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

ITS TEST REPORT No. J99031222-231
TEST OF A WOOD BURNING STOVE FOR EMISSIONS & EFFICIENCY USING EPA METHOD 28 AND 5G-3
MODEL: 3410 OWL
FOR
MORSO JERNSTOBERI A/S
FURVEJ 6
NYKOBING MORS 7900
DENMARK

TEST OF A WOOD BURNING STOVE
FOR

EMISSIONS AND EFFICIENCY

PER

EPA METHODS 28 AND 5G-3
FOR
MORSO JERNSTOBERI
NYKOBING MORS, DENMARK

TESTED BY:

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

TEST DATES: JULY 11-14,2000
REPORT DATE: JULY 18, 2000

VI. QUALITY ASSURANCE

I. INTRODUCTION

I.A. GENERAL

From July 11 through 14, 2000 Intertek Testing Services NA Inc. (ITS) conducted tests on Morso's model 3410 (Owl) wood burning stove to determine compliance with U.S. EPA emissions regulations.

Rick Armstrong and Ayn Chappelle-Steinlein conducted tests. Present, as an observer for tests was Derik Andors of Ferguson, Andors and Co. representing 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

Morso's model 3410 (Owl) wood burning stove is rectangular in shape sitting on four legs. The Unit is constructed from cast iron with a glass and cast iron door that was hinged on the left. The single door gives access to both the firebox for fuel loading and to the ash pan. The bottom of the firebox is a grate. The sides of the stove are embossed with three owls. The sole control is a lever located below the ash-lip. Combustion by-products exit through a six-inch flue collar located centrally at the rear of the top. (See photograph pages)

I.C. RESULTS

The unit as tested produced a weighted average emissions rate of 3.469 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 July 6, 2000 via Emery. The unit was inspected upon receipt and found to be in good condition. The unit was set up following the manufacturer's instructions without difficulty. Following assembly, the unit was placed on the test stand and instrumented with thermocouples in the specified locations. Prior to beginning the emissions tests the unit was operated for a minimum of 10 hours at high-to-medium burn rates. The unit was found to be operating satisfactory during this break-in. The 14 plus hours of pre-burning was conducted on July 7,2000. 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 July 10, 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	7/11/00	.0700	5.648	7.658	59.07
2	7/12/00	1.698	1.360	2.347	65.53
3	7/1200	1.958	1.087	1.951	74.84
4	7/12/00	0.818	2.210	3.514	64.91

**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	0.700	7.658	59.07	8440.74	.1500	.2322	1.7785	13.72
4	0.818	3.510	64.91	9863.61	.2322	.6894	2.4198	44.75
2	1.698	2.347	65.53	20474.82	.8394	.6747	1.5836	44.21
3	1.958	1.951	74.84	23609.96	.9070	.1606	.3133	.1202
					Sums:	1.75696	6.0952	114.70

Weighted Average Emissions Rate: 6.0952÷1.75696 = 3.4692

Weighted Average Overall Heating Efficiency: 114.70 ÷1.75696= 65.28%

*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	82	83	29.15	29.12	74	64	0	0
2	85	84	29.12	29.12	57	45	0	0
3	89	89	29.12	29.12	45	38	0	0
4	83	85	29.15	29.12	63	50	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	10.69	20.65	1.6	6.72	6.733	21.53	14.00	3	0
2	9.34	21.59	1.6	6.66	6.633	21.59	14.00	3	0
3	8.57	19.49	1.5	6.50	6.533	20.45	14.00	3	0
4	10.47	21.40	1.6	6.46	6.492	20.97	14.00	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	215	13.63	143.11	553.48	49.58	49.24	32.8	32.2
2	87	13.75	140.03	570.50	20.03	20.14	3.60	2.90
3	75	14.10	141.10	580.22	17.19	17.07	2.30	2.10
4	177	13.67	141.43	561.53	40.83	40.59	10.2	11.0

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	620.60	624.86	20.36	20.12	0.97
2	608.15	604.8	2.19	1.75	5.74
3	615.78	619.88	1.42	1.30	7.00
4	613.05	616.70	6.25	6.78	6.76

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	0.700	463.87	320.72	-54.8	0.050	full closed	215	.042
2	1.698	735.5	448.32	-37.40	0.076	hole #2	87	.076
3	1.958	804.78	498.64	-48.80	0.075	full open	75	.085
4	0.818	548.11	364.16	-104.8	0.057	hole #1	177	.050

III. PROCESS DESCRIPTION

III.A. DISCUSSION

RUN #1 (July 11,2000) the primary air was set at full closed. The test was loaded in 25 seconds. The door was open for 4 minutes and the primary air was open for 5 minutes. Burn time was 215 minutes making the burn rate 0.700 kg/hour, a category 1-burn rate.

RUN #2 (July 12,2000) the air control was set at hole #2. The test was loaded in 20 seconds. The door was open for 1 minute. The air control was set to the second hole at 5:00. Burn time was 87 minutes for category a 3-burn rate of 1.698 kg/hr.

RUN #3 (July 12, 2000) the air control was set to full open. The test was loaded in 20 seconds. The door was open for 55 seconds. Burn time was 75 minutes for a category 4-burn rate of 1.958 kg/hr.

RUN #4 (July 13, 2000) the primary air control was set hole #1. The test was loaded in 30 seconds. The air control was set to the first hole at 5 min. The door was closed at 4 minutes. Burn time was 117 minutes for a category 2-burn rate of 0.818 kg/hr.

III.B. UNIT DIMENSIONS

27-1/8" high, 19" wide and 19" deep.

III.C. AIR SUPPLY SYSTEM

Controlled primary combustion air enters the unit at the lower rear of the unit where it is channeled above the door where it empties into the firebox as air wash. Secondary air enters the unit at the lower rear also but is uncontrolled. Secondary air is channeled to the baffle that has outlet holes in it. Additional secondary air is channeled under the grate and enters the firebox at the lower front center and is directed at the coal bed. 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 laboratory equipment worked with no problems during the 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. When the kindling was burning well a small amount of the pre-test fuel was loaded. After this was burning well additional pre-test fuel was added until the required one hour. Pretest loads were fired on high until burning well. Stirring was done as required to insure uniform charcoalization. At least one hour prior to loading 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

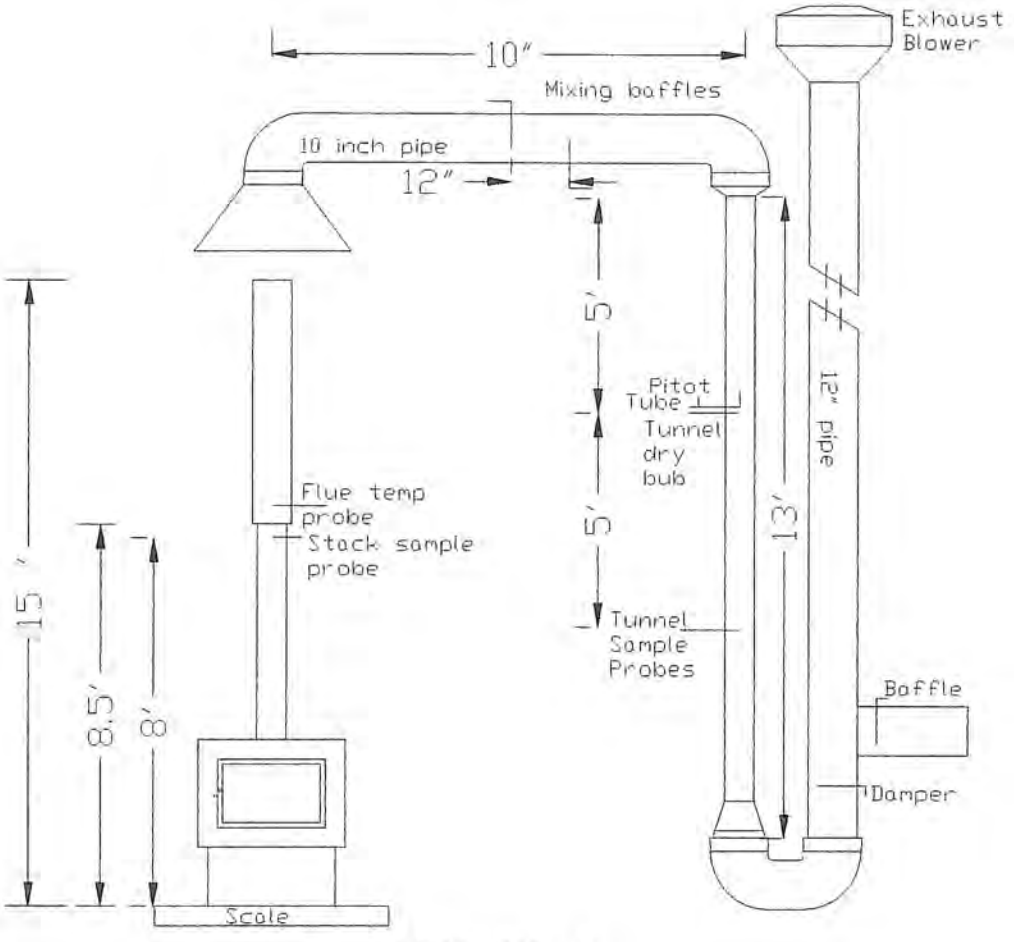
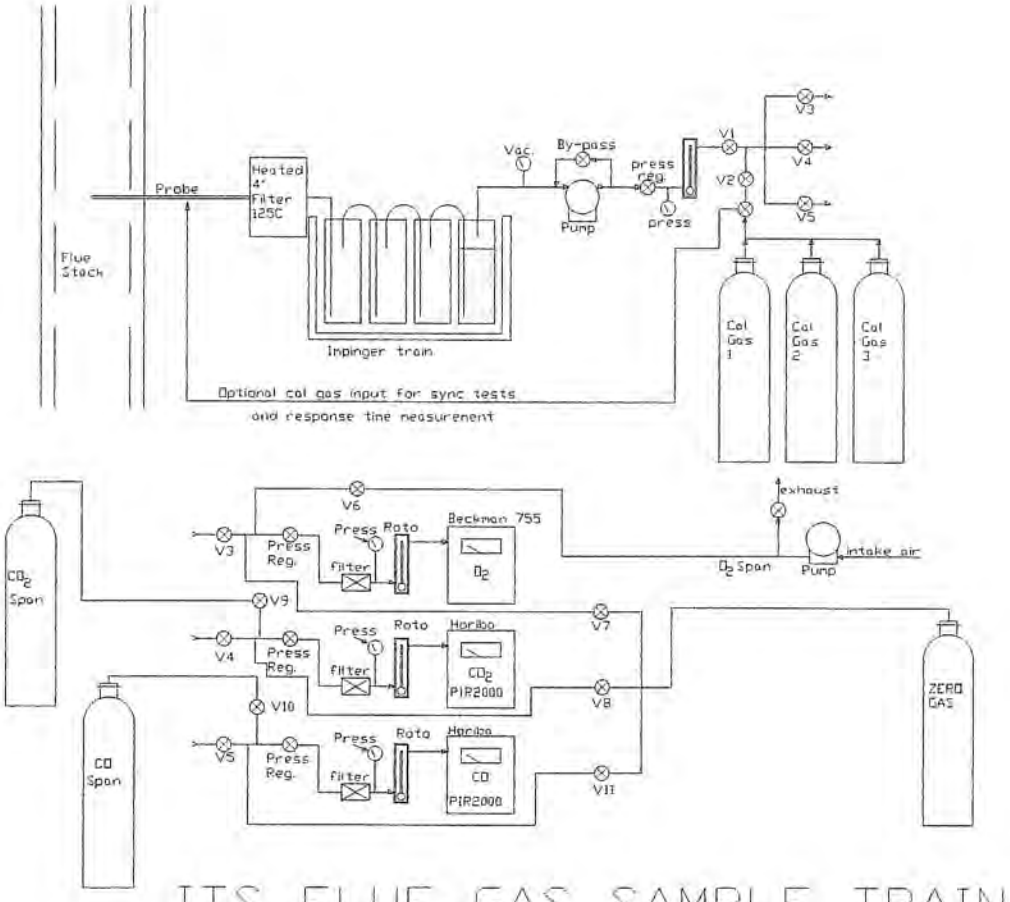


FIGURE 1

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

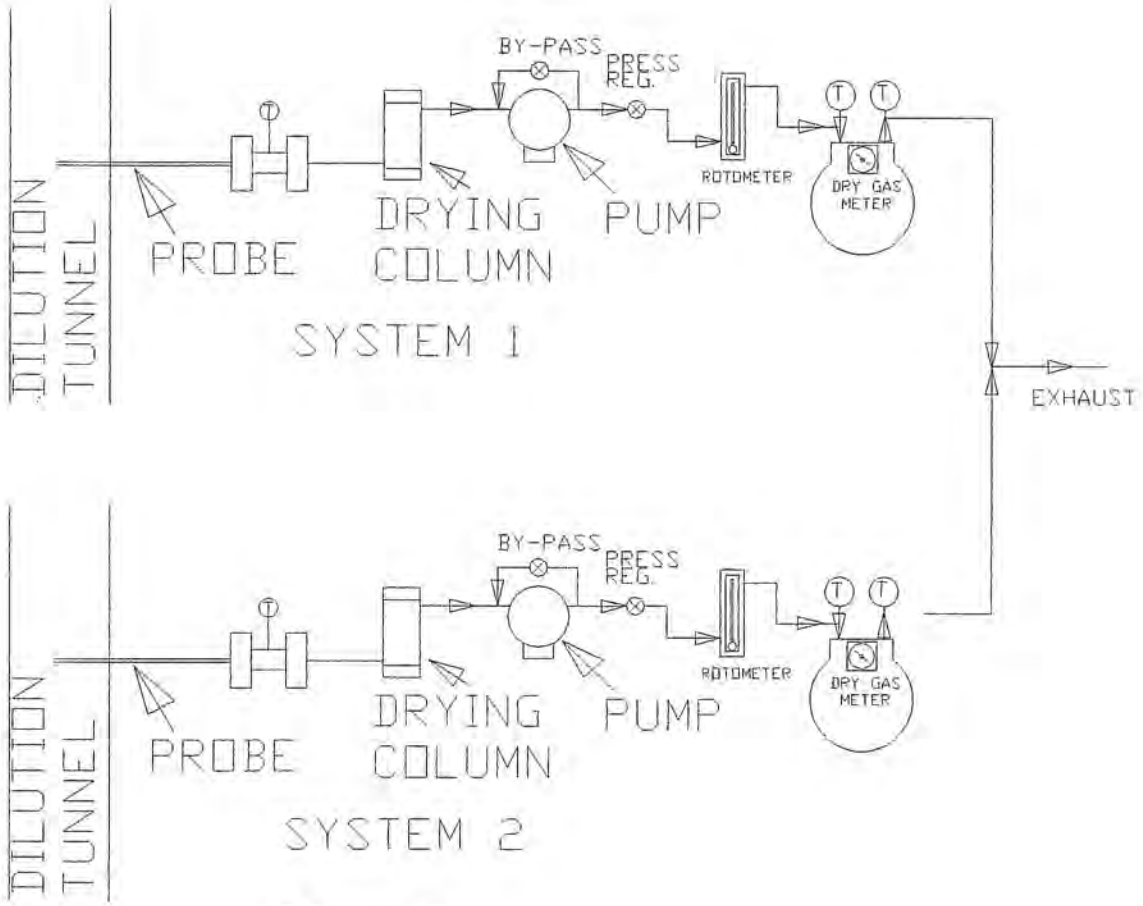


Figure 3

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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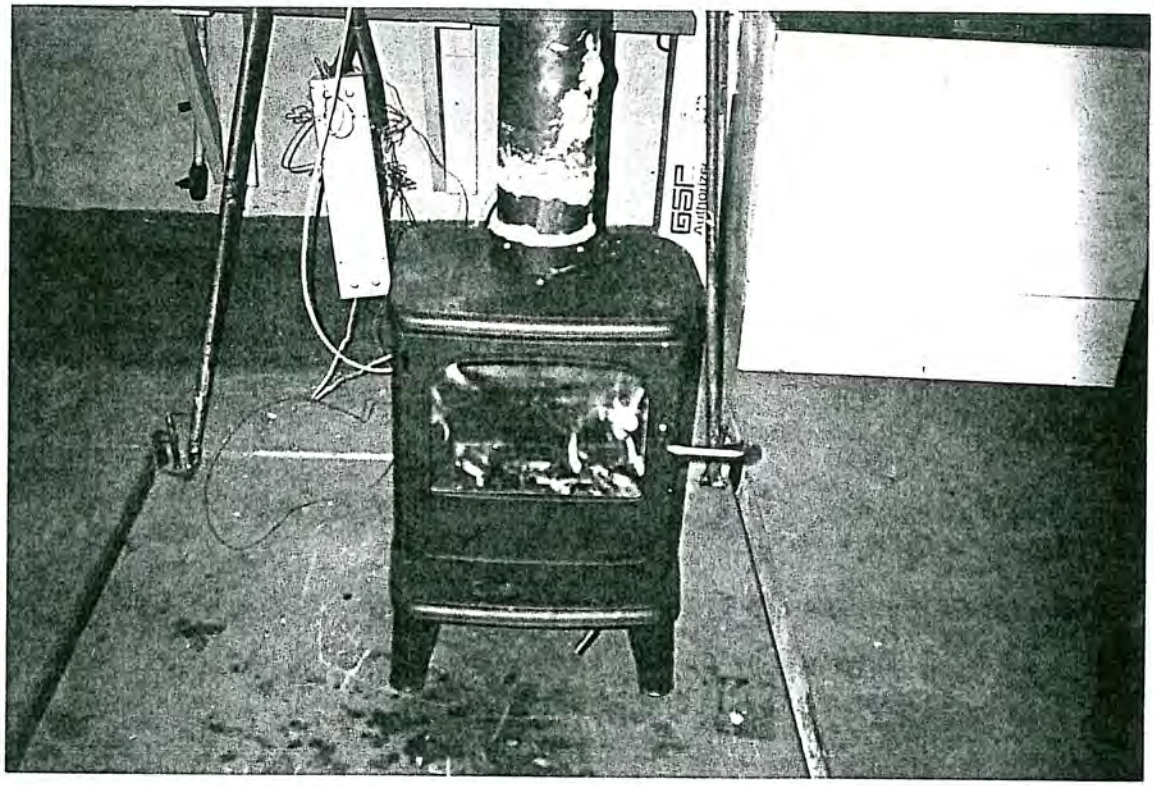

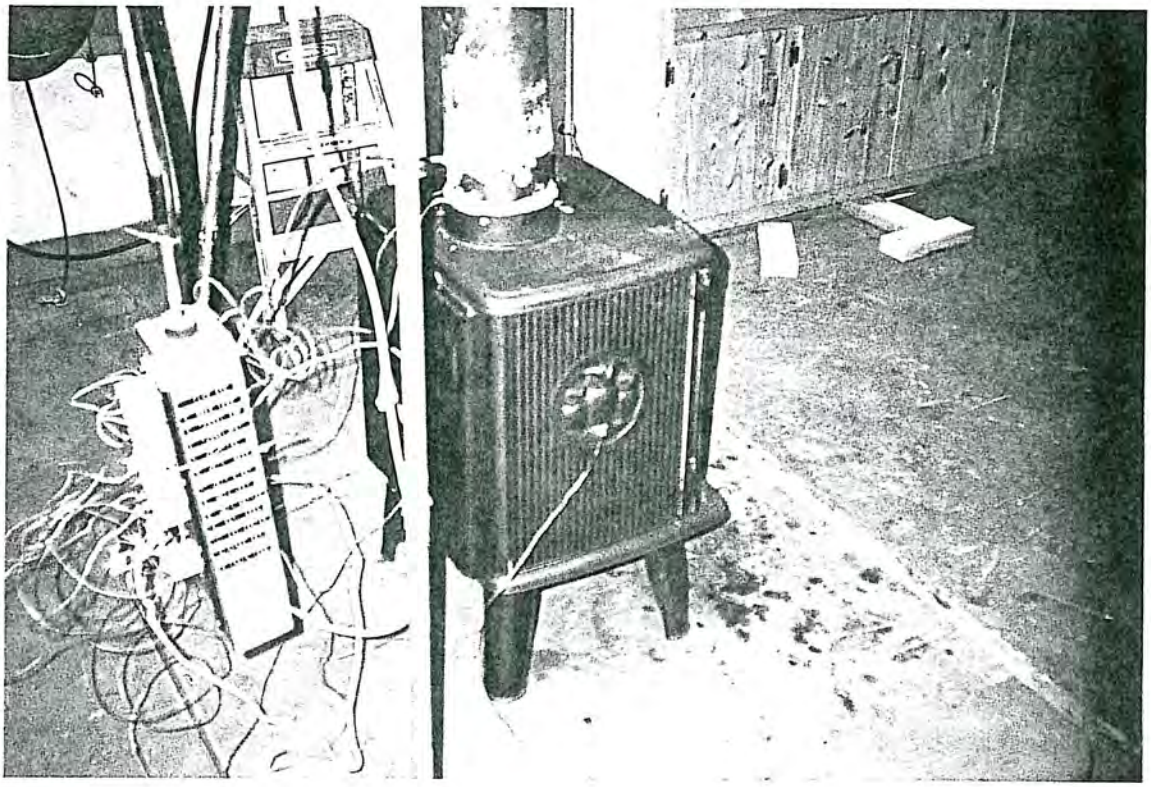

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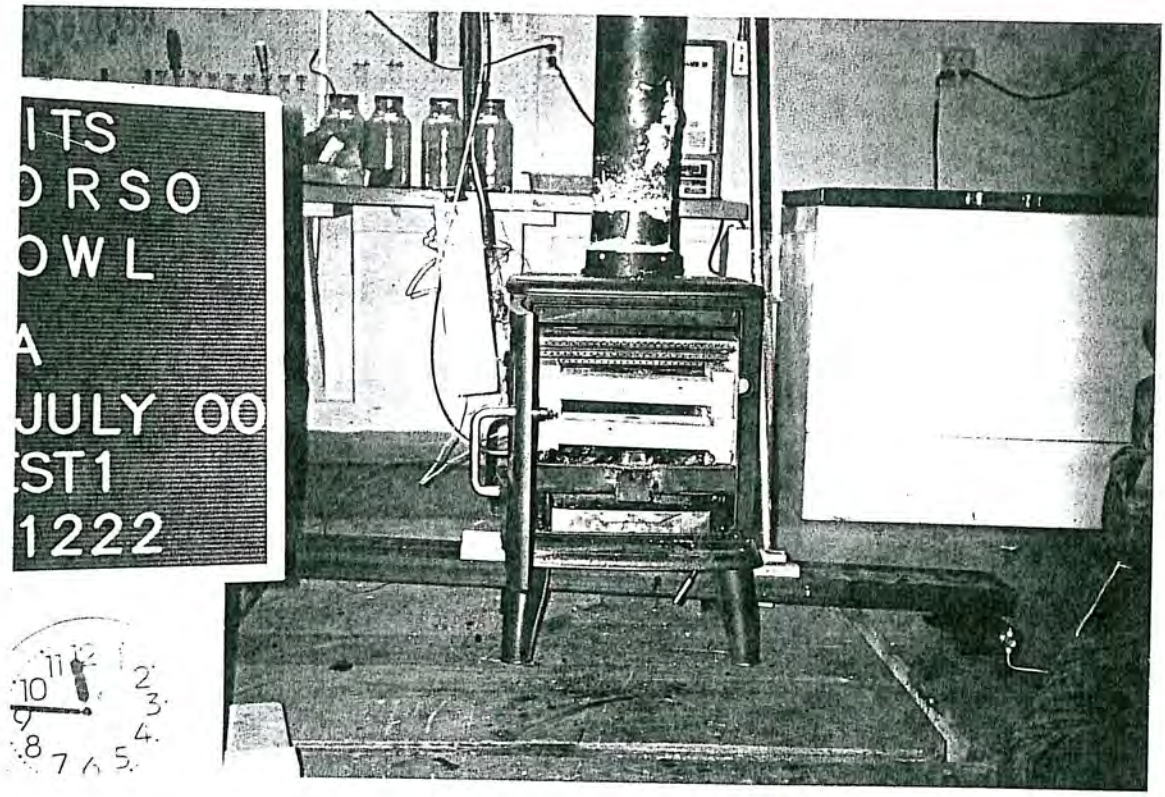

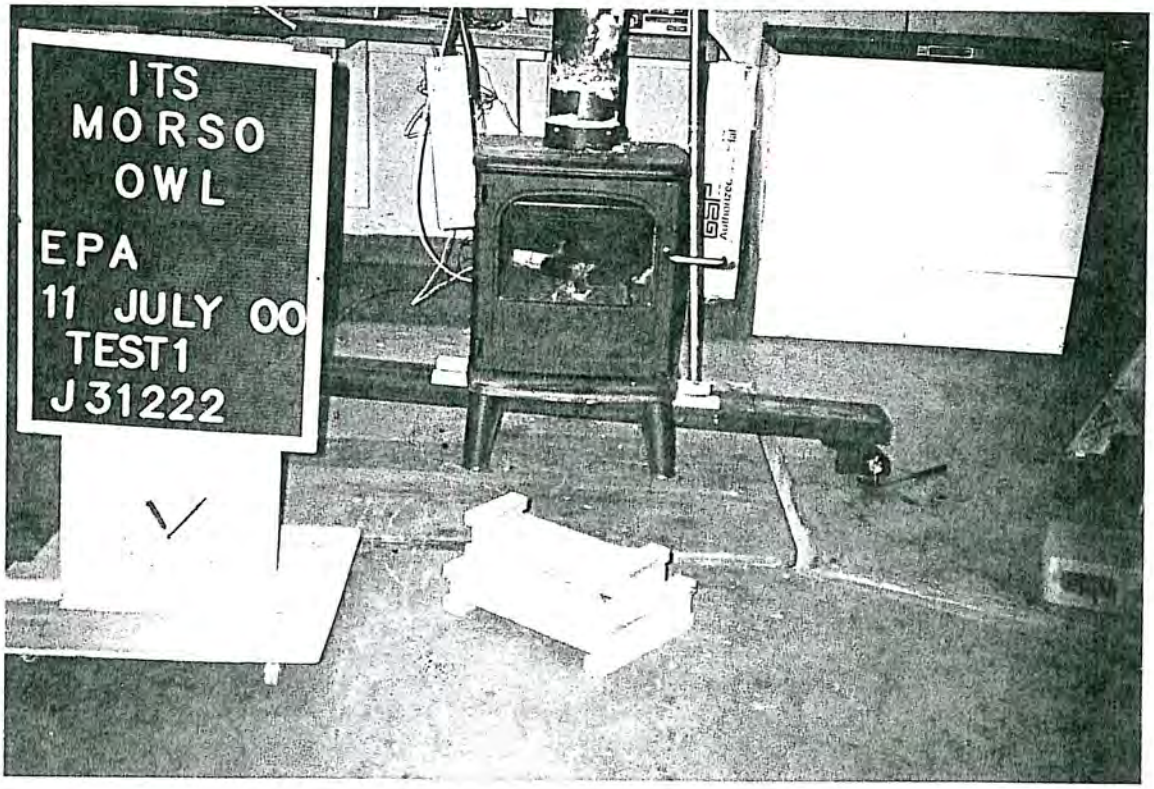

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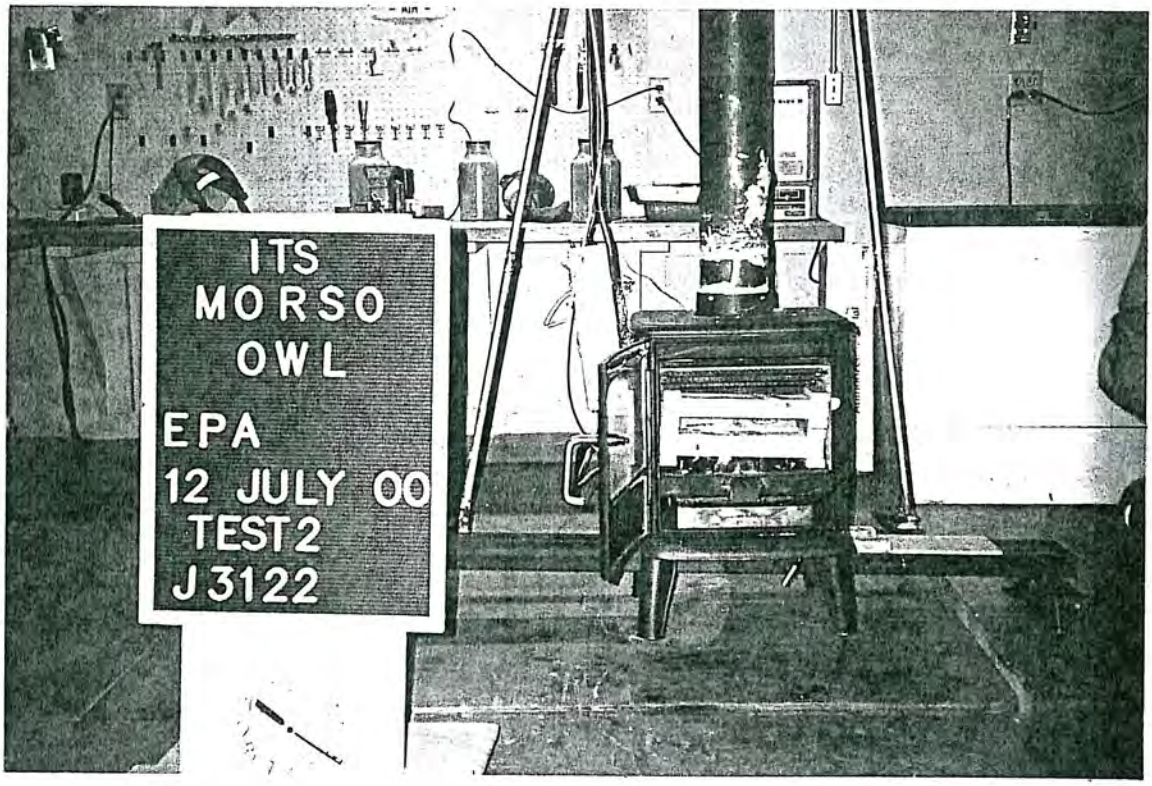

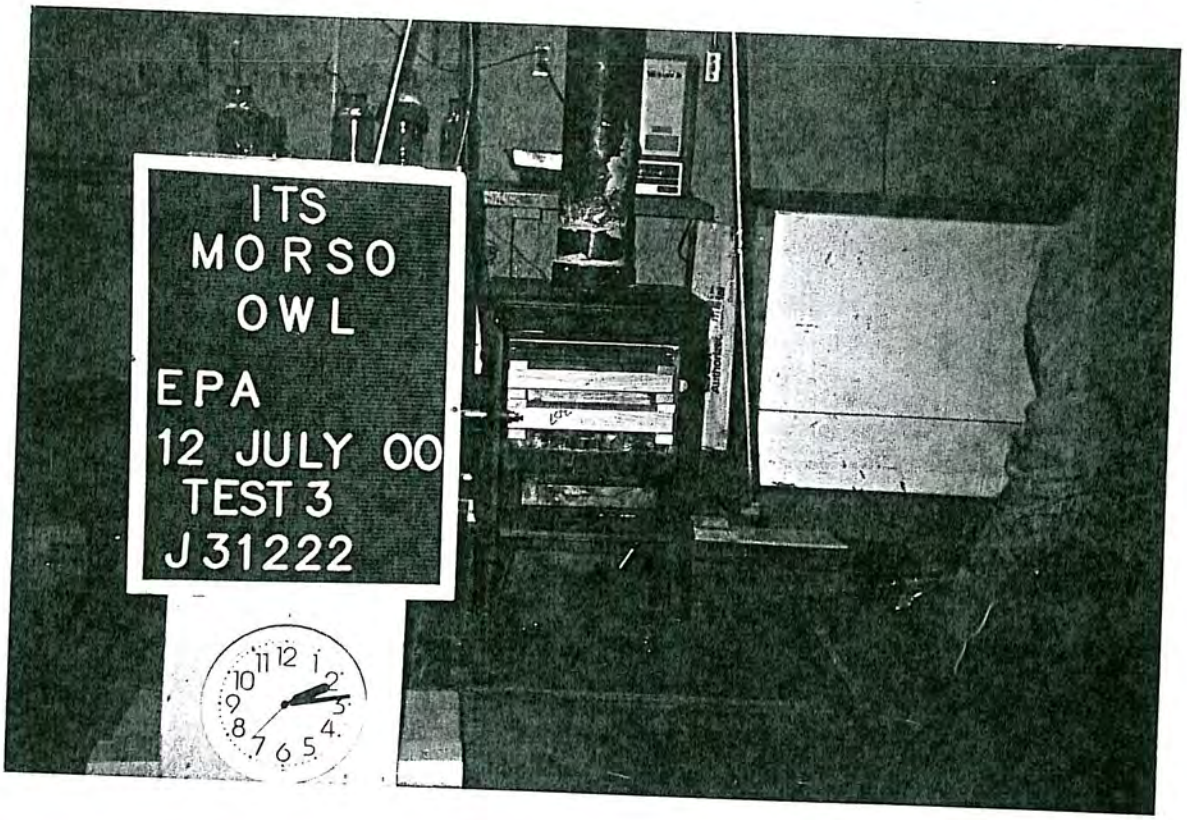
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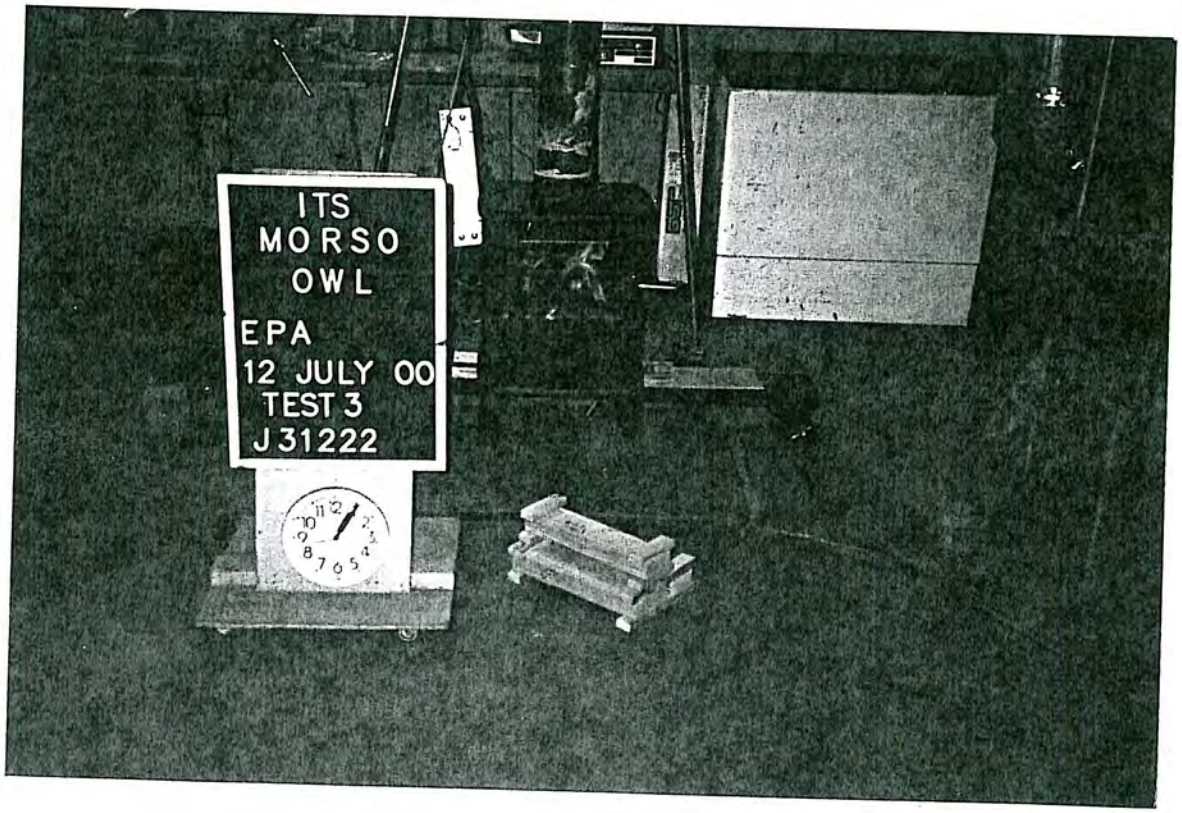
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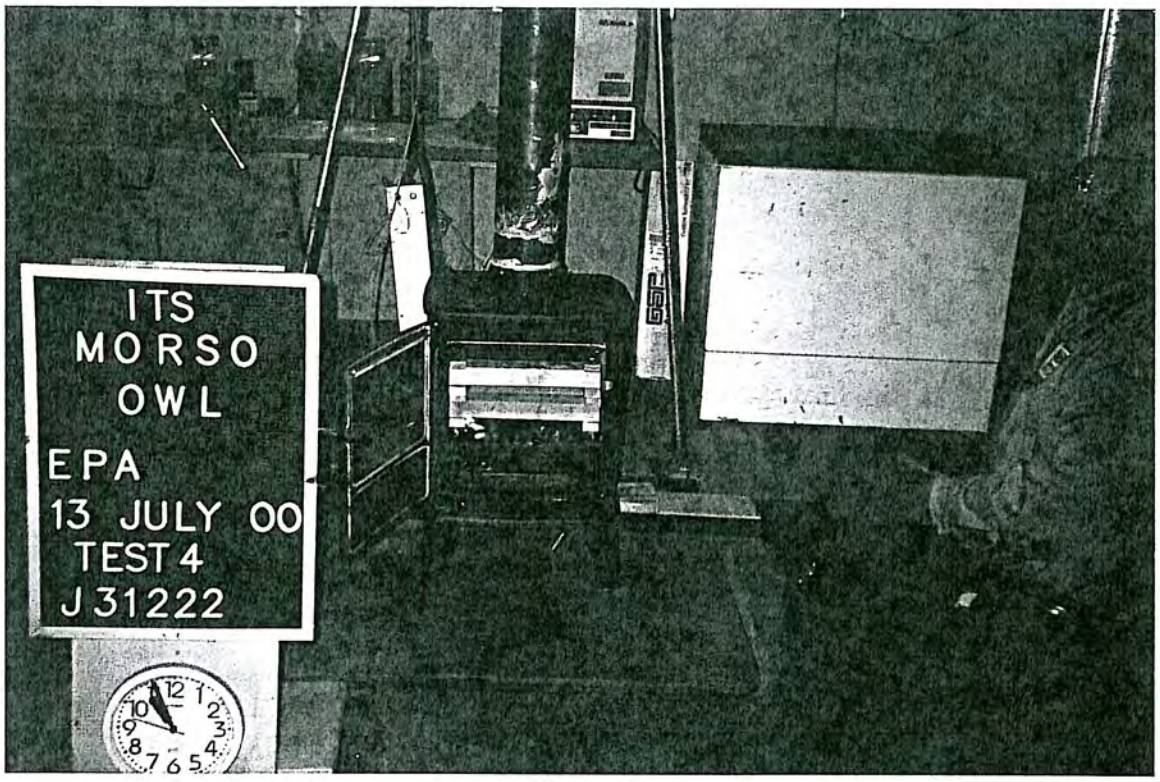
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APPENDIX A

Intertek Testing Services

SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Morso
Model:	Owl
Date:	07/11/00
Run:	1
Project #:	31222
Test Duration: (minutes)	215

PRESSURE FACTOR:	0.97426

TEMPERATURE FACTORS

DGM #1:	0.97171
DGM #2:	0.97183

VOLUMES SAMPLED

DGM #1:	49.60437
DGM #2:	49.26674
TOTAL TUNNEL VOLUME (scf):	30776.659

SAMPLE RATIOS

Sample Train 1:	620.442
Sample Train 2:	624.694

TOTAL EMISSIONS

Sample Train 1 (g):	20.3505
Sample Train 2 (g):	20.1152

EMISSION RATES

Sample Train 1 (g/hr):	5.6792
Sample Train 2 (g/hr):	5.6135

ADJUSTED EMISSION RATES

Sample Train 1 (g/hr):	7.6936
Sample Train 2 (g/hr):	7.6197
DEVIATION:	0.97%

RESULTS

AVERAGE ADJUSTED EMISSION R	7.657
Burn Rate (Dry kg/hr):	0.700

BAROMETRIC PRESSURE

Average:	29.15
Start:	29.15
End:	29.15

DRY GAS METER VALUES

DGM #1	Final:	942.465
	Initial:	890.868
DGM #2	Final:	319.193
	Initial:	267.710

TEMPERATURES (DEG. RANKIN)

DGM #1:	543.370
DGM #2:	543.304

CALIBRATION FACTORS

DGM #1:	1.0155
DGM #2:	1.0107

TUNNEL FLOW RATE:	143.147

PARTICULATE CATCH (mg)

Sample Train 1:	32.8
Sample Train 2:	32.2

Intertek Testing Services

SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Morso
Model:	Owl
Date:	07/12/00
Run:	2
Project #:	31222
Test Duration: (minutes)	87

PRESSURE FACTOR: 0.97326

TEMPERATURE FACTORS

DGM #1:	0.97480
DGM #2:	0.97841

VOLUMES SAMPLED

DGM #1:	20.03185
DGM #2:	20.14291

TOTAL TUNNEL VOLUME (scf): 12182.364

SAMPLE RATIOS

Sample Train 1:	608.150
Sample Train 2:	604.797

TOTAL EMISSIONS

Sample Train 1 (g):	2.1893
Sample Train 2 (g):	1.7539

EMISSION RATES

Sample Train 1 (g/hr):	1.5099
Sample Train 2 (g/hr):	1.2096

ADJUSTED EMISSION RATES

Sample Train 1 (g/hr):	2.5621
Sample Train 2 (g/hr):	2.1314

DEVIATION: 18.35%

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

Use the following:

Catalytic units 7.5% of 4.1 g/hr	10.51%
Non catalytic units 7.5% of 7.5 g/hr	5.74%

RESULTS

AVERAGE ADJUSTED EMISSION RA 2.347

Burn Rate (Dry kg/hr): 1.698

BAROMETRIC PRESSURE

Average:	29.12
Start:	29.12
End:	29.12

DRY GAS METER VALUES

DGM #1	Final:	963.286
	Initial:	942.494
DGM #2	Final:	340.133
	Initial:	319.204

TEMPERATURES (DEG. RANKIN)

DGM #1:	541.650
DGM #2:	539.650

CALIBRATION FACTORS

DGM #1:	1.0155
DGM #2:	1.0107

TUNNEL FLOW RATE: 140.027

PARTICULATE CATCH (mg)

Sample Train 1:	3.6
Sample Train 2:	2.9

Intertek Testing Services

SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Morso		RESULTS		
Model:	Owl				
Date:	07/12/00		AVERAGE ADJUSTED EMISSION RA		1.951
Run:	3				
Project #:	31222		Burn Rate (Dry kg/hr):		1.958
Test Duration: (minutes)	75				
	PRESSURE FACTOR:	0.97326	BAROMETRIC PRESSURE		
				Average:	29.12
TEMPERATURE FACTORS				Start:	29.12
	DGM #1:	0.97029		End:	29.12
	DGM #2:	0.97367			
			DRY GAS METER VALUES		
VOLUMES SAMPLED			DGM #1	Final:	981.236
	DGM #1:	17.18597		Initial:	963.315
	DGM #2:	17.07237			
			DGM #2	Final:	357.966
TOTAL TUNNEL VOLUME (scf):		10582.814		Initial:	340.141
SAMPLE RATIOS			TEMPERATURES (DEG. RANKIN)		
	Sample Train 1:	615.782		DGM #1:	544.167
	Sample Train 2:	619.880		DGM #2:	542.278
TOTAL EMISSIONS			CALIBRATION FACTORS		
Sample Train 1 (g):		1.4163		DGM #1:	1.0155
Sample Train 2 (g):		1.3017		DGM #2:	1.0107
EMISSION RATES			TUNNEL FLOW RATE:		141.104
Sample Train 1 (g/hr):		1.1330			
Sample Train 2 (g/hr):		1.0414	PARTICULATE CATCH (mg)		
				Sample Train 1:	2.3
ADJUSTED EMISSION RATES				Sample Train 2:	2.1
Sample Train 1 (g/hr):		2.0188			
Sample Train 2 (g/hr):		1.8823			
	DEVIATION:	7.00%			

Intertek Testing Services

SFBA EPA ADJUSTED EMISSION RESULTS

Manufacturer:	Morso		RESULTS		
Model:	Owl				
Date:	07/13/00		AVERAGE ADJUSTED EMISSION R		3.514
Run:	4				
Project #:	31222		Burn Rate (Dry kg/hr):		0.818
Test Duration: (minutes)	177				
	PRESSURE FACTOR:	0.97376	BAROMETRIC PRESSURE		
				Average:	29.135
TEMPERATURE FACTORS				Start:	29.15
	DGM #1:	0.97129		End:	29.12
	DGM #2:	0.97479			
			DRY GAS METER VALUES		
VOLUMES SAMPLED			DGM #1	Final:	1023.779
	DGM #1:	40.83437		Initial:	981.264
	DGM #2:	40.59271			
			DGM #2	Final:	400.294
TOTAL TUNNEL VOLUME (scf):		25033.674		Initial:	357.982
SAMPLE RATIOS			TEMPERATURES (DEG. RANKIN)		
	Sample Train 1:	613.054		DGM #1:	543.605
	Sample Train 2:	616.704		DGM #2:	541.658
TOTAL EMISSIONS			CALIBRATION FACTORS		
Sample Train 1 (g):		6.2532		DGM #1:	1.0155
Sample Train 2 (g):		6.7837		DGM #2:	1.0107
EMISSION RATES			TUNNEL FLOW RATE:		141.433
Sample Train 1 (g/hr):		2.1197			
Sample Train 2 (g/hr):		2.2996	PARTICULATE CATCH (mg)		
				Sample Train 1:	10.2
ADJUSTED EMISSION RATES				Sample Train 2:	11
Sample Train 1 (g/hr):		3.3953			
Sample Train 2 (g/hr):		3.6328			
	DEVIATION:	6.76%			

ITS Intertek Testing Services

Manufacturer HORSO Model OWL Date 7/7/00

Job # 31222 Run _____ Tech RA/ACS

EMISSIONS TESTING UNIT PREPARATION

Unit description (check all that apply)

X Stove	X Top Vent	____ Manual Draft
____ Insert	X 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: _____

Air introduction: _____

Control mechanism: _____

Unit net weight with all components: 216 lbs. 97.9 Kg.

Unit fire box volume: .995 Ft^3 (attach fire box volume calculations and drawings)

Ideal Load Weight: 6.97 lbs. (Volume x 7)

Load Weight Range: (±10% of ideal weight) 6.27 lbs. to 7.66 lbs.

Ideal piece length specification: _____ inches. (5/6 of longest fire box dimension)

Thermocouples attached: 5 Attached by: RA (attach T/C map)

Unit conditioned prior to test

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

____ 50 hours at medium burn rate (attach burn log)

Date started: 7-7-00 Date completed: 7-7-00

Catalyst manufacturer: _____

Serial number: _____ Dimensions: _____ Cell size: _____ $cells/in.^2$

Unit ready for testing (date): _____ **Initialed:** _____

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7/6/00

Job # 31222 Run _____ Tech RA/KS

Emissions Testing Initial Stove Check Out

Date received: 7-6-00 Carrier: EMERY

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: _____

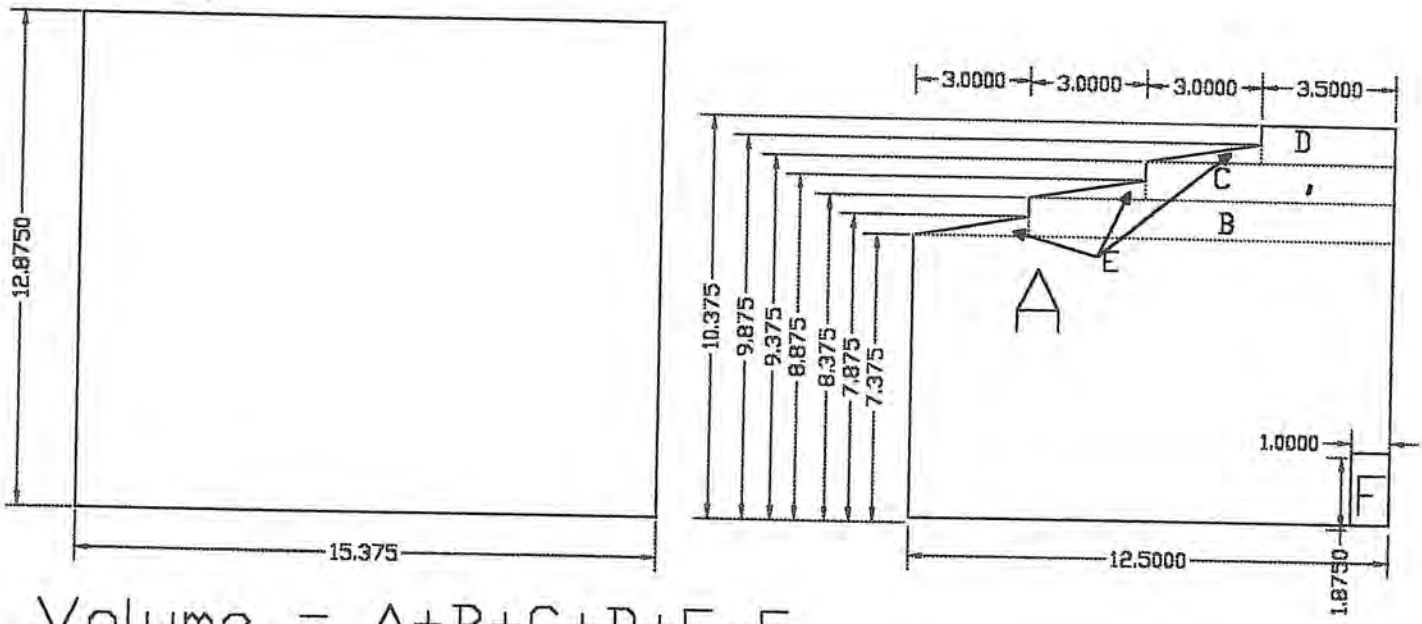
ITS Intertek Testing Services

Manufacturer HORSO Model OWL Date

Job # 31222 Run Tech RA/ACS

Measurements By: RA Checked By:

FIRE BOX VOLUME CALCULATION



Volume = A+B+C+D+E−F

A = 7.375x12.5x15.375 = 1417.38

B = 9.375x1x15.375 = 144.14

C = 6.375x1x15.375 = 98.01

D = 3.5x1x15.375 = 53.81

E = 3((.5x3x15.375)/2) = 34.59

F = 1.x1.875x15.375 = 28.83

Volume = 1719.1 cubic inches

or .995 cubic feet

Manufacturer MORSO Model OWL Date 7/7/00

Job # 31222 Run _____ Tech RA/ACS

Thermocouple Location

Thermocouples are placed centrally on the top, back, right and left sides and the bottom and numbered as shown below.

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

ITS Intertek Testing Services

Manufacturer NORSO Model OWL Date 7/11/06

Job # 31722 Run 1 Tech RA/ACS

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.15 (inches Hg.) Static pressure (P_q) .107 (inches w.c.)

Inside diameter: Port A 6in. Port B 6in. Tunnel cross sectional area: 0.1963Ft^2

Pitot tube type: Standard

Traverse Point	Position (inches)	Velocity Head Δ_p (inches H_2O)	Tunnel Temperature (°F)	$\sqrt{\Delta p}$
A-Centroid	3.00	.040	104	.2000
B-Centroid	3.00	.039	101	.1975
A-1	0.40	.037	103	.1924
A-2	1.50	.041	103	.2025
A-3	4.50	.040	103	.2000
A-4	5.60	.036	103	.1897
B-1	0.40	.036	102	.1897
B-2	1.50	.039	101	.1975
B-3	4.50	.040	101	.2000
B-4	5.60	.034	101	.1844
		AVERAGE	102.2	.1954

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 .9830

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 ()$_p$) 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 NORSO Model OWL Date 7/11/00

Job # 31227 Run 1 Tech RA/ACS

Pre/Post Checks

Moisture Meter Calibration Check:	Time: 0800	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	7/10/00	
Date Dilution Tunnel Cleaned	7/10/00	
Induced Draft Check	0	0
Tunnel Velocity	.039	
Flow Rate 140-cfm ±10%		143,147
Pitot Leak Check:		
Side A	✓	✓
Side B	✓	✓
Temperature System:		
Ambient (65°- 90°F)		54.8 °F
Wood Heater Surface (±125°F)		143,147 °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	5	7
Filter Back	6	8
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 HORSO Model OWL Date 7/11/00

Job # 31227 Run 1 Tech RA/ACS

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 6WL Date 7/11/00

Job # 31222 Run 1 Tech RA/ACS

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)	890.858	942.471	267.710	319,200
Initial 1minute DGM (ft^3)	890.858	~~890~~ 942.471 ACS	267.710	319,200
Change (C) (ft^3)	0	0	0	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

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

Manufacturer MORSO Model CMC Date 7/11/00

Job # 31222 Run 1 Tech RA/ACS

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	9.99	9.99	2.35	2.36
CO_2	0	0	24.65	24.65	5.79	5.88
O_2	0	0	20.93	20.93	5.66	5.55
	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	.02	10.02	2.37	.02	.03	.02	✓	
CO_2	.02	24.74	5.79	.02	.09	0	✓	
O_2	.11	20.89	5.71	.11	.04	.05	✓	

* Greater than ± 5% of the range used.

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7-11-00

Job # 31222 Run 1 Tech RA ACS

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Samples in Desecrator. Date: 7-11-00 Time: 15:32

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # 3	Filter Numbers 5+6	Probe and Front Half Housing # 4	Filter Numbers 7+8
Post Test Weight:	93.1213 grams	.2667 grams	89.9736 grams	.2596 grams
Pre Test Weight:	93.1213 grams	.2339 grams	89.9736 grams	.2274 Grams
Gain:	0 grams	.0328 grams	0 grams	.0322 Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0328 grams a2 + b2 = .0322 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	3	5	6	4	7	8	°F	%
7-10-00	7:15	93.1210	.1166	.1181	89.9732	.1146	.1124	75	48
7-11-00	7:15	93.1213	.1163	.1176	89.9736	.1148	.1126	73	46
		Total	.2339		Total	.2274			

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	3	5+6	4	7+8	°F	%
7-11-00	15:32	93.1216	.2694	89.9740	.2606	80	45
7-12-00	7:00	93.1214	.2668	89.9737	.2601	74	48
7-13-00	7:05	93.1213	.2467	89.9736	.2596	73	49
7-14-00	7:20	93.1213	.2667	89.9736	.2596	78	50

Manufacturer MORSO Model OWL Date 7/11/00

Job # 31222 Run 1 Tech RA/ACS

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft^3)	942.465	39.193
Initial (ft^3)	890.868	267.710

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.15	29.12
Wet Bulb (°F)	70	70
Dry Bulb (°F)	76	79
Humidity (%)	74	64

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7-11-00

Job # 31222 Run 1 Tech RA ACS

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:
Kindling weight: Comm Elec Consisting of: Scrap and paper Fire lit Time:
Pre-test load weight: 6.72 lbs. Consisting of: 2X4X inches Time loaded:
Pre-test moisture content: Uncorrected: 19.32 % Corrected Dry: 20.65 % Wet: 17.12 %

Test Air Control Settings: AIR CONTROL CLOSED Time: 0:17
Test Unit Fan Settings: NA Time:

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	6.27 Lbs.	6.97 lbs.	7.66 Lbs.

Fire Box Volume:	.995 Ft.^{3}	Ideal Length:	Inches
Load Volume:	.1667 Ft.^{3}	Loading Density:	6754 lbs/ft^3
Number of Spacers	12 ¾x1½x5	Load Density:	40,320 lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 14 in.	2.11 lbs.	21.80 %	20.80 %	19.30 %
2 x 4 x 14 in.	2.30 lbs.	19.50 %	18.50 %	21.20 %
2 x 4 x 14 in.	2.31 lbs.	19.00 %	21.50 %	19.40 %
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: 6.72 lbs. **DRY WEIGHT:** 2.51 kg.
AVERAGE MOISTURE CONTENT:
(DRY) 20.11 % CORRECTED TO TWO PIN: (DRY) 21.53% (WET) 17.71 %
COAL BED RANGE: 1.4 lbs. to 1.6 lbs. (20% to 25% of test load)
TEST CHARGE:
Time loaded: 11:45 Coal bed weight: 1.6 lbs. Coal bed weight = 23.8 % of test load weight

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

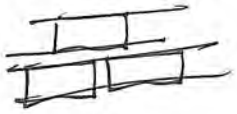
Manufacturer MODSO Model OWL Date 7/11/00

Job # 31222 Run _____ Tech RA / ACS

COMMENTS

0928 - 3.7 LBS OF KINDLING - FIRE LIT
0938 3.55 LBS PRE LOAD FUEL
0946 3.44 LBS PRE LOAD FUEL
1046 FIRE STIRRED
1113 FIRE STIRRED

TEST LOAD CONFIGURATION



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Manufacturer Morso Model Our Date 7/1-00

Job # 31222 Run 1 Tech RA ACS

AIR CONTROL FULL 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	10:17	0	3.80	439	83	114	82	631	256	419	401	344	824	.040	.074	C
1		10	3.60	335	82	103	82	597	280	431	414	368	679	.040	.064	C
2		20	3.2	286	84	99	82	526	287	410	399	371	595	.040	.060	C.
3		30	2.9	289	82	100	82	470	289	386	380	371	548	.040	.062	C.
4		40	2.7	240	82	96	82	423	290	372	371	373	500	.040	.055	L.
5		50	ACS 2.4	223	83	95	83	388	290	359	361	370	467	.040	.055	L.
6		60	1.9	222	83	92	83	364	287	347	350	369	465	.040	.052	L ACS
7		70	1.7	206	82	94	84	349	285	337	338	368	429	.040	.050	C.
8		80	1.7	196	83	87	84	334	271	326	328	361	417	.040	.045	C.
9		90														
10		100														
11		110														
12		120														
13		130														
14		140														
15		150														
16		160														
17		170														
18		180														
19		190														
20		200														
21		210														
22		220														
23		230														
24		240														
25		250														

Comments:

11:43 FIRE STIRRED DOOR OPEN 45 SEC.

1046 - FIRE STIRRED
1113 - FIRE STIRRED

WHI LTO#: 31222 AIR CONTROL CLOSED

MANUFACTURER: MORSO MODEL: OWL FIRE SIZE: LOW DATE: 7-11-00 RUN#: 1 TECHNICIAN: KEACS

SWITCH NUMBER:

READING#	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 SWPL 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	MAN'L DGM PRESS
0	1145	0	6.72	1.09	5.10	14.88	197	82	93	84	323	267	321	328	362	379				135	890.8	120	79	79	75	267.7	120	77	77	74	.039	.050	C	2
1		10	5.60	.89	5.52	14.95	284	81	100	84	410	268	324	327	425	480				135	893.2	120	80	80	84	270.0	120	79	78	84	.039	.055	M	2
2		20	5.10	1.12	4.90	15.38	232	82	96	84	368	266	322	320	393	445				135	895.6	120	81	81	84	272.4	120	80	78	84	.039	.048	H	2
3		30	4.70	1.18	5.97	14.49	225	82	96	84	353	256	312	305	366	448				135	898.0	120	82	82	84	274.6	120	81	79	84	.042	.045	H	2
4		40	4.10	1.04	8.90	11.10	240	84	95	85	370	250	309	296	345	509				135	900.4	120	83	83	84	277.2	120	82	81	84	.041	.050	H	2
5		50	3.40	1.14	1.354	7.39	313	84	96	85	483	251	324	308	329	702				135	902.8	120	85	84	85	279.6	120	84	82	85	.041	.053	T	2
6	1245	60	2.80	.21	16.60	4.23	362	85	100	85	618	261	350	335	307	825				135	905.2	120	84	84	86	282.0	120	83	83	86	.041	.063	T	2
7		70	1.50	.44	11.61	9.40	337	87	101	85	663	281	376	368	297	693				135	907.6	120	84	84	87	284.4	120	84	84	88	.041	.060	T	2
8		80	1.30	1.15	2.38	13.71	274	87	99	85	540	300	377	382	297	586				135	910.0	120	84	84	88	286.8	120	84	84	88	.040	.052	C	2
9	1:15	90	1.30	1.40	5.32	14.42	246	86	98	86	453	300	371	375	307	522				135	912.4	120	84	84	88	289.3	120	85	85	88	.041	.046	C	2
10		100	1.20	1.75	4.93	14.69	228	85	96	86	411	294	361	364	314	481				135	914.7	120	84	84	88	291.6	120	85	85	88	.041	.044	C	2
11		110	1.20	1.77	4.41	15.21	213	85	96	86	374	285	350	352	318	452				135	917.1	120	85	85	87	293.9	120	85	85	87	.040	.041	C	2
12	1345	120	1.10	1.93	4.19	15.32	203	85	94	86	347	276	339	340	317	431				135	919.5	120	85	84	87	296.3	120	86	86	87	.040	.040	C	2
13		130	1.00	1.56	5.00	14.73	195	86	93	86	329	269	330	331	313	413				135	921.9	120	85	85	87	298.7	120	85	86	87	.040	.038	C	2
14		140	.80	1.37	5.13	14.78	190	88	93	86	320	263	324	324	311	404				135	924.3	120	84	85	87	301.1	120	85	86	87	.040	.035	C	2
15		150	.50	1.62	4.42	15.29	185	89	94	87	310	260	319	316	308	390				135	926.7	120	84	84	88	303.5	120	85	85	87	.040	.034	C	2
16		160	.50	1.88	3.87	15.77	180	89	94	87	299	256	313	311	304	376				135	929.1	120	84	84	87	305.9	120	84	85	88	.041	.032	C	2
17		170	.40	2.02	3.95	15.56	176	88	88	79	284	251	305	302	299	372				135	931.5	120	84	84	86	308.3	120	84	85	86	.041	.032	C	2
18		180	.40	1.90	4.52	15.18	176	88	87	77	283	244	300	297	295	370				135	933.9	120	84	84	85	310.7	120	84	85	86	.041	.032	C	2
19		190	.30	2.12	3.55	15.99	172	85	86	76	277	241	296	295	291	359				135	936.3	120	84	84	85	313.1	120	84	85	85	.040	.032	C	2
20		200	.30	2.10	3.28	16.17	168	83	85	76	268	238	289	289	285	351				135	938.8	120	83	83	84	315.6	120	83	84	84	.040	.035	C	2
21	210	~~210~~	.20	1.91	3.07	16.64	165	82	85	75	262	234	284	283	277	343				135	941.2	120	83	83	84	317.9	120	84	84	83	.041	.030	C	2
22	2.15	~~220~~	0	1.84	3.02	16.76	163	83	85	75	258	232	280	279	273	338				135	942.4	120	83	83	83	319.1	120	83	84	83	.040	.030	C	2
23		230																																
24		240																																
25		250																																
26		260																																
27		270																																
28		280																																
29		290																																
30		300																																
31		310																																
32		320					215 MAIN																											
33		330																																
34		340																																
35		350																																
36		360					1,700 Kg/HR																											
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 4 MIN AIR CONTROL CLOSED AT 5 MIN

Manufacturer MORSO Model OVAL Date 7/12/00

Job # 31222 Run 2 Tech RA / ACS

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.12 (inches Hg.) Static pressure (P_g) .15 (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	116	.2000
B-Centroid	3.00	.040	114	.2000
A-1	0.40	.038	111	.1949
A-2	1.50	.040	110	.2000
A-3	4.50	.040	110	.2000
A-4	5.60	.037	111	.1924
B-1	0.40	.038	114	.1949
B-2	1.50	.040	114	.2000
B-3	4.50	.040	114	.2000
B-4	5.60	.036	113	.1897
		AVERAGE	112.7	.1972

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 .9860

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 OWC Date 7-12-00

Job # 31222 Run 2 Tech RA ACS

Pre/Post Checks

Moisture Meter Calibration Check:

Time: 7:45	X: ✓	Y: ✓	12: ✓	22: ✓

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	0 fpm	0 fpm
Smoke Capture Check	0 ✓	0 ✓
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	7-10-00	
Date Dilution Tunnel Cleaned	7-10-00	
Induced Draft Check	0	0
Tunnel Velocity	.040	
Flow Rate 140-cfm ±10%		140,027
Pitot Leak Check:		
Side A	✓	✓
Side B	✓	✓
Temperature System:		
Ambient (65°- 90°F)	✓ °F	
Wood Heater Surface (±125°F)	37.4 °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	5	6
Filter Front	9	11
Filter Back	10	12
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 OWL Date 7-12-GO

Job # 31222 Run 2 Tech RA ACS

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)	942.494	963,296	319.204	340,140
Initial 1minute DGM (ft^3)	942;494	963,296	319,204	340,140
Change (C) (ft^3)	0	0	0	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

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

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7-12-00

Job # 31222 Run 2 Tech RA ACS

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 OWL Date 7/12/00

Job # 31227 Run 2 Tech RA / ACS

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	Ø	Ø	9.99	9.99	2.34	2.36
CO_2	Ø	Ø	24.65	24.65	5.75	5.88
O_2	Ø	Ø	20.93	20.93	5.65	5.55
	Actual	Should Be	Actual	Should Be	Actual	Should Be

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO	.01	10.05	2.38	.01	.05	.04	✓	
CO_2	.01	24.40	5.88	.01	.25	.13	✓	
O_2	.02	20.83	5.72	.02	.10	.07	✓	

* Greater than ± 5% of the range used.

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7/12/00

Job # 31222 Run 2 Tech RA/ACS

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Samples in Desecrator. Date: 7/12/00 Time: 1145

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # 5	Filter Numbers 9+10	Probe and Front Half Housing # 6	Filter Numbers 11+12
Post Test Weight:	91.0642 grams	.2380 grams	91.5728 grams	.2310 grams
Pre Test Weight:	91.0642 grams	.2344 grams	91.5728 grams	.2281 Grams
Gain:	.0 grams	.0036 grams	.0 grams	.0029 Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0036 grams a2 + b2 = .0029 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	9	10	6	11	12	°F	%
7-11-00	7:25	91.0641	.1166	.1177	91.5732	.1144	.1143	73	46
7-12-00	7:05	91.0642	.1166	.1178	91.5728	.1139	.1142	74	48
		Total	.2344		Total	.2281			

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	9+10	6	11+12	°F	%
7-12-00	11:45	91.0644	.2384	91.5728	.2315	80	45
7-13-00	7:05	91.0643	.2382	91.5728	.2313	73	49
7-14-00	7:20	91.0642	.2380	91.5728	.2310	78	50
7-17-00	7:30	91.0642	.2380	91.5728	.2310	74	50

Manufacturer MORSO Model OWL Date 7/12/00

Job # 31222 Run 2 Tech RA/ACS

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft^3)	963.286	340.133
Initial (ft^3)	942.494	319.204

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.12	29.12
Wet Bulb (°F)	67	67
Dry Bulb (°F)	76	82
Humidity (%)	57	45

Manufacturer MORSO Model OWL Date 7/12/00

Job # 31222 Run 2 Tech RA/ACS

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:
Kindling weight: 2.30 lbs. Consisting of: Scrap and paper Fire lit Time: 8:22
Pre-test load weight: _____ lbs. Consisting of: 2X4X _____ inches Time loaded: _____
Pre-test moisture content: Uncorrected: 19.85 % Corrected Dry: 21.24 % Wet: 17.52 %

Test Air Control Settings: HOLE #2 Time: 9:14
Test Unit Fan Settings: N/A Time: _____

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	6.27 Lbs.	6.97 lbs.	7.66 Lbs.

Fire Box Volume:	.995 Ft.^{3}	Ideal Length:	Inches
Load Volume:	0.1667 Ft.^{3}	Loading Density:	6.633 lbs/ft^3
Number of Spacers	12 ¾x1½x5	Load Density:	39.000 lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 14 in.	2.04 lbs.	19. %	19.6 %	18.6 %
2 x 4 x 14 in.	2.00 lbs.	19.8 %	18.2 %	19.1 %
2 x 4 x 14 in.	2.56 lbs.	21.2 %	23 %	23. %
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: 6.60 lbs. **DRY WEIGHT:** 2.46 kg.
AVERAGE MOISTURE CONTENT:
(DRY) 20.17% CORRECTED TO TWO PIN: (DRY) 21.59% (WET) 17.76%
COAL BED RANGE:
1.4 lbs. to 1.6 lbs. (20% to 25% of test load)
TEST CHARGE:
Time loaded: 1019 Coal bed weight: 1.6 lbs. Coal bed weight = 24 % of test load weight

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

Manufacturer MORSO Model OVAL Date 7/12/00

Job # 31222 Run 2 Tech RA/ACS

COMMENTS

0828 - 2.84 LBS PRE-BURN FUEL ADDED

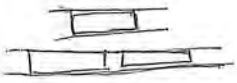
0847 - 3.41 LBS PRE-BURN FUEL ADDED

0859 - 2.04 LBS PRE-BURN FUEL ADDED

0956 - 1.05 LBS PRE-BURN FUEL ADDED

NO FAN

TEST LOAD CONFIGURATION



Manufacturer MORSO Model OWL Date 7/12/00

Job # 31227 Run 2 Tech RA / ACS

HOLE #2 (AIR CONTROL)

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	9.15	0	4.80	462	82	118	80	514	186	352	306	293	772	.045	.075	T
1		10	3.8	445	82	117	81	562	217	404	358	329	794	.045	.075	C
2		20	2.9	434	84	117	82	576	248	427	393	360	765	.045	.080	C
3		30	2.3	403	85	115	82	549	273	438	417	405	703	.045	.080	C
4		40	1.8	375	84	112	85	506	291	406	420	445	646	.040	.080	C
5		50	2.2	398	90	104	85	521	303	436	422	463	700	.115	.080	C
6		60	1.7	369	86	111	84	505	309	433	421	487	644	.040	.075	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: 10:18 started fire, door open 1 min

SEE MAIN COMMENTS

WHI LTO#: 31222 AIRCONTROL ON HOLE #2 page 26 of 48

MANUFACTURER: MORSO MODEL: OWL FIRE SIZE: MEDHIGH DATE: 7/12/00 RUN#: 2 TECHNICIAN: RA/ACS

SWITCH NUMBER:

READING#	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 SMPL 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	1019	0	6.6	.52	5.76	1443	362	85	111	84	443	310	419	436	490	568				135	942.49	120	79	79	76	319.2	120	76	76	76	.040	.076	C	2
1		10	5.00	.27	15.42	4.37	518	90	128	85	627	309	421	440	499	962				135	944.8	120	80	79	89	321.5	120	78	77	89	.039	.082	C	2
2		20	3.50	.07	14.80	5.86	516	89	122	79	720	321	436	418	457	935				135	947.1	120	80	80	89	323.9	120	79	77	89	.039	.083	C	2
3		30	2.30	.05	14.77	5.60	508	88	120	78	726	340	455	435	433	970				135	949.5	120	81	80	89	326.3	120	79	78	90	.038	.083	C	2
4		40	1.20	.63	12.82	7.94	418	89	117	78	754	366	418	459	432	902				135	951.9	120	82	81	88	328.7	120	80	79	87	.040	.080	C	2
5		50	.60	.29	7.08	13.11	392	88	101	78	610	383	481	471	441	738				135	954.3	120	82	82	85	331.1	120	81	79	85	.040	.080	C	2
6		60	.40	.63	6.28	14.03	365	88	103	77	524	382	465	438	451	610				135	956.8	120	83	82	84	333.5	120	81	80	85	.040	.075	C	2
7		70	.30	.88	5.07	15.30	330	86	101	76	473	372	446	439	453	587				135	959.0	120	84	83	85	335.9	120	82	81	83	.040	.072	C	2
8		80	.01	1.23	4.27	15.82	307	86	98	76	432	335	406	415	427	553				135	961.5	120	84	84	85	338.4	120	82	83	85	.040	.070	C	2
9		~~90~~ 87	0	1.43	4.18	15.82	295	84	98	76	403	322	411	400	425	530				135	963.2	120	84	84	84	340.1	120	83	82	84	.040	.056	C	2
10		100																																
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44		440																																
45		450																																
46		460																																
47		470																																
48		480																																

87 min

1.698 K/HR

COMMENTS: door open 1 minute, controls fell open for

TEST LOADED IN 20 SECONDS

Manufacturer HORSO Model QNL Date 7/12/00

Job # 31227 Run 3 Tech RA/ACS

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.12 (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	116	
B-Centroid	3.00	.040	120	
A-1	0.40	.036	118	
A-2	1.50	.040	117	
A-3	4.50	.040	116	
A-4	5.60	.036	118	
B-1	0.40	.035	118	
B-2	1.50	.040	119	
B-3	4.50	.041	119	
B-4	5.60	.035	117	
		AVERAGE		

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 .9781

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 HORSO Model OWL Date 7/12/00

Job # 31222 Run 3 Tech RA/ACS

Pre/Post Checks

Moisture Meter Calibration Check:	Time: 7:45	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	7-10-00	
Date Dilution Tunnel Cleaned	7-10-00	
Induced Draft Check	0	0
Tunnel Velocity	640	
Flow Rate 140-cfm ±10%		141.104
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	7	8
Filter Front	13	15
Filter Back	14	16
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 HORSO Model OWL Date 7/12/00

Job # 3122 Run 3 Tech RA/DCS

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 OWL Date 7/12/00

Job # 31222 Run 3 Tech RA / ACS

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)	963.315	981.250	340.141	357.979
Initial 1minute DGM (ft^3)	963.315	981.250	340.141	357.978
Change (C) (ft^3)	Ø	0	Ø	.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)	Ø	0
Flow Rate (CFM)	Ø	0
Allowable (.04 x Sample Rate)		
Check OK	✓	✓

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7/12/00

Job # 31222 Run 3 Tech RA / ACS

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	9.99	9.99	2.35	2.34
CO_2	0	0	24.65	24.65	5.79	5.88
O_2	0	0	20.93	20.93	5.66	5.55
	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	2.34	0	.01	.01	✓	
CO_2	.01	24.62	5.78	.01	.03	.01	✓	
O_2	.02	20.80	5.73	.02	.13	.07	✓	

* Greater than ± 5% of the range used.

Manufacturer MORSO Model OWL Date

Job # 31222 Run 3 Tech RA/ACS

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Samples in Desecrator. Date: 7/12/00 Time: 1540

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # 7	Filter Numbers 13 + 14	Probe and Front Half Housing # 8	Filter Numbers 15 + 16
Post Test Weight:	90.9534 grams	.2346 grams	92.1912 grams	.2292 grams
Pre Test Weight:	90.9534 grams	.2323 grams	92.1911 grams	.2272 Grams
Gain:	.0 grams	.0023 grams	.0001 grams	.0020 Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0023 grams a2 + b2 = .0021 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	7	13	14	8	15	16	°F	%
7/12/00	7:05	90.9534	.1160	.1164	92.1911	.1140	.1134	74	48
7-12-00	11:50	90.9534	.1162	.1161	92.1911	.1137	.1135	80	45
		Total	.2323		Total	.2272			

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	7	13+14	8	15+16	°F	%
7-12-00	15:40	90.9535	.2349	92.1914	.2292	83	43
7-13-00	7:05	90.9534	.2346	92.1912	.2292	73	49
7-14-00	7:20	90.9534	.2346	92.1912	.2292	78	50
7-17-00	7:30	90.9534	.2346	92.1912	.2292	74	50

Manufacturer HORIBA Model OWL Date 7/12/00

Job # 31222 Run 3 Tech RA / ACS

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft^3)	981.236	357.964
Initial (ft^3)	963.315	340.141

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.12	29.12
Wet Bulb (°F)	67	69
Dry Bulb (°F)	82	88
Humidity (%)	45	38

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7/12/00

Job # 31272 Run 3 Tech RA/ACS

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:

Kindling weight: 2.5 lbs. Consisting of: Scrap and paper Fire lit Time: 12:45

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

Pre-test moisture content: Uncorrected: 18.26 % Corrected Dry: 19.49 % Wet: 16.31 %

Test Air Control Settings: FULL OPEN Time: 12:45

Test Unit Fan Settings: _____ Time: _____

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	6.27 Lbs.	6.97 lbs.	7.66 Lbs.

Fire Box Volume:	.995 Ft.^{3}	Ideal Length:	Inches
Load Volume:	.1667 Ft.^{3}	Loading Density:	6.533 lbs/ft^3
Number of Spacers	12 ¾x1½x5	Load Density:	39.000 lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 14 in.	1.97 lbs.	19.0 %	18.0 %	19.5 %
2 x 4 x 14 in.	1.94 lbs.	20.0 %	18.5 %	18.9 %
2 x 4 x 14 in.	2.57 lbs.	19.0 %	19.0 %	20.6 %
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: 6.50 lbs. **DRY WEIGHT:** 2.45 kg.

AVERAGE MOISTURE CONTENT:

(DRY) 19.17% CORRECTED TO TWO PIN: (DRY) 19.45 % (WET) 17.00%

COAL BED RANGE:

1.3 lbs. to 1.6 lbs. (20% to 25% of test load)

TEST CHARGE:

Time loaded: 14:12 Coal bed weight: 1.5 lbs. Coal bed weight = _____ % of test load weight

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

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7/12/00

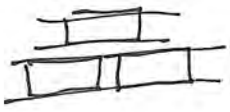
Job # 31222 Run 3 Tech RA/ACS

COMMENTS

1254 - 2.77 LBS PRE BURN FUEL ADDED

1311 - 5.80 LBS PRE BURN FUEL ADDED

TEST LOAD CONFIGURATION



Manufacturer HORSO Model OWL Date 7/12/00

Job # 31222 Run 3 Tech RA / ACS

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	12:57	0	3.80	433	82	123	76	333	226	239	250	219	655	.875	.057	C
1		10	2.60	460	82	118	76	473	220	294	271	230	743	.875	.040	C
2		20	7.50	399	84	108	76	461	240	355	309	279	691	.85	.040	L
3		30	6.40	496	84	121	76	536	338	382	316	313	792	.825	.040	L
4		40	4.90	522	86	126	76	630	294	414	345	338	870	.825	.040	T
5		50	3.60	527	86	127	77	661	271	441	395	371	886	.825	.045	C
6		60	2.70	490	88	123	77	636	302	455	431	423	831	.825	.040	C
7		70	2.10	465	88	120	77	608	337	454	455	467	790	.080	.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:

FIRESTIRED 1411 FOR 10SECONDS

WHI LTO#: 31222 AIR CONTROL FULL OPEN

page 37 of 48

MANUFACTURER: MORSO MODEL: OWL FIRE SIZE: HIGH DATE: 7-12-06 RUN#: 3 TECHNICIAN: RA DES

SWITCH NUMBER:

READING#	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 SMPL. ROTO.	DGN #1 READING	ROTO 1 READING	17 DGN TEMP INLET	18 DGN TEMP OUTLET	19 FILTER TEMP	DGN #2 READING	ROTO 2 READING	20 DGN TEMP INLET	21 DGN TEMP OUTLET	22 FILTER TEMP	TUNNEL VELOCITY	DRAFT	SMOKE	MAX DGN INTENS
0	1912	0	6.50	.46	5.26	13.26	428	89	112	78	563	562	450	463	504	690				135	963.3	120	82	82	78	340.1	120	80	80	80	.040	.076	L	0
1		10	4.70	.08	15.34	11.96	597	89	131	78	631	367	452	456	521	1035				136	965.7	120	82	82	89	342.5	120	80	80	89	.040	.090	C	2
2		20	3.20	.03	13.89	6.60	569	89	134	80	763	379	481	455	499	1035				135	968.0	120	83	83	89	344.8	120	81	81	89	.042	.094	C	2
3		30	1.90	.04	12.85	7.35	544	89	130	80	748	405	508	470	494	994				135	970.4	120	83	84	87	347.2	120	82	81	89	.042	.095	C	2
4		40	1.10	.10	9.73	10.60	481	89	124	80	691	424	511	486	510	842				135	972.8	120	84	84	90	349.6	120	83	81	89	.042	.096	C	2
5		50	.09	.34	6.88	11.94	423	89	117	80	575	458	504	489	532	723				135	975.2	120	85	84	89	351.9	120	84	83	89	.042	.098	C	2
6		60	.76	.64	6.47	13.76	394	89	113	80	508	413	488	475	557	699				135	977.6	120	86	85	88	354.3	120	84	83	89	.042	.088	C	2
7		70	.10	.80	6.14	14.14	375	89	110	80	473	396	471	480	566	626				135	980.0	120	86	86	87	356.7	120	85	84	88	.042	.088	C	2
8		75	0	.90	5.45	14.82	363	89	111	81	460	396	469	462	531	619				135	981.2	120	87	87	85	357.9	120	85	84	86	.042	.080	C	2
9		90																																
10		100																																
11		110																																
12		120																																
13		130																																
14		140																																
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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																																

75 MIN

1.958 Kg/HR

COMMENTS: Door open for 55seconds

TEST LOADED IN 20 SECONDS

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7-13-00

Job # 31222 Run 4 Tech RA ACS

PRETEST DILUTION TUNNEL TRAVERSE RUN

Barometric pressure (P_{bar}) 29.15 (inches Hg.) Static pressure (P_q) .110 (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	104	.2025
B-Centroid	3.00	.039	105	.1975
A-1	0.40	.037	105	.1924
A-2	1.50	.041	105	.2025
A-3	4.50	.041	104	.2025
A-4	5.60	.036	105	.1897
B-1	0.40	.037	105	.1924
B-2	1.50	.039	105	.1975
B-3	4.50	.039	105	.1975
B-4	5.60	.036	105	.1897
		AVERAGE	104.8	.1964

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 .9821

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 ()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 OWL Date 7-13-00

Job # 31222 Run 4 Tech RA ACS

Pre/Post Checks

Moisture Meter Calibration Check:	Time: 7:50	X: ✓	Y: ✓	12: ✓	22: ✓

	Pre-Test	Post-Test
Facility Conditions:		
Air Velocity	0 fpm	Ø fpm
Smoke Capture Check	✓	✓
Wood Heater Conditions:		
Date Wood Heater Stack Cleaned	7-10-00	
Date Dilution Tunnel Cleaned	7-10-00	
Induced Draft Check	0	Ø
Tunnel Velocity	1040	
Flow Rate 140-cfm ±10%		141.486
Pitot Leak Check:		
Side A	✓	✓
Side B	✓	✓
Temperature System:		
Ambient (65°- 90°F)	✓ °F	
Wood Heater Surface (±125°F)	104.8 °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	17	19
Filter Back	18	20
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

Manufacturer Morso Model OWL Date 7-13-00

Job # 31222 Run 4 Tech RA ACS

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 OWL Date 7-13-00

Job # 31222 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)	981.264	23.784	357.982	400.304
Initial 1minute DGM (ft^3)	981.264	23.784	357.982	400.304
Change (C) (ft^3)	0	0	0	0
Allowable leakage .04 x Sample rate or .02cfm	0.0100	0.0100	0.0100	0.0100
Check OK	✓	✓	✓	✓

Leakage Checks Flue Gas Sampler

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

Manufacturer MORSO Model OWL Date 7-13-00

Job # 31222 Run 4 Tech RA ACS

CONTINUOUS ANALYZERS

Pre-Test (Adjust and Record)

	ZERO		SPAN		CAL. (Record Only)	
CO	0	0	9.99	9.99	2.34	2.36
CO_2	0	0	24.65	24.65	5.78	5.88
O_2	0	0	20.93	20.93	5.67	5.55
	Actual	Should Be	Actual	Should Be	Actual	Should Be

Post Test (Record Only)

	Zero	Span	Cal.	Zero Drift	Span Drift	Cal. Drift	OK?	Not OK*
CO	.01	10.07	2.36	.08	.02	.02	✓	
CO_2	.03	24.92	5.86	.27	.08	.08	✓	
O_2	.06	20.81	5.72	.12	.05	.05	✓	

* Greater than ± 5% of the range used.

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7/13/00

Job # 31222 Run 4 Tech RA/ACS

DILUTION TUNNEL PARTICULATE SAMPLER DATA

FILTER TYPE: Gelman 47mm A/E

Samples in Desecrator. Date: 7/13/00 Time: 1408

	SYSTEM 1		SYSTEM 2	
	Probe and Front Half Housing # 9	Filter Numbers 17 & 18	Probe and Front Half Housing # 10	Filter Numbers A & 20
Post Test Weight:	92.2260 grams	.2382 grams	92.0565 grams	.2442 grams
Pre Test Weight:	92.2260 grams	.2280 grams	92.0565 grams	.2332 Grams
Gain:	.0 grams	.0102 grams	0 grams	.0110 Grams
	a1	b1	a2	b2

Total Gain: a1 + b1 = .0102 grams a2 + b2 = .0110 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	9	17	18	10	19	20	°F	%
7-12-00	12:06	92.2263	.1149	.1133	92.0570	.1193	.1153	80	45
7-13-00	7:05	92.2260	.1151	.1129	92.0565	.1180	.1152	73	49
		Total	.2280		Total	.2332			

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	9	17+18	10	19+20	°F	%
7-13-00	14:08	92.2266	.2394	92.0569	.2456	82	50
7-14-00	7:20	92.2261	.2392	92.0565	.2444	78	50
7-17-00	7:30	92.2260	.2383	92.0565	.2442	74	50
7-17-00	10:45	92.2260	.2382	92.0565	.2442	77	49

Manufacturer MORSO Model OWL Date 7-13-00

Job # 31222 Run 4 Tech RA ACS

TEST DATA LOG

RAW DRY GAS METER READINGS

	System 1	System 2
Final (ft^3)	1023.779	400.294
Initial (ft^3)	981.264	357.982

AMBIENT CONDITIONS

	Start	End
Barometer. (inches Hg)	29.15	29.12
Wet Bulb (°F)	68	71 ~~85~~ ACS
Dry Bulb (°F)	76	85
Humidity (%)	63	50

ITS Intertek Testing Services

Manufacturer MORSO Model OWL Date 7-13-00

Job # 31222 Run 4 Tech RA ACS

FUEL DATA

PRE-TEST LOAD

FUEL DESCRIPTION:
Kindling weight: 2.20 lbs. Consisting of: Scrap and paper Fire lit Time: 8:42
Pre-test load weight: COMMENTS lbs. Consisting of: 2X4X inches Time loaded:
Pre-test moisture content: Uncorrected: 20.00 % Corrected Dry: 21.40 % Wet: 17.63 %

Test Air Control Settings: HOLE 1 Time: 9:35
Test Unit Fan Settings: Time:

TEST LOAD

	Lower Limit	Ideal	Upper Limit
Test Load Weight:	6.27 Lbs.	6.97 lbs.	7.66 Lbs.

Fire Box Volume:	.995 Ft.^{3}	Ideal Length:	Inches
Load Volume:	Ft.^{3}	Loading Density:	1.492 lbs/ft^3
Number of Spacers	12 ¾x1½x5	Load Density:	38.760 lbs/ft^3

Piece Size	Weight	Meter Moisture Content (% dry)*		
2 x 4 x 14 in.	2.27 lbs.	20.5 %	18.5 %	19.5 %
2 x 4 x 14 in.	2.27 lbs.	21 %	19.5 %	20.5 %
2 x 4 x 14 in.	1.92 lbs.	19.5 %	18 %	19.5 %
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: 6.46 lbs. **DRY WEIGHT:** 2.42 kg.
AVERAGE MOISTURE CONTENT:
(DRY) ~~20.00~~% 19.61 ACS CORRECTED TO TWO PIN: (DRY) ~~21.40~~% 20.97 ACS (WET) ~~17.63~~% 17.34 ACS
COAL BED RANGE: 1.3 lbs. to 1.4 lbs. (20% to 25% of test load)
TEST CHARGE:
Time loaded: 1055 Coal bed weight: 1.6 lbs. Coal bed weight = 24 % of test load weight

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

ITS Intertek Testing Services

Manufacturer MORSO Model 8WL Date 7-13-00

Job # 31222 Run 4 Tech RA ACS

COMMENTS

0901 3.3 LBS PREBURN FUEL ADDED
0912 4.75 LBS PRE BURN FUEL ADDED
0948 1.26 LBS PRE BURN FUEL ADDED
1017 1.16 LBS PRE BURN FUEL ADDED

TEST LOAD CONFIGURATION

Manufacturer MORSO Model OWL Date 7/13/00

Job # 31222 Run 4 Tech RG/ACS

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	936	0	4.0	405	83	118	76	583	218	366	346	317	813	.043	.076	C
1		10	3.10	400	83	109	77	599	249	406	378	326	768	.045	.076	C
2		20	3.60	401	84	109	77	608	273	412	394	333	764	.045	.080	C
3		30	2.70	387	84	107	77	585	285	410	403	356	737	.045	.080	C
4		40	2.10	365	83	106	79	569	297	411	413	375	702	.045	.080	C
5		50	2.80	358	83	107	80	549	310	402	416	388	675	.045	.075	C
6		60	2.10	333	85	105	81	513	379	396	410	393	637	.041	.075	C
7		70	1.90	313	84	104	81	480	313	392	401	398	605	.041	.075	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: FIRE STIRRED AT 10:54 DOOR OPEN 40 SEC

~~0901~~

WHI LTO#: 31222 AIR CONTROL SET TO R1 HOLE 1 page 48 of 48

MANUFACTURER: MORSO MODEL: OWL FIRE SIZE: MED LOW DATE: 7-13-05 RUN#: 4 TECHNICIAN: RS ACS

SWITCH NUMBER:

READING#	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 SMPL ROTO.	DGM #1 READING ↓	ROTO 1 READING	17 DGM TEMP INLET	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	1055	0	6.46	.32	5.22	14.44	308	83	103	82	455	306	392	395	401	605				135	981.2	120	77	78	74	357.9	120	76	75	74	.040	.057	C	0
1		10	5.40	.78	5.46	14.98	339	84	109	83	460	310	385	378	447	590				135	983.6	120	78	78	84	360.3	120	77	76	85	.040	.055	L	2
2		20	4.40	.10	13.45	7.13	424	84	112	85	568	301	373	358	414	873				135	985.9	120	79	79	87	362.7	120	78	76	87	.040	.055	C	2
3		30	3.10	.02	14.80	5.73	435	86	114	85	562	310	372	368	385	526				135	988.3	120	80	80	89	365.2	120	79	78	86	.040	.055	C	2
4		40	2.10	.00	15.87	4.44	425	88	113	87	718	346	408	390	367	935				135	990.7	120	81	80	88	367.5	120	79	78	88	.040	.055	C	2
5		50	1.50	.09	16.02	9.76	370	88	110	84	674	342	421	404	352	768				135	993.2	120	82	81	89	369.9	120	80	79	89	.040	.055	C	2
6		60	1.30	.56	6.83	13.37	316	86	105	86	568	348	420	415	350	660				135	996.6	120	83	82	86	372.3	120	81	80	87	.040	.055	C	2
7		70	1.10	.82	6.17	13.91	278	87	102	85	474	336	409	363	583					135	998.0	120	84	83	85	374.7	120	82	81	86	.040	.055	C	2
8		80	1.00	1.09	5.55	14.41	262	86	101	85	439	326	395	402	365	540				135	1000.4	120	84	83	85	377.0	120	82	81	86	.040	.052	C	2
9	.90	90	.90	1.26	5.40	14.52	247	86	99	85	404	314	380	390	368	573				135	1002.8	120	85	84	85	379.4	120	83	82	85	.040	.050	C	2
10		100	.80	1.09	5.43	14.38	239	86	99	85	382	302	367	379	360	500				135	1005.2	120	86	85	84	381.8	120	83	82	85	.040	.049	C	2
11		110	.70	1.31	5.18	14.72	232	86	98	86	370	291	360	369	363	481				135	1007.6	120	86	85	85	384.2	120	84	83	85	.040	.045	C	2
12		120	.60	1.50	4.72	15.20	224	85	97	84	356	279	352	358	358	463				135	1010.0	120	86	86	85	386.6	120	84	83	86	.040	.044	C	2
13		130	.40	1.20	4.10	15.36	216	85	97	86	342	276	342	348	351	443				135	1012.4	120	86	86	85	389.0	120	84	84	86	.040	.041	C	2
14		140	.30	1.31	3.91	16.16	208	85	96	86	328	262	333	340	342	421				135	1014.8	120	86	87	85	391.4	120	85	84	85	.040	.040	C	2
15		150	.20	1.15	3.46	16.73	198	85	95	86	319	256	324	330	332	399				135	1017.2	120	87	87	86	393.8	120	85	84	86	.040	.040	C	2
16		160	.10	1.18	3.23	16.91	190	85	91	87	315	252	310	320	328	375				135	1019.6	120	87	87	88	396.2	120	86	85	86	.040	.040	C	2
17		170	.10	1.16	3.29	16.88	186	85	94	86	284	246	300	310	310	369				135	1022.0	120	88	88	85	398.6	120	86	85	86	.040	.040	C	2
18	1177	180	.00	1.25	3.54	16.88	184	85	94	86	279	243	294	305	304	361				135	1023.7	120	88	88	84	400.	120	86	85	85	.040	.040	C	2
19		190																																
20		200																																
21		210																																
22		220																																
23		230																																
24		240																																
25		250																																
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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																																

117 MIN

818 KPH

COMMENTS:

TEST LOADED IN 30 SECONDS DOOR CLOSED 4 MINUTES, AIR CONTROL CLOSED 5 MINUTES

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 250^0 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 800^0 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 $_1S$ 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.

V. DISPOSITION OF TESTED UNIT.

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 WHI logo 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:	Owl
Date:	07/11/00
Run:	1
Project #:	31222
Test Duration:	215
Total Gas Volume (DGM 1):	49.5686
Total Gas Volume (DGM 2):	49.14104
Average Barometric Pressure:	29.15
Molecular Weight:	28.56
Pitot Correction:	0.983
Calibration Factor (DGM #1):	1.0155
Calibration Factor (DGM #2):	1.0107
(1) VS:	0.029802
(2) VS:	0.030061

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	890.8	79	79	267.7	77	77	93		
10	893.2	80	80	270.0	79	78	100	20.01	19.14
20	895.6	81	81	272.4	80	78	96	19.97	19.95
30	898.0	82	82	274.6	81	79	96	19.93	18.25
40	900.4	83	83	277.2	82	81	95	19.90	21.51
50	902.8	85	84	279.6	84	82	96	19.84	19.80
60	905.2	84	84	282.0	83	83	100	19.86	19.80
70	907.6	84	84	284.4	84	84	101	19.86	19.77
80	910.0	84	84	286.8	84	84	99	19.86	19.77
90	912.4	84	84	289.3	85	85	98	19.86	20.55
100	914.7	84	84	291.6	85	85	96	19.03	18.91
110	917.0	85	85	293.9	85	85	96	19.00	18.91
120	919.5	85	84	296.3	86	86	94	20.67	19.69
130	921.9	85	85	298.7	85	86	93	19.82	19.71
140	924.3	84	85	301.1	85	86	93	19.84	19.71
150	926.7	84	84	303.5	85	85	94	19.86	19.73
160	929.1	84	84	305.9	84	85	94	19.86	19.75
170	931.5	84	84	308.3	84	85	88	19.86	19.75
180	933.9	84	84	310.7	84	85	87	19.86	19.75
190	936.3	84	84	313.1	84	85	86	19.86	19.75
200	938.7	83	83	315.5	83	84	85	19.90	19.78
210	941.2	83	83	317.9	84	84	85	20.73	19.77
215	942.4	83	83	319.1	83	84	85	19.90	19.78

Proportional Rate Calculations

(EPA Formulas from PR5G)

Stack area (ft2):	0.1963	Manufacturer:	Morso
Wood moisture (% wet):	17.71	Model:	Owl
Load Weight (lbs wet):	6.72	Date:	07/11/00
Burn Rate (Dry kg/hr):	0.700	Run:	1
Final Temperature (DGM #1) Degrees Rankin:		543.370	
Final Temperature (DGM #2) Degrees Rankin:		543.304	
Final Tunnel Temperature Degrees Rankin:		553.478	
Final Tunnel Velocity (feet per second):		13.6271066	
Standardized Tunnel Flow (dscfm):		143.147249	

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	13.392	539.0	537.0					0
0.039	13.477	540.0	538.5	102.98	99.36	2.321	2.220	10
0.039	13.429	541.0	539.0	102.43	103.21	2.316	2.314	20
0.041	13.769	542.0	540.0	99.71	92.10	2.312	2.117	30
0.041	13.756	543.0	541.5	99.44	108.45	2.308	2.495	40
0.041	13.769	544.5	543.0	99.25	99.92	2.302	2.297	50
0.041	13.818	544.0	543.0	99.70	100.28	2.304	2.297	60
0.041	13.830	544.0	544.0	99.79	100.18	2.304	2.293	70
0.040	13.636	544.0	544.0	100.85	101.25	2.304	2.293	80
0.041	13.793	544.0	545.0	99.52	103.89	2.304	2.384	90
0.041	13.769	544.0	545.0	95.21	95.40	2.208	2.193	100
0.040	13.600	545.0	545.0	96.21	96.59	2.204	2.193	110
0.040	13.575	544.5	546.0	104.49	100.42	2.398	2.284	120
0.040	13.563	545.0	545.5	100.12	100.42	2.299	2.287	130
0.040	13.563	544.5	545.5	100.22	100.42	2.302	2.287	140
0.040	13.575	544.0	545.0	100.40	100.61	2.304	2.289	150
0.041	13.744	544.0	544.5	99.17	99.46	2.304	2.291	160
0.041	13.669	544.0	544.5	98.63	98.92	2.304	2.291	170
0.041	13.657	544.0	544.5	98.54	98.83	2.304	2.291	180
0.040	13.477	544.0	544.5	99.67	99.97	2.304	2.291	190
0.040	13.465	543.0	543.5	99.76	100.06	2.308	2.295	200
0.041	13.632	543.0	544.0	102.64	98.74	2.404	2.293	210
0.040	13.465	543.0	543.5	99.76	100.06	1.154	1.147	215

Manufacturer:	Morso
Model:	Owl
Date:	07/12/00
Run:	2
Project #:	31222
Test Duration:	87
Total Gas Volume (DGM 1):	19.93602
Total Gas Volume (DGM 2):	20.09422
Average Barometric Pressure:	29.12
Molecular Weight:	28.56
Pitot Correction:	0.986
Calibration Factor (DGM #1):	1.0155
Calibration Factor (DGM #2):	1.0107
(1) VS:	0.072559
(2) VS:	0.071988

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	942.5	79	79	319.2	76	76	111		
10	944.8	80	79	321.5	78	77	128	19.25	19.15
20	947.1	80	80	323.9	79	77	122	19.15	19.97
30	949.5	81	80	326.3	79	78	120	19.97	19.95
40	951.9	82	81	328.7	80	79	117	19.93	19.91
50	954.3	82	82	331.1	81	79	107	19.91	19.89
60	956.7	83	82	333.5	81	80	103	19.89	19.87
70	959.1	84	83	335.9	82	81	101	19.86	19.84
80	961.5	84	84	338.4	82	83	98	19.84	20.63
87	963.2	84	84	340.1	83	82	98	20.08	20.04

	Proportional Rate Calculations			(EPA Formulas from PR5G)				
	Stack area (ft2):	0.1963		Manufacturer:		Morso		
	Wood moisture (% wet):	17.76		Model:		Owl		
	Load Weight (lbs wet):	6.6		Date:		07/12/00		
	Burn Rate (Dry kg/hr):	1.698		Run:		2		
Final Temperature (DGM #1) Degrees Rankin:				541.650				
Final Temperature (DGM #2) Degrees Rankin:				539.650				
Final Tunnel Temperature Degrees Rankin:				570.500				
Final Tunnel Velocity (feet per second):				13.7541969				
Standardized Tunnel Flow (dscfm):				140.027174				

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	13.831	539.0	536.0					0
0.039	13.859	539.5	537.5	99.70	98.39	2.234	2.222	10
0.039	13.788	540.0	538.0	98.67	102.04	2.222	2.316	20
0.038	13.587	540.5	538.5	104.03	103.10	2.316	2.314	30
0.040	13.904	541.5	539.5	100.95	100.05	2.312	2.310	40
0.040	13.783	542.0	540.0	99.97	99.08	2.310	2.307	50
0.040	13.734	542.5	540.5	99.53	98.64	2.308	2.305	60
0.040	13.710	543.5	541.5	99.17	98.29	2.303	2.301	70
0.040	13.673	544.0	542.5	98.81	101.92	2.301	2.393	80
0.040	13.673	544.0	542.5	99.99	99.01	1.630	1.627	87

		Manufacturer:		Morso					
		Model:		Owl					
		Date:		07/12/00					
		Run:		3					
		Project #:		31222					
		Test Duration:		75					
		Total Gas Volume (DGM 1):		17.15571					
		Total Gas Volume (DGM 2):		17.03679					
		Average Barometric Pressure:		29.12					
		Molecular Weight:		28.56					
		Pitot Correction:		0.9781					
		Calibration Factor (DGM #1):		1.0155					
		Calibration Factor (DGM #2):		1.0107					
			(1) VS:	0.084967					
			(2) VS:	0.08556				Filter	Filter
Elapsed	DGM 1	DGM 1	DGM 1	DGM 2	DGM 2	DGM 2	Tunnel	Face Velocity	Face Velocity
Time	Reading	Inlet T	Outlet T	Reading	Inlet T	Outlet T	Dry Bulb	DGM 1	DGM 2
0	963.3	82	82	340.1	80	80	112		
10	965.7	82	82	342.5	80	80	131	19.91	19.89
20	968.0	83	83	344.8	81	81	134	19.05	19.03
30	970.4	83	84	347.2	82	81	130	19.86	19.84
40	972.8	84	84	349.6	83	81	124	19.84	19.82
50	975.2	85	84	351.9	84	83	117	19.82	18.94
60	977.6	86	85	354.3	84	83	113	19.78	19.76
70	980.0	86	86	356.7	85	84	110	19.77	19.73
75	981.2	87	87	357.9	85	84	111	19.73	19.73

	Proportional Rate Calculations				(EPA Formulas from PR5G)			
	Stack area (ft2):	0.1963			Manufacturer:		Morso	
	Wood moisture (% wet):	17			Model:		Owl	
	Load Weight (lbs wet):	6.5			Date:		07/12/00	
	Burn Rate (Dry kg/hr):	1.958			Run:		3	
Final Temperature (DGM #1) Degrees Rankin:					544.167			
Final Temperature (DGM #2) Degrees Rankin:					542.278			
Final Tunnel Temperature Degrees Rankin:					580.222			
Final Tunnel Velocity (feet per second):					14.0961824			
Standardized Tunnel Flow (dscfm):					141.104182			
		Average Inlet + Outlet Temp.	Average Inlet + Outlet Temp.			#1 dDGM Vol.Std.	#2 dDGM Vol.Std.	
Tunnel Velocity	Tunnel Velocity Ft/Sec	Meter 1 Deg. R	Meter 2 Deg. R	PR1	PR2	(ft3)	(ft3)	Time
0.040	13.733	542.0	540.0					0
0.040	13.959	542.0	540.0	103.87	104.48	2.310	2.307	10
0.042	14.340	543.0	541.0	97.21	97.78	2.210	2.207	20
0.042	14.292	543.5	541.5	101.00	101.60	2.303	2.301	30
0.042	14.219	544.0	542.0	100.39	100.99	2.301	2.299	40
0.042	14.133	544.5	543.5	99.70	95.93	2.299	2.197	50
0.042	14.084	545.5	543.5	99.17	99.75	2.295	2.293	60
0.042	14.047	546.0	544.5	98.82	99.31	2.293	2.288	70
0.042	14.060	547.0	544.5	98.72	99.40	1.144	1.144	75

Manufacturer:	Morso
Model:	Owl
Date:	07/13/00
Run:	4
Project #:	31222
Test Duration:	177
Total Gas Volume (DGM 1):	40.78394
Total Gas Volume (DGM 2):	40.63902
Average Barometric Pressure:	29.135
Molecular Weight:	28.56
Pitot Correction:	0.9821
Calibration Factor (DGM #1):	1.0155
Calibration Factor (DGM #2):	1.0107
(1) VS:	0.035824
(2) VS:	0.035952

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	981.2	77	78	357.9	77	76	103		
10	983.6	78	78	360.3	77	76	109	20.07	20.03
20	985.9	79	79	362.7	78	76	112	19.20	20.01
30	988.3	80	80	365.2	79	78	114	20.00	20.79
40	990.7	81	80	367.5	79	78	113	19.98	19.13
50	993.2	82	81	369.9	80	79	110	20.77	19.92
60	995.6	83	82	372.3	81	80	105	19.90	19.88
70	998.0	84	83	374.7	82	81	102	19.87	19.85
80	1000.4	84	83	377.0	82	81	101	19.87	19.02
90	1002.8	85	84	379.4	83	82	99	19.83	19.81
100	1005.2	86	85	381.8	83	82	99	19.79	19.81
110	1007.6	86	85	384.2	84	83	98	19.79	19.77
120	1010.0	86	86	386.5	84	83	86	19.78	18.95
130	1012.4	86	86	389.0	84	84	97	19.78	20.58
140	1014.8	86	87	391.4	85	84	96	19.76	19.74
150	1017.2	87	87	393.8	85	84	95	19.74	19.74
160	1019.6	87	87	396.2	86	85	91	19.74	19.70
170	1022.0	88	85	398.6	86	85	94	19.76	19.70
177	1023.7	88	88	400.3	86	85	94	19.94	19.87

	Proportional Rate Calculations				(EPA Formulas from PR5G)			
	Stack area (ft2):	0.1963			Manufacturer:		Morso	
	Wood moisture (% wet):	17.63			Model:		Owl	
	Load Weight (lbs wet):	6.46			Date:		07/13/00	
	Burn Rate (Dry kg/hr):	0.818			Run:		4	
Final Temperature (DGM #1) Degrees Rankin:					543.605			
Final Temperature (DGM #2) Degrees Rankin:					541.658			
Final Tunnel Temperature Degrees Rankin:					560.947			
Final Tunnel Velocity (feet per second):					13.659639			
Standardized Tunnel Flow (dscfm):					141.505557			
		Average Inlet + Outlet Temp. Meter 1	Average Inlet + Outlet Temp. Meter 2			#1 dDGM Vol.Std.	#2 dDGM Vol.Std.	
Tunnel Velocity	Tunnel Velocity Ft/Sec	Deg. R	Deg. R	PR1	PR2	(ft3)	(ft3)	Time
0.040	13.676	537.5	536.5					0
0.040	13.749	538.0	536.5	101.83	101.99	2.328	2.324	10
0.040	13.785	539.0	537.0	97.66	102.17	2.227	2.322	20
0.040	13.809	540.0	538.5	101.90	106.31	2.320	2.412	30
0.040	13.797	540.5	538.5	101.71	97.72	2.317	2.219	40
0.040	13.761	541.5	539.5	105.48	101.52	2.410	2.311	50
0.040	13.700	542.5	540.5	100.63	100.88	2.309	2.306	60
0.042	14.001	543.5	541.5	97.76	98.01	2.305	2.302	70
0.040	13.652	543.5	541.5	100.09	96.16	2.305	2.206	80
0.040	13.627	544.5	542.5	99.73	99.97	2.300	2.298	90
0.040	13.627	545.5	542.5	99.54	99.97	2.296	2.298	100
0.040	13.615	545.5	543.5	99.45	99.70	2.296	2.294	110
0.040	13.468	546.0	543.5	98.29	94.51	2.294	2.198	120
0.039	13.432	546.0	544.0	100.54	104.99	2.294	2.387	130
0.040	13.591	546.5	544.5	99.09	99.34	2.292	2.290	140
0.040	13.579	547.0	544.5	98.91	99.25	2.290	2.290	150
0.040	13.530	547.0	545.5	98.56	98.71	2.290	2.285	160
0.040	13.566	546.5	545.5	98.91	98.98	2.292	2.285	170
0.040	13.566	548.0	545.5	99.82	99.80	1.619	1.613	177

APPENDIX D

Intertek Testing Services

Warnock Hersey

Middleton, Wisconsin

Post Test Dry Gas Meter Calibration Data

Manufacturer: Morso Model: Owl Job Numbe 31222 Date: 07/14/00 Tech: RA ACS

Barometric Press: 29.05 Calibration Factors: DGM#1: 1.0155 DGM#2: 1.0107 Std.Meter DGM#3: 1.0293

Trial No.	Standardized Meter # 3 Press Drop	Initial Ft.^{3}	Final Ft^3	Change Ft.^{3}	Temp °F	Std. Ft^3	System # 1 Initial Ft.^{3}	Final Ft.^{3}	Change Ft.^{3}	Temp °F	Std Ft.^{3}	Cal Factor
1	0.4	442.082	444.525	2.4430	73.5	2.4163	26.552	29.01	2.4580	77.5	2.3807	1.0150
2	0.4	444.525	446.894	2.3690	74	2.3409	29.01	31.527	2.5170	78	2.4356	0.9611
3	0.4	446.894	448.137	1.2430	74	1.2283	31.527	32.799	1.2720	78	1.2308	0.9979
											Average:	0.9913

Previous Cal Factor:	Minus -	Avg. Cal. Factor	divided by /	Previous Cal Factor	Times 100 *	equals =	Precent Deviation
1.0155		0.9913		1.0155			2.3800

Trial No.	Standardized Meter #3 Press Drop	Initial Ft.^{3}	Final Ft^3	Change Ft.^{3}	Temp °F	Std. Ft^3	System # 2 Initial Ft.^{3}	Final Ft.^{3}	Change Ft.^{3}	Temp °F	Std Ft.^{3}	Cal Factor
1	0.4	449.8745	452.222	2.3475	75	2.3153	402.05	404.452	2.4020	78	2.3133	1.0009
2	0.4	452.222	454.512	2.2900	75.5	2.2565	404.452	406.741	2.2890	79	2.2004	1.0255
3	0.4	454.512	455.69	1.1780	76	1.1597	406.741	407.945	1.2040	77.5	1.1606	0.9992
											Average:	1.0085

Previous Cal Factor:	Minus -	Avg. Cal. Factor	divided by /	Previous Cal Factor	Times 100 *	equals =	Precent Deviation
1.0107		1.008528		1.0107			0.21491

ITS Intertek Testing Services

Page___of___

Manufacturer_____ Model_____ Date_____

Job #_____ Run_____ Tech_____

POST TEST DRY GAS METER CALIBRATION DATA

MANUFACTURER: Horso MODEL: CWL LTO:_____ DATE: 7/14/00 TECHNICIAN: RA/ACS

BAROMETRIC PRESSURE: 29.04 CALIBRATION FACTOR DGM#1: 1.0155 DGM#2: 1.0107 STANDARDIZED DGM#3:

	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	.4	444.525	442.082	24430	73.5	2.4163	29.010	26.552	2.458	77.5	2.3807	1.0150
2	.4	446.894	444.525	2369	74	2.3409	31.527	29.070	2.5170	78	2.4356	.9611
3	.4	448.137	446.907	1.2430	74	1.2283	32.799	31.527	1.272	78	1.2308	.9979

AVERAGE CALIBRATION FACTOR: .9913

PREVIOUS CAL. FACTOR	MINUS	AVERAGE CAL.FACTOR	DIVIDED BY	PREVIOUS CAL.FACTOR	MULTIPLIED *100	EQUALS	DEVIATION PERCENT
	-		/		*100	=	%

	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	.4	452.222	449.874	2.3475	75	2.3153	404.470	402.050	2.4020	76.5	2.3133	1.0009
2	.4	454.512	452.222	2.2900	75.5	2.2565	406.741	404.425	2.2890	79	2.2054	1.0255
3	.4	455.690	454.512	1.1780	76	1.1597	407.945	406.741	1.2040	77.5	1.1606	.9992

AVERAGE CALIBRATION FACTOR: 1.0085

PREVIOUS CAL. FACTOR	MINUS	AVERAGE CAL. FACTOR	DIVIDED BY	PREVIOUS CAL. FACTOR	MULTIPLIED *100	EQUALS	DEVIATION %
	-		/		*100	=	%

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 OWL Date 7/14

Job # 31222 Run _____ Tech RA/ACS

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	0	0	0
Span Gas	9.99	9.99	24.65	24.65	20.93	20.93
Cal Gas #1	2.34	2.489	5.78	6.086	5.36	5.20
Deviation						
Cal Gas #2	2.35	2.36	5.77	5.88	5.67	5.55
Deviation						
Cal Gas #3	7.68	7.68	19.28	19.86	17.47	17.16
Deviation						
Average Deviation						

Manufacturer: Morso
Project No: 31222
Model: 3410
Date: 07/14/00

	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	24.65	20.93	20.93
Cal GAS #1	2.34	2.489	5.78	6.086	5.36	5.2
Deviation		5.99%		5.03%		3.08%
Cal GAS #2	2.35	2.36	5.77	5.88	5.67	5.55
Deviation		0.42%		1.87%		2.16%
Cal GAS #3	7.68	7.68	19.28	19.86	17.47	17.16
Deviation		0.00%		2.92%		1.81%
Average Deviation		2.14%		3.27%		2.35%

ITS EQUIPMENT CALIBRATION RECORD

ITS# ~~EE~~ 500

DESCRIPTION: THERMOCOUPLES

MANUFACTURER: OMEGA

SERIAL #: — MODEL: —

EQUIPMENT LOCATION: E+E LAB

PURPOSE & ACCURACY: 6 mos.

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	
5/30/00	11/30/00			

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: 5-30-08 **CALIBRATED BY:** RA
REVIEWED BY: [illegible]

ITS # 500

ROOM TEMPERATURE 69

Thermocouple number and location	Thermocouple immersed in boiling water	Thermocouple immersed in ice bath
1) Flue Gas	211	32
2) Room Temperature	211	32
3) Dry Bulb (in tunnel)	211	32
4) Wet Bulb (in tunnel)	211	32
5) Unit Top	211	32
6) Unit Back	211	32
7) Unit Right Side	211	32
8) Unit Left Side	211	32
9) Unit Bottom	211	32
10) Catalyst Downstream	211	32
11) Catalyst Center	211	32
12)	211	32
13)	211	32
14)	212	32
15)	212	33
16)	211	33
17) DGM (in)	212	33
18) DGM (out)	212	33
19) Filter (1)	212	33
20) DGM (in)	212	33
21) DGM (out)	212	33
22) Filter (2)	212	33

ITS EQUIPMENT CALIBRATION RECORD

ITS# 8 & 259

DESCRIPTION: Weigh

MANUFACTURER: Tronix

SERIAL #: (6)(8)G800082 (25)(254)03082 MODEL: (8) NCI 5780 (259) WI 110

EQUIPMENT LOCATION:

PURPOSE & ACCURACY: .1 16

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	
3/00	9/00	" "	"	~~Big Scale only~~

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 ITC. DATE 3/00

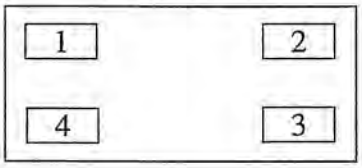
ADDRESS

CITY, STATE & ZIP middleton

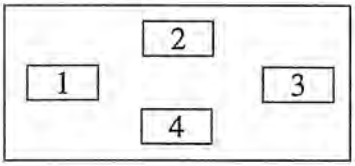
INDICATOR MFG.	GSE	CAPACITY	100	CLASS	III
MODEL	450	DIVISIONS	.01 lb	ACCURACY	1 %
SERIAL NO.	101722	LOCATION	E of ECAB	TOLERANCES USED	
BASE MFG.	NCI	I.D. #			Hb44
MODEL	3200	CALIBRATION INTERVAL			Semi Annual
SERIAL NO.	790193	NEXT CALIBRATION DUE			9/00

SHIFT TEST

FLOOR SCALE



BENCH SCALE



SECTION	LOAD	READING	ERROR
1	25.00	25.00	0
2	25.00	25.00	0
3	25.00	25.00	0
4	25.00	25.00	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
	30.00	30.00	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. 978-206

LIST TEST WEIGHTS USED BY SERIAL NO. kit 5

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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NOTIFICATION # 300002176

#70

HORIBA FIELD SERVICE REPORT 421407 PAGE ____ OF ____

SERVICE LOCATION	INVOICE TO CUST. NO:	
INSTITUTION NAME: TERTEK TESTING SERV.	INSTITUTION NAME:	DATE STARTED: 4/27
STREET ADDRESS: 8431 MURPHY DR.	STREET ADDRESS:	CALL COMPLETE: ✓ YES ___ NO
CITY: MIDDLETON COUNTY/PARISH:	CITY: STATE: ZIP:	PRODUCT CODE: PIR-2000
STATE: WISCONSIN ZIP: 53562	ATTENTION:	PRODUCT SER. # AND MFG. DATE: 606[illegible]6 1986
DEPT/BLDG/LOCATION: direct/608/824-7421	TAX NUMBER (IF EXEMPT):	SYSTEM PRODUCT CODE: 0-.1/.3/.5% CO
INDIVIDUAL'S NAME: BILL KEEN	P.O. NUMBER: 29257	SYSTEM SER. # AND MFG. DATE:
TELEPHONE NUMBER: (608) 836-4400 x421	AUTHORIZED BY: HEATHER ROBINSON	CHARGE TYPE: X CS ___ POL ___ WAR ___ IN ___ CO
		CONTRACT #: TYPE: ___ CO ___ DEMAND

ANALYSIS OF PROBLEM: Will ZERO & SPAN, but doesn't read correctly sample. Intermittent problem - (reading ON and OFF again & each time different results)

- replaced BPA bd.
- repaired the mother bd. (power supply part; trays, soldering; connectors) 4-03
- repaired the NOR-44 bd. (replaced 3-PIN & 6-PIN connectors)
- cleaned the optical bench (sample cell, windows)
- cleaned the solid filters w. spacers (there has been brown powder-like build-up)
- done optical alignment; linearization (new curve) tested and verified linearity ⇒ repeatability @ .5% F.S.
- leak test passed - O.K.

DC

MATERIAL AND OUTSIDE SERVICES

ITEM	PART NUMBER	DESCRIPTION	QTY.	UNIT COST	TOTAL	CHG
01	352194	PCB, BPA (60Hz)	1	132.00	132.00	
02	NXPN	3-PIN CONNECTOR	1	12.00	12.00	
03	NXPN	6-PIN CONNECTOR	1	18.00	18.00	

SERVICE LABOR

DATE	TYPE	HOURS	RATE	TOTAL	CHG
4/27	L	1.0	120.00		
4/28	L	3.5	420.00		
5/1	L	3.5	420.00		

EXPENSES

FIXED COST CONTRACT PRICE		
AUTO MILES AT $		
PHONE		
LODGING		
MEALS		
AUTO/TAXI/FUEL/PARKING/TOLLS		
OUTSIDE SERVICES		
AIRFARE & TRAVEL EXPENSES		
SUBTOTAL	1,092.00	
SALES TAX AT %		
FREIGHT AND INSURANCE		
TOTAL CHARGES		

CUSTOMER SIGNATURE DATE

SERVICE REPRESENTATIVE: JERRY BEDNAR EMPLOYEE NO.: 284

CARRIER: UPS PRIORITY: NEXT DAY WAYBILL NO. SHIPPER NO.: 66449

CUSTOMER

NTEP CERTIFICATE OF CONFORMANCE
CALIBRATION DATA

MODEL: 60001A300-1138
CAP: 300 lbs
FSO: 3.569 mV/V
CERT#: 86-043
DATE: 4/7/99

S/N: 868456

B16 SCALE

Class IIIL/ Single LC	Divisions 10000
Vmin 0.012LB	Min. Dead Load 6.0LB
Compensated Temp. 14 to 104 DegF	
Safe Overload 150 % of Capacity	
	Rated Excitation 10 Vdc
	Input Resistance 380 Ohms
	Output Resistance 350 Ohms
Barometric Effect Nil	Insulation Res> 1000 MOhms @ 50 Vdc

WIRING CODE

+ Excitation: Red
- Excitation: Black
Shield: Orange

+ Output: Green
- Output: White

Data obtained utilizing standards traceable to the National Institute of Technology.

Factory Mutual System Approved

IS CL I,II,III; DIV 1, GP A-G, NI CL 1; DIV 2, GP A-D
S CL II, III DIV 2, GP F&G. HAZ LOC. TEMP CODE: T4
OPERATING TEMP: 0 TO 150F
ENTITY PARAM: Vmax = 30V, Imax = 600mA, Ci = 0uF, Li = 0Mh
WHEN INSTALLED PER DWG: 20038

Michael J. Maksimik
Q.A Approval

SENSORTRONICS

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 3-W

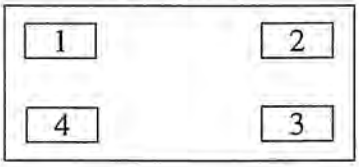
ADDRESS

CITY, STATE & ZIP Middleton

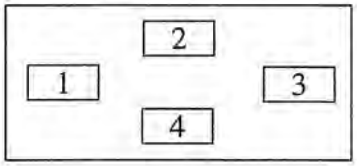
INDICATOR MFG.	Weigh Tronix	CAPACITY	100 Lb	CLASS	III
MODEL	WI110	DIVISIONS	.1 Lb	ACCURACY	1%
SERIAL NO.		LOCATION		TOLERANCES USED	HB44
BASE MFG.	Toledo	I.D. #			
MODEL	Dormont	CALIBRATION INTERVAL		6 mo	
SERIAL NO.	N/A	NEXT CALIBRATION DUE		9-W	

SHIFT TEST

FLOOR SCALE



BENCH SCALE



SECTION	LOAD	READING	ERROR
1	50.0	50.0	0
2	50.0	50.0	0
3	50.0	50.0	0
4	50.0	50.0	0

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

INCREASING LOAD TEST

PRELIMINARY LOAD TEST

SUBSTITUTION WEIGHT	TEST WEIGHT	READING	ERROR
	100.0	100.0	0
	20.0	20.0	0
	30.0	30.0	0
	40.0	40.0	0
	50.0	50.0	0
	70.0	70.0	0
	80.0	80.0	0
	100.0	100.0	0

FINAL LOAD TEST AFTER ADJUSTMENT

SUBSTITUTION WEIGHT	TEST WEIGHT	READING	ERROR

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

IS SCALE WITHIN ACCEPTANCE TOLERANCE ( ) Y ( ) N

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

COMMENTS: Replaced Load cell

TEST WEIGHT CLASSIFICATION F

NIST TRACEABILITY CERTIFICATE NO. 778-206

LIST TEST WEIGHTS USED BY SERIAL NO. 71-80 + 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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CREAM CITY SCALE LLC
STATELINE

2009 S. STOUGHTON RD., MADISON, WISCONSIN 53716 PHONE 608/222-9427
10350 N. SECOND ST. (HWY. 251), ROCKFORD, ILLINOIS 61115 PHONE 815/654-1055
www.creamcityscale.com

Initiated By _____
Date Initiated _____
Date Promised _____

SERVICE REPORT

CUSTOMER T. T. S.
JOB NO.
ADDRESS
PURCHASE ORDER NO.
CITY / STATE / ZIP
PHONE
WORK REQUESTED BY
SPECIAL INSTRUCTIONS
MECHANIC SHOULD SEE

SERVICE REQUESTED CONTRACT ☐ REG. SERVICE ☐ OVERTIME ☐ PARTS ORDER ☐

W : REQUESTED

WORK PERFORMED

Equipment Disposition:
[ ]paired [ ] Calibrated [ ] Reject – Parts To Customer [ ] Reject – Scrap@CCS Confirmed w/_____ [ ] Other: _____

PARTS USED

QTY.	PART NO. / LOCATION #	DESCRIPTION	PRICE
1		Shop Equip 1125	
		#1 Rail	
		with Stem	TOTAL PARTS

THIS SERVICE AS DESCRIBED HAS BEEN RECEIVED

X _____ CUSTOMER'S SIGNATURE

DATE

TECHNICIAN

FOR OFFICE USE ONLY

COUNTY	@		
RH	@		
OT	@		
SHOP	@		
OTHER	@		
TAX RATE			
		TOTAL	

Supplier N/C Assessment [ ] Yes [ ] No Manager Approval _____

VISA ☐ MasterCard ☐ American Express ☐ Acct. # _____ Exp. Date _____ Cardholder _____

Form # 3.1-01

CREAM CITY SCALE LLC
STATELINE

2009 S. STOUGHTON RD., MADISON, WISCONSIN 53716 PHONE 608/222-9427
10350 N. SECOND ST. (HWY. 251), ROCKFORD, ILLINOIS 61115 PHONE 815/654-1055
www.creamcityscale.com

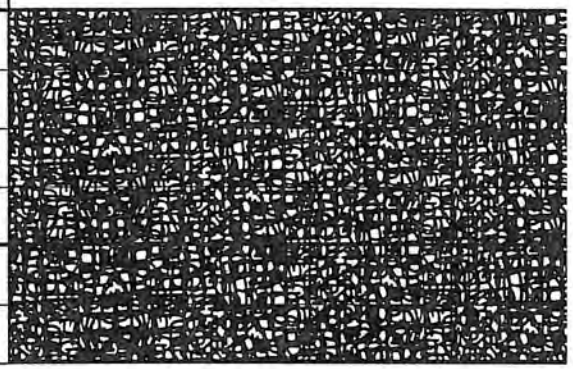
Initiated By _____
Date Initiated _____
Date Promised _____

SERVICE REPORT

CUSTOMER ITS
JOB NO.
ADDRESS
PURCHASE ORDER NO.
CITY / STATE / ZIP
PHONE
WORK REQUESTED BY
SPECIAL INSTRUCTIONS
MECHANIC SHOULD SEE

SERVICE REQUESTED CONTRACT ☐ REG. SERVICE ☐ OVERTIME ☐ PARTS ORDER ☐

W K REQUESTED



WORK PERFORMED

Del'ed + Set up Bldg 4-9

Cust # 93211198 P/N 561311

100 x .1 mV test to gnd

Sent out DISP.

Equipment Disposition:
[epaired [ ] Calibrated [ ] Reject – Parts To Customer [ ] Reject – Scrap@CCS Confirmed w/_____ [ ] Other: _____

PARTS USED

QTY.	PART NO. / LOCATION #	DESCRIPTION	PRICE
		TOTAL PARTS	

THIS SERVICE AS DESCRIBED HAS BEEN RECEIVED

X _____ CUSTOMER'S SIGNATURE

_____ DATE

_____ TECHNICIAN

FOR OFFICE USE ONLY

COUNTY	@		
RH	@		
OT	@		
SHOP	@		
OTHER	@		
TAX RATE			
	TOTAL		

Supplier N/C Assessment [ ] Yes [ ] No Manager Approval _____

VISA ☐ MasterCard ☐ American Express ☐ Acct. # _____ Exp. Date _____ Cardholder _____

Form # 3.1-01

#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

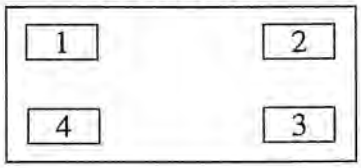
ADDRESS 8931 Murphy DR

CITY, STATE & ZIP Middleton WI 53562

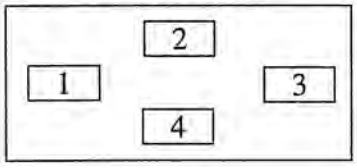
INDICATOR MFG.	Weighmax	CAPACITY	980#	CLASS	III
MODEL	WI 110	DIVISIONS	.1	ACCURACY	1%
SERIAL NO.	30821	LOCATION	E+E	TOLERANCES USED	
BASE MFG.	Toledo	I.D. #	259		HB 44
MODEL	Dormant	CALIBRATION INTERVAL		Semi Annual	
SERIAL NO.	N/A	NEXT CALIBRATION DUE		5/00	

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

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. 4198-206

LIST TEST WEIGHTS USED BY SERIAL NO. 71,72,73,74,75,76,77,78, m689

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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ITS Intertek Testing Services NA Inc.

Middleton, Wisconsin

CALIBRATION DATE: 5-15-00 **CALIBRATED BY:** RA
REVIEWED BY: _____

DESCRIPTION: Readout/75 lb Scale **MODEL:** NCI 5780

SERIAL NUMBER: G800082 **WHI INVENTORY #008**

WEIGHT APPLIED	READING
5 lbs.	5.00 lbs.
10 lbs.	10.00 lbs.
15 lbs.	15.00 lbs.

THIS IS CALIBRATED BY CREAM CITY SCALE
THIS SHEET REALLY ISN'T NECESSARY

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

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 WH1 #12
② Rockwell T-110 #26873 WH1 #13
③ Rockwell T-110 #27002 WH1 #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 #27692 MODEL: #14

EQUIPMENT LOCATION: E + E

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

								1.003	
			SPIROMETER						
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 Interte Testing Services

Page ___ of ___

Manufacturer ROOKWELL Model T/10 Date 1/12-99

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 (1.0469)	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	1.0469 ~~296.000~~	296.008	1.0269
3	296.608	29.19	64.5	.6495	65	.47	23.5625	1.0710	297.032	1.0197
4	298.083	29.19	66	~~1.6380~~	65.5	.47	22.9375	1.0426	299.082	1.0195
5 RA	~~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

299.3225 ~~299.082~~

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	64.5	.6495	69	.47	23.5625	1.0710	905.893	1.0069
									AVERAGE	1.0157

SN 26873 Meter Number 2 Inventory Number 013

1	283.205	29.18	66	.6380	67	.47	22.9375	1.0426	284.197	1.0300
2 RA	~~284.197~~	29.19	66	.6380	67	.47	23.125	1.0511	~~300~~ 285.428	1.0384
3	285.428	29.19	65	.4140	67		22.875	1.0398	286.4105	1.0399
									AVERAGE	1.0361

284.436 ~~284.211~~

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

ITS EQUIPMENT CALIBRATION RECORD

ITS# 021

DESCRIPTION: Alnor Velometer

MANUFACTURER: Alnor

SERIAL #: MD1057 MODEL: 8525

EQUIPMENT LOCATION: E+E 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
.162	66	.8	34.64	2078.2	1750	15.79
.28	66	.89	35.82	2151.8	1840	14.49

AVG. DEV 11.87%

$K_p = 85.49$
$C_p = .99$
$T_s = {}^oF + 460$
$P_s = P_{Bar} + (P_g \text{ (static)})$ **(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

3/24/99

Cal-lab cannot do this.
Next date due is 7/22/99
We should send back to ALNOR
prior to this date to have it
serviced/calibrated by them.

#21

April 26, 1999

Service Bulletin

Subject: Repair obsolescence of some models of 8500 and 8525

Some previously discontinued thermal anemometers from Alnor are now no longer serviceable at our factory.

These include: All models Compuflow 8500DI
All models CompuFlow 8500 DII
Some models of Compuflow 8525 identified as stated below.

Alnor is offering several options for the owners of these products.

1. While parts last, upgrade of the 8525, price $370 (allows continuing calibration or service life).
2. Purchase of new Compuflow 8570 at 10% discount.

Identification of unserviceable 8525 units:

Open the battery compartment: If you can see a set of 2 white switches in a red plastic surround next to the battery connector, the unit can be serviced. If you cannot, the unit cannot be serviced or re-calibrated.

Please call Alnor Customer Service at 1-800-424-7427 for more information

at1-39

5/99 -
Will calibrate in-house until the unit is no longer calibratable in-house - will then purchase new one.

ITS EQUIPMENT CALIBRATION RECORD

ITS# 22

DESCRIPTION: Manometer 0-1" Inclined

MANUFACTURER:

SERIAL #: 882 MODEL: 125 AV

EQUIPMENT LOCATION: Emissions Lab - E+E

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

CALIBRATION SPECIFICATIONS/INTERVAL: ~~6 mos.~~ Yearly

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:** RP
REVIEWED BY:

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

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

CHANGE THIS TO
1 TIME PER YEAR

MICROTECTOR	MANOMETER	DEVIATION IN.
.022,026	.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# 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: 1-14-00 **CALIBRATED BY:** RA
REVIEWED BY:

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	.0501G	.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# 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	
5/24/00	11/24/00	Cal Lab		~~Cal Lab~~

MAINTENANCE AND REPAIR:

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

CAL LAB

CERTIFICATE OF CALIBRATION

Cert. No. 1045166

Customer
Intertek Testing Services
8431 Murphy Dr.
Middleton, WI 53562

Equipment
Manufact:Omega
Model #:199
Descript:Digital Temp. Meter
Serial #:NONE
I.D. #:54

Calibration Interval: 12 month Calibration Date: 05/24/2000 Recalibration Date: 05/24/2001
Test Conditions: Temperature: 71°F Humidity:57% Technician:Sara Cullum Calibrated On-site
Received Condition: Fully operational and within tolerance
Work Performed: No adjustments required and calibrated to manufacturers specifications using manufacturers procedure

Standards Used

Cal:01/27/2000 Due:01/31/2001 ID#1390 Fluke 743B Process Calibrator Serial#7005629

This instrument was calibrated with a minimum 4:1 TUR/TAR unless otherwise stated. These represent best uncertainties. Actual uncertainties are available upon request. CAL LAB Co., Inc. is accredited to ISO Guide 25 by A2LA.

Best Measurement Uncertainty

Temperature ±0.2°C

Reviewed and approved by _____ Quality Team Member - Issue Date: 05/26/2000

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# 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

1390 Fluke 743B Process Calibrator 01/31/2000

This instrument was calibrated with a minimum 4:1 TUR/TAR unless otherwise stated. These represent best 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)

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

#93

A. **IDENTFICATION:**

1. TYPE AND MODEL DESIGNATION - Magnehelic 2000-00C
2. MANUFACTURER/SUPPLIER - Dwyer
3. SERIAL NO./WH DESIGNATION NO. R60825-M39

B. **EQUIPMENT LOCATION:**

1. PURPOSE & ACCURACY - ~~2%~~ ± 0.01 in.
2. CALIBRATION INTERVAL - 1 year

C. **CALIBRATIONS:** DONE BY-

CALIBRATION DATE	CALIBRATION DUE NEXT	CALIBRATION AGENCY	ACCEP	CALIBRATION RESULTS ADJUSTMENTS REQUIRED
3/28/95	3/28/96	Inhouse	WK	
3-19-96	3-19-97	INHOUSE	RB	
4-20-97	4-20-98	"	RA	
4-8-98	4-8-99	"	WK	
5/10/99	5/10/00	"	RA	
5/30/00	5/30/01	"	RA	

D. **MAINTENANCE AND REPAIR:**

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

ITS Intertek Testing Services NA Inc.

Middleton, Wisconsin

CALIBRATION DATE: 5-30-00 **CALIBRATED BY:** RA

REVIEWED BY: [signature]

DESCRIPTION: MAGNEHELIC **MODEL: Dwyer - 2000**

SERIAL NUMBER: **WHI INVENTORY #093**

WHI # 103

MICROTECTOR	ACTUAL	MAGNEHELIC	DEVIATION %
.05	.10	.10	0
.024	.048	.05	.002
.039	.078	.08	.002
.050	.100	.100	0
.060	.120	.120	0
.073	.146	.150	.004

AVERAGE DEVIATION = .13 **%**

ITS EQUIPMENT CALIBRATION RECORD

ITS# 126

DESCRIPTION: Sling Psychrometer

MANUFACTURER: Taylor

SERIAL #: — MODEL: —

EQUIPMENT LOCATION: E+E

PURPOSE & ACCURACY: ± 5% RH

CALIBRATION SPECIFICATIONS/INTERVAL: 6 mo.

CALIBRATION DATE	NEXT CALIBRATION	CALIBRATION AGENCY	CAL. BY	RESULTS/ADJUST.
5/24/99	11/24/99	In-house	RA	
5/15/00	11/15/00	"	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: 5-15-00 **CALIBRATED BY:** RA
REVIEWED BY: [signature]

DESCRIPTION: SLING PSYCHROMETER **MODEL:** TAYLOR

SERIAL NUMBER: **WHI INVENTORY #126**

USING WHI#174 OMEGA CALIBATOR TO CALIBRATE

Calibrator	Wet Bulb Thermometer	Deviation	Dry Bulb Thermometer	Deviation
34.4	36	+1.6	36	+1.6
40	41	+1	41	+1
55	56	+1	55	-1
70	70	0	71	+1
80	81	+1	80	0
90	91	+1	89	-2
		AVG .934°F		AVG .1°F

APPENDIX F

DRAWING INDEX

WHI FIGURE	MFG. DRAWING NUMBER	DESCRIPTION	CURRENT REVISION	ORIGINAL DRAWING DATE	WHI APPROVAL DATE
1	NA	PARTS LIST	NA	NA	16 AUG 00
2	1400-205	GLASS FITTING	A	7 MAR 00	16 AUG 00
3	1400-206	GLASS FITTING	A	7 MAR 00	16 AUG 00
4	3100-29	DOOR HANDLE	A	3 MAY 00	16 AUG 00
5	3100-30	DOOR NANDLE AXIS	B	4 MAY 00	16 AUG 00
6	3400-04	REAR PLATE CAST IRON	F	28 MAY 00	16 AUG 00
7	3400-04	REAR PLATE CAST IRON	F	28 MAY 00	16 AUG 00
8	3400-09	FUEL DOOR	D	15 MAY 98	16 AUG 00
9	3400-09	FUEL DOOR	D	15 MAY 98	16 AUG 00
10	3400-81	BAFFLE PLATE STAINLESS	A	19 JUN 00	16 AUG 00
11	3400-82	INSIDE REAR PLATE	A	4 JUN 00	16 AUG 00
12	3400-83	INTERMEDIATE FRAME (GRATE)	A	3 AUG 00	16 AUG 00
13	3400-84	BAFFLE PLATE CAST IRON	A	23 JUN 00	16 AUG 00
14	3400-85	PLATE FOR INTERMEDIATE FRAME	A	27 JUN 00	16 AUG 00
15	3400-87	HANDLE HANGER	A	7 JULY 00	16 AUG 00
16	3400-88	CUT AWAY VIEW	A	7 AUG 00	16 AUG 00
17	3400-89	CUT AWAY VIEW	A	7 AUG 00	16 AUG 00
18	3400-90	REAR PLATE	B	7 AUG 00	16 AUG 00

Morsø 3400 USA

Pos.No.	Parts	Drawing No.
1	Intermediate frame	3400 - 83
2	Inside top plate	3400 - 08
3	Plate for intermediate frame	3400-85
4	Draft reducer	2100-54
5	Inside rear plate	3400-82
6	Fitting w. thread for flue collar	1400-204
7	Cover	1126-16
8	Handle for riddling grate	1120-42
9	Flue collar	1126-64
10	Base plate	3400-01
11	Front frame	3400-02
12	Rear plate, cast iron	3400-04
13	Top plate	3400-12
14	Leg	"
15	Door	3400-09
16	Baffle plate, cast iron	3400-84
17	Side plate w. owl	3400-40
18	Poker	9000-05
19	Distance tube	3400-50
20	Distance tube	"
21	Ash tray	2100-33
22	Hinge pin	1126-38
23	Distance tube	1400-302
24	Radiant shielding, bottom	3400-44
25	Hanging for handle	3400-87
26	Brick securing bracket, side	3400-79
27	Convection rear plate	3400-45
28	Rear plate	3400-90
29	Riddling bar	3400-46
30	Hinge pin	"
31	Flat bar	5000-63
32	Distance tube	5000-64
33	Hinge pin	"
34	Baffle plate, stainless	3400-81
35	draught control	3400-15
36	Air inlet arm	3400-17
37	Assemble steel	3400-18
38	Assemble plate	3400-49
39	4x16 screw	"
40	5x8 black steel set screw	"
41	6x10 black steel set screw	"
42	6x16 black steel set screw	"
43	6x20 black steel set screw	"
44	6x25 black steel set screw	"
45	6x35 black steel set screw	"
46	6x40 black steel set screw	"
47	6x45 black steel set screw	"
48	6x60 black steel set screw	"
49	8x20 black steel set screw	"
50	Steel box 6 mm	"
51	Steel box 8 mm	"
52	3x8 indvendig 6kt. Skrue	"
53	4x5 pinol skrue	"
54	6x10 screw	"
55	4x30 screw	"
56	2x25 cotter pin	"
57	4x8 screw	"
58	5x8 screw	"
59	6x25 screw	"
60	6 mm brass washer	"
61	4 mm nut	"
62	Stainless handle for adjustment	3400-41
63	Knob for riddling grate	5000-60
64	Bush, brass	1126-27
65	Handle	3100-29
66	Axis for handle	3100-30
67	Stainless pressure spring	"
68	Glass fitting	1400-205
69	6 mm air slider washer	"
70	6 mm washer	"
71	Ceramic glass	3400-20
72	Stone, side, back	3400-47
73	Stone, side, front	3400-47
74	Convection side plate	3400-11
75	Tightening tape	"
76	3.5x9.5 screw	"
77	6X30 screw	"
78	Glass fitting	1400-206

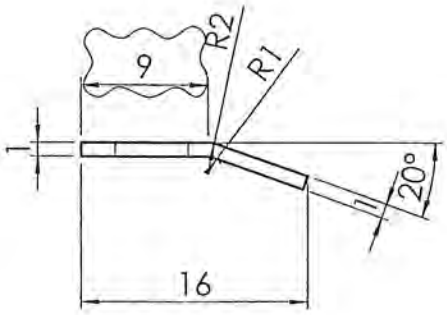
(1)

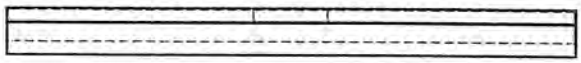
Wilmock Hersey

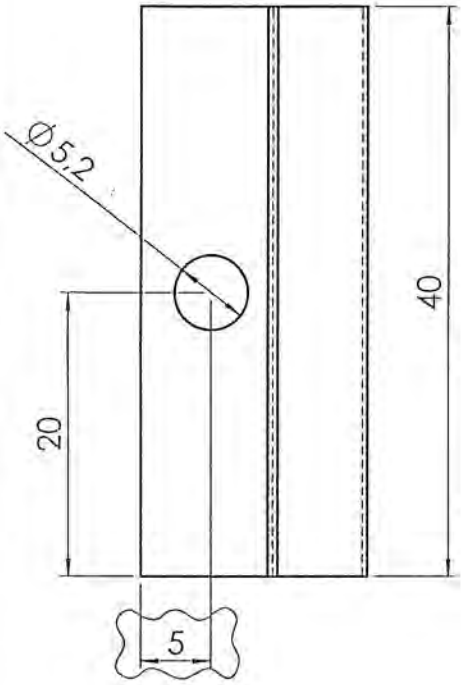
AUG 1 6 2000

INTERTEK TESTING SERVICES
Middleton, WI
By:

PARTS LIST 3410, 3440





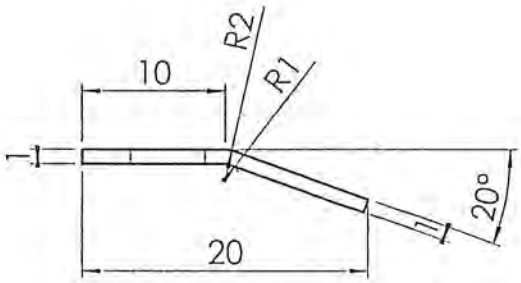


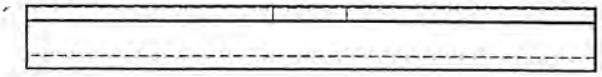
(2)

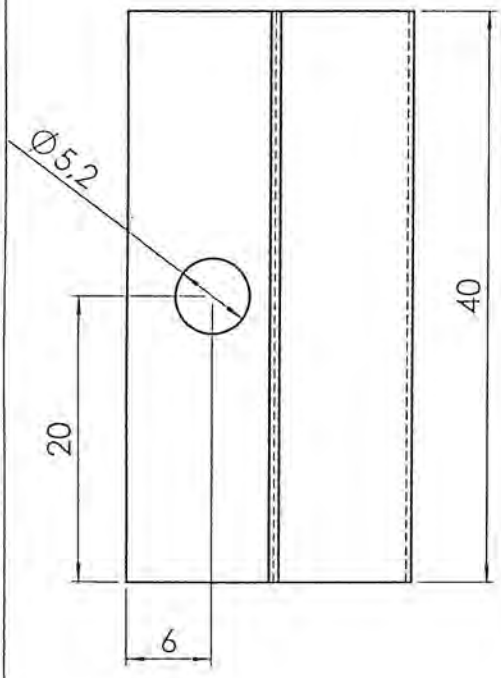
Rev.	Revisionstekst:	Sign.:	Dato:

Materiale:	1 mm rustfri plade			Titel:	Konstr.:	RSV	07.03.2000
Vægt:	0,005 kg.	Bearbejdes:	buk/bore	**Glasbeslag 1**	Frigivet:	KDU	10.08.00
Overfladebeh.:	-		- m²	Glass Fitting	Tegn.format:	A4	
Måltolerance:	Mål uden toleranceangivelse DS/ISO 2768-1 m			**Morsø 1400**	Målforhold:	**2:1**	
Ruhedstolerance:					Varenr.:	**71145700**	
Værktøjsnr.:	-			morsø	Tegningsnr.:	**1400-205 a**	
Tegningstype:	Emnetegning						

1400-205 - Sheet1







3

Warnock Hersey

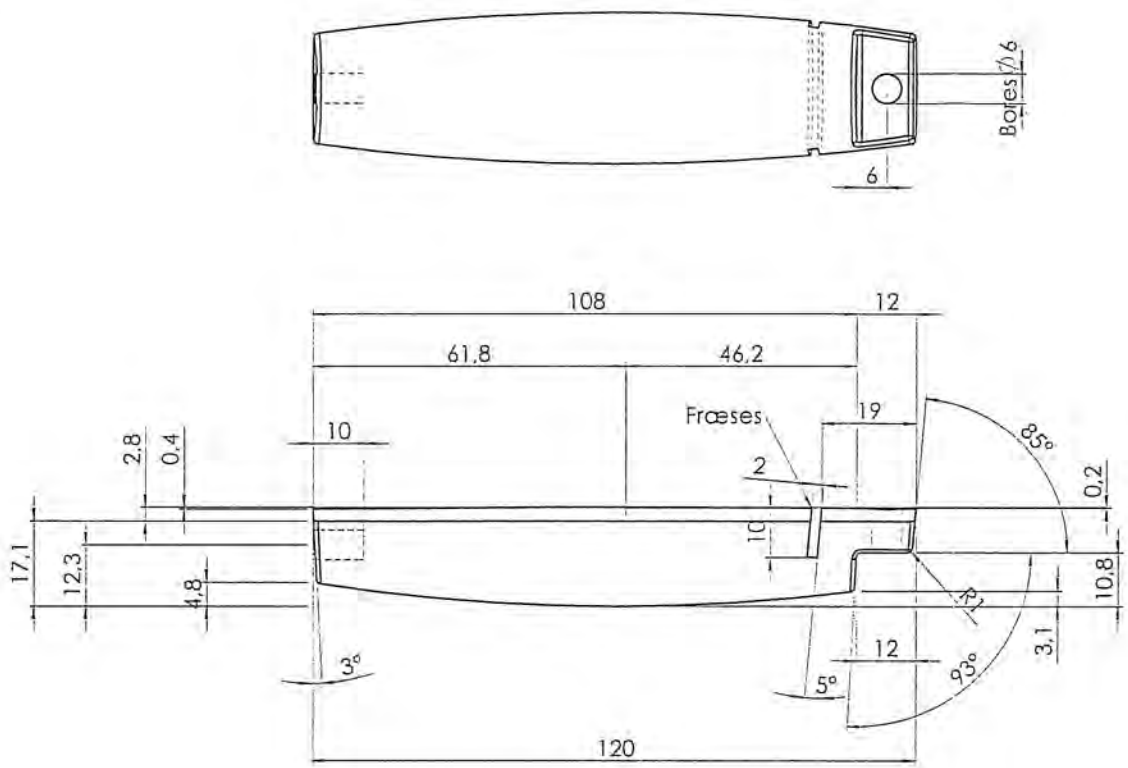
AUG 1 6 2000

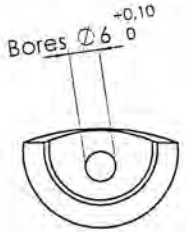
INTERTEK TESTING SERVICES
Middleton, WI
By: OK EK

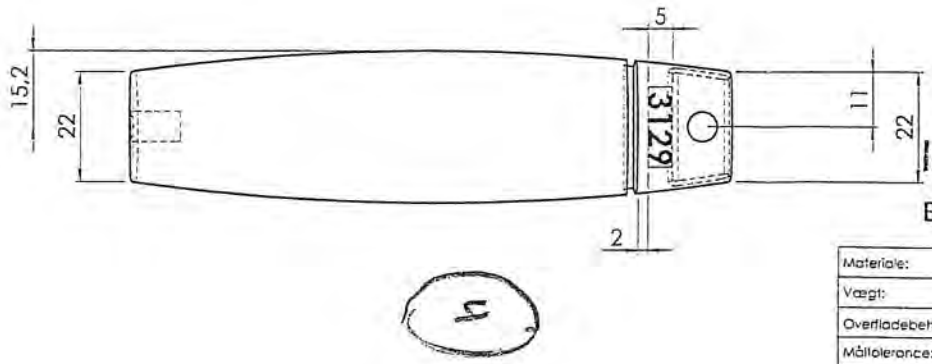
Rev.	Revisionstekst:	Sign.:	Dato:

Materiale:	1 mm rustfri plade			Titel:	Konstr.:	RSV	07.03.2000
Vægt:	0,006 kg.	Bearbejdes:		Glasbeslag 2	Frigivet:	RSV	30.06.2000
Overfladebeh.:			m²	GLASS FITTING	Tegn.format:	A4	
Måltolerance:	Mål uden toleranceangivelse DS/ISO 2768-1 m				Målforhold:	2:1	
Ruhedstolerance:				Morsø 1400	Varenr.:	71145900	
Værktøjsnr.:				morsø	Tegningsnr.:	1400-206 a	
Tegningstype:	Emnetegning						

1400-206 - Sheet1







Warnock Hersey

AUG 1 6 2000

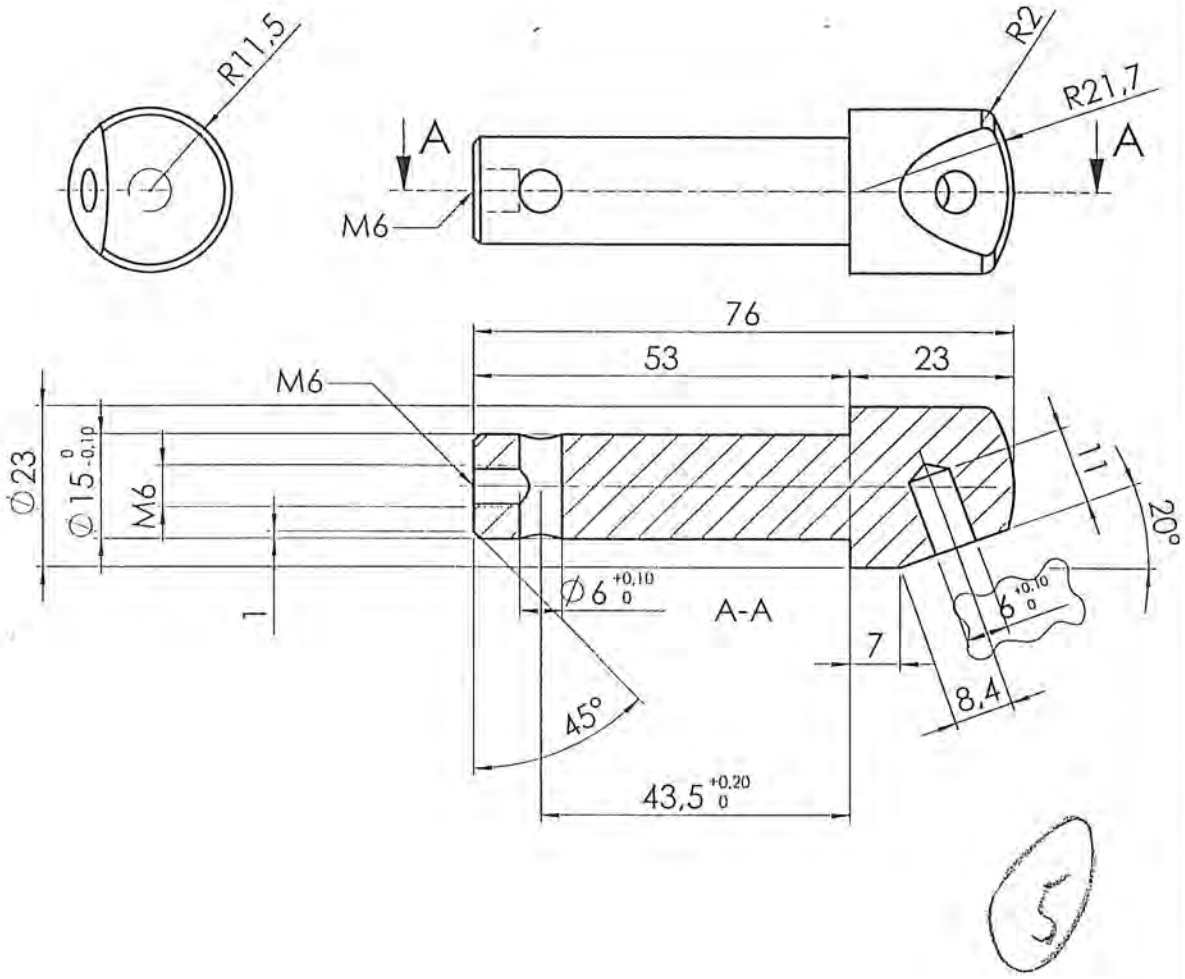
INTERTEK TESTING SERVICES
Middleton, WI

By: OK ER

Generelt radius = 1mm

Rev.	Revisionstekst:	Sign.:	Dato:

Materiale:	GG15		Titel:	Konstr.:	KDU 03.05.2000
Vægt:	0,33 kg.	Bearbejdes: Bores/fræses	Håndtag DOOR HANDLE	Frigivet:	KDU 08.08.2000
Overfladebeh.:	Males	0,01 m²		Tegn.format:	A3
Måltolerance:	Mål uden toleranceangivelse ISO-norm nr. 8062 CT8		Morsø 3100	Målforhold:	1:1
Ruhedstolerance:				Varenr.:	34312900
Værktøjsnr.:	Modelnr. 3129		morsø	Tegningsnr.:	3100-29 a
Tegningstype:	Støbetegning				



5

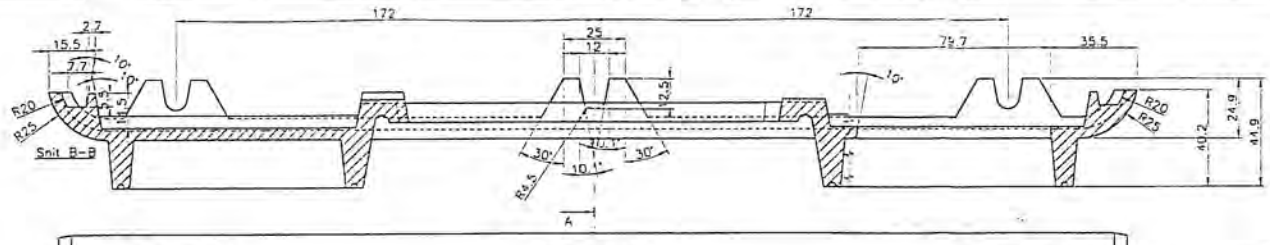
Note:
Fræsning og boring orienteres j.v.f. tegning.

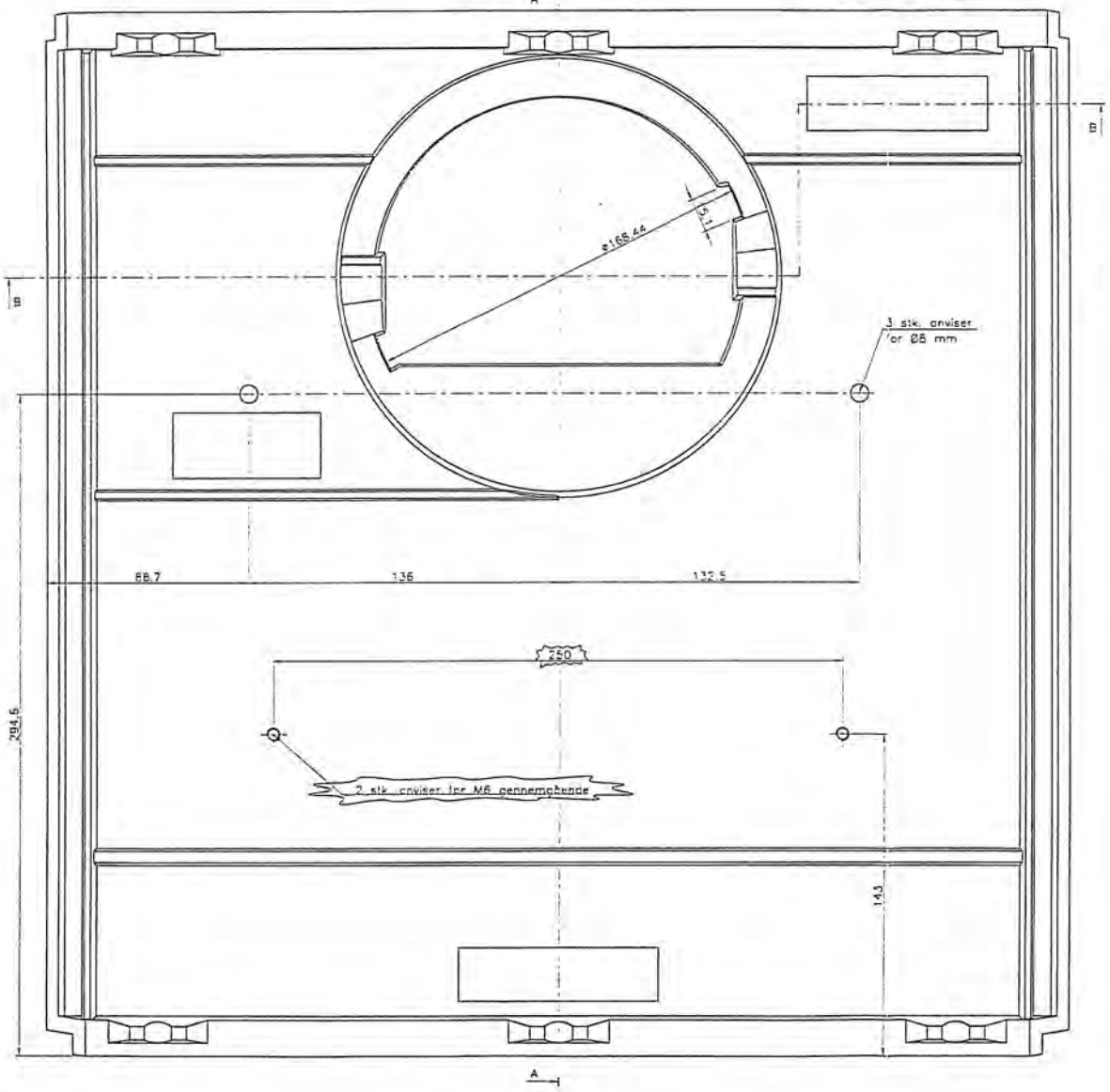
AUG 1 6 2000

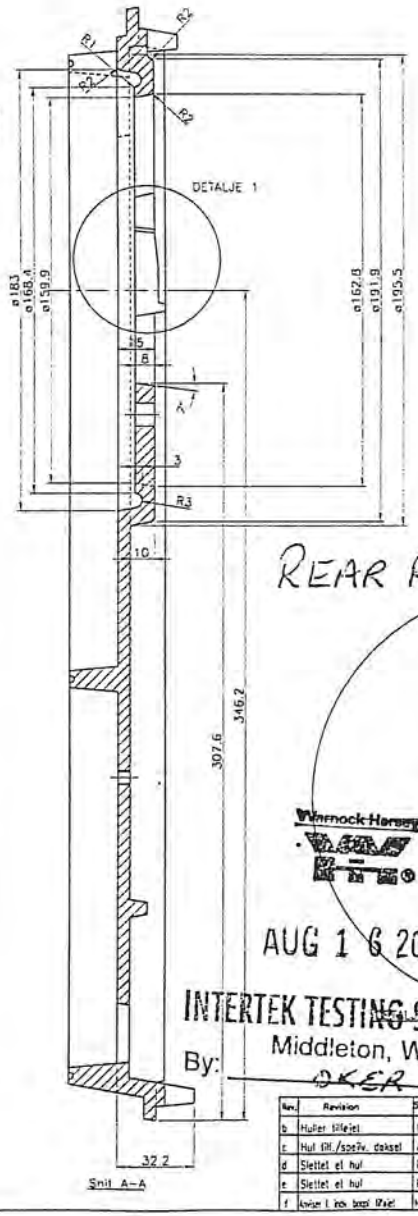
INTERTEK TESTING SERVICES
Middleton, WI
By: OK ER

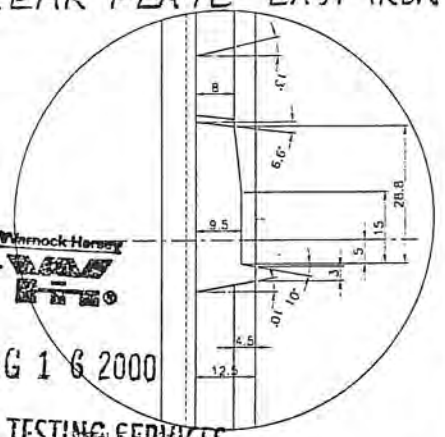
	b	Tolerance hul påført. Note iflg. leverandør påført			KDU	09.06.2000
	Rev.	Revisionstekst:			Sign.:	Dato:
Materiale:	Rustfast stål		Titel:		Konstr.:	KDU	04.05.2000
Vægt:	0,13 kg.	Bearbejdes: Drejes/bores	**Døraksel**		Frigivet:	KDU	30.05.2000
Overfladebeh.:	Ubehandlet	m²	DOOR HANDLE AXIS		Tegn.format:	A4	
Måltolerance:	Mål uden toleranceangivelse DS/ISO 2768-1 m		**Morsø 3100**		Målforhold:	1:1	
Ruhedstolerance:					Varenr.:	71312900	
Værktøjsnr.:			morsø		Tegningsnr.:	3100-30 b	
Tegningstype:	Emnetegning						

3100-30 - Sheet1









REAR PLATE CAST IRON

AUG 1 6 2000

INTERTEK TESTING SERVICES
Middleton, WI

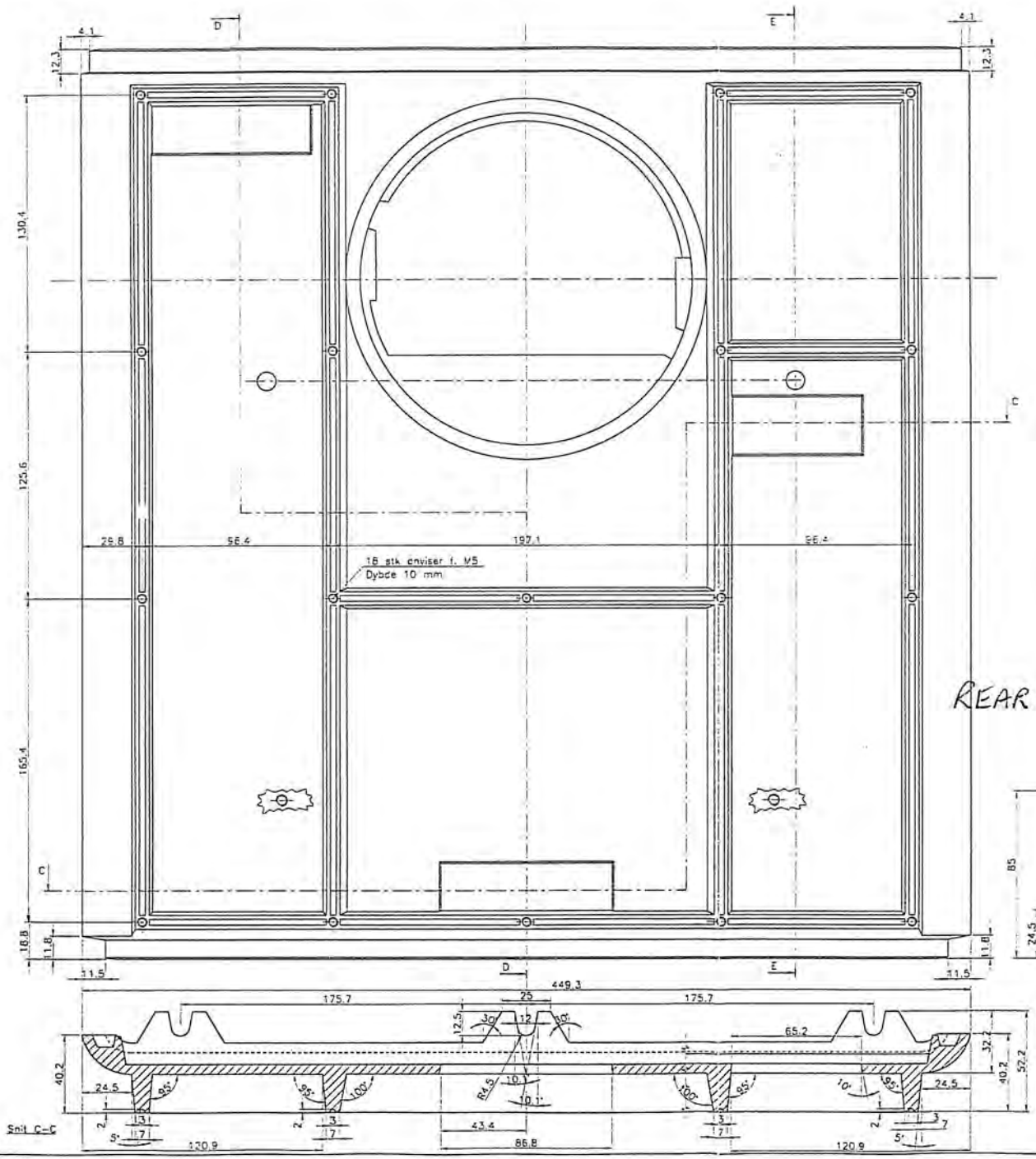
By: DKER

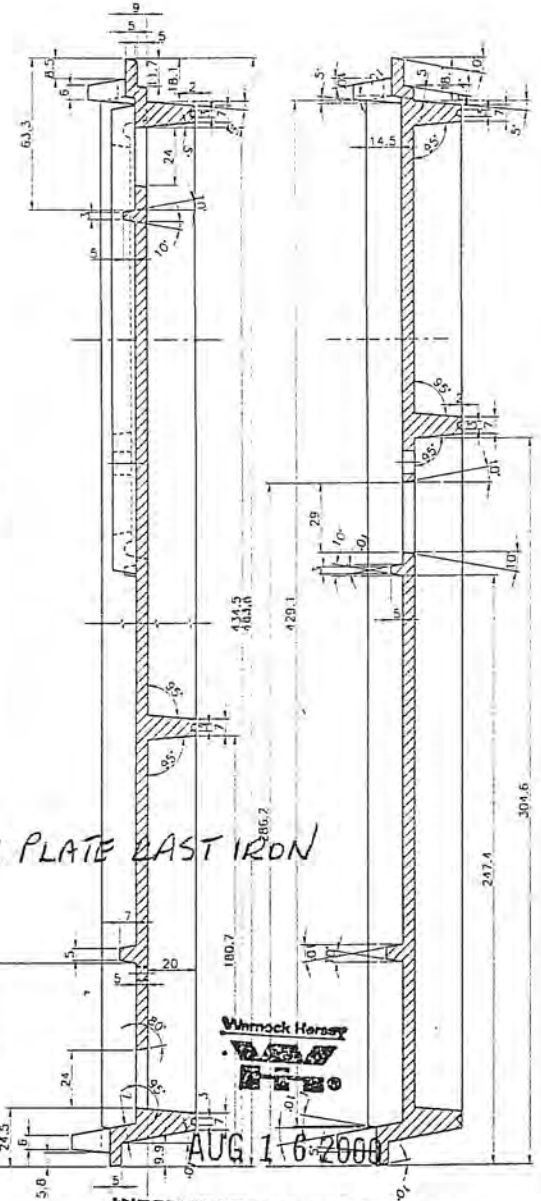
Ikke angivne radier: R=1,5

Rev.	Revision	Sign.	Dato
b	Huller tilføjet	KDU	29.07.98
c	Hul Ø8./spejv. dækket	ABS	02.12.98
d	Slettet ø1 hul	RSV	13.01.99
e	Slettet ø1 hul	RSV	28.05.99
f	Anviser i stk. bred Ø4x6	KDU	10.05.00

Modelnr.: 3404	Matr.: GG 15	Vægt: 7,6 kg.	
Titel: Bogplade Morse 3400		Sign.: KDU	Dato: 28.05.98
Tegningsnr.: 3400-04		Målforhold: A1	1:1
		Varenummer: 34340400	
		Tegningsnummer: 3400-04 f	Ser 1/2

morse





REAR PLATE CAST IRON

AUG 16 2000

INTERTEK TESTING SERVICES
Middleton, WI

Ikke angivne radier: R=1,5

Rev.	Revision	Sign.	Dato
b	Huller tilføjet	KDU	26.07.98
c	Huller tilf./spejlv. gzkant	AØS	23.12.98
d	Stellet et hul	RSV	13.01.99
e	Stellet et hul	RSV	26.05.99
f	Vægt i ink. bagpl. tilføj.	KDU	10.08.00

Titel: Bagplade Morse 3400

Tegn.nr.: 3400-04

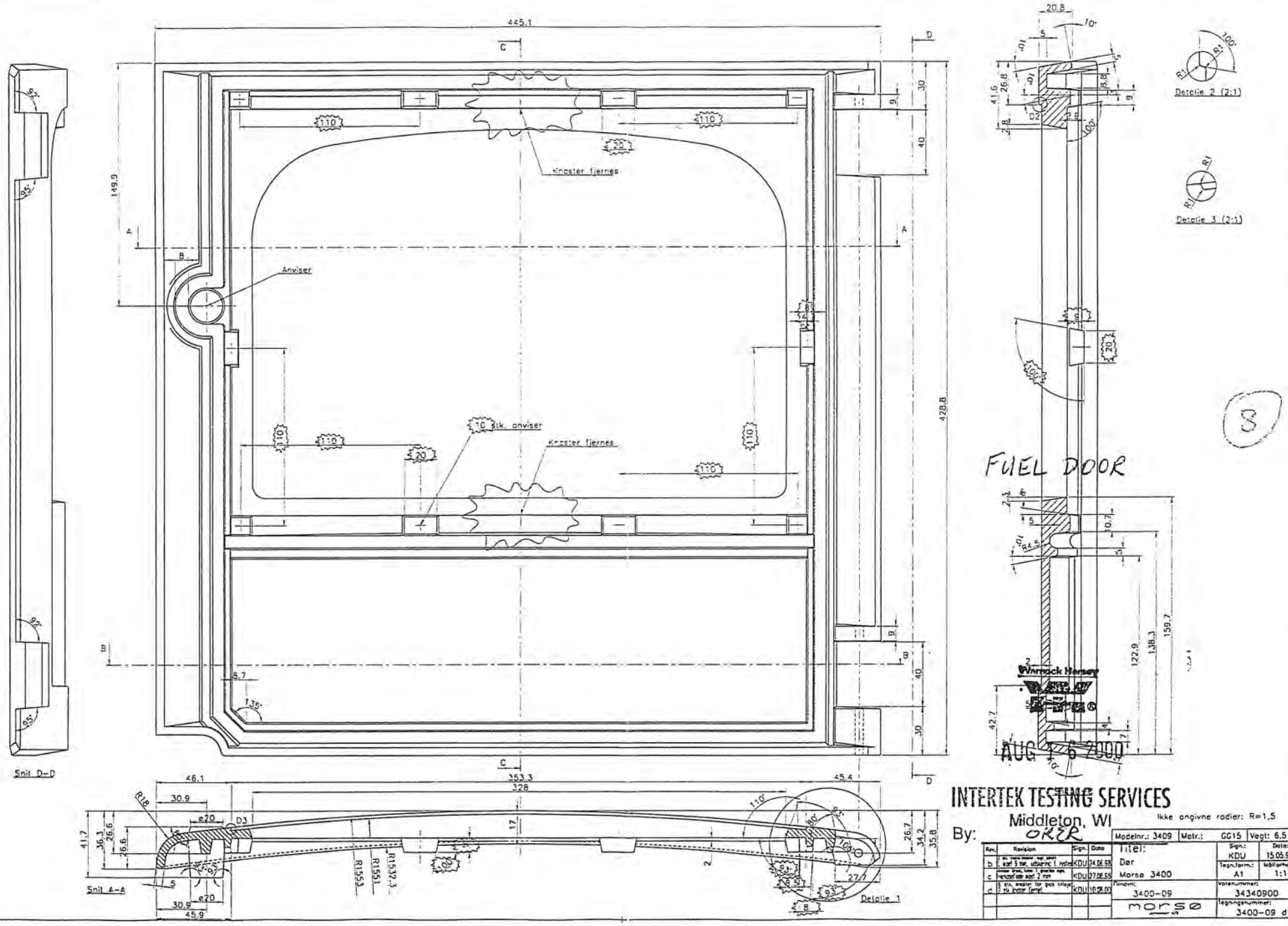
Sign.: KDU — Dato: 26.05.98

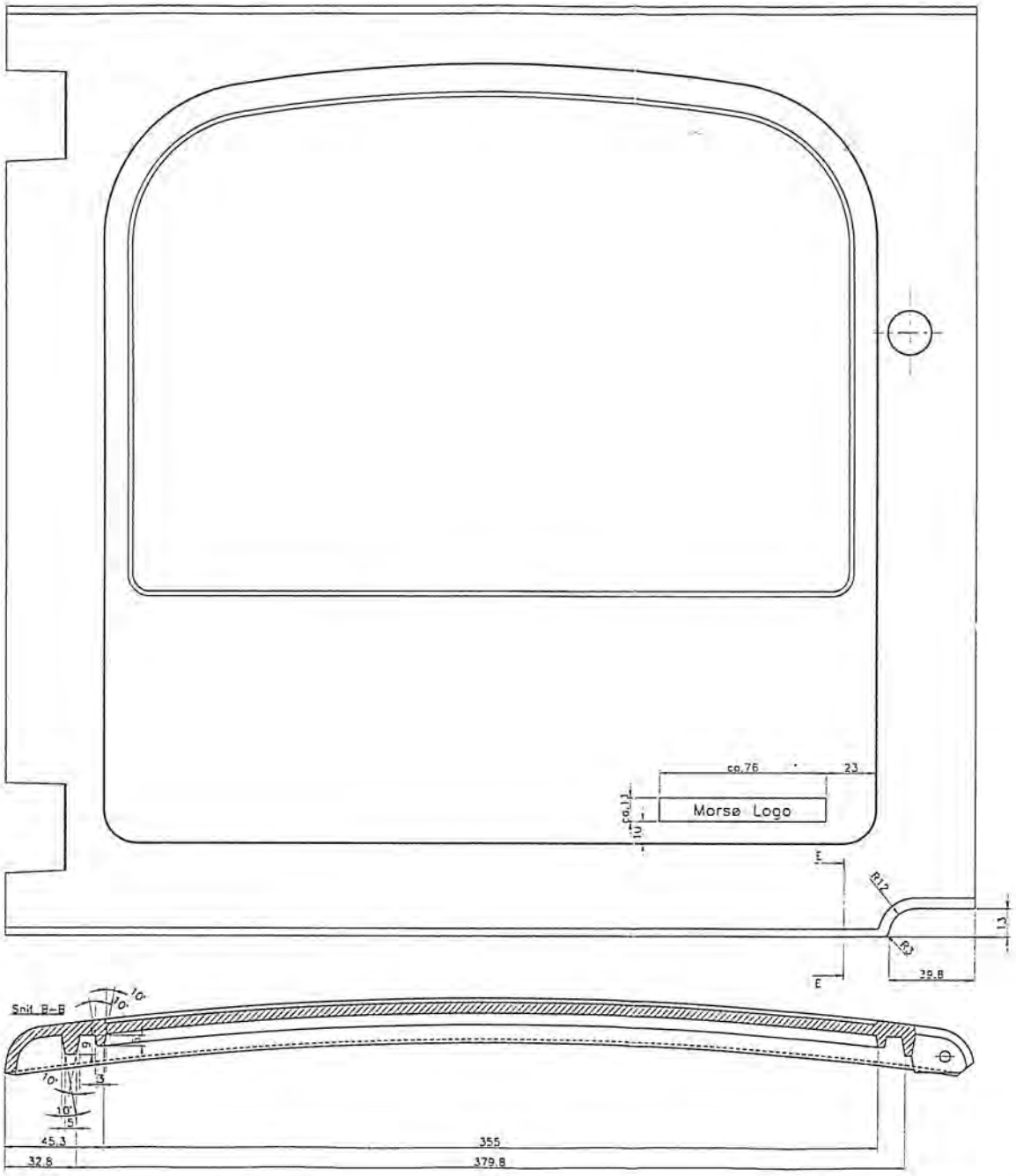
Tegn.form.: A1 — Målforhold: 1:1

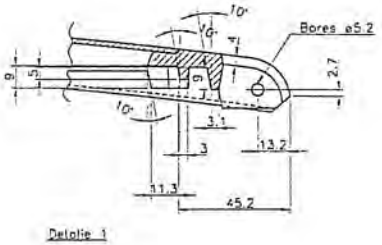
Varenummer: 34340400

Tegningsnummer: 3400-04 f 2/2

By: CKER


445.1
149.9
428.8
Anviser
10 3tk. anviser
Knaster fjernes
Knaster fjernes
Snit D-D
Snit A-A
Detalje 1
Detalje 2 (2:1)
Detalje 3 (2:1)
FUEL DOOR
Warnock Hersey
AUG 16 2000
INTERTEK TESTING SERVICES
Middleton, WI
By: ORER
Ikke angivne radier: R=1,5
Titel:
Der
Morse 3400
Modelnr.: 3409
Matr.: GG15
Vægt: 6.5 kg.
Sign.: KDU
Dato: 15.05.98
Tegn.form.: A1
Målforhold: 1:1
Varenummer: 34340900
Tegningsnummer: 3400-09
Sæt d 1/1
Rev. Revision Sign. Dato
b KDU 24.06.98
c KDU 27.08.98
d KDU 10.09.00





Detalje 1

9

FUEL DOOR

Wrmack Hansey

AUG 1 6 2000

INTERTEK TESTING SERVICES
Middleton, WI

By: OKER

Ikke angivne radier: R=1.5

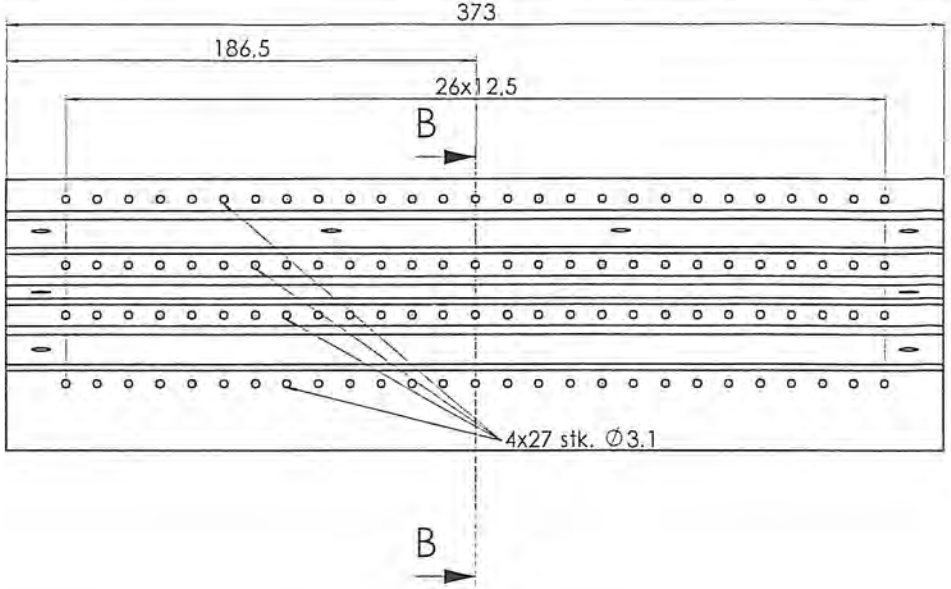
Rev.	Revision	Sign.	Dato
b	[illegible]	KDU	24.06.98
c	[illegible]	KDU	27.08.98
d	[illegible]	KDU	10.09.98

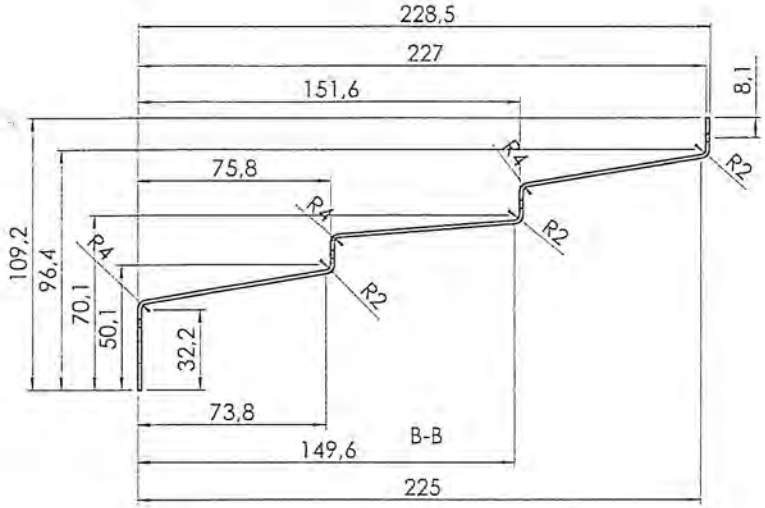
Titel: Dør Morsø 3400

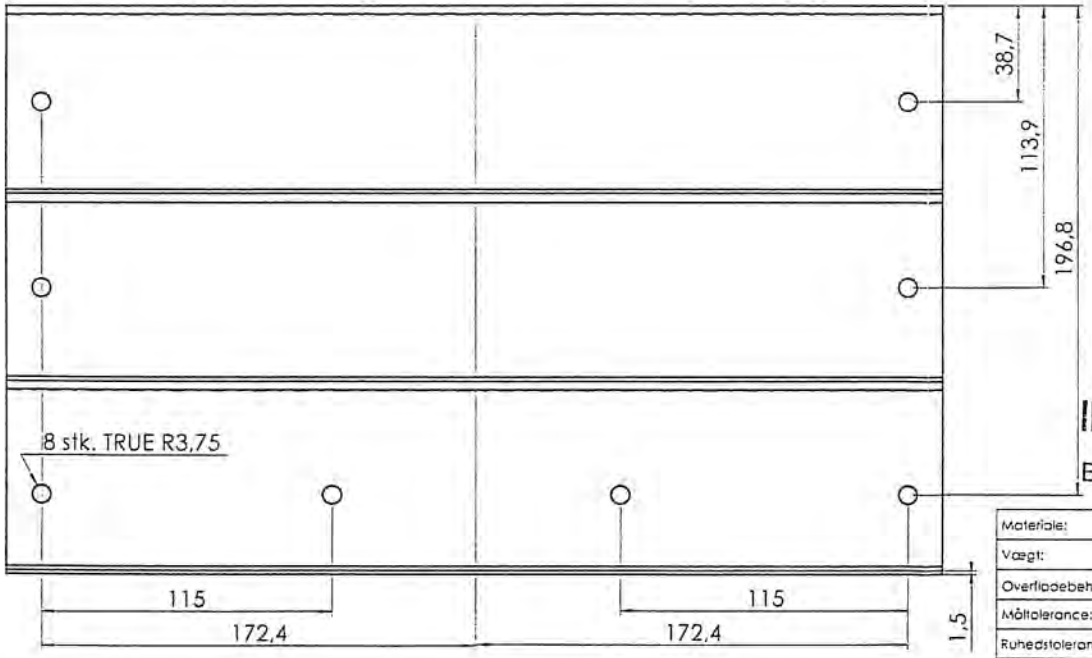
Fjernvn: 3400-09

morsø

Sign.:	Dato:
KDU	15.05.98
Tegn.form.: A1	Målforhold 1:1
Varenummer: 34340900	
Tegningsnummer: 3400-09 d	Ser 1/1







Wirnock Horsley

BAFFLE PLATE. STAINLESS

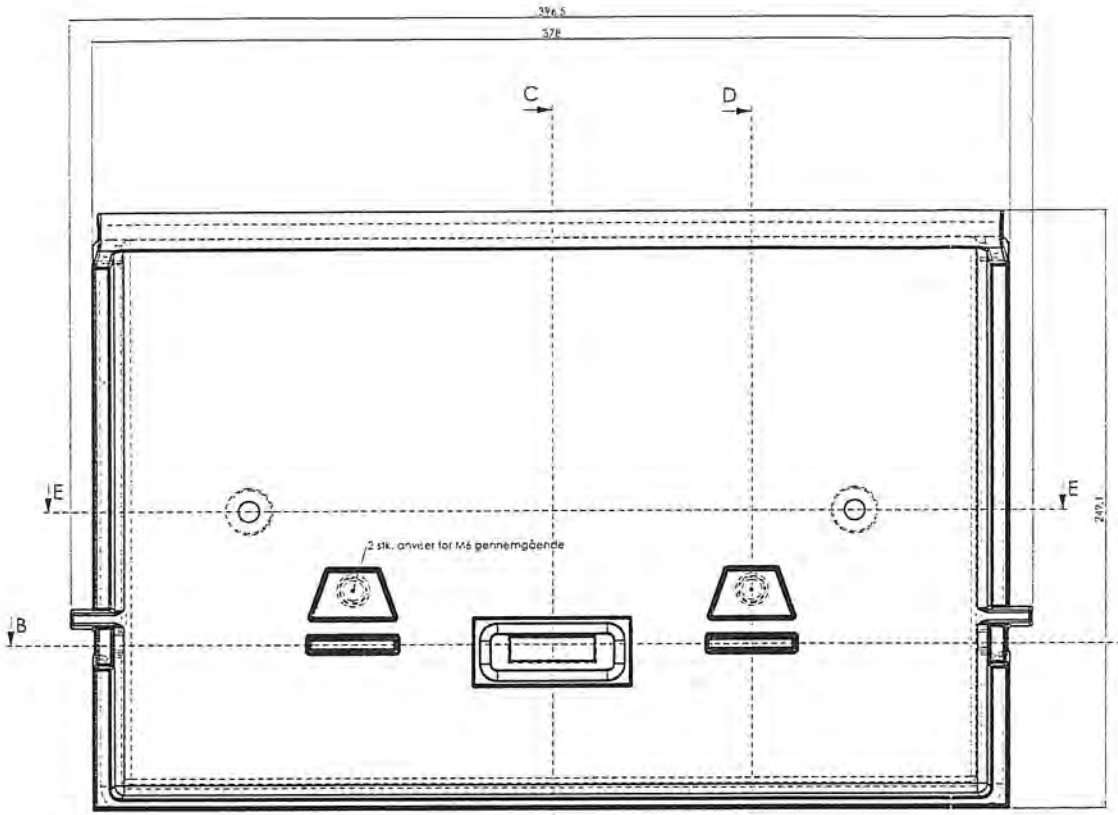
AUG 1 6 2000

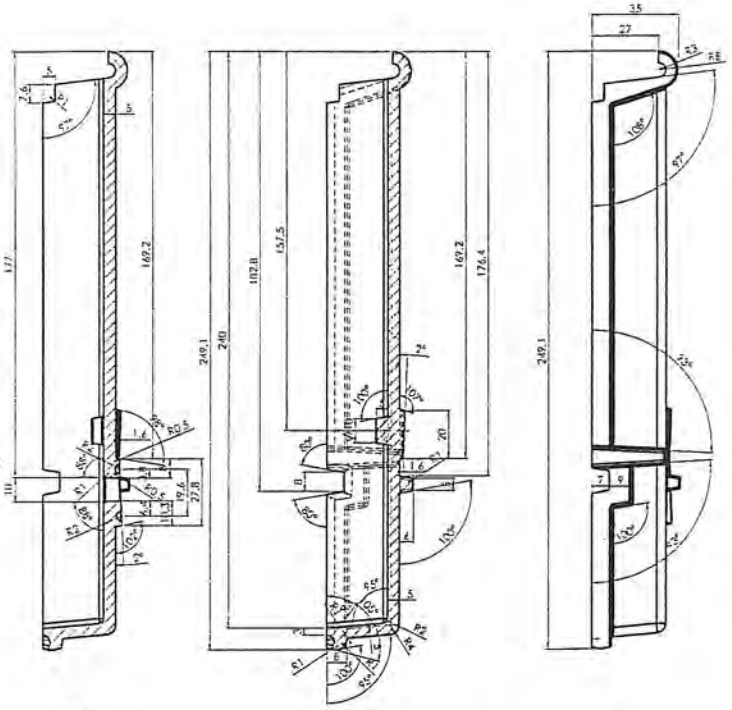
INTERTEK TESTING SERVICES
Middleton, WI

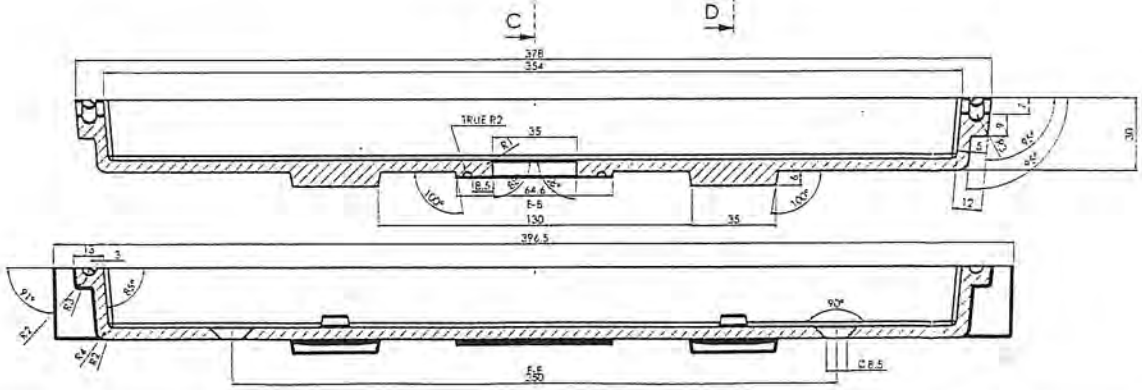
By: OK ER

Materiale:	1.5mm rustfri plade		
Vægt:	1,43 kg.	Bearbejdes:	Buk/bore
Overfladebeh.:	Ubehandlet		· m²
Måltolerance:	Mål uden toleranceangivelse DS/ISO 2768-1 m		
Ruhedstolerance:			
Værktøjsnr.:	-		
Tegningstype:	Emnetegning		

Rev.	Revisionstekst:	Sign.:	Dato:
Titel:	Røgledeplade rustfri U.S.A. Morsø 3400	Konstr.:	KDU 19.06.2000
		Frigivet:	KDU 08.08.2000
		Tegn.format:	A3
		Målforhold:	1:2
		Varenr.:	71348100
morsø		Tegningsnr.:	3400-81 a







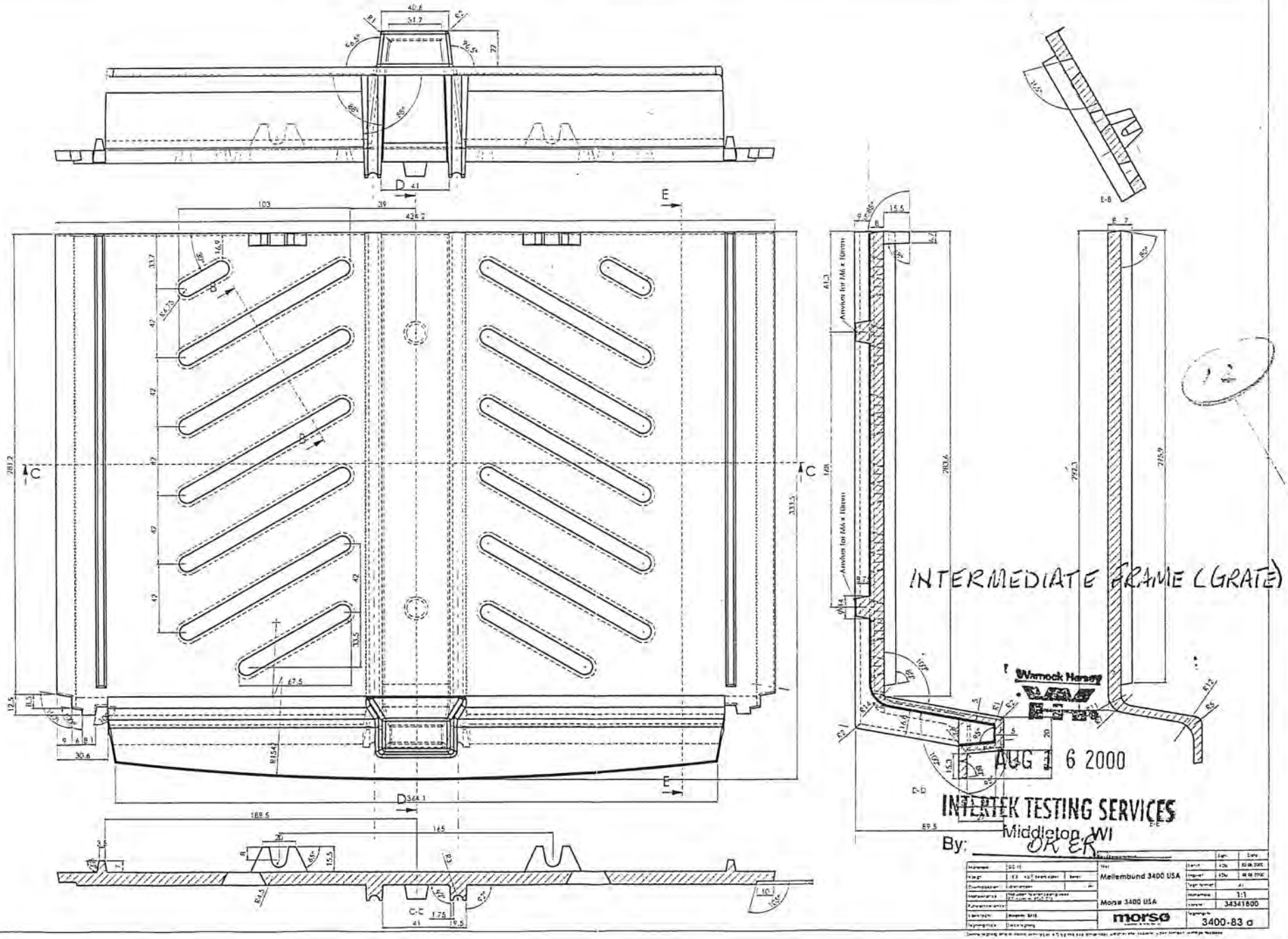
Wynnock Hersey

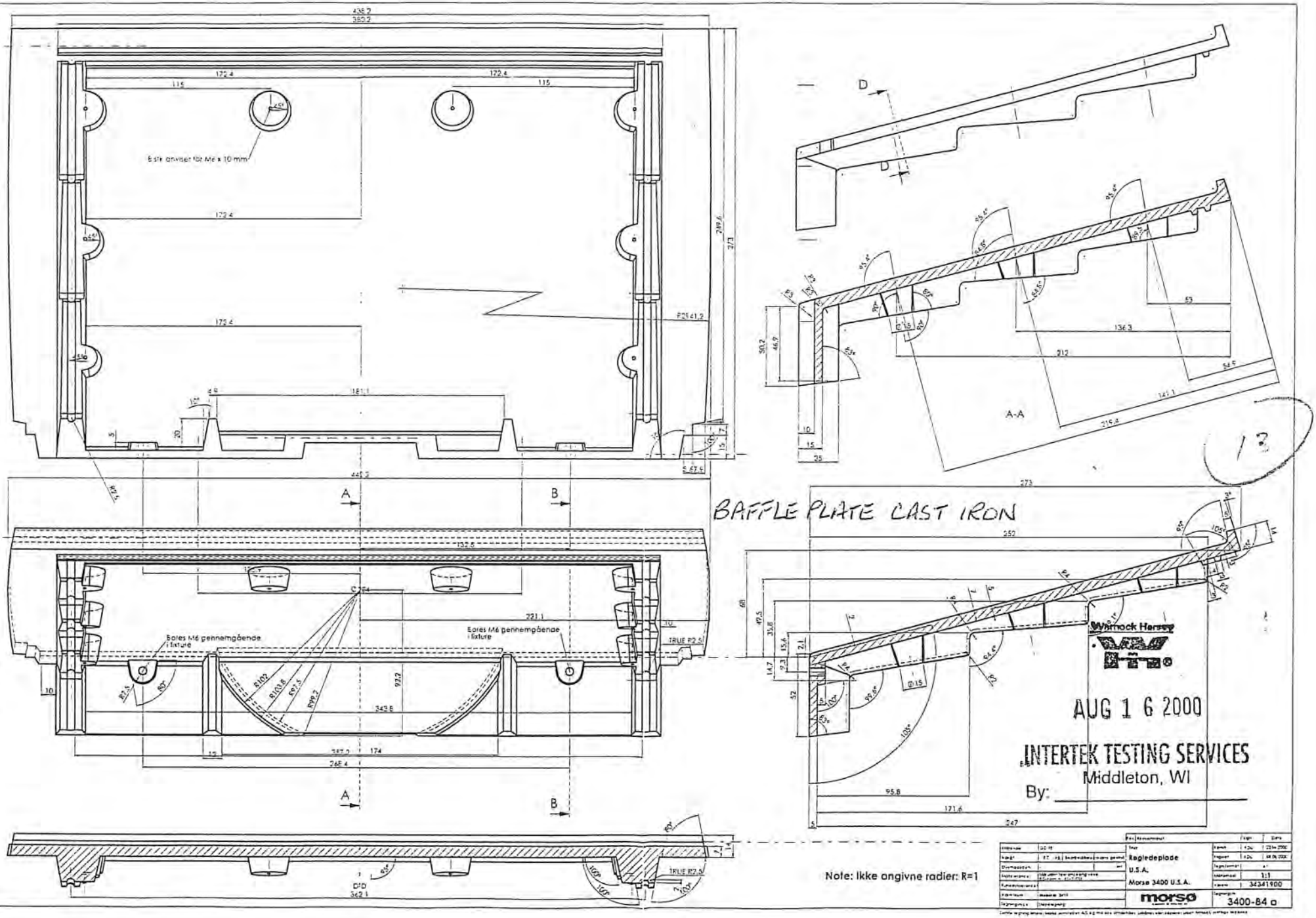
INSIDE REAR PLATE

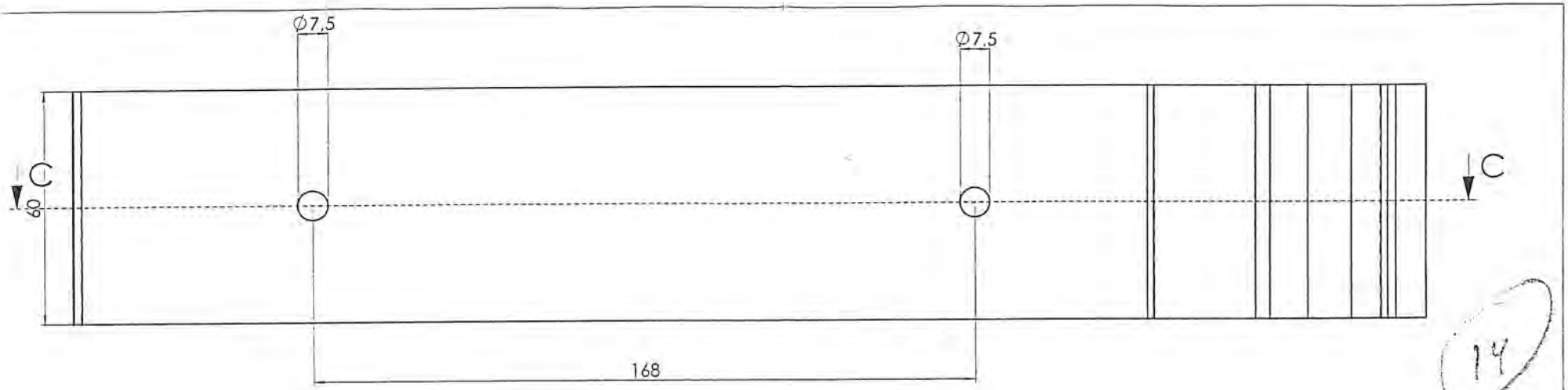
AUG 1 6 2000

INTERTEK TESTING SERVICES
Middleton, WI
By: OK ER

Indv. bagplade			
Morse 3400 USA		1:1	
morse		34341700	
		3400-82 a	

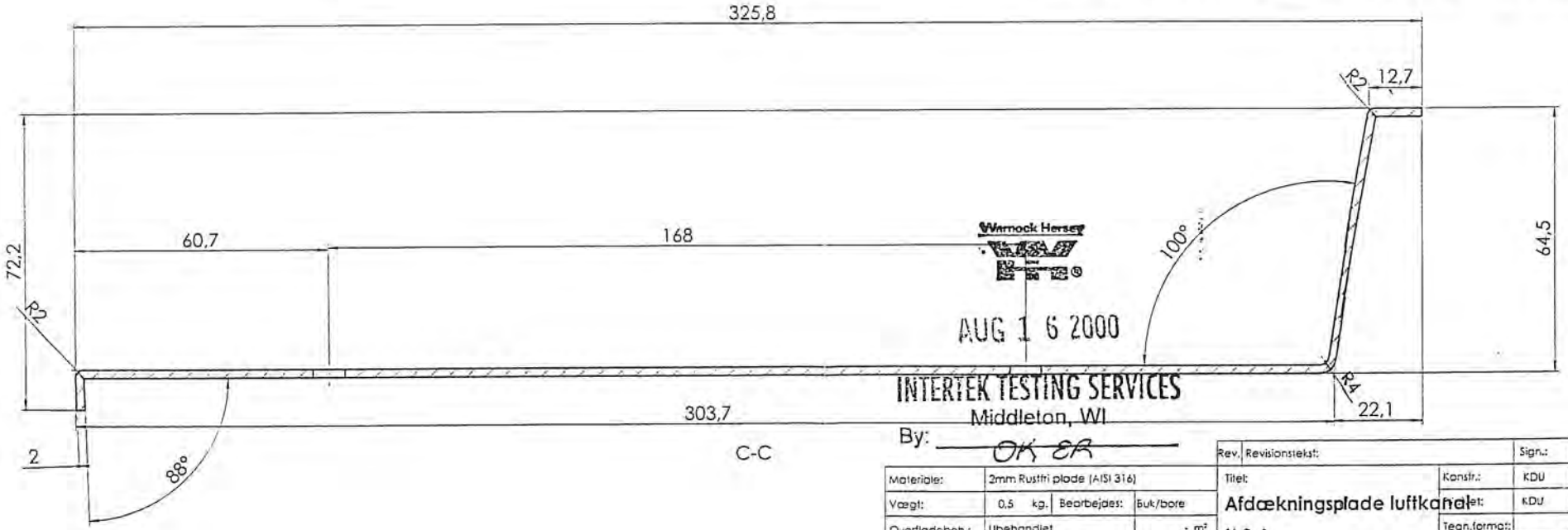

INTERMEDIATE FRAME (GRATE)
Warnock Hersey
AUG 16 2000
INTERTEK TESTING SERVICES
Middleton, WI
By:
ORDER
Mellembund 3400 USA
Mørsø 3400 USA
1:1
34341800
3400-83 a


BAFFLE PLATE CAST IRON
A-A
Note: Ikke angivne radier: R=1
Regledeplade
U.S.A.
Morse 3400 U.S.A.
3400-84 a
AUG 1 6 2000
INTERTEK TESTING SERVICES
Middleton, WI
By:



14

PLATE FOR INTERMEDIATE FRAME



Warnock Hersey

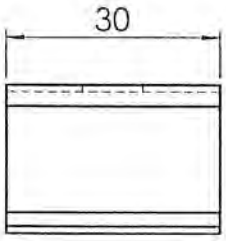
AUG 1 6 2000

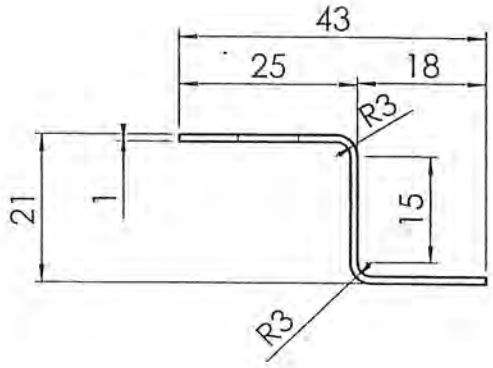
INTERTEK TESTING SERVICES
Middleton, WI

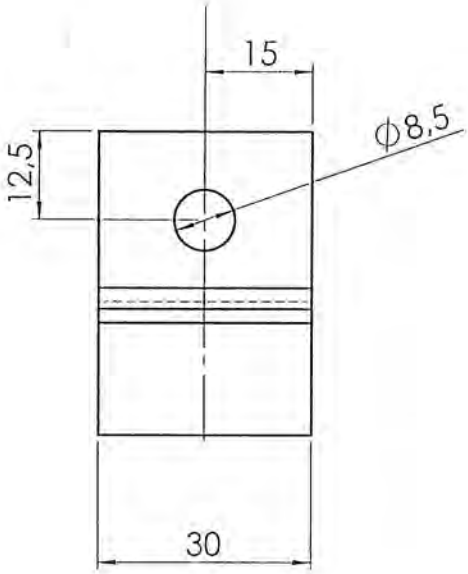
By: OK ER

Materiale:	2mm Rustfri plade (AISI 316)		
Vægt:	0,5 kg.	Bearbejdes:	Buk/bore
Overfladebeh.:	Ubehandlet		- m²
Måltolerance:	Mål uden toleranceangivelse DS/ISO 2768-1 m		
Ruhedstolerance:			
Værktøjsnr.:	-		
Tegningstype:	Emnetegning		

Rev.	Revisionstekst:	Sign.:	Dato:
	Titel:	Konstr.: KDU	27.06.2000
	Afdækningsplade luftkanalet:	Tegn.: KDU	08.08.2000
	U.S.A.	Tegn.format:	A3
		Målforhold:	1:1
	Morsø 3400 U.S.A.	Varenr.:	71348000
	morsø	Tegningsnr.:	3400-85 a







15

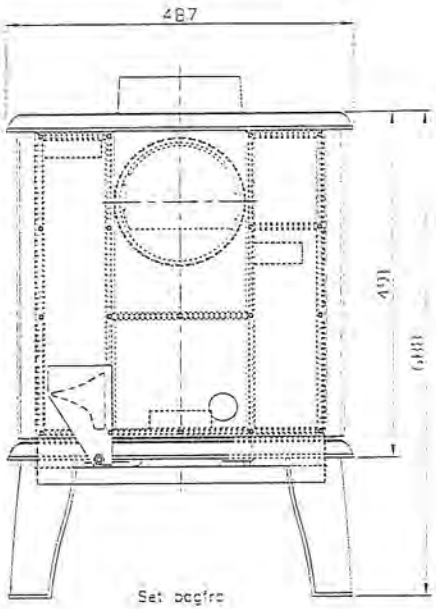
Warnock Hersey

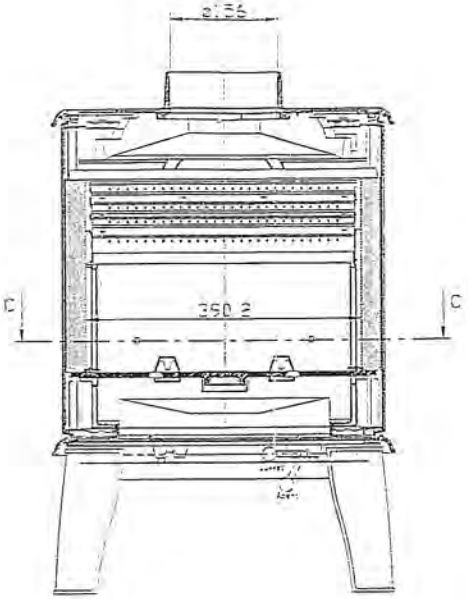
AUG 1 6 2000

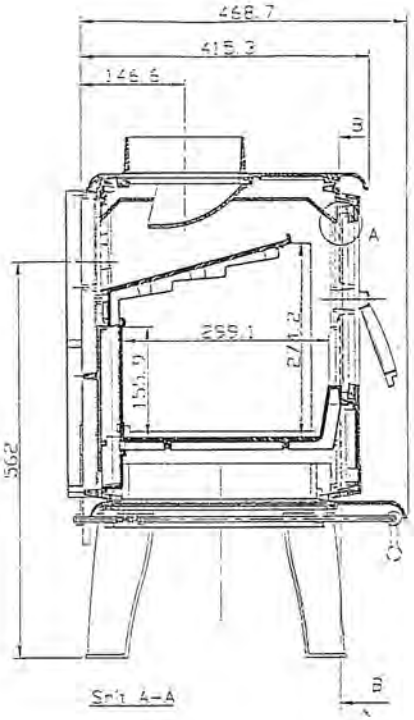
INTERTEK TESTING SERVICES
Middleton, WI
By:

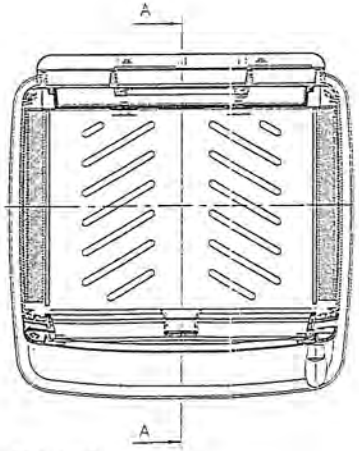
				Rev.	Revisionstekst:	Sign.:	Dato:
Materiale:	1 mm SPD plade			Titel:		Konstr.:	RSV 07.07.2000
Vægt:	0,015 kg.	Bearbejdes:	Buk/bore	**Ophæng til greb**		Frigivet:	KDU 08.08.2000
Overfladebeh.:	Males		- m²	HANDLE HANGER		Tegn.format:	A4
Måltolerance:	Mål uden toleranceangivelse DS/ISO 2768-1 m					Målforhold:	1:1
Ruhedstolerance:				**Morsø 3400**		Varenr.:	71347900
Værktøjsnr.:	-			morsø		Tegningsnr.:	3400-87 a
Tegningstype:	Emnelegning						

3400-87 - Sheet1









16

CUT AWAY VIEW
3410

Firmaets Navn
Adresse
Telefon

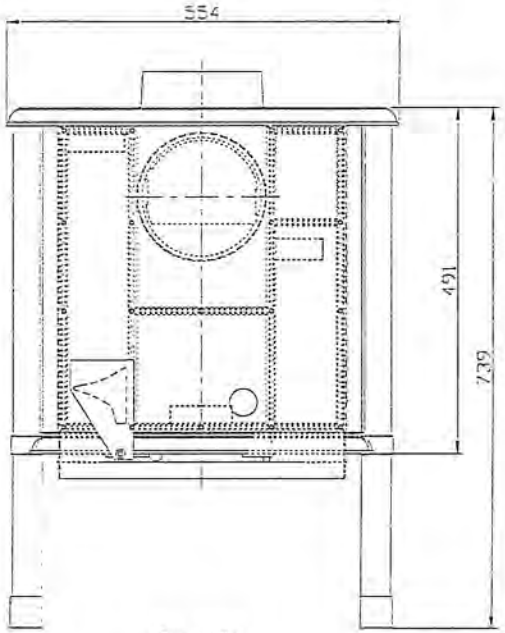
AUG 16 2000

INTERTEK TESTING SERVICES
Middleton, WI
By: OK. ER

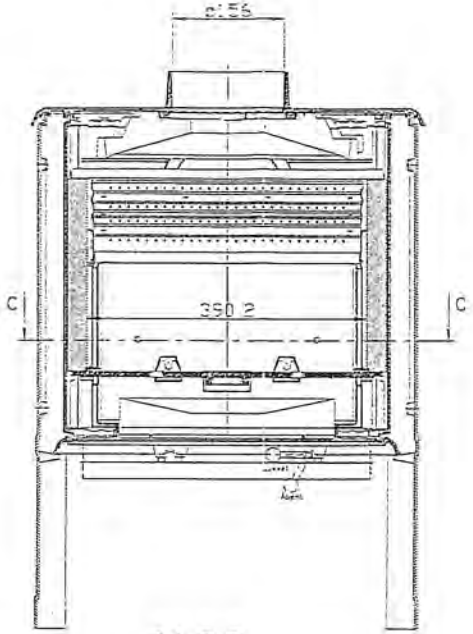
Rev.	Revision	Sign.	Date

Titel:
Godkendelsestegning
Morsø 3410 USA

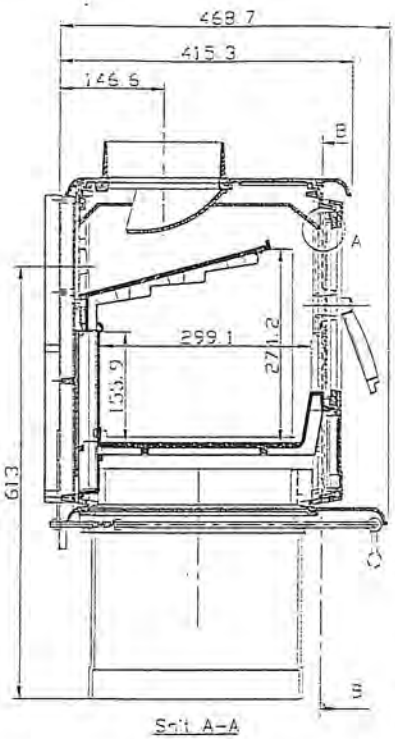
Sign.:	Dato:
KDU	07.05.00
Tegn.form.: A2	Målforhold: 1:5
Filnavn: 3400-88	Varenummer: -
morsø	Tegningsnummer: 3400-88 c



Set bagfra

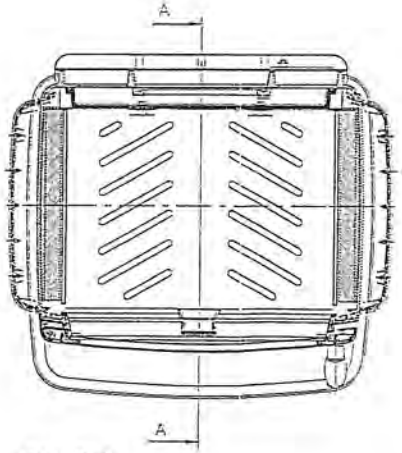


Snit B–B

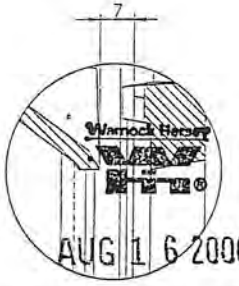


Snit A–A

17



Snit C–C



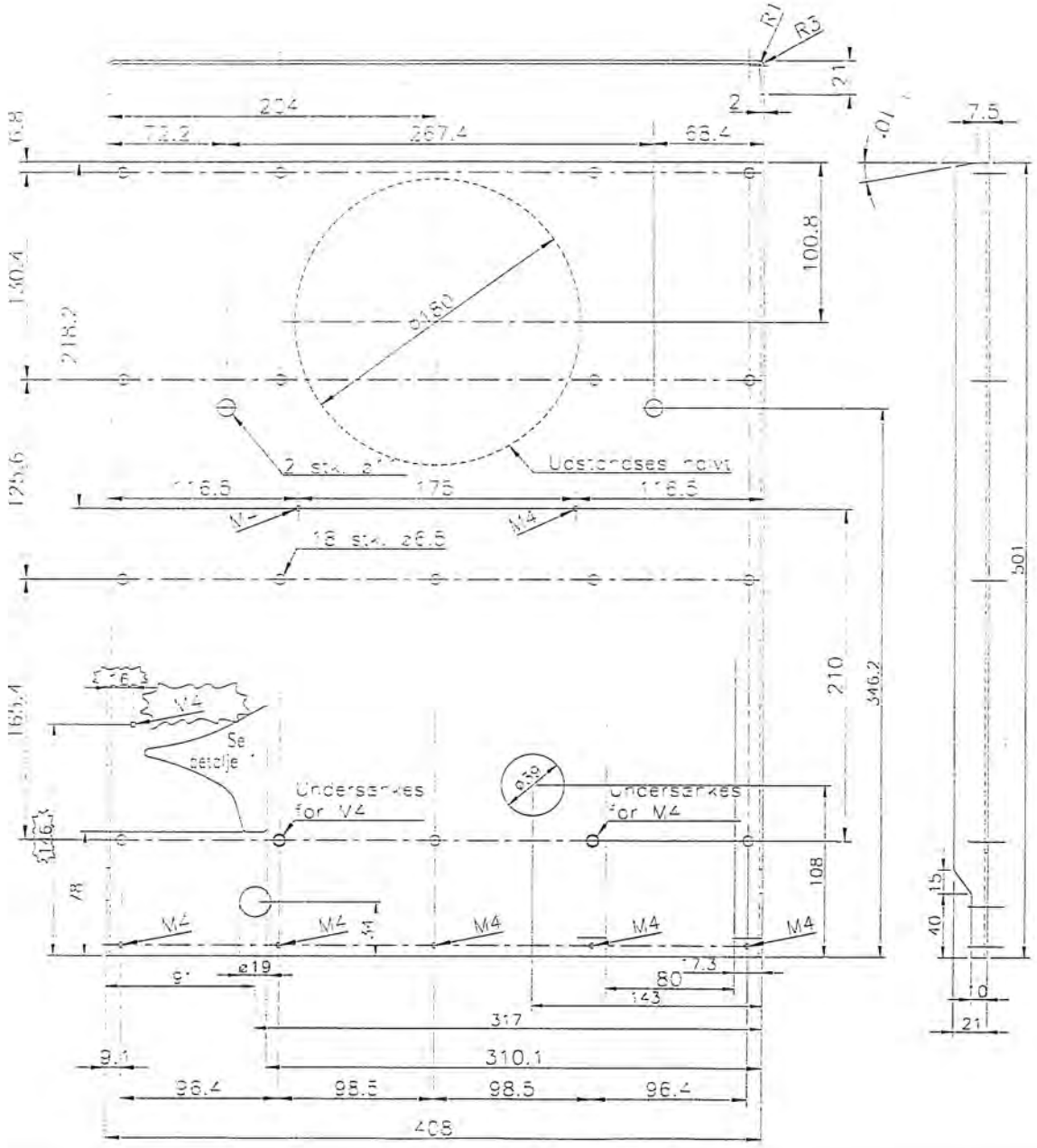
AUG 16 2000

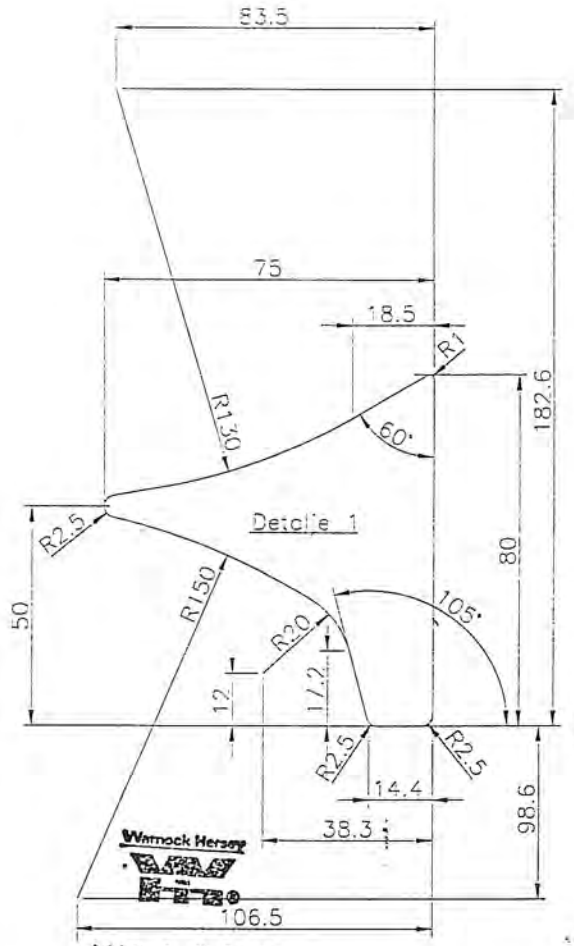
INTERTEK TESTING SERVICES
Middleton, WI

By: OK ER

CUT AWAY VIEW
3440

Rev.	Revision	Sign.	Date	Titel:	Sign.:	Date:
				Godkendelsestegning	KDU	07.08.00
				Morse 3440 USA	Tegn.form.: A2	Målforhold: 1:5
				Filnavn: 3400-89	Varenummer: –	
				morsø	Tegningsnummer: 3400-89 a	





18

AUG 1 6 2000

INTERTEK TESTING SERVICES
Middleton, WI

By:

REAR PLATE

Mstr.: 2 mm SPD plade | Vægt: 3,0 Kg.

Rev.	Revision	Sign.	Dato
b	M4 hul Ø4fejet for stop	KDU	09.08.00

Titel: Bagdækplade USA f. Airtight Morse 3400 USA

Sign.: KDU | Dato: 07.08.00

Tegn.form.: A2 | Målforhold: 1:2

Filnavn: 3400-90

Varenummer: 71348200

morse

Tegningsnummer: 3400-90 b

APPENDIX G

MORSØ JERNSTØBERI A/S

BY APPOINTMENT TO THE ROYAL DANISH COURT

DK-7900 NYKØBING MORS

July 6, 2000

Mr. Rick Armstrong
Intertek Testing Services
8431 Murphy Drive
Middleton, WI 53562
USA

Dear Mr. Armstrong:

The following information is being provided regarding the Morsø Owl stove you will be testing for EPA certification starting on Monday, July 10, 2000.

The stove is a non-catalytic model. The model number is 3400.

The combustion air control is located on the lower right front of the stove beneath the ashlip.

Based on our pre-testing, appropriate air settings for EPA testing are as follows:

Minimum burn rate - Air control lever to the fully clockwise (closed) position. The air control has a minimum setting with a "stop". The width of the air opening at this position is 0.75" when measured at the actual air opening. A minimum burn rate less than 1 kg/hour but above 0.8 kg/hour is anticipated.

Maximum burn rate - Air control lever to the fully counterclockwise (open) position.

Medium Low burn rate - Air control open at #1 position as indicated by the holes in air position locator plate by the air control handle. This corresponds to an air opening width of 1.188" at the actual air opening.

Medium High burn rate - Air control open at #3 position as indicated by the holes in air position locator plate by the air control handle. This corresponds to an air opening width of 2.00" at the actual air opening.

These air settings should be used only as a guideline. Adjustments should be made as required, based on the results of each previous certification test run.

The startup procedure during the first five minutes is the same the low and medium low categories. The air control lever should be in the maximum position for the first five minutes. The front door should be cracked open until the fuel load is burning briskly, 3 1/2 minutes maximum and then closed. The air control should be set at the run setting after 5 minutes. On the high and medium high categories, the door should be cracked open for the first 1 minute only

Address:
Morsø Jernstøberi A/S
Furvej 6
DK-7900 Nykøbing Mors
Phone: Salesdept.: +45 96 69 19 00
Accounts: +45 96 69 19 20
Production: +45 96 69 19 30

A/S no. 209.161
VAT no. DK 17 06 35 37 (export only)
PBS nr. 00 18 27 96 (only for DK)
E-mail Stoves@morsoe.com
Homepage www.morsoe.com
Fax +45 97 72 21 69

Bank:
DKK Giro 3 35 11 57
DKK Den Danske Bank, Thisted - acc no. 4784 - 421465
DKK Morsø Bank, Nykøbing Mors - acc.no. 7380 . 2010865
DEM Den Danske Bank, Hamburg - Kto. Nr. 32394009 (BLZ 203 205 00)
GBP Den Danske Bank, London - acc. no. 69639

and then closed. The air control should be left open for the full 5 minutes and then set at the run setting.

Questions about air control settings should be directed to Mr. Derik Andors, of Ferguson, Andors & Company. They will be witnessing the certification testing on Morsø's behalf.

Sincerely,

Morsø Jernstøberi A/S

Svend Erik Nielsen
Development Manager

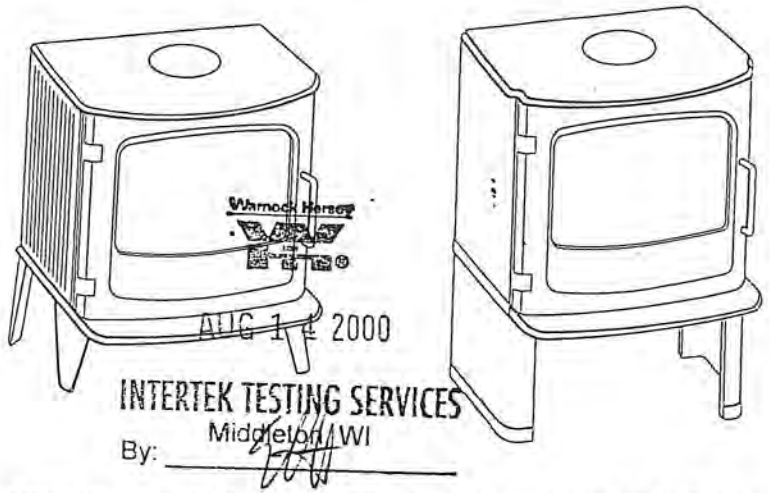
morsø

By appointment to the Royal Danish Court

Installation and Operating Instructions

3410 and 3440

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 3410 owl the U.S. Environmental Protection Agency's emission limits for wood heaters sold on or after July 1, 1990

Warnock Hersey ®

The Morsø 3410 owl 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.

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 safety 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).

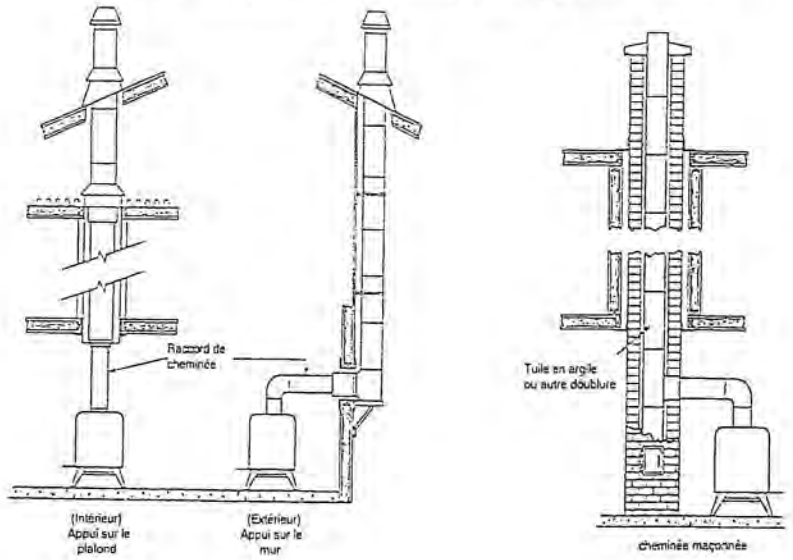
Use a residential type masonry or listed type HT factory-built chimney.

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).

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

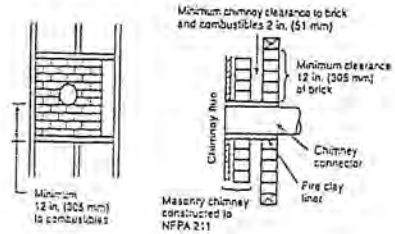
A chimney connector is the double-wall or single-wall pipe that connects the stove to the chimney. The chimney itself is the masonry or prefabricated structure that encloses the flue. Chimney connectors are used only to connect the stove to the chimney.

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 fumes under high heat. The connector must be 6 inches (150mm) in diameter.

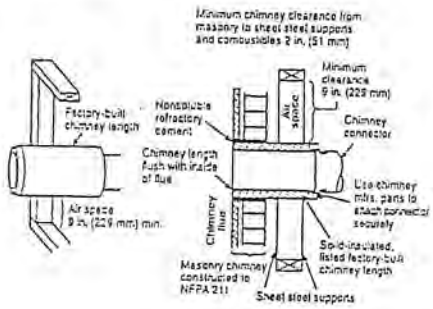
If possible, do not pass the chimney connector through a combustible wall or ceiling. If passage through a combustible wall is unavoidable, refer to the sections on Wall Pass- Throughs. Do not pass the connector through an attic, a closet or similar concealed space when installing the chimney connectors.

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.

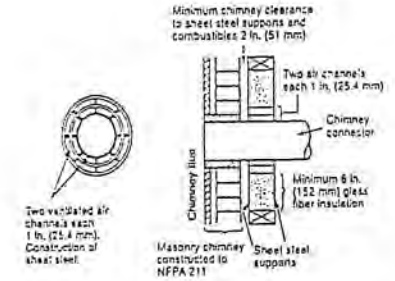
Be sure the installed stove and chimney connector are correct distances from near by combustible materials. See the clearance paragraph page 8.



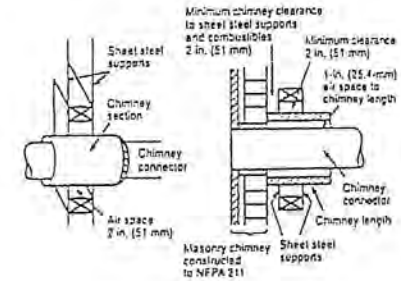
A Minimum 3.5-in thick brick masonry all framed into combustible wall with a minimum of 12-in brick separation from clay liner to combustibles. The fireclay liner shall run from outer surface of brick wall to, but not beyond, the inner surface of chimney flue liner and shall be firmly cemented in place.



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:

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Using single or double wall chimney connector	In	Mm		In	Mm
Unit to sidewall	16	405	Unit to backwall	12	305
Unit corner to diagonal wall	12	305	Flue collar to backwall	14,5	370
Fireplace Hearth mount					
Unit to top trim	19	485	Unit to side trim	11	280
Unit to mantle	20	510	Unit to sidewall	15	380

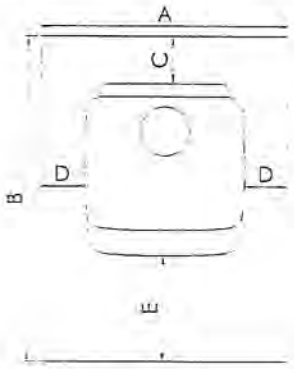
3440

Using single or double wall chimney connector	In	Mm		In	Mm
Unit to sidewall	8	205	Unit to backwall	8	205
Unit corner to diagonal wall	6	150	Flue collar to backwall	10,5	265
Fireplace Hearth mount					
Unit to top trim	19	485	Unit to side trim	8	205
Unit to mantle	20	510	Unit to sidewall	8	205

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.



	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.
Do not use gasoline, gasoline-type lantern fuel, kerosene, charcoal lighter or fluid or similar liquids to start or freshen up a fire in this heater. Keep all such liquids away from the heater while it is in use.

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 under the ash lip. 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.

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, morso 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. We recommend you to fit a smoke detector in the room where the stove is installed.

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 morso glass cleaner, applied when the glass is cold, in accordance with the instructions. Never use abrasive cleaners on the glass surface.

Reasons for dirty glass

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

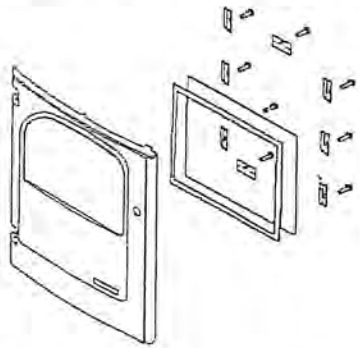
Replace broken glass immediately.
Do not operate your stove if the glass in the door is damaged.

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

Installing the glass

Never install the glass when the stove is in function.

Lift the door off its hinges an place face-down on a sheet of cardboards or other non-abrasieve fabric. The door is removed by loosening the 2 screws with a hexagon box wrench by the hinges



2. Unscrew the eight 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.

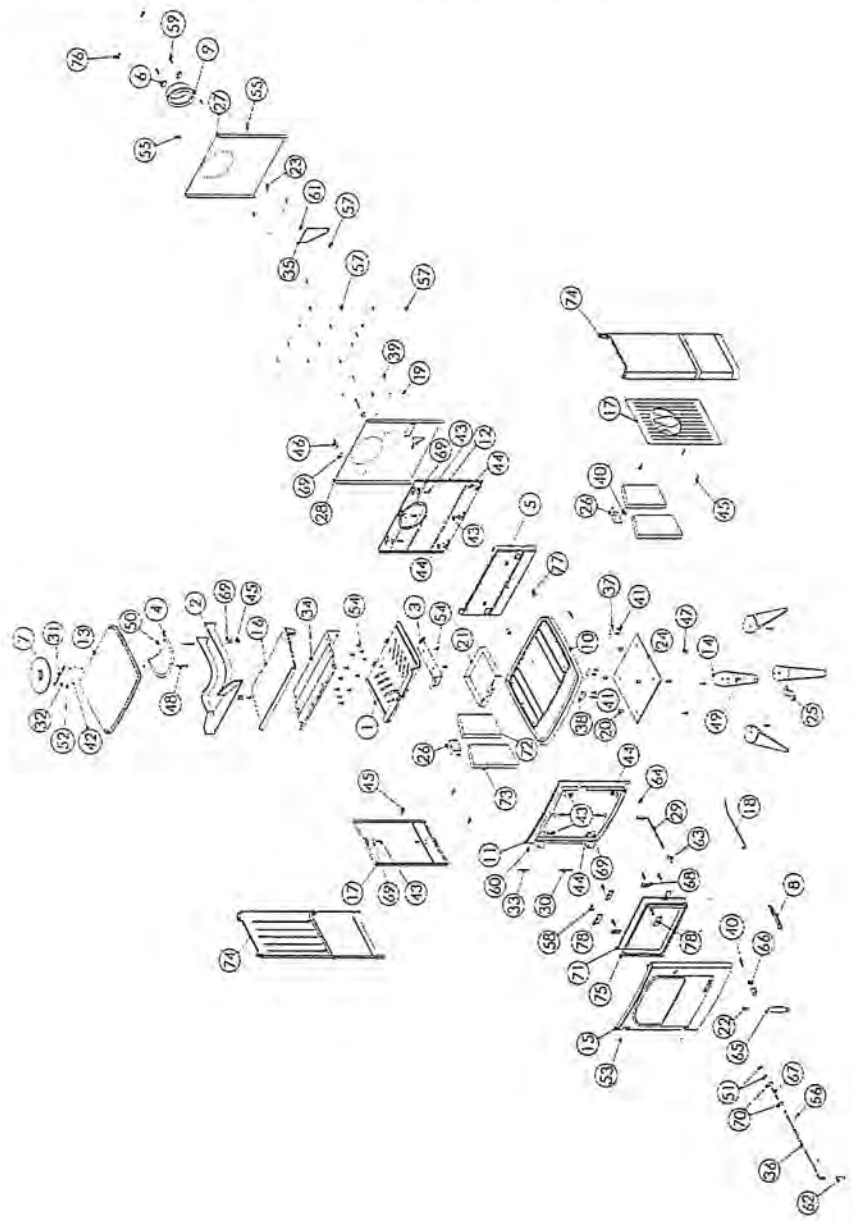
3.4 Leaving the stove for extended periods

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 3410 and 3440



3.6 Parts list for the model Morsø 3410 and 3440

Pos.No.	Parts
1	Intermediate frame
2	Inside top plate
3	Plate for intermediate frame
4	Draft reducer
5	Inside rear plate
6	Fitting w. thread for flue collar
7	Cover
8	Handle for riddling grate
9	Flue collar
10	Base plate
11	Front frame
12	Rear plate, cast iron
13	Top plate
14	Leg
15	Door
16	Baffle plate, cast iron
17	Side plate w. owl
18	Poker
19	Distance tube
20	Distance tube
21	Ash tray
22	Hinge pin
23	Distance tube
24	Radiant shielding, bottom
25	Hanging for handle
26	Brick securing bracket, side
27	Convection rear plate
28	Rear plate
29	Riddling bar
30	Hinge pin
31	Flat bar
32	Distance tube
33	Hinge pin
34	Baffle plate, stainless
35	draught control
36	Air inlet arm
37	Assemble steel
38	Assemble plate
39	4x16 screw
40	6x8 black steel set screw
41	6x10 black steel set screw
42	6x16 black steel set screw
43	6x20 black steel set screw
44	6x25 black steel set screw
45	6x35 black steel set screw
46	6x40 black steel set screw
47	6x45 black steel set screw
48	6x65 black steel set screw
49	8x20 black steel set screw
50	Steel box 6 mm
51	Steel box 8 mm
52	3x8 indvendig 6kt. Skrue
53	4x5 pinol skrue
54	6x10 screw
55	4x30 screw
56	2x25 cotter pin
57	4x8 screw
58	5x8 screw
59	6x25 screw
60	6 mm brass washer
61	4 mm nut
62	Stainless handle for adjustment
63	Knob for riddling grate
64	Bush, brass
65	Handle
66	Axis for handle
67	Stainless pressure spring
68	Glass fitting
69	6 mm air slider washer
70	8 mm washer
71	Ceramic glass
72	Stone, side, back
73	Stone, side, front
74	Convection side plate
75	Tightening tape
76	3.5x9.5 screw
77	6x30 screw
78	Glass fitting

72145200 Morsø bogtrykkeri

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: Owl
Date: 36718
Run: 1
Control #: 31222
Test Duration: 215

	Start	End
Barometer	29.15	29.12
W	70	70
D	76	79
Hu	74	64

Average Stove Temperature: 320.7
Moisture cont 17.71

Warnock Hersey Efficiency Test Report

Overall Heating Efficiency:			59.07%	
Combustion Efficiency:			74.40%	
Heat Transfer Efficiency:			79.39%	
Heat Output:	8153	BTU/Hr	8595	KJ/Hr
Heat Input:	13802	BTU/Hr	14550	KJ/Hr
Burn Duration:	3.58	Hours		
Burn Rate:	1.54	Lb/Hr	0.700	Kg/Hr
Stack Temp:	223.1	Deg.F	106.2	Deg.C

	Average	1.41	5.969	14.01	223.086957	85.04	0.11444	0.22812335	#DIV/0!	#DIV/0!	6.66119	0.246	
*	*	*	*	*	*	*	Comb	Combust	Heat	Net	*	*	
Elapsed Time	Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	% K	Eff %	Transfer Transfer	Eff Eff	air Fuel	Unit MN	
0	6.72	1.09	5.10	14.88	191	82	0.37	80.7%	23.4%	18.9%	11	3.05	
10	5.60	0.89	5.52	14.95	284	81	1.56	57.4%	43.8%	25.1%	11	2.54	
20	5.10	1.12	4.90	15.38	232	82	1.45	55.5%	54.6%	30.3%	12	2.31	
30	4.70	1.18	5.97	14.49	225	82	2.03	52.2%	60.7%	31.7%	10	2.13	
40	4.10	1.04	8.90	11.10	250	84	1.58	70.3%	73.0%	51.3%	8	1.86	
50	3.40	0.14	13.54	7.39	313	84	2.21	75.1%	78.1%	58.7%	6	1.54	
60	2.50	0.21	16.60	4.23	362	85	1.31	86.8%	83.2%	72.3%	6	1.13	
70	1.50	0.44	11.61	9.40	337	87	0.69	88.2%	86.4%	76.2%	11	0.68	
80	1.30	1.15	6.38	13.71	276	87	-0.08	93.1%	84.7%	78.9%	19	0.59	
90	1.30	1.40	5.32	14.42	246	86	-0.36	97.5%	84.7%	82.6%	23	0.59	
100	1.20	1.75	4.93	14.69	228	85	-0.25	91.2%	85.5%	78.0%	23	0.54	
110	1.20	1.77	4.41	15.40	213	85	0.00	83.2%	85.7%	71.3%	24	0.54	
120	1.10	1.93	4.19	15.32	203	85	-0.27	89.0%	86.3%	76.8%	26	0.50	
130	1.00	1.56	5.00	14.73	195	86	-0.27	93.2%	88.4%	82.3%	25	0.45	
140	0.60	1.37	5.13	14.76	190	88	-0.19	92.5%	90.3%	83.6%	29	0.27	
150	0.50	1.62	4.42	15.29	185	89	-0.23	90.4%	90.1%	81.4%	33	0.23	
160	0.50	1.88	3.87	15.77	180	89	-0.12	83.5%	89.9%	75.1%	34	0.23	
170	0.40	2.02	3.95	15.56	176	88	-0.16	83.8%	90.5%	75.8%	34	0.18	
180	0.40	1.90	4.52	15.18	176	88	0.00	81.5%	91.6%	74.7%	31	0.18	
190	0.30	2.12	3.55	15.99	172	85	-0.04	77.6%	90.6%	70.3%	37	0.14	
200	0.30	2.10	3.38	16.17	169	83	-0.05	77.3%	90.3%	69.8%	38	0.14	
210	0.20	1.91	3.07	16.64	165	82	0.01	75.1%	90.3%	46.4%	43	0.09	
215	0.00	1.84	3.02	16.76	163	83	0.07	72.7%	91.2%	66.3%	47	0.00	

Manufacturer: Morso
Model: Owl
Date: 36719
Run: 2
Control #: 31222
Test Duration: 87

	Start	End
Barometer	29.12	29.12
W	67	67
D	78	82
Hu	57	45

Average Stove Temperature: 448.32
Moisture cont 17.76
Average 0.54 9.045 11.234 406.1 87.3 0.051598 0.11221488 #DIV/0! #DIV/0! 2.65714

Elapsed Time	Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	Comb % K	Combust Eff %	Heat Transfer	Net Eff Transfer	Eff air Fuel
0	6.60	0.52	5.76	14.43	362	85	0.19	90.3%	16.8%	15.2%	11
10	5.00	0.27	15.42	4.37	518	90	2.23	76.3%	59.9%	45.7%	5
20	3.50	0.07	14.80	5.86	516	89	2.14	77.6%	71.4%	55.4%	6
30	2.30	0.05	14.77	5.60	508	88	0.23	97.2%	79.6%	77.4%	7
40	1.20	0.03	12.82	7.94	478	89	-0.01	100.0%	83.8%	83.8%	12
50	0.60	0.29	7.08	13.17	392	88	-0.55	113.1%	81.7%	92.4%	27
60	0.40	0.63	6.28	14.03	355	88	-0.20	99.9%	82.7%	82.6%	30
70	0.30	0.88	5.07	15.30	330	86	0.07	88.5%	81.5%	72.1%	34
80	0.01	1.23	4.27	15.82	307	86	0.02	84.9%	81.4%	68.1%	42
87	0.00	1.43	4.18	15.82	295	84	0.06	81.3%	82.2%	66.8%	41

Warnock Hersey Efficiency Test Report

Overall Heating Efficiency:			65.53%
Combustion Efficiency:			86.52%
Heat Transfer Efficiency:			75.74%
Heat Output:	22539	BTU/Hr	23760
Heat Input:	34393	BTU/Hr	36257
Burn Duration:	1.45	Hours	
Burn Rate:	3.74	Lb/Hr	1.698
Stack Temp:	406.1	Deg.F	207.8

Warnock Hersey Efficiency Test Report

Manufacturer: Morso
Model: Owl
Date: 36719
Run: 3
Control #: 31222
Test Duration: 75

	Start	End
Barometer	29.12	29.12
W	67	69
D	82	88
Hu	45	38

Average Stove Temperature: 498.64
Moisture cont 17

	Average	0.3789	9.1178	10.822	463.777778	89	-0.02202	0.13132259	#DIV/0!	#DIV/0!	2.489161

*	*	*	*	*	*	*	Comb	Combust	Heat	Net	*
Elapsed Time	Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	% K	Eff %	Transfer Transfer	Eff Eff	air Fuel
0	6.50	0.48	5.26	13.26	428	89	-2.32	211.4%	50.9%	107.6%	21
10	4.70	0.08	15.39	4.96	597	89	2.84	71.3%	58.2%	41.5%	5
20	3.20	0.03	13.89	6.60	569	89	1.38	84.1%	71.4%	60.1%	6
30	1.90	0.04	12.85	7.35	544	89	-0.43	105.9%	79.2%	83.8%	10
40	1.10	0.10	9.73	10.60	481	89	-0.57	110.7%	80.9%	89.5%	17
50	0.09	0.34	6.88	11.91	423	89	-2.34	192.9%	80.5%	155.2%	48
60	0.70	0.64	6.47	13.76	394	89	-0.32	103.3%	80.3%	83.0%	26
70	0.10	0.80	6.14	14.14	375	89	-0.05	93.9%	82.0%	73.7%	33
75	0.00	0.90	5.45	14.82	363	89	0.02	90.1%	81.1%	73.1%	37

Overall Heating Efficiency: 74.84%
Combustion Efficiency: 94.50%
Heat Transfer Efficiency: 79.19%

Heat Output:	30130	BTU/Hr	31763
Heat Input:	40262	BTU/Hr	42444
Burn Duration:	1.25	Hours	
Burn Rate:	4.32	Lb/Hr	1.958
Stack Temp.	463.8	Deg.F	239.9

Warnock Hersey Efficiency Test Report

Manufacturer: Morso
Model: Owl
Date: 36720
Run: 4
Control #: 31222
Test Duration: 177

	Start	End
Barometer	29.15	29.12
W	68	71
D	76	85
Hu	63	50

Overall Heating Efficiency: 64.91%
Combustion Efficiency: 83.44%
Heat Transfer Efficiency: 77.79%

Heat Output: 10471 BTU/Hr 11039 KJ/Hr
Heat Input: 16132 BTU/Hr 17006 KJ/Hr

Burn Duration: 2.95 Hours

Burn Rate: 1.80 Lb/Hr 0.818 Kg/Hr

Average Stove Temperature: 364.2

Stack Temp: 267.7 Deg.F 130.9 Deg.C

Moisture cont 17.63

	Average	0.865	6.675	13.47	267.684211	85.53	0.03387	0.2128354	#DIV/0!	#DIV/0!	6.32163	0.166
*	*	*	*	*	*	*	Comb	Combust	Heat	Net	*	*
Elapsed Time	Weight Remaining	CO	CO2	O2	Flue Gas	Room Temp	% K	Eff %	Transfer Transfer	Eff Eff	air Fuel	Unit MN
0	6.46	0.32	5.22	14.44	308	83	-0.85	127.9%	38.5%	49.2%	15	2.93
10	5.40	0.78	5.46	14.98	339	84	1.37	60.9%	40.9%	24.9%	11	2.45
20	4.40	0.10	13.45	7.13	424	84	2.67	69.7%	65.1%	45.4%	6	2.00
30	3.10	0.02	14.80	5.73	435	86	1.47	84.1%	76.6%	64.5%	6	1.41
40	2.10	0.20	15.87	4.44	425	88	0.19	97.3%	83.1%	80.9%	7	0.95
50	1.50	0.09	10.62	9.76	370	88	-0.41	106.7%	84.3%	89.9%	13	0.68
60	1.30	0.56	6.83	13.37	316	86	-0.40	105.8%	83.0%	87.8%	20	0.59
70	1.10	0.82	6.17	13.91	278	87	-0.38	103.3%	84.7%	87.5%	23	0.50
80	1.00	1.08	5.55	14.41	262	86	-0.34	100.0%	84.9%	84.9%	25	0.45
90	0.09	1.26	5.40	14.52	247	86	-0.16	92.5%	88.4%	81.7%	35	0.04
100	0.80	1.09	5.43	14.38	239	86	-0.53	105.7%	86.6%	91.5%	28	0.36
110	0.70	1.31	5.18	14.72	232	86	-0.24	94.5%	87.2%	82.4%	28	0.32
120	0.60	1.50	4.72	15.20	224	85	-0.06	86.9%	87.4%	76.0%	30	0.27
130	0.40	1.20	4.70	15.36	21	85	-0.10	90.4%	102.1%	92.3%	34	0.18
140	0.30	1.37	3.91	16.16	208	85	0.05	82.0%	88.0%	72.1%	39	0.14
150	0.20	1.15	3.45	16.73	198	85	0.01	83.5%	87.7%	73.3%	47	0.09
160	0.10	1.18	3.23	16.91	190	85	-0.01	83.1%	88.1%	73.2%	51	0.05
170	0.10	1.16	3.29	16.88	186	85	0.02	82.5%	88.8%	46.5%	50	0.05
177	0.00	1.25	3.54	16.88	184	85	0.44	67.2%	91.2%	61.2%	45	0.00

APPENDIX J

ITS Intertek Testing Services

Manufacturer MORSO Model _____ Date 7-7-00

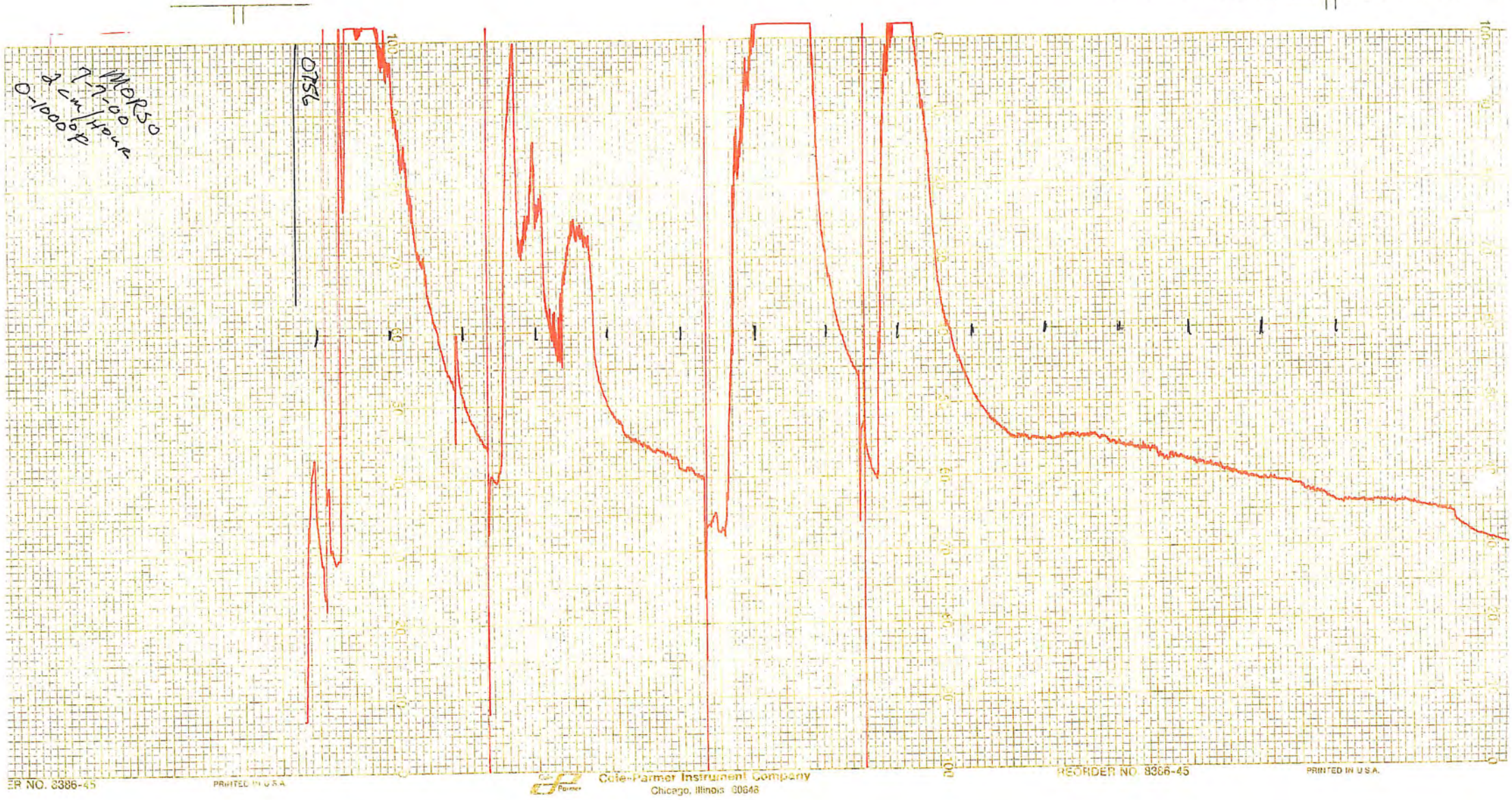
Job # _____ Run _____ Tech RA / ACS

Break-in Data log

Type of fuel used: RED OAK
Moisture content corrected to 2-pin and for the type of fuel used.

Catalytic X Non-catalytic _____

Date	Time	Flue Temp	Comb. Cham. Or Catalyst Temp	lbs. Fuel weight added	Moisture content
7-7-00	7:56	78	78	2.2	KINDLING
	8:10	241	376	13.35	20.9
	10:31	222	447	7.20	20.5
	13:31	205	330	13.70	21.2
	15:41	265	471	7.90	23.4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