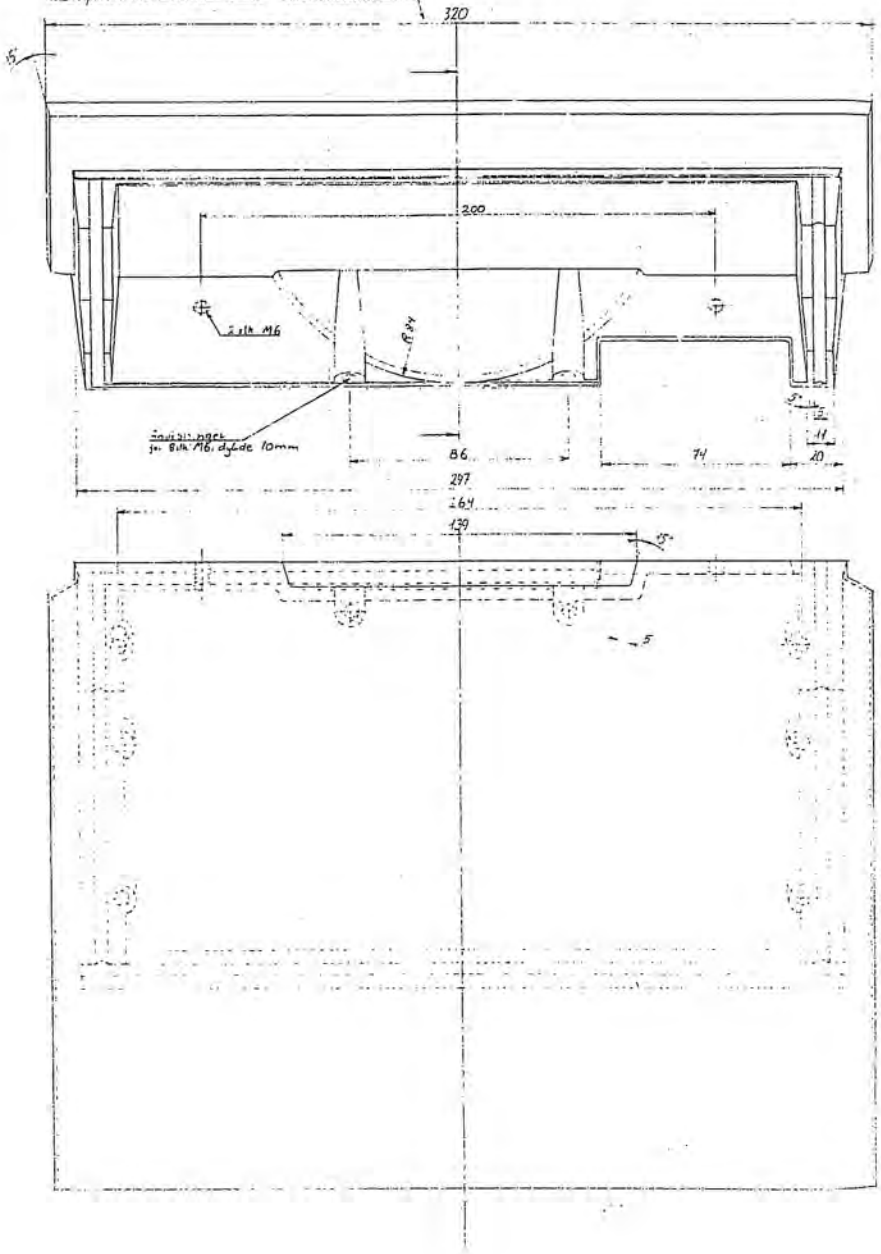
Varenummer:
71141361

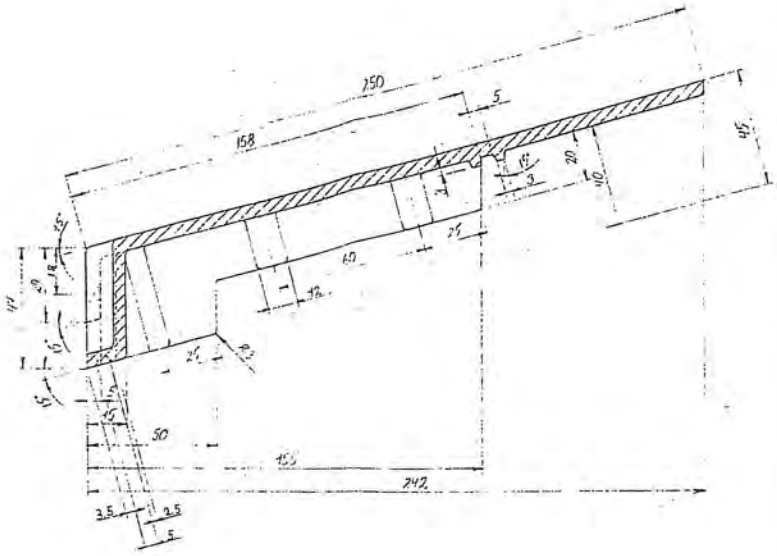
Tegningsnummer:
1400-187-3


260
248
21
12
Flue outlet backside
Hole in backside
12
120


180
10
R8
25
15°
62
300
230
5
morsø

De støbte knaster i siderne er ikke tegnet med på dette tegning





Vægt 4,3 kg

VARENR.: 341452.00

morsø		DATO 17.02.98	SIGN.
		MÅL 1:1	RETRET 17.02.98 85
			MODEL NR. 1452
		TEGNINGSNR.	

APPENDIX G

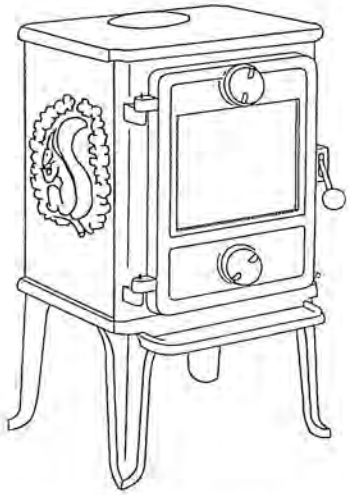
morsø

By appointment to the Royal Danish Court

Installation and Operating Instructions

1410 Squirrel

For use in North America



Read this entire manual before you install and use your new room heater. If this room heater is not properly installed, a house fire may result. To reduce the risk of fire, follow the installation instructions. Failure to follow instructions may result in property damage, bodily injury, or even death.

Contact local building officials about restrictions and installation inspection-equirements in your area.

Save these instructions

MORSØ JERNSTØBERI A/S . DK-7900 NYKØBING MORS
E-Mail: stoves@morsoe.com · Website: www.morsoe.com

Distributed by: HEARTHLINK INTERNATIONAL
9 Maple St. - Randolph, Vermont - 05060 - USA

We congratulate you on your choice of a Morsø stove. Morsø has been producing some of the world's best stoves since 1853. If you follow this installation- and operating instruction carefully, we can assure you many years of warmth and pleasure.

Optional Accessories

A wide range of accessories (such as handling gloves, fireside tools, glass cleaner and heatproof paint) are available for use with your Morsø stove. They help with day-to-day running and maintenance. Contact your Morsø dealer for more information.

The Morsø 1410 squirrel meets the U.S. Environmental Protection Agency's emission limits for wood heaters sold on or after July 1, 1990

Warnock Hersey ®

The Morsø 1410 squirrel has been tested by Intertek Testing Services and is listed by Warnock Hersey, Inc. The test standards are ANSI/UL-1482 for the United States and ULC S627 for Canada.

The stove is listed for burning wood only. Do not burn other fuels.

Under specific test conditions this heater has been shown to deliver heat at rates ranging from 11,000 to 25,000 Btu's.

CONTENTS:

1.0 Installation of your Morsø stove

Installation of woodburning stoves must be safe and legal.

If your Morsø stove is not installed correctly, it may cause a house fire. To reduce the risk of fire, the installation instructions must be followed carefully. Contact the local building officials about restrictions and installation inspection in your area.

Before you start installing your stove, make sure that:

- The stove and chimney connection are placed far enough from combustible materials to meet all clearance requirements.
- The floor protection must be adequate and must be made correctly according to the requirements.
All neccessary approvals are needed from the local building officials.

The data plate, which is located on the back of the stove, provides information regarding saftety testing information, name of certified testing laboratory, and installation requirements.

Installation requirements vary in different districts, and the local building officials have the final authorization to approve your installation. You should discuss the installation with them before beginning. Please ask your dealer for further information.

Do not connect to any air distribution duct or system.

Important: If the installation instructions are not followed carefully, it may cause dangerous situations like chimney - and house fires. Follow the instructions carefully and do not deviate from them as it may cause injuries to people or property.

1.1 Checking loose parts in the stove

After unpacking, check that the center grate (in the centre of the fire bed) and the fire bricks are firmly in position and have not shifted in transit. Check also that the air control works freely.

Standard Accessories

Poker, ceramic flue connection gasket and riddling tool are standard accessories, and can usually be found in the ashpan or firebox area.

1.2 The chimney / flue system

Note that the flue system must be independently secured and must not rely on the stove for support.

The stove must not be connected to a chimney flue serving any other appliance. (Several flues may run up a single chimney stack; use one flueway per appliance).

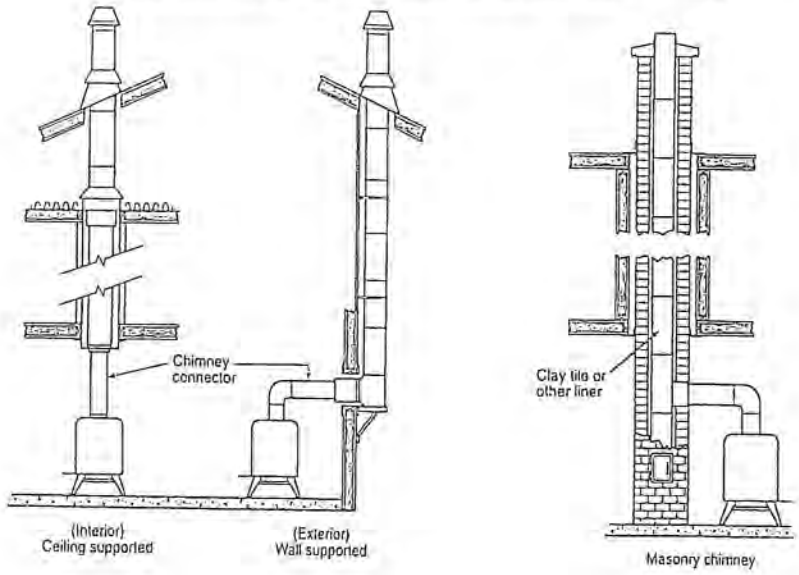
Use a residential type masonry or listed type HT factory-built chimney.

High Temperature (H.T.) Chimney Standard UL-103-1985 (2100° F.) for the USA, and High Temperature (650°C) Standard ULC S-629 for Canada.

The internal dimensions of the chimney connector and chimney must not be less than 6 inches diameter (or equivalent cross section), and should not be significantly larger than this. Too large a section will tend to allow the flue gases to cool excessively, causing sluggishness or unpredictability in the stove's performance.

The length of the chimney system should be at least 16 feet above the stove in normal domestic situations, measured from the flue collar to the top of the chimney.
Local conditions like for example - roof constructions, large trees nearby and high altitude, may influence the chimney draft and height. Therefore, contact the local professional chimney sweep or your Morsø dealer.

Typical Factory-Built or Masonry Chimney Installations



1.3 Flue Connection

The stove is supplied from the factory with a flue collar fitted to the top plate and a round blanking plate blocking off the rear flue exit (behind the rear shield plate).

The flue collar is from the factory prepared for fitting the enlosed 6 inche adapter.
Use a 24 MSG black or blue chimney connector or listed double wall chimney connector. Refer to local codes and the chimney manufacturer's instructions for precautions required for passing a chimney through a combustible wall or ceiling. Remember to secure the chimney connector with a minimum of three screws to the product and to each adjoining section.
The collar can be fitted to the rear outlet. Simply knock out the round panel on the rear heat shield plate to reveal the cast iron plate. Untwist the blanking plate and the flue collar and swap their positions. Re-secure by pushing down and tighten the enclosed screws.
Position the stove and connect to the flue system.

Wear gloves and protective eyewear when drilling, cutting or joining sections of chimney connector

1.4 Connection to the existing chimney

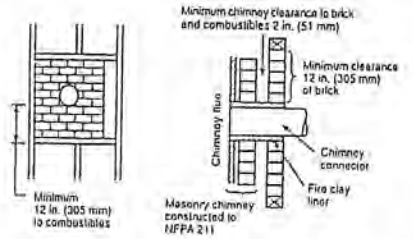
A Chimney connector is the double-wall or single-wall pipe that connects the stove to the chimney. The chimney itself is the masonry or prefabricated structure that encloses the flue. Chimney connectors are used only to connect the stove to the chimney.

Double-wall connectors must be tested and listed for use with solid-fuel burning appliances. Single-wall connectors should be made of 24 gauge or heavier gauge steel. Do not use galvanized connector; it cannot withstand the high-temperatures that smoke and exhaust gases can reach, and may release toxic furnes under high heat. The connector must be 6 inches (150mm) in diameter.

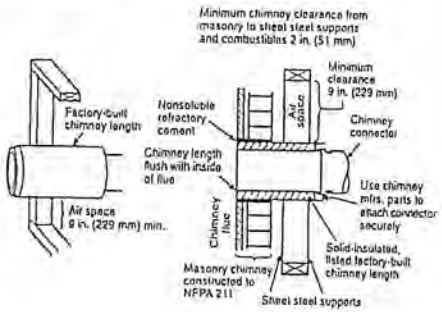
If possible, do not pass the chimney connector through a combustible wall or ceiling. If passage through a combustible wall is unavoidable, refer to the sections on Wall Pass- Throughs. Do not pass the connector through an attic, a closet or similar concealed space when installing the chimney connectors.

It is important to keep the flue gases moving smoothly in the right direction. Do not vent into a large void at this location; rather form one continuous section all the way up. Use mild bends (e.g. 45° vs. 90°) rather than sharp angles where a change of direction is required. All parts of the venting must be accessible for cleaning purposes.
In horizontal runs of chimney, maintain a distance of 18 inches from the ceiling. Keep it as short and direct as possible, with no more than two 90 degree turns. Slope horizontal runs of connector upward 1/4 per foot (20 mm per metre) going from the stove toward the chimney. The recommended maximum length of a horizontal run is 3 feet (1 metre), and the total length should be no longer than 8 feet (2.5 metres).
Information on assembling and installing connectors is provided by the manufacturer's instructions exactly as you assemble the connector and attach it to the stove and chimney.

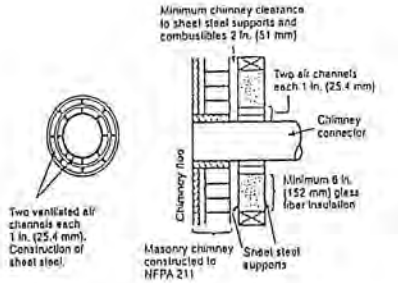
Be sure the installed stove and chimney connector are correct distances from near by combustible materials. See the clearance paragraph page 8.



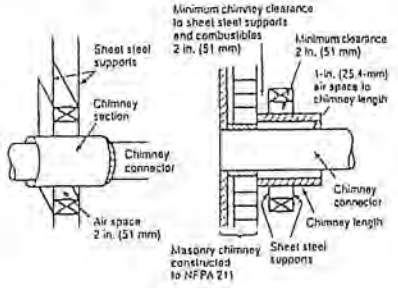
A Minimum 3.5-in thick brick masonry all framed into combustible wall with a minimum of 12-in brick separation from clay liner to combustibles. The fireclay liner shall run from outer surface of brick wall to, but not beyond, the inner surface of chimney flue liner and shall be firmly cemented in place.



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



C Sheet steel chimney connector, minimum 24 gauge in thickness, with a ventilated thimble, minimum 24 gauge in thickness, having two 1-in. air channels, separated from combustibles by a minimum of 6-in. of glass-fiber insulation. Opening shall be covered, and thimble supported with a sheet steel support, minimum 24 gauge in thickness.



D Solid insulated, listed factory-built chimney length with an inside diameter 2-in. larger than the chimney connector and having 1-in. or more of insulation, serving as a pass-through for a single wall sheet steel chimney connector of minimum 24 gauge thickness, with a minimum 2-in. air space between the outer wall of chimney section and combustibles. Minimum length of chimney section shall be 12-in. chimney section spaced 1-in. away from connector using sheet steel support plates on both ends of chimney section. Opening shall be covered, and chimney section supported on both sides with sheet steel supports securely fastened to wall surfaces of minimum 24 gauge thickness. Fasteners used to secure chimney section shall not penetrate chimney flue liner.

1.5 Positioning the stove

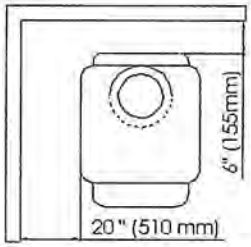
Distance to walls and lintel

When the stove is positioned near *combustible* materials, observe all current local and national building regulations with regards to clearances. Whatever regulations apply to your area, do not in any case install the stove within 8 inches of combustible materials around the sides or 16 inches above the top of the stove. These distances may need to be increased if the materials are sensitive to heat. Note also that wall paper and other decorative materials may become detached with the effects of heat and care should be taken to ensure that they do not fall towards the stove in such an event.

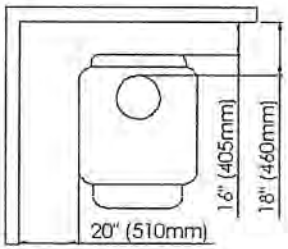
When the stove is positioned near *non-combustible* materials, a gap of 4 inches or more is recommended for cleaning purposes and to ensure that heat circulates around the stove and out into the room.

Clearance chart:

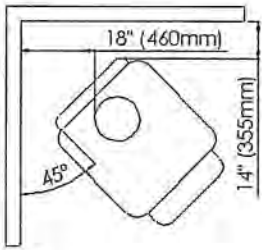
With double-wall or single-wall chimney connector				
	Unit to backwall	Unit to sidewall	Connector to wall	Unit corner to wall
Morsø 1410 double-wall	6" (155 mm)	20" (510 mm)		
Morsø 1410 single-wall	16" (405 mm)	20" (510 mm)	18" (460 mm)	
Morsø 1410 corner				14" (355 mm)



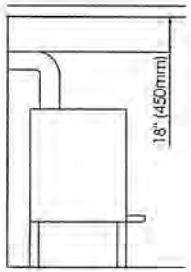
Double-wall chimney connector



Single-wall chimney connector



Corner

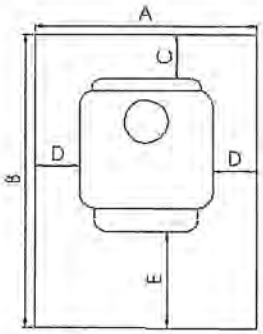


Side

On the floor

If the stove is to be placed on a combustible floor, a, solid, non-combustible layer should cover the floor beneath the stove. This layer should cover an area of at least 16 inches in front of the stove door and at least 8 inches either side of the opening and 6" to the rear.
You must ensure that the floor in this area can hold the weight of the stove comfortably.

In Canada non-combustible floor protector is required under the stove as well. The floor protector must extend 18 inches (460mm) to the front and 6 inches (155mm) from the sides and rear.



Top exit

	U.S.	Canada
A.	41"	41" (1045 mm)
B.	43"	45" (1145 mm)
C	6"	6" (155 mm)
D.	8"	6" (155 mm)
E.	16"	18" (460 mm)

Distance to furniture

The recommended minimum distance from stove to furniture is 30 inches. Note that some furniture is more easily affected by heat and may need to be moved to a greater distance. This is your responsibility.

In addition other combustible materials, away from the stove. In general, a distance of 30 inches must be maintained between the stove and moveable combustible item such as drying clothes, newspapers, firewood etc.

Note:

Acid Protection

If acid-washing the masonry around the stove, protect the stove surface with an acid-proof cover

Fresh Air Inlet

Unless there is deemed to be sufficient ambient leakage of air into the room via doorways, windows and the like, a dedicated fresh air inlet will be needed. This inlet should have 2 square inches (1250 square mm) of free air space. This is particularly important where the room is well sealed, or where an extractor hood or ventilation system disturbs the natural air pressure. Such an inlet should not be on a wall that is usually subject to negative pressure from normal wind pattern. Avoid placing the inlet directly across the room from the stove, thus causing a cold air draft.

2.0 Operation

2.1 Before you start firing

For Use with Solid Wood Fuel Only. Do Not Overfire, If Heater or Chimney Connector Glows You Are Overfiring. Inspect and Clean Chimney Frequently. Under Certain Conditions of use creosote buildup may occur rapidly. Because of risk of smoke and flame spillage, operate only with door fully closed.

Caution:
Hot while in operation. Keep children, clothing and furniture away. Contact may cause skin burns.
Do not use chemicals or fluids to start the fire.
Do not burn garbage or flammable fluids.

Choosing your fuel

All types of natural wood can be burned on your stove, but they must be well-seasoned and dry. Once the wood is cut to length, it should be split down middle - to suit the dimensions given below - to allow moisture to evaporate.
Cut the wood to a length of 10 inches (25 cm) and approx. 3 to 3,5 inches (7-8 cm) in section. If you can weigh your wood, aim for around 0,7 kg.
The maximum moisture content of the wood should be around 20%.
Store the logs under cover in a location where fresh air can move through the stack. Some soft woods may take as little as one good summer to season, where some harder woods may take a couple of years or more. Well seasoned wood will be remarkably light to hold and will probably have radial cracking at the ends. If your wood spits or sizzles when burnt, and your stove's door glass persistently mists up, your wood is not properly seasoned.
Never use drift wood (from the sea), whose salt content may cause corrosion, nor construction wood that may have been impregnated with chemicals.

Firing

The initial fire should be small, so that the stove paint can cure and the main plates of the stove can settle into position. Some fumes will be given off by the paint. Ventilate the room during this phase.
The setting of the valve, lighting techniques and loading intervals will depend on chimney draft, the fuel used, the heat required and so on. Some basic techniques are outlined below.

In principle

Your stove has two air supplies:
Primary air is controlled by the upper air controler of the door. The air eventually washes at high speed down the back face of the door glass. This super-heated air helps with the combustion of volatile gases produced by the fire.
Secondary air is supplied to the top of the fire through two rows of holes in the steel baffle. This effectively burns off other residual gases, making for very clean emissions. This air supply is

constant and cannot be varied.
The lower air controler on the door is fixed, and only for decoration purposes.

2.2 Lighting and loading intervals

When first lighting the stove, a large volume of air is needed. When the stove is cold, you should leave the door open an inch or two for the first few minutes and open the primary air supply completely. While the door is open, do not leave the stove unattended.

To form a reasonable bed of ash on the floor of the stove, you should use 5-6 inches thickness (2-4 pound) of dry kindling at the initial lighting. Always maintain a 1-1,5 inch (2-3 cm) layer of ash on the floor of the combustion chamber at all other times.

Step-by-step procedure

1. The air supply must be fully open. Maximum 4 turns.
2. Light the fire. An ember bed will quickly be formed by lighting with firelighters, morsø kindling bags or 7-10 pieces of twisted paper under the dry kindling wood (see above).
3. After lighting, partially close the door, leaving it open an inch or two to allow in plenty of combustion air.
4. When the chimney is warmed through after 5-10 minutes, the door should be closed. A suitable ember bed will be formed after a further 15-20 minutes.
5. When ready to reload, use a poker to spread the ember across the firebox floor, bringing plenty towards the front of the stove.
6. Lay three pieces of wood (see dimensions above) onto the embers. Leave half an inch (1 cm) or more between each piece. Place the ends of your logs towards the opening, but not too close to the front.

7. Close the door. Leave the primary air supply fully open.
8. After a few minutes, and adjust the primary air supply to suit your heating requirements.
9. Anticipate each refueling, remembering to add a modest layer of wood while there are still plenty of live embers, Repeat steps 5-8.

Do not for any reason attempt to increase the firing of your heater by altering the air control adjustment range outlined in these directions.

Warning: Fireplace stoves must never be left unattended with doors open.

If door are left partly open, gas and flame may be drawn out of the fireplace stove opening, creating risks from both fire and smoke.

DO NOT OVERFIRE THIS HEATER. Overfiring may cause a house fire, or can result in permanent damage to the stove. If any part of the stove glows, you are overfiring.

Draft conditions

If smoke or fumes come out of your stove when lightning up and reloading, or if the fire simply will not respond, a poor draft is almost certainly to blame. (In a very few cases, there may be insufficient fresh air getting into the room - see installation advice above). Take advice from your stove supplier on how best to upgrade your flue system to improve draft.

Rules of woodburning

If you want less heat, put fewer logs on the stove and reduce the amount of air. It is still important to maintain a good layer of embers.

Less heat - less wood - less air
Greater heat - more wood - more air
Soot deposits will settle on the glass if the stove is run too slowly or if your wood is not well seasoned.

3.0 MAINTENANCE

When perfoming maintenance on ,your stove always protect yourself, using safety goggles or gloves

3.1 Exterior Maintenance

The stove surface is painted with heat-resistant Senotherm paint. It is best kept clean by vacuuming with a soft brush attachment or by wiping with a lint-free cloth.
Over a period of time, the painted surface may become slightly grey. A can of Morsø touch-up spray paint should be available from your stove supplier. This can be applied - in accordance with the instructions - in just a few minutes. When first firing after touching up, the stove will give off a slight smell as the paint cures. Make sure to ventilate the room well during this phase.

3.2 Internal maintenance

Glass

If the stove is generally run at the correct temperatures, there should be little or no dirt on the glass. If dirt does settle during lighting, most will burn off as temperatures increase.For heavier deposits that will not burn off, use morsø glass cleaner, applied when the glass is cold, in accordance with the instructions.

Reasons for dirty glass

- **Fuel too wet**
- **Logs too large or not split**
- **Combustion temperatures too low**

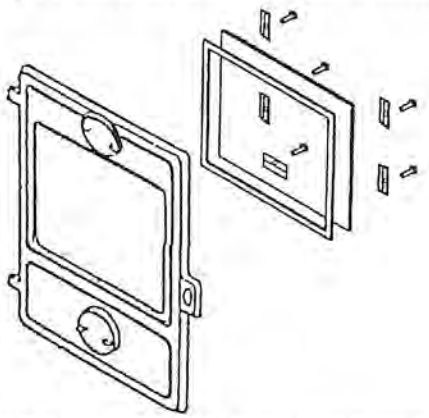
Replace broken glass immediately.
Do not operate your stove if the glass in the door is damaged.

If you need to replace the glass, it should be replaced with the high temperature ceramic class supplied by Morsø, contact your Morso dealer.

Installing the glass

Never install the glass when the stove is in function.

1. Lift the door off its hinges an place face-down on a sheet of cardboards or other non-abrasieve fabric.



2. Unscrew the five bolts that secure the glass. (In the event that a bolt sheers off when being unscrewed, remove the remaining body of the bolt by drilling down its cnetre with 1/8 inch high speed steel drill bit. Smaller drill bits may be successful, but do not use a lager bit. Make sure the bit stays away from the edges of the bolt - this may damage the thread in the cast iron).

3. Remove the old ceramic gaskets and clean up the surface underneath with wire wool or emery paper to remove loose particles.

4. Place the new gasket material in position around the perimeter of the window area, making sure to pinch them to the length in such a way that they make a continuous seal. Leave no gaps.

5. Place the new glass in position on the strips and screw home the fresh bolts and fitting by hand.

6. Finally, give each of the bolts an extra half turn or so. The glass should held tight enought that cleaning will not dislodge it. Do not over-tighten the bolts as this may put excessive pressure on the glass, resulting in cracking - important!

To reduce the risk of breaking the glass, avoid striking the glass or slamming the door.

Internal service parts
The flame-path equipment - consisting of the ashpan, grate, firebricks, glass, baffle and flue collar - are subject to the extremes of heat produced by the fire. From time to time, one or other of these parts may need replacing as a matter of routine maintenance.

NOTE: The flame-path equipment, the ceramic rope and the paint finish are not covered by guarantee.

All of these service parts can be bought from your morsø dealer, and we recommend that damaged parts are replaced as soon as possible to avoid collateral damage.

The grate may be replaced by lifting it by its left hand edge and twisting it backwards. Dislocate the riddling arm from the grate by feel from beneath the floor of the firebox. If you find this difficult for any reason, raising the rectangular grate surround casting may help.

Should the baffle be distorted by an overfire, the stove will still function, although its efficiency may be compromised. Replace it as soon as possible. The rear casing is removed (four bolts). Remove these and withdraw the baffle from the firebox (this may be easier if the firebricks are first removed).
Before replacing the baffle, scrape out the old fire furnace and replace with new to make an effective seal.

Reasons for fast internal wear and tear
Persistent heavy firing
Soot and ashes left to accumulate

Ceramic Gasket
The gasket around the perimeter of the door may harden over a period of time. It should be replaced if it becomes difficult to close the door or if air starts to leak in around the perimeter of the door, causing the fire to become a little less controllable. A morsø rope gasket kit is available from your stove supplier.

3.3 Cleaning the Stove and the Flue

Check for soot above the baffle plate and around the flue outlet every month or so to start with. If the stove suddenly becomes sluggish, check for a soot fall around the flue collar or in the flue/chimney. - at least once a year. Inspect every month.
Clean the flue/chimney - all the way from the stove to the flue terminal point above the house.

A good routine is to clean the flue after each heating season in any case, and inspect prior to the season to ensure that bird's nests or other blockages have not ocurred during the off season.

Ash disposal
Empty the ashpan on a daily basis or as needed. Ash allowed to build up towards the underside of the grate will trap heat and could cause premature failure of the grate.

Empty the ashpan according to this procedure:
When the door is closed, the grate can be operated by means of the riddling bar. Open the front door, and use a shovel or poker to stir excess ash through the ash slots in the grate down into the ash pan. Remove the ash pan, making sure to keep it level.
Dispose the ash in a metal container with a tight fitting lid.
The closed container of ashes should be placed on a noncombustible floor or on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally disperded, they should be retained in the closed container until all cinders have thoroughly cooled.
Return the ash pan to its original position in the stove, and close.

Caution:
Never empty a stove in operation.
Never use your household or shop vacuum cleaner to remove ash from the stove; always remove and dispose of the ash properly.

Creosote - formation and need for removal
When wood is burned slowly, it produces tar and other organic vapors, which combine with expelled moisture to form creosote. The creosote vapors condense in the relatively cool chimney flue of a slow-burning fire. As a result, creosote residue accumulates on the flue lining. When ignited this creosote makes an extremely hot fire. When burning wood, inspect the chimney connector periodically to determine if a creosote buildup has occurred.

Chimney sweeping
Inspect the system regularly during the heating season as part of a regular maintenance schedule. To inspect the chimney, let the stove cool completely. Then, using a mirror, sight up through the flue collar into the chimney flue. If you cannot inspect the flue system in this fashion, the stove must be disconnected to provide better viewing access.
Clean the chimney using a brush the same size and shape as the flue liner. Run the brush up and down the liner, causing any deposits to fall to the bottom of the chimney where they can be removed through the clean-out door.
Clean the chimney connector disconnecting the sections, taking them outside, and removing any deposits with a stiff wire brush. Reinstall the connetor sections after cleaning, being sure to secure the joints between individual sections with sheet metal screws.
If you cannot inspect or clean the chimney yourself, contact your local Morsø Deler or a professional chimney sweep.

If you do experience a chimney fire, act promptly and:
Close the air control.
Get everyone out of the house.
Call the Fire Department.

Annual maintenance
Before the heating season, perform a thorough cleaning, inspection and repair:
Thoroughly clean the chimney and chimney connector.
Inspect the chimney for damage and deterioration. Replace weak sections of prefabricated chimney. Have a mason make repairs to a masonry chimney.
Inspect the chimney connector and replace any damaged sections.
Check gasketing for wear or compression, and replace if necessary.
Check the glass for cracking; replace if needed.
Check door and handles for tightness. Adjust if needed.

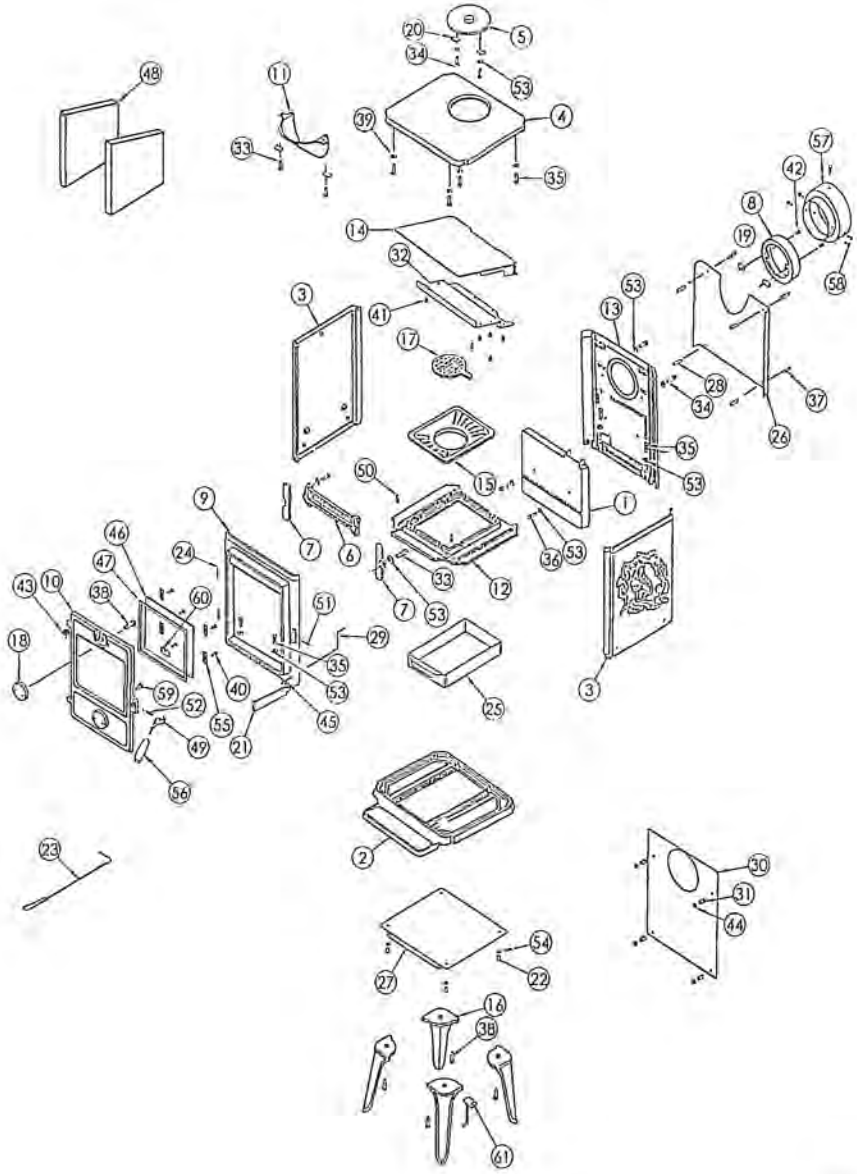
3.4 Leaving the stove for extended periods

Important:
If the stove is to be left unused for any period of time, clean it out thoroughly and leave the spinner slightly open to allow airflow. Make sure that the flue does not allow rainwater to come anywhere near the stove; install a chimney cap, but do not block off the flue completely.
These measures should ensure there is a slight movement of air through the stove, and that the body of the stove remains dry, right into the corners.
Any ash left within an unfired stove can attract moisture like blotting paper. If moisture is allowed to settle within the stove, rust will form. Rust expands as it takes a grip. This can lead to undue pressure on the stove joints, and this in turn may result in damage to the stove.

NOTE: It is best to thoroughly clean the stove after the heating season has concluded. Adding a dessicant, such as kitter litter, into the ash pan helps absorb moisture during the summer months. Be sure to remove this prior to the heating season.

Thank you for buying a morsø stove.
We hope you have many years of carefree warmth in its company. Some initial experimentation with loading and running techniques will decide your normal routine. If you have any problems after this short learning phase, please refer to your stove dealer. Should they be unable to help for any reason, please contact us in writing at the address on the front of this publication.

3.5 Parts diagram for the model Morsø 1410 squirrel



3.6 Parts list for the model Morsø 1410 squirrel

1	Rear plate, inside	34145100
2	Base plate	44140100
3	Side plate w. squirrel	44140600
4	Top plate	44140700
5	Cover	44141021
6	Front grate	44141400
7	Attachment for front grate	44141600
8	Flue collar	44141700
9	Front frame	44142200
10	Door	44142321
11	Draft reducer	44142800
12	Intermediate frame	44144900
13	Rear plate, outside	44145000
14	Baffle plate, cast iron	44145200
15	Frame for riddling grate	44203100
16	Leg	44203221
17	Riddling grate	44203300
18	Air valve	44241421
19	Fitting w. thread for flue collar	44256700
20	Fitting without thread f. cover	44256800
21	Handle for riddling grate	44262021
22	Distance tube	540614
23	Poker	541075
24	Hinge pin	541403
25	Ash tray	541405
26	Convection rear plate	541425
27	Radiant shielding, bottom	541426
28	Distance tube	541439
29	Riddling bar	541442
30	Radiant shielding, rear	541446
31	Distance tube	542635
32	Baffle plate, stainless	71141361
33	6x12 black steel set screw	731612
34	6x16 black steel set screw	731616
35	6x25 black steel set screw	731625
36	6x40 black steel set screw	731640
37	8x25 black steel set screw	731825
38	8x30 black steel set screw	731830
39	6 mm black washer	736106
40	5x8 bolt	742508
41	6x10 bolt	74361000
42	6x25 bolt	743625
43	6 mm brass washer	746006
44	6 mm clip pulley	746206
45	Knob for riddling grate	752619
46	Ceramic glass	790724
47	Tightening tape	79074400
48	Stone	79094700
49	Locking device	79127200
50	5x30 cotter pin	79186300
51	6x32 cotter pin	791868
52	6x26 cotter pin	791869
53	6 mm air slider washer	791891
54	8 mm washer	79189500
55	Glass fitting	71145700
56	Handle	79127300
57	Adaptor	71145800
58	3,5x9,5 self tapping schrew	791835
59	6x20 black steel set screw	731620
60	Glas fitting	71145900
61	Hanging for handle	71146000

72145200 Morsø bogtrykkeri

MORSØ JERNSTØBERI A/S

BY APPOINTMENT TO THE ROYAL DANISH COURT

DK-7900 NYKØBING MORS

Rick Armstrong
Intertek Testing Services
8431 Murphy Drive
Middleton, Wisconsin 53562

Subject: Air control settings for Model 1410 Wood-burning stove.

Dear Mr. Armstrong

The Squirrel wood heater scheduled to be tested in your facility for EPA particulate emissions can be operated in the following manner to obtain results in each category.

Burn rate category	Primary air setting	Time at full open setting
1	1 turn	5 min
2	1 ¼ turns	5 min
3	2 ½ turns	5 min
4	full open	n/a

Door open time is at the discretion of the tester.

Regards.

Karsten Aagaard

Karsten Aagaard
Morso Stoves

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DKK Morsø Sparekasse, Nykøbing Mors - acc.no. 8100 - 102119516
DEM Den Danske Bank, Hamburg - Kto. Nr. 32394009
(BLZ 203 205 00)
GBP Den Danske Bank, London - acc. no. 69639

APPENDIX H

1. TUNNEL FLOW RATE

Tunnel flow rates are determined using the velocity pressure measurement made by a standard Pitot tube. The Pitot tube is located at the center of the dilution tunnel. Three x/y axis traverses were used to determine the relationship between the center velocity pressure and the average obtained by traversing. This procedure was carried out in accordance with EPA Method 2.

Velocity pressure and tunnel temperature data are used to calculate tunnel velocity via EPA Method 2, equation 2-9 as follows:

$$T_v = K_p * C_p * \sqrt{\Delta P} * \sqrt{\frac{T_s}{P_s * M_s}}$$

Where:
K_p = 85.49 (English units constant for ft/sec.)
F_p = Pitot tube center point coefficient determined from traverses
C_p = .99 Coefficient for standard pitot tube
ΔP = Pitot tube velocity pressure (in. w.c.)
Ts = Absolute tunnel temperature (1R)
Ps = Absolute tunnel pressure (in. Hg)
Ms = Mole. Wt. of tunnel gas stream (lb./lb.-mole, wet basis) = 29 * (1-.04) + 18 * .04 =28.56
T_v = Tunnel velocity (ft./sec.)

Tunnel flow is calculated by multiplying the average velocity as calculated by the above formula by the following equation (adaptation of EPA Method 2, formula 2-10).

$$T_f = \overline{T_v} * 60 * 0.1961 * \frac{528}{TT_{ave}} * \frac{PS}{29.92} * 1 - .04$$

Where:

$\overline{Tv}$ = Average tunnel velocity (ft/sec.)
0.1961 = Tunnel cross sectional area (ft5)
T_f = Tunnel flow rate (SCFM)
TT_{ave} = Average tunnel temp. (1R)
PS = Average barometric pressure during test.
60 = sec. to min. conversion
0.04 = Assumed tunnel moisture content (4% by Vol.)

2. EMISSIONS RATE CALCULATION

Emissions rates are calculated from the total weight gain of the probe and first and second filters of each sampling system as follows:

$$ER = \left(\frac{T_f * Wt.Gain * 60}{vol.sampled} \right)_{0.83} * 1.82$$

Where:
ER = Emissions rate (grams/hour OM7 equivalent)
Vol. Samp. = Total volume sampled (SCFM, Dry)
Wt. Gain = Total weight gain for filter system (grams)
T_f = Tunnel flow rate (SCFM, Dry)

3. CORRECTIONS TO STANDARD CONDITIONS

The tunnel flow rate is corrected to standard conditions through the EPA Method 2 formulae. The volume sampled is measured by dry gas meters and must be corrected for meter temperature and ambient barometric pressure. The inlet and outlet temperatures of each dry gas meter are measured and recorded at 10-minute intervals during the test. The ambient barometric pressure is recorded at the beginning and end of each test.

The following formula is used to correct the total volume as measured by the dry gas meter to total volume at standard conditions (681F, 29.92 in. Hg):

$$VOL_{std} = VOL_m * \frac{PS}{29.92} * \frac{528}{AMT} * Y$$

Where:
$VOL_{std.}$ = Total volume in Standard Cubic Feet
VOL_m = Total volume as measured by dry gas meter.
PS = Average barometric pressure
AMT = Average meter temperature (1R)
Y = Dry gas meter calibration factor

EXAMPLE CALCULATIONS

1. TUNNEL VELOCITY

INPUTS: P =.038 in. w.c.
T_s = 1001F
P_s = 29.3 in. Hg.
M_s = 28.56 lb./lb.-mole
C_p = .99
F_p = .945

$$T_v = 85.49 * .99 * .945 * \sqrt{.038} * \sqrt{\frac{560}{29.3 * 28.56}} = 12.754$$

2. TUNNEL FLOW RATE

INPUTS: T_v = 12.754 ft./sec.
TT_{ave} = 5601R
PS = 29.3 in. Hg.

$$T_f = 12.754 * 60 * 0.1961 * \frac{528}{560} * \frac{29.3}{29.92} * (1 - .04) = 133.0 SCFM$$

3. EMISSIONS RATE

INPUTS: T_f = 133.0 SCFM
Wt. Gain = .0200 grams
Vol. Samp. = 100 Std. cubic feet

$$ER = \left(\frac{133 * .0200 * 60}{100} \right)_{83} * 1.82 = 2.68 grams / hour$$

4. VOLUME CORRECTION FOR DRY GAS METERS

INPUTS: $VOL_m = 104.479$ (Metered Feet3)
PS = 29.3 (Average baro. pressure)
AMT = 801F (Ave. meter temp.) = 5401R
Y = .9996 (Meter cal. factor)

$$VOL_{std} = 104.479 * \frac{29.3}{29.92} * \frac{528}{540} * .9996 = 100.00 \text{Standard} Ft_3$$

APPENDIX I

Manufacturer:	Morso
Model:	1410
Date:	02/03/00
Run:	1
Control #:	31218
Test Duration:	143

	Start	End
Barometer (in.Hg):	28.73	28.78
Wet Bulb (F):	56	59
Dry Bulb (F):	73	79
Humidity (%):	33	34

Average Stove Temperature: #DIV/0!

oisture content of wood (wet basis): 18.05

	Average	1.8513	9.8763	9.2919	198.625	74.75	-0.00249	0.184107	#DIV/0!	#DIV/0!	3.298515
*	*	*	*	*	*	*	Comb	Combust	Heat	Net	*
Elapsed	Weight				Flue	Room	%	Eff	Transfer	Eff	air
Time	Remaining	CO	CO_2	O_2	Gas	Temp	K	%	Transfer	Eff	Fuel
0	5.10	1.75	7.81	11.51	224	73	0.45	82.2%	21.2%	17.4%	7
10	4.20	1.41	9.99	10.24	251	74	2.86	57.2%	52.7%	30.2%	6
20	3.50	1.26	12.52	6.38	257	75	1.21	80.4%	72.6%	58.4%	6
30	2.70	0.38	16.18	3.84	288	75	1.76	81.9%	79.3%	64.9%	5
40	1.90	1.63	18.36	1.53	305	75	1.46	84.0%	84.5%	71.0%	5
50	1.10	1.43	16.93	2.75	288	76	-0.13	96.8%	89.4%	86.5%	8
60	0.70	0.49	12.52	7.10	230	76	-1.13	115.5%	91.1%	105.2%	14
70	0.60	1.73	9.01	10.12	187	75	-0.83	105.4%	91.5%	96.5%	17
80	0.50	2.60	6.90	11.60	167	74	-0.98	103.4%	91.3%	94.4%	21
90	0.40	3.00	7.45	10.83	155	75	-0.91	99.1%	92.7%	91.9%	20
100	0.30	2.78	7.40	10.97	147	75	-0.95	101.4%	93.3%	94.6%	22
110	0.20	2.72	7.22	11.23	140	75	-0.87	100.1%	94.0%	94.0%	23
120	0.20	2.73	6.93	11.57	135	75	-0.80	98.5%	94.1%	92.7%	24
130	0.10	1.50	4.86	15.03	147	75	-0.03	85.6%	93.8%	80.3%	35
140	0.10	2.11	7.12	11.81	129	74	-0.71	100.9%	94.9%	91.6%	26
143	0.00	2.10	6.82	12.16	128	74	-0.63	99.0%	95.3%	94.3%	28

Warnock Hersey Efficiency Test Report

Overall Heating Efficiency:			70.61%
Combustion Efficiency:			81.72%
Heat Transfer Efficiency:			86.41%
Heat Output:	11113	BTU/Hr	11715
Heat Input:	15738	BTU/Hr	16591
Burn Duration:	2.38	Hours	
Burn Rate:	1.75	Lb/Hr	0.796
Stack Temp:	198.6	Deg.F	92.6

Manufacturer:	Morso		
Model:	1410		
Date:	02/04/00		
Run:	2		
Control #:	31218		
Test Duration:	117		
		Start	End
Barometer (in.Hg):		29.22	29.28
Wet Bulb (F):		56	58
Dry Bulb (F):		72	78
Humidity (%):		35	28
Average Stove Temperature:		#DIV/0!	
oisture content of wood (wet basis):		18.82	

	Average	1.846	11.3	8.112	229.076923	74.46	
*	*	*	*	*	*	*	
Elapsed Time	Weight Remaining	CO	CO_2	O_2	Flue Gas	Room Temp	
0	5.22	1.40	8.63	10.80	280	73	
10	3.80	1.58	14.91	4.48	335	74	
20	2.90	1.36	18.65	2.08	307	74	
30	2.00	0.85	18.48	1.91	296	74	
40	1.30	1.53	16.95	1.11	289	75	
50	0.70	0.36	13.89	6.69	255	76	
60	0.60	2.24	8.74	10.13	214	76	
70	0.50	2.55	8.56	10.12	191	75	
80	0.40	2.46	7.96	10.83	177	74	
90	0.30	2.58	7.72	10.97	168	74	
100	0.20	2.48	7.20	11.64	160	74	
110	0.10	2.32	6.69	12.24	155	75	
117	0.00	2.29	6.47	12.46	151	74	

Warnock Hersey Efficiency Test Report

Overall Heating Efficiency:			65.37%	
Combustion Efficiency:			79.70%	
Heat Transfer Efficiency:			82.02%	
Heat Output:	13149	BTU/Hr	13861	KJ/Hr
Heat Input:	20115	BTU/Hr	21205	KJ/Hr
Burn Duration:	1.95	Hours		
Burn Rate:	2.17	Lb/Hr	0.986	Kg/Hr
Stack Temp:	229.1	Deg.F	109.5	Deg.C

0.07064	0.14455518	#DIV/0!	#DIV/0!	2.34883	0.101	
Comb	Combust	Heat	Net	*	*	
%	Eff	Transfer	Eff	air	Unit	
K	%	Transfer	Eff	Fuel	MN	
0.37	86.2%	14.3%	12.4%	7	2.37	
3.02	66.9%	64.4%	43.1%	5	1.72	
4.61	63.7%	75.6%	48.1%	4	1.32	
1.58	84.6%	84.4%	71.5%	5	0.91	
0.65	90.4%	88.9%	80.4%	6	0.59	
0.02	98.2%	91.6%	90.0%	12	0.32	
-0.76	101.0%	90.5%	91.4%	17	0.27	
-0.75	98.9%	91.7%	90.7%	17	0.23	
-0.67	97.8%	92.3%	90.3%	19	0.18	
-0.69	97.2%	92.9%	90.4%	21	0.14	
-0.55	94.9%	93.5%	88.7%	23	0.09	
-0.55	95.5%	93.8%	84.5%	26	0.05	
-0.55	95.5%	94.2%	90.0%	29	0.00	

Manufacturer:	Morso		
Model:	1410		
Date:	02/07/00		
Run:	3		
Control #:	31218		
Test Duration:	82		
		Start	End
Barometer (in.Hg):		29.34	29.4
Wet Bulb (F):		56	59
Dry Bulb (F):		70	80
Humidity (%):		41	30
Average Stove Temperature:		#DIV/0!	
oisture content of wood (wet basis):		18.56	

	Average	1.267	10.32	9.459	317.9	73.7
*	*	*	*	*	*	*

Elapsed Time	Weight Remaining	CO	CO_2	O_2	Flue Gas	Room Temp
0	5.16	1.27	6.66	13.19	252	68
10	3.70	0.46	18.55	1.25	438	70
20	2.50	0.46	17.84	2.44	417	72
30	1.50	0.99	17.70	2.39	393	75
40	0.90	0.16	12.59	7.83	357	76
50	0.50	0.80	8.85	11.05	311	76
60	0.40	1.53	6.54	13.04	279	75
70	0.20	2.27	5.17	14.08	257	75
80	0.10	2.28	4.75	14.59	239	75
82	0.00	2.45	4.50	14.73	236	75

Warnock Hersey Efficiency Test Report

Overall Heating Efficiency:			65.52%	
Combustion Efficiency:			82.31%	
Heat Transfer Efficiency:			79.61%	
Heat Output:	18746	BTU/Hr	19762	KJ/Hr
Heat Input:	28610	BTU/Hr	30159	KJ/Hr
Burn Duration:	1.37	Hours		
Burn Rate:	3.07	Lb/Hr	1.395	Kg/Hr
Stack Temp:	317.9	Deg.F	158.8	Deg.C

0.05534	0.10915354	#DIV/0!	#DIV/0!	2.1664	0.084
Comb	Combust	Heat	Net	*	*
%	Eff	Transfer	Eff	air	Unit
K	%	Transfer	Eff	Fuel	MN
0.58	79.7%	10.8%	8.6%	8	2.34
3.19	72.5%	64.9%	47.0%	4	1.68
2.07	81.0%	77.4%	62.7%	5	1.13
0.44	93.0%	85.1%	79.2%	6	0.68
-0.35	104.5%	87.0%	90.9%	12	0.41
-0.57	106.7%	87.3%	93.2%	20	0.23
-0.43	98.5%	86.6%	85.3%	25	0.18
-0.25	86.8%	86.7%	75.3%	29	0.09
-0.11	82.0%	87.6%	57.6%	32	0.05
-0.09	79.5%	87.7%	69.7%	34	0.00

Manufacturer:	Morso
Model:	1410
Date:	02/08/00
Run:	4
Control #:	31218
Test Duration:	65

	Start	End
Barometer (in.Hg):	29.4	29.38
Wet Bulb (F):	52	56
Dry Bulb (F):	68	76
Humidity (%):	32	25

Average Stove Temperature: #DIV/0!

oisture content of wood (wet basis): 18.65

Average:	0.961	11.67	8.138	385.25	73.75	
*	*	*	*	*	*	*
Elapsed Time	Weight Remaining	CO	CO_2	O_2	Flue Gas	Room Temp
0	5.36	2.04	6.07	12.99	246	71
10	3.80	1.83	18.29	0.97	478	72
20	2.40	0.65	18.10	1.84	482	73
30	1.20	0.34	17.64	2.62	463	75
40	0.60	0.15	10.38	10.03	407	75
50	0.40	0.57	8.13	11.60	356	75
60	0.10	1.00	7.60	12.32	330	74
65	0.00	1.11	7.12	12.73	320	75

Warnock Hersey Efficiency Test Report

Overall Heating Efficiency:			66.79%	
Combustion Efficiency:			84.08%	
Heat Transfer Efficiency:			79.44%	
Heat Output:	25146	BTU/Hr	26508	KJ/Hr
Heat Input:	37649	BTU/Hr	39689	KJ/Hr
Burn Duration:	1.08	Hours		
Burn Rate:	4.02	Lb/Hr	1.826	Kg/Hr
Stack Temp:	385.3	Deg.F	196.3	Deg.C

0.04003	0.09399606	#DIV/0!	#DIV/0!	1.52788	0.078	
Comb	Combust	Heat	Net	*	*	
%	Eff	Transfer	Eff	air	Unit	
K	%	Transfer	Eff	Fuel	MN	
0.14	83.2%	13.1%	10.9%	8	2.43	
3.89	65.9%	61.8%	40.7%	4	1.72	
1.41	86.0%	77.6%	66.7%	5	1.09	
-0.21	101.0%	85.4%	86.3%	8	0.54	
-0.42	106.9%	84.9%	90.8%	17	0.27	
-0.97	119.9%	84.7%	101.5%	25	0.18	
-0.31	99.9%	86.4%	82.9%	27	0.05	
-0.30	98.5%	86.5%	85.3%	30	0.00	

APPENDIX J

ITS Intertek Testing Services

Manufacturer MORSO Model SQUIRREL Date 1-31-08

Job # 31218 Run PRETEST Tech RA

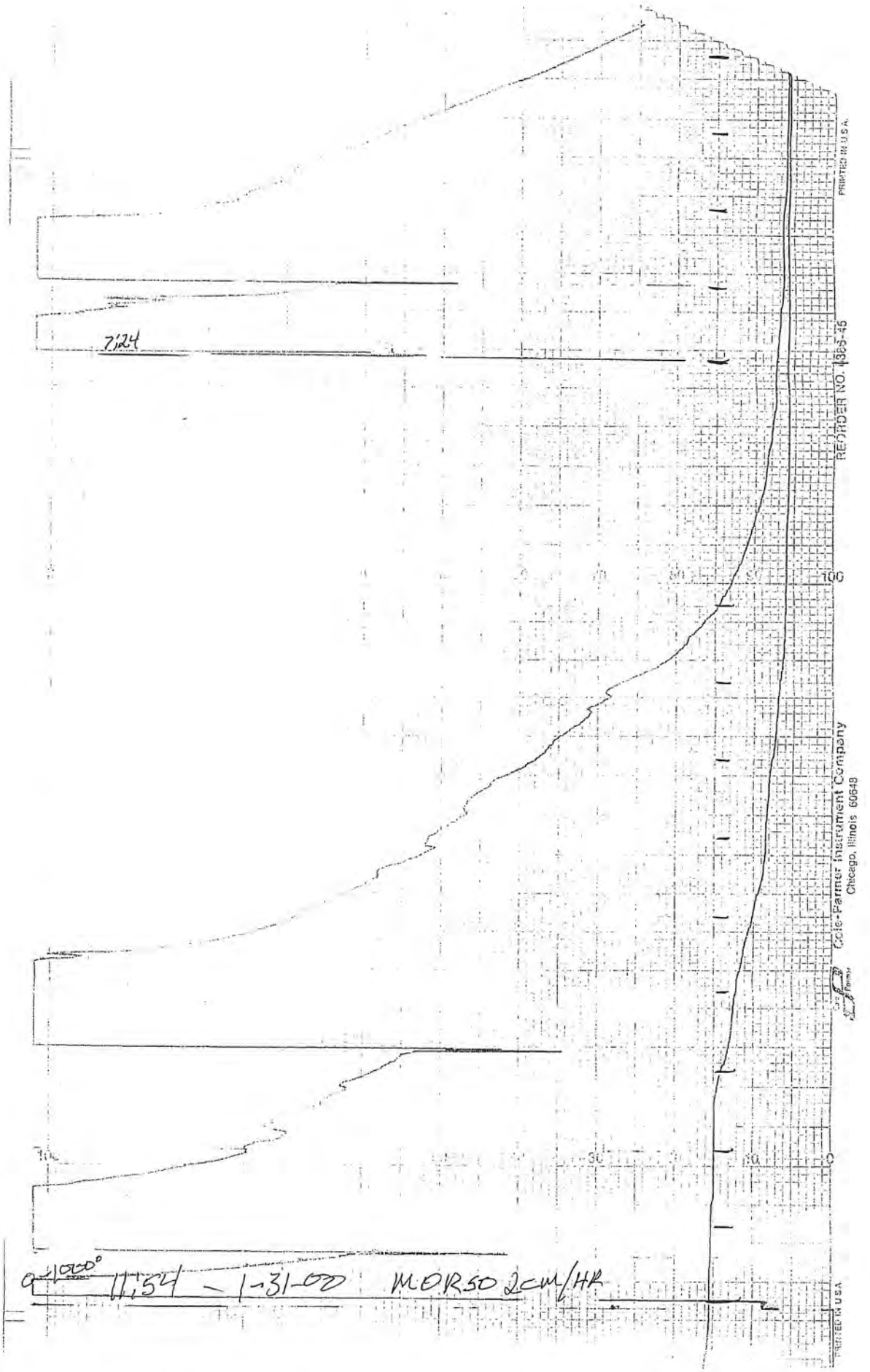
Break-in Data log

Type of fuel used: _____

Moisture content corrected to 2-pin and for the type of fuel used.

Catalytic _____ Non-catalytic ✓

Date	Time	Flue Temp	Comb. Cham. Or Catalyst Temp	lbs. Fuel weight added	Moisture content
1.31.08	11:54	68	68	3.4	KINDLING
	12:36	280	1160	8.1	~~19.05~~
	15:11	290	650	9.5	18.90
2-1-08	7:15	68	68	5.2	KINDLING
	8:22	238	558	4.6	18.50


7124
RECORDER NO. 1363-45
Cole-Parmer Instrument Company
Chicago, Illinois 60648
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11:54 - 1-31-00
MOR50 2cm/HR