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Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

RESULTS OF THE NOVEMBER 4 AND 11, 1988 PARTICULATE AND CHLORIDE EMISSION COMPLIANCE TEST ON THE MORSE BOULGER INCINERATOR AT THE MAYO FOUNDATION INSTITUTE HILLS RESEARCH FACILITY LOCATED IN ROCHESTER, MINNESOTA

Prepared for: HDR Techserv, Inc.
Mayo Foundation
Prepared by: PACE Laboratories, Inc.
Project No: 881003.403
Date: November 30, 1988

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ACFM	Actual cubic feet per minute
^{o}C	Degrees Centigrade
cc(ml)	Cubic centimeter (milliliter)
Cu. Ft.	Cubic feet
DSCFM	Dry standard cubic feet per minute
DSML	Dry standard milliliter
^{o}F	Degrees Farenheit
Dia.	Diameter
Ft./Sec.	Feet per second
GPM	Gallons per minute
GR/ACF	Grains per actual cubic foot
GR/DSCF	Grains per dry standard cubic foot
g	Gram
Hrs.	Hours
In.	Inches
In. Hg	Inches of mercury
In. H_2O	Inches of water
LB	Pound
LB/DSCF	Pounds per dry standard cubic foot
LB/HR	Pounds per Hour
LB/10^6BTU	Pounds per million British Thermal Units heat input
LB/MMBTU	Pounds per million British Thermal Units heat input
MW	Megawatt
mg/DSCM	Milligrams per dry standard cubic meter
Min.	Minutes
PPM	Parts per million
PSI	Pounds per square inch
PSIG	Pounds per square inch - gauge
^{o}R	Degrees Rankin
Sec.	Seconds
Sq. Ft.	Square Feet
%v/v	percent by volume
%w/w	percent by weight

Mayo Foundation Institute Hills Research Facility
Morse Boulger Incinerator
Rochester, Minnesota

Introduction

On November 4 and 11, 1988, PACE Laboratories, Inc. personnel conducted particulate and chloride emission compliance testing on the Morse Boulger Incinerator Stack at the Mayo Foundation Institute Hills Research Facility located in Rochester, Minnesota. On-site testing was performed by a three man team supervised by D. Stock. Coordination between plant and testing activities was provided by Karen Christensen of PACE and Collin Frennie with the Mayo Foundation. Testing was not witnessed by Minnesota Pollution Control Agency personnel. Three separate tests were performed. Each test consisted of three independent one-hour samplings for particulate with concurrent integrated gas sampling for Orsat gas composition determinations. Hydrogen chloride and wet catch condensibles were collected in the backhalf. In addition, temporary semi-continuous gas monitors for oxygen, carbon dioxide and carbon monoxide were used to follow incinerator operational trends.

The Morse Boulger Control Incinerator was installed in 1978. The input capacity of the incinerator is 1600 LB/HR of typical hospital waste. The waste stream for this incinerator is typically non-infectious hospital waste and infectious "red bag" wastes. Hospital waste is fed from the tipping floor to a receiving hopper using a small front end loader. Infectious "red bag wastes are fed to the hopper from gondolas which also are used to store and transport the waste. A hydraulic ram pushes the waste into the incinerator bed. The secondary combustion chamber is maintained above 1800°F using natural gas as auxiliary fuel. Emissions from the incinerator are controlled by incinerator operational parameters with no secondary control. Exhaust gases are normally vented in common with another incinerator through a brick/concrete stack to atmosphere.

Testing on the Morse Boulger Incinerator Stack was performed from two test ports oriented at 90 degrees, approximately 8.5 duct diameters downstream from the inlet duct and 2.2 duct diameters from the stack outlet. The stack dimension at this point was verified on site and measures 49.25 inches in diameter. A 12 point traverse was used to extract representative flue gas samples. Each point was sampled five minutes for a run time of 60 minutes.

Testing was performed in accordance with EPA Methods 1-5 & 9, 40 CFR 60, Appendix A (July 1, 1987). A preliminary velocity traverse and moisture estimation were conducted so that an appropriate sampling nozzle required for isokinetic sample withdrawal could be selected. A PACE sampling train which meets or exceeds the specifications outlined in the above reference was used to collect particulate samples. A temperature controlled stainless steel lined sampling probe was used to extract flue gas samples and transport them to an all-glass filter and cyclone assembly in a temperature controlled oven. The back half of the particulate sampling train consisted of a series of three glass impingers, the first two prepared with 100 mls deionized water, followed by a desiccant-packed drying column. In addition, integrated gas samples were collected in 30 liter Tedlar bags concurrently with the three particulate runs so that gas composition (orsat) could be determined. Opacity observations were made by a certified observer during each run.

Upon recovery of wet catch samples, a 5 ml aliquot was removed for hydrogen chloride analyses and the remainder analyzed for condensible organic matter. The volume correction for the aliquot removed is not significant to the particulate data. This procedure was approved verbally by Tom Kelly of the Minnesota Pollution Control Agency at a pretest meeting on October 24, 1988.

Results are summarized in the following section and details are reported in the results section. All supporting data follow in the appendices.

Summary

Results of particulate determinations and gas composition are summarized in Tables 1-3. Significant emissions data is shown below as an average for each test.

Parameter	Test 1	Test 2	Test 3
Date	11/4/88	11/11/88	11/11/88
Average Particulate Concentration (GR/DSCF@12% CO_2)	0.27	0.28	0.22
Average Particulate Emission Rate (LB/HR)	5.0	4.3	3.0
Average HCL Emission Rate (LB/HR)	51.4	53.3	37.6

Opacity observations were recorded every 15 seconds for a one hour time period during each run. Most of the 240 observations were in the 0-10 percent range with a few readings of 15 and 20 percent. For all test runs, the highest possible consecutive six minute average opacity was 7.9 percent. Of the nine determinations the higest one-hour average opacity was 1.8 percent. The highest single reading was 20 percent and the lowest reading was zero percent.

Results

Results of all field and laboratory evaluations are shown in Tables 4 through 21. Table 3-6 includes results of orsat and moisture determinations. Particulate loading results are in Tables 7-9 with hydrogen chloride in Tables 10-12. Results of opacity observations are shown in Tables 13-21.

Results of preliminary measurements and traverse point and test port locations are in Appendices A and B. Copies of raw data sheets are included in Appendices C, D and E.

All sampling, analyses, and data reduction were performed by PACE Laboratories, Inc. under my supervision.

Donald B. Stock
Manager, Air Sampling

SUMMARY OF RESULTS

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29,1988

TABLE 1

SUMMARY OF THE RESULTS

TEST 1

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Date of Run	11/4/88	11/4/88	11/4/88	
Time of Run	810-913	935-1037	1058-1200	
Waste Input (LB/HR)	2013	1122	1084	1406
Natural Gas Usage (CFH)	5700	4800	4700	5067
Excess Air	431%	414%	409%	418%
Volumetric Flow Rate				
ACFM	32600	32300	32200	32400
DSCFM	11900	11900	11700	11800
Gas Temperature (°F)	817	813	837	822
Gas Moisture Content (%v/v)	6.3	6.0	5.5	6.0
Gas Composition (%v/v,Dry)				
CO2	2.9	2.8	3.0	2.9
O2	17.1	17.1	17.0	17.1
N2	79.9	80.2	80.0	80.1
Isokinetic Variation (%)	99.0	98.3	98.1	
Particulate Emission Rate (LB/HR)	5.7	4.0	5.3	5.0
Particulate Concentration				
GR/ACF	0.020	0.014	0.019	0.018
GR/DSCF	0.056	0.039	0.053	0.049
GR/DSCF @ 12% CO2	0.32	0.22	0.27	0.27

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 2

SUMMARY OF THE RESULTS

TEST 2

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Date of Run	11/11/88	11/11/88	11/11/88	
Time of Run	620-722	740-842	918-1020	
Waste Input (LB/HR)	1210	1583	1105	1299
Natural Gas Usage (CFH)	5700	4800	4800	5100
Excess Air	529%	489%	449%	489%
Volumetric Flow Rate				
ACFM	32400	31700	32100	32100
DSCFM	12900	12500	12200	12500
Gas Temperature (°F)	761	763	809	777
Gas Moisture Content (%v/v)	4.7	5.3	5.3	5.1
Gas Composition (%v/v,Dry)				
CO2	2.0	2.5	2.7	2.4
O2	17.8	17.5	17.3	17.5
N2	80.2	80.0	80.0	80.1
Isokinetic Variation (%)	98.7	98.7	98.8	
Particulate Emission Rate (LB/HR)	3.2	4.8	4.9	4.3
Particulate Concentration				
GR/ACF	0.012	0.018	0.018	0.016
GR/DSCF	0.029	0.045	0.046	0.040
GR/DSCF @ 12% CO2	0.27	0.29	0.28	0.28

TABLE 3

SUMMARY OF THE RESULTS

TEST 3

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Date of Run	11/11/88	11/11/88	11/11/88	
Time of Run	1053-1154	1213-1315	1333-1434	
Waste Input (LB/HR)	1158	837*	1237*	1077*
Natural Gas Usage (CFH)	4900	5700	4900	5167
Excess Air	624%	609%	537%	590%
Volumetric Flow Rate				
ACFM	31300	31100	31300	31200
DSCFM	12200	12300	12300	12300
Gas Temperature (°F)	786	762	771	773
Gas Moisture Content (%v/v)	5.1	5.2	4.8	5.0
Gas Composition (%v/v,Dry)				
CO2	2.4	2.1	2.3	2.3
O2	18.1	18.1	17.8	18.0
N2	79.6	79.8	79.9	79.8
Isokinetic Variation (%)	99.0	99.0	98.5	
Particulate Emission Rate (LB/HR)	2.9	2.4	3.5	3.0
Particulate Concentration				
GR/ACF	0.011	0.009	0.013	0.011
GR/DSCF	0.028	0.022	0.034	0.028
GR/DSCF @ 12% CO2	0.20	0.21	0.24	0.22

*Weight of "red bag" wastes, other waste weights not recorded.

RESULTS OF ORSAT & MOISTURE DETERMINATIONS

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29,1988

TABLE 4

RESULTS OF ORSAT AND MOISTURE DETERMINATIONS

TEST 1

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/4/88	11/4/88	11/4/88
Time of Run	810-913	935-1037	1058-1200
ORSAT (%v/v)			
Dry Basis			
Carbon Dioxide	2.93	2.78	2.98
Oxygen	17.13	17.05	16.98
Carbon Monoxide	*	*	*
Nitrogen	79.94	80.17	80.04
WetBasis			
Carbon Dioxide	2.74	2.61	2.82
Oxygen	16.05	16.02	16.05
Carbon Monoxide	*	*	*
Nitrogen	74.89	75.32	75.64
Moisture Collected (ml)	57.0	54.0	48.0
Moisture Content (%v/v)	6.32	6.05	5.50
Molecular Weight of Flue Gas (lb/lb-mole)			
Dry	29.15	29.13	29.16
Wet	28.45	28.45	28.54
Fo	1.287	1.385	1.315

*Carbon monoxide was not measured on integrated samples, assumed concentrations less 0.005%.

TABLE 5

RESULTS OF ORSAT AND MOISTURE DETERMINATIONS

TEST 2

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/11/88	11/11/88	11/11/88
Time of Run	620-722	740-842	918-1020
ORSAT (%v/v)			
Dry Basis			
Carbon Dioxide	2.03	2.50	2.68
Oxygen	17.80	17.53	17.28
Carbon Monoxide	*	*	*
Nitrogen	80.17	79.97	80.04
WetBasis			
Carbon Dioxide	1.93	2.37	2.54
Oxygen	16.97	16.60	16.36
Carbon Monoxide	*	*	*
Nitrogen	76.42	75.71	75.77
Portable Oxygen Monitor Result			
Time Weighted Average (%02)	#DIV/0!	#DIV/0!	#DIV/0!
Moisture Collected (ml)	45.0	50.0	49.0
Moisture Content (%v/v)	4.68	5.32	5.34
Molecular Weight of Flue Gas (lb/lb-mole)			
Dry	29.04	29.10	29.12
Wet	28.52	28.51	28.53
Fo	1.527	1.348	1.351

*Carbon monoxide was not measured on integrated samples, assumed concentrations less 0.005%

TABLE 6

RESULTS OF ORSAT AND MOISTURE DETERMINATIONS

TEST 3

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/11/88	11/11/88	11/11/88
Time of Run	1053-1154	1213-1315	1333-1434
ORSAT (%v/v)			
Dry Basis			
Carbon Dioxide	2.35	2.08	2.33
Oxygen	18.10	18.10	17.78
Carbon Monoxide	*	*	*
Nitrogen	79.55	79.82	79.89
WetBasis			
Carbon Dioxide	2.23	1.97	2.22
Oxygen	17.17	17.16	16.93
Carbon Monoxide	*	*	*
Nitrogen	75.46	75.68	76.06
Moisture Collected (ml)	47.0	48.0	44.0
Moisture Content (%v/v)	5.14	5.19	4.79
Molecular Weight of Flue Gas (lb/lb-mole)			
Dry	29.10	29.06	29.08
Wet	28.53	28.48	28.55
Fo	1.191	1.346	1.339

*Carbon monoxide was not measured on integrated samples, assumed concentrations less 0.005%.

RESULTS OF PARTICULATE LOADING DETERMINATIONS

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29,1988

TABLE 7

RESULTS OF PARTICULATE LOADING DETERMINATIONS

TEST 1

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/4/88	11/4/88	11/4/88
Time of Run	810-913	935-1037	1058-1200
Sample Duration (Min.)	60.0	60.0	60.0
Average Flue Gas Temperature (°F)	817.0	813.1	836.8
Moisture Content of Flue Gas (%v/v)	6.32	6.05	5.50
Particulate Collected (Mg)*			
Wet Catch	3.1	1.5	3.2
Dry Catch	141.5	99.5	129.3
Total	144.6	101.0	132.5
Volumetric Flow Rate			
ACFM	32550	32330	32240
DSCFM	11880	11870	11690
Sample Volume (Cubic Feet)			
Meter Conditions	41.50	41.57	40.98
Dry Standard	39.80	39.50	38.80
Isokinetic Variation (%)	99.0	98.3	98.1
Particulate Concentration*			
Wet Catch, GR/DSCF	0.001	0.001	0.001
Dry Catch, GR/DSCF	0.055	0.039	0.051
Total, GR/DSCF	0.056	0.039	0.053
Particulate Emission Rate*			
Total, LB/HR	5.71	4.01	5.28

*Dry catch plus organic wet catch

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PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29,1988

TABLE 8

RESULTS OF PARTICULATE LOADING DETERMINATIONS

TEST 2

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/11/88	11/11/88	11/11/88
Time of Run	620-722	740-842	918-1020
Sample Duration (Min.)	60.0	60.0	60.0
Average Flue Gas Temperature (°F)	761.0	762.7	808.6
Moisture Content of Flue Gas (%v/v)	4.68	5.32	5.34
Particulate Collected (Mg)*			
Wet Catch	0.6	2.0	1.1
Dry Catch	81.1	119.1	122.0
Total	81.7	121.1	123.1
Volumetric Flow Rate			
ACFM	32400	31690	32090
DSCFM	12910	12530	12230
Sample Volume (Cubic Feet)			
Meter Conditions	42.37	41.94	41.98
Dry Standard	43.12	41.87	40.89
Isokinetic Variation (%)	98.7	98.7	98.8
Particulate Concentration*			
Wet Catch, GR/DSCF	0.000	0.001	0.000
Dry Catch, GR/DSCF	0.029	0.044	0.046
Total, GR/DSCF	0.029	0.045	0.046
Particulate Emission Rate*			
Total, LB/HR	3.24	4.79	4.87

*Dry catch plus organic wet catch

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Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29,1988

TABLE 9

RESULTS OF PARTICULATE LOADING DETERMINATIONS

TEST 3

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/11/88	11/11/88	11/11/88
Time of Run	1053-1154	1213-1315	1333-1434
Sample Duration (Min.)	60.0	60.0	60.0
Average Flue Gas Temperature (°F)	785.5	762.4	771.4
Moisture Content of Flue Gas (%v/v)	5.14	5.19	4.79
Particulate Collected (Mg)*			
Wet Catch	1.5	2.1	1.6
Dry Catch	73.0	57.8	87.8
Total	74.5	59.9	89.4
Volumetric Flow Rate			
ACFM	31310	31130	31270
DSCFM	12180	12330	12350
Sample Volume (Cubic Feet)			
Meter Conditions	41.40	41.19	41.05
Dry Standard	40.79	41.31	41.18
Isokinetic Variation (%)	99.0	99.0	98.5
Particulate Concentration*			
Wet Catch, GR/DSCF	0.001	0.001	0.001
Dry Catch, GR/DSCF	0.028	0.022	0.033
Total, GR/DSCF	0.028	0.022	0.034
Particulate Emission Rate*			
Total, LB/HR	2.94	2.36	3.55

*Dry catch plus organic wet catch

RESULTS OF HYDROGEN CHLORIDE DETERMINATIONS

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No 881003.403

PACE Laboratories, inc.
November 29,1988

TABLE 10

Results Of Hydrogen Chloride Analyses

Test 1

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/4/88	11/4/88	11/4/88
Time of Run	810-913	935-1037	1058-1200
Sample Duration (Min)	60.0	60.0	60.0
Total Weight of Hydrogen Chloride (mg)			
Hydrogen Chloride (By Ion Chromatography)	1220	1220	1440
Hydrogen Chloride Concentration (mg/dscm)			
Hydrogen Chloride (By Ion Chromatography)	1082	1091	1310
ppm	713	719	863
Hydrogen Chloride Emission Rate (LB/HR)			
Hydrogen Chloride (By Ion Chromatography)	48.2	48.5	57.4

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PACE Laboratories, Inc.
November 29, 1988

TABLE 11

Results Of Hydrogen Chloride Analyses

Test 2

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/11/88	11/11/88	11/11/88
Time of Run	620-722	740-842	918-1020
Sample Duration (Min)	60.0	60.0	60.0
Total Weight of Hydrogen Chloride (mg)			
Hydrogen Chloride (By Ion Chromatography)	1175	1440	1428
Hydrogen Chloride Concentration (mg/dscm)			
Hydrogen Chloride (By Ion Chromatography)	962 634	1214 800	1233 812
Hydrogen Chloride Emission Rate (LB/HR)			
Hydrogen Chloride (By Ion Chromatography)	46.5	57.0	56.5

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PACE Laboratories, Inc.
November 29, 1988

TABLE 12

Results Of Hydrogen Chloride Analyses

Test 3

Morse Boulger Incinerator Stack

PARAMETER	RUN 1	RUN 2	RUN 3
Date of Run	11/11/88	11/11/88	11/11/88
Time of Run	1053-1154	1213-1315	1333-1434
Sample Duration (Min.)	60.0	60.0	60.0
Total Weight of Hydrogen Chloride (mg)			
Hydrogen Chloride (By Ion Chromatography)	952 627	960 632	940 617
Hydrogen Chloride Concentration (mg/dscm)			
Hydrogen Chloride (By Ion Chromatography)	824	820	806
Hydrogen Chloride Emission Rate (LB/HR)			
Hydrogen Chloride (By Ion Chromatography)	37.6	37.9	37.3

RESULTS OF OPACITY OBSERVATIONS

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 13

RESULTS OF OPACITY OBSERVATIONS

TEST 1

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		82.92
	5	0.022		14.17
	10	0.046		2.92
	15	0.071		0.00
	20	0.097		0.00
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	1.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	1.0	0.004	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	0.0
2	0.6	7	0.0
3	1.3	8	2.7
4	1.9	9	0.6
5	0.0	10	2.9

Highest six minute average: 3.3
Maximum reading: 10.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/4/88
Time of test: 810-910

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods.

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PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 14

RESULTS OF OPACITY OBSERVATIONS

TEST 1

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		92.92
	5	0.022		6.25
	10	0.046		0.42
	15	0.071		0.00
	20	0.097		0.42
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	1.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	0.4	0.002	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	2.7
2	0.0	7	1.3
3	0.2	8	0.0
4	0.2	9	0.0
5	0.0	10	0.0

Highest six minute average: 2.7
Maximum reading: 20.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/4/88
Time of test. 935-1035

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 15

RESULTS OF OPACITY OBSERVATIONS

TEST 1

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		78.33
	5	0.022		15.83
	10	0.046		4.58
	15	0.071		1.25
	20	0.097		0.00
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	1.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	1.4	0.006	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	1.9
2	0.0	7	0.2
3	0.0	8	7.5
4	2.1	9	1.0
5	1.0	10	0.6

Highest six minute average: 7.9
Maximum reading: 15.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/4/88
Time of test: 1058-1158

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 16

RESULTS OF OPACITY OBSERVATIONS

TEST 2

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		78.75
	5	0.022		17.92
	10	0.046		3.33
	15	0.071		0.00
	20	0.097		0.00
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	1.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	1.2	0.005	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	3.1	6	2.5
2	0.0	7	0.6
3	0.0	8	0.2
4	0.8	9	2.7
5	0.0	10	2.3

Highest six minute average: 5.0
Maximum reading: 10.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/11/88
Time of test. 640-740

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 17

RESULTS OF OPACITY OBSERVATIONS

TEST 2

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		77.08
	5	0.022		19.58
	10	0.046		3.33
	15	0.071		0.00
	20	0.097		0.00
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	1.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	1.3	0.006	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	1.0
2	0.4	7	0.6
3	0.0	8	3.8
4	0.4	9	2.3
5	2.9	10	1.7

Highest six minute average: 5.0
Maximum reading: 10.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/11/88
Time of test: 745-845

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 18

RESULTS OF OPACITY OBSERVATIONS

TEST 2

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		83.75
	5	0.022		15.42
	10	0.046		0.83
	15	0.071		0.00
	20	0.097		0.00
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	1.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	0.9	0.004	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	0.2	6	1.0
2	0.0	7	0.6
3	1.0	8	2.7
4	0.0	9	1.7
5	0.0	10	1.3

Highest six minute average: 3.1
Maximum reading: 10.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/11/88
Time of test: 918-1018

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 19

RESULTS OF OPACITY OBSERVATIONS

TEST 3

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		85.00
	5	0.022		15.00
	10	0.046		0.00
	15	0.071		0.00
	20	0.097		0.00
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	1.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	0.8	0.003	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	1.0	6	1.0
2	0.2	7	3.8
3	0.8	8	0.0
4	0.4	9	0.0
5	0.0	10	0.2

Highest six minute average: 4.0
Maximum reading: 5.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/11/88
Time of test. 1058-1158

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 20

RESULTS OF OPACITY OBSERVATIONS

TEST 3

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		89.58
	5	0.022		10.42
	10	0.046		0.00
	15	0.071		0.00
	20	0.097		0.00
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	1.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	0.5	0.002	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	0.8
2	0.2	7	1.5
3	1.0	8	0.8
4	0.2	9	0.2
5	0.0	10	0.4

Highest six minute average: 1.7
Maximum reading: 5.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/11/88
Time of test. 1213-1313

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

TABLE 21

RESULTS OF OPACITY OBSERVATIONS

TEST 3

Morse Boulger Incinerator Stack

	Percent Opacity	Optical Density		Relative Frequency
	0	0.000		65.00
	5	0.022		33.75
	10	0.046		1.25
	15	0.071		0.00
	20	0.097		0.00
	25	0.125		0.00
	30	0.155		0.00
	35	0.187		0.00
	40	0.222		0.00
	45	0.260		0.00
	50	0.301		0.00
	55	0.347		0.00
	60	0.398		0.00
	65	0.456		0.00
	70	0.523		0.00
	75	0.602		0.00
	80	0.699		0.00
	85	0.824		0.00
	90	.000		0.00
	95	1.301		0.00
	99	2.000		0.00
Average >	1.8	0.008	**Total >**	100

Average Opacity Per Six Minute Period:

Period	Opacity	Period	Opacity
1	0.0	6	2.7
2	0.2	7	0.6
3	0.2	8	0.0
4	1.9	9	4.6
5	3.1	10	4.8

Highest six minute average: 5.0
Maximum reading: 10.0
Minumum reading: 0.0

Observer: Dirk Wold
Date of test: 11/11/88
Time of test: 1332-1432

NOTE: The six minute high average opacity not may coincide with any of the 10 reported six minute periods. The high value is the maximum consecutive period possible and may overlap other periods

Appendix A
Results of Preliminary Determinations

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No. 881003.403

PACE Laboratories, Inc.
November 29, 1988

RESULTS OF AIR FLOW DETERMINATIONS

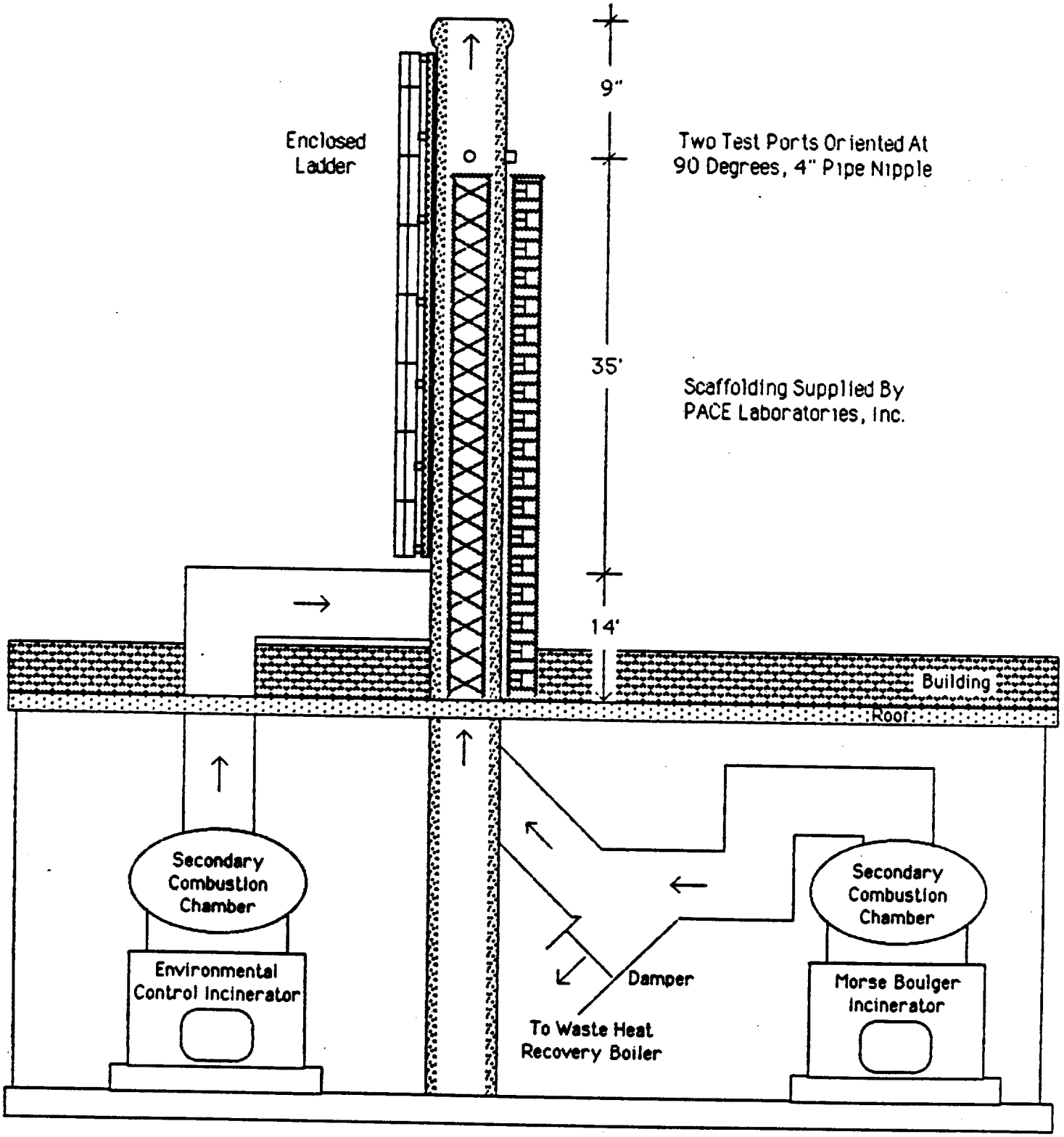
TEST 1

Morse Boulger Incinerator Stack

Date of Run	11/4/88
Time of Measurement	0753
Number of Sampling Ports	2
Number of Points Sampled	12
Barometric Pressure (In. Hg)	28.20
Static Pressure (In. WC)	-0.18
Absolute Flue Gas Pressure (In. Hg)	28.19
Average Flue Gas Temperature (F)	805
Average Moisture Content (%v/v)	6
Flue Gas Average Velocity (Feet/Second)	40.31
Duct Dimension (Inches)	49.25
Duct Cross-sectional Area (Square Feet)	13.23
Volumetric Flow Rate	
ACFM	32000
DSCFM	11820

Appendix B
Test Ports and Traverse Points Locations

Mayo Foundation
Institute Hills Research Facility
Rochester, Minnesota
Common Incinerator Stack

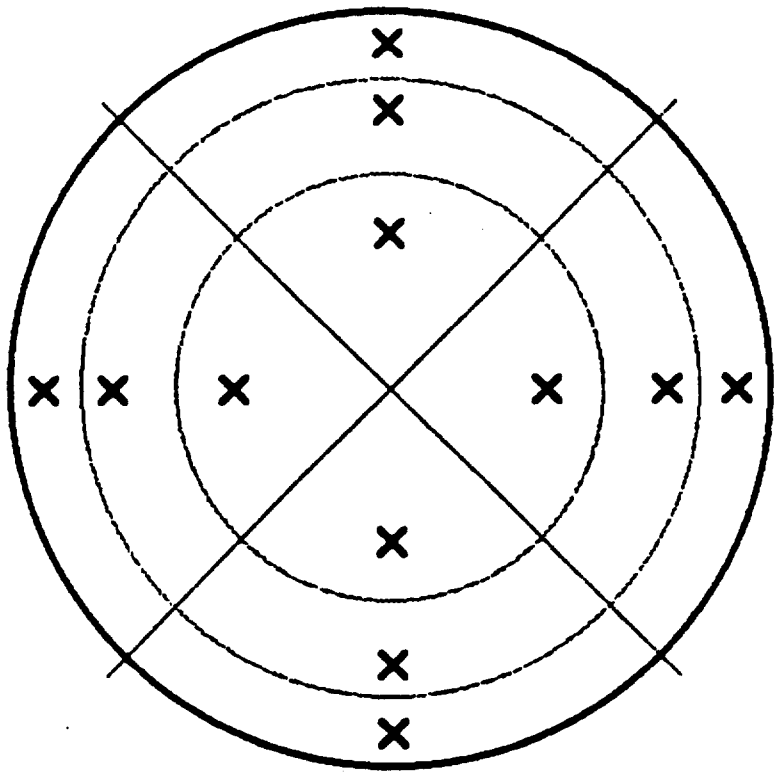


PACE Laboratories, Inc | DBS | 11/30/88 | Not to Scale

Mayo Foundation

Institute Hills Research Facility
Rochester, Minnesota
Common Incinerator Stack

Traverse Point Locations



Number of Sampling Ports	2
Number of Traverse Points	12
Duct Dimension (Inches)	49.25

PACE Laboratories, Inc | DBS | 11/30/88 | Not to Scale

Appendix C
EPA Methods 2 & 5 Field Data Sheets

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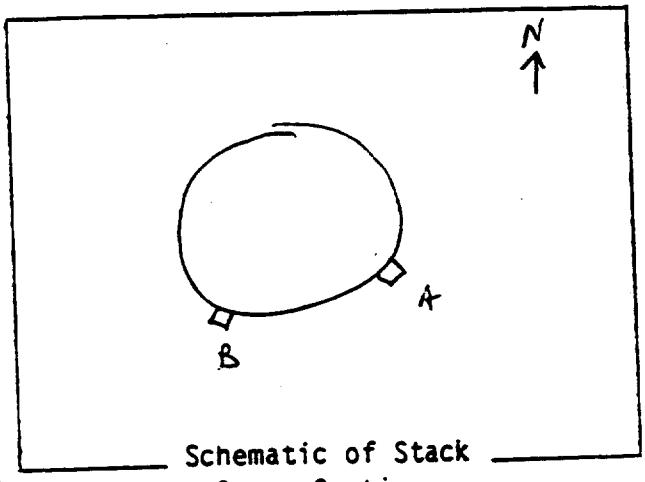
EPA METHOD 2
FIELD DATA SHEET

Project Mayo Research Institute
Test Location Morris Bulger Inc. Stack
Date 11-4-88 Test 1 Run 0
Operators D. Sbck + T. Russell
Barometric Pressure 28.20 inches Hg
Static Pressure -.18 inches H_2O

Pitot Tube No. 4 Cp .835
Duct Dimensions 49.25 inches
Port Length 20.75 inches
Wet Bulb Temp. ____ °F
Dry Bulb Temp. 805 °F
Moisture Content ____ %

Traverse Point				0753 Velocity Head P "H_2O	Stack Temp °F
Number	% Dia.	Inches from: Wall	Port		
A-1		2.15	22.40	.15	805
2		7.21	27.96	.19	
3		14.57	35.32	.22	
4		31.68	55.43	.23	
5		42.64	62.79	.21	
6		47.10	67.85	.20	
B-1				.17	
2				.18	
3				.24	
4				.24	
5				.21	
6				.20	



Schematic of Stack Cross-Section

Data Summary:

P(S) ____ inches Hg
AREA (FT^2) ____
M(D) ____
M(S) ____
@ TS ____ °F
@ √^P ____
V(S) ____ FPS
ACFM ____
DSCFM ____

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Morris Burger Inc Stack
Date 11-4-88 Test 1 Run 1
Operators DBS JMR

Train No. C3 S-1 P-1 D-4
Meter Coef. γ .9991
ΔH @ 1.83
Nozzle No. ~~1-4~~ 1-4 Dn ~~.302~~ .310

Pitot Tube No. 4 Cp .835
Bar. Pres. 28.30 Ins. Hg
Static Pres. -.15 Ins. H_2O
Estimated MC 6 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 5 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head – ΔP Ins. H_2O	Orifice Meter – ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %
	(0810)	(477.30)												
A-6	5	480.72	.20	1.44	331	069	3.5	773	246	249	44	54	52	NA
5	10	484.18	.22	1.55	352	421		817				58	52	
4	15	487.85	.24	1.69	368	789		821				62	52	
3	20	491.48	.23	1.61	359	1148	3.9	840	244	235	46	65	53	
2	25	494.87	.20	1.41	337	485		837				66	54	
1	30	497.82	.15	1.10	297	782		791	243	234	47	67	55	
B-6	35	501.30	.21	1.53	351	134		800				65	56	
5	40	504.85	.21	1.50	348	482		837				69	57	
4	45	508.57	.24	1.75	375	857	4.2	813	243	249	47	70	57	
3	50	512.34	.25	1.78	380	237		835				70	58	
2	55	515.61	.18	1.30	325	562		815				71	58	
1	60	518.80	.17	1.24	318	880		805				71	54	
	(0913)													

θ = 60 V_m = 41.50 $\overline{\Delta H}$ = 1.49 T_s = 515.7 T_m = 60.5

Samples Recovered: Filter Number 800 ; [X] Probe Wash ; [X] Wet Catch ; [ ] _____

Gas Sampling Data:

Box No. B-1
Bag No. 1
Bag Vol. 30 Liters

Bag Material Tedlar
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. NA

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	134	108	2		1191.0	
Initial Vol.	100	100	0		1178.0	
Difference	34	8	2		13.0	57.0

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Morse Boulger Inc. Stack
Date 11-4-88 Test 1 Run 2
Operators DBS + TMR

Train No. C-3 S-1 P-1 D-4
Meter Coef. γ .9991
ΔH @ 1.83
Nozzle No. 1-4 Dn .310

Pitot Tube No. 4 Cp .85
Bar. Pres. 28.20 Ins. Hg
Static Pres. -.18 Ins. H_2O
Estimated MC 6.5 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 5 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head – ΔP Ins. H_2O	Orifice Meter – ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %
	(0935)	(519.00)												
B-6	5	522.51	.21	1.50	348	248		810	229	228	42	62	59	NA
5	10	526.09	.23	1.61	361	609	3.8	833	232	231	639	66	59	
4	15	529.70	.22	1.61	361	970		786	247	253	40	69	59	
3	20	533.30	.22	1.59	359	330	4.0	806	247	246	42	70	60	
2	25	536.59	.18	1.35	332	661		760	~~239~~	~~242~~		71	60	
1	30	539.69	.16	1.16	307	964	3.5	805				72	60	
A-B	35	543.12	.20	1.44	343	311		815	239	242	48	69	61	
5	40	546.75	.23	1.63	365	676		828				72	61	
4	45	550.39	.23	1.62	364	040	4.0	845				72	61	
3	50	553.94	.22	1.56	357	397		832				74	61	
2	55	557.39	.20	1.43	342	739		824	243	230	47	73	62	
1	60	560.57	.17	1.23	317	057	3.5	813				73	62	
	(1037)													

θ = 60 V_m = 41.57 $\overline{\Delta H}$ = 1.48 $\overline{T_s}$ = 813.1 $\overline{T_m}$ = 65.3

Samples Recovered: Filter Number 801 ; ☒ Probe Wash ; ☒ Wet Catch ; ☐ _____

Gas Sampling Data:

Box No. B-1
Bag No. 2
Bag Vol. 30 Liters

Bag Material Tedlar
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. NA

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	130	112	2		1145.0	
Initial Vol.	100	100	0		1145.0	
Difference	30	12	2		10.0	54

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Morse Boulder Inc. Stack
Date 11-4-88 Test 1 Run 3
Operators DBS + TMR

Train No. C-3 S-1 P-1 D-4
Meter Coef. γ .9991
ΔH @ 1.83
Nozzle No. 1-4 Dn .310

Pitot Tube No. 4 Cp .835
Bar. Pres. 28.20 Ins. Hg
Static Pres. -.18 Ins. H_2O
Estimated MC 6.3 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 5 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head – ΔP Ins. H_2O	Orifice Meter – ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %
	(1058)	(560.80)												NA
A-6	5	564.29	.21	1.48	348	428	3.5	840	229	227	40	66	62	
5	10	567.74	.21	1.47	346	774		848				~~71~~ 69	~~69~~ 61	
4	15	571.22	.20	1.49	348	122	3.7	775				71	61	
3	20	574.76	.22	1.57	358	480	4.0	828	245	244	41	72	61	
2	25	578.33	.22	1.54	355	835		851				73	62	
1	30	581.50	.17	1.22	319	152		821				73	62	
B-6	35	584.83	.18	1.29	325	477		827	237	240	47	69	62	
5	40	588.33	.23	1.56	357	834	3.8	875				73	62	
4	45	592.08	.24	1.73	377	210	4.3	818				75	63	
3	50	595.55	.21	1.45	345	555		881	242	232	51	75	63	
2	55	598.81	.18	1.29	326	881		830				74	64	
1	60	601.78	.15	1.08	298	178		827				74	63	
	(1200)													

θ = 60 V_m = 40.98 ΔH = 1.43 T_s = 836.8 T_m = 67.1

Samples Recovered: Filter Number 815 ; ☒ Probe Wash ; ☒ Wet Catch ; ☐ _____

Gas Sampling Data:

Box No. B-1
Bag No. 3
Bag Vol. 30 Liters

Bag Material Tedlar
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. NA

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	130	108	2		1149.0	
Initial Vol.	100	100	0		1141.0	
Difference	30	8	2		8	48

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AIR SAMPLING DIVISION

PROJECT Mayo Research Foundation
SOURCE Morris Bulger Incinerator
OPERATOR D. Stock

DATE 11-4-88
TEST NO. 1

INITIALIZATION PARAMETERS	
(G) γ =	.9991
(S) $\Delta H@$ =	1.83
(C) C_p =	.835
(D) D_n =	.370
(I) P_b =	28.20
(J) Δt =	5
(W) MC =	6
(O) B'_{O2} =	12
(E) t_m =	54
(Z) P_g =	-.18

INPUT PARAMETERS

	RUN 1	RUN 2	RUN 3	RUN 4
V/O	477.30	579.00	560.55	
NO. OF POINTS	12	12	12	
MC	6	6.5	6.3	
V/F	518.80	560.57	601.78	
G-H_2O	57	54	48	
RUN TIME	60	60	60	
1-RND/2-RECT	1	1	1	
DIA(INS)	49.25	49.25	49.25	
L(INS)	X	X	X	
W(INS)	X	X	X	

END OF RUN SUMMARY

	RUN 1	RUN 2	RUN 3	RUN 4
$\sqrt{\Delta P}$	.4553	.4529	.4481	
$\overline{\Delta H}$	1.49	1.48	1.43	
$\overline{TS}$	815.67	813.08	836.75	
$\overline{TM}$	60.46	65.33	67.08	
V/STD	39.80	39.50	38.60	
MC	6.31	6.04	5.5	
VEL	40.31	40.10	40.03	
ISO%	100.6	99.9	99.5	
ACFM	31994	31830	31772	
DSCFM	11687	11684	11517	

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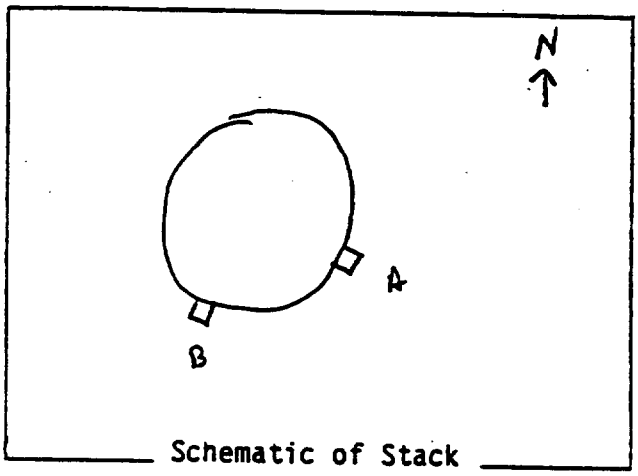
EPA METHOD 2
FIELD DATA SHEET

Project Mayo Research Institute
Test Location Morse Boulger Inc Stack
Date 11-11-85 Test 2 Run 0
Operators A Stock + T. Russell
Barometric Pressure 25.95 inches Hg
Static Pressure -.16 inches H_2O

Pitot Tube No. 41 Cp .835
Duct Dimensions 49.25 inches
Port Length 20 1/4 inches
Wet Bulb Temp. ____ °F
Dry Bulb Temp. ____ °F
Moisture Content ____ %

Traverse Point Number	% Dia.	Inches from: Wall	Inches from: Port	Velocity Head P "H_2O	Stack Temp °F
A - 1		2.15	22.40		
2		7.21	27.46		
3		14.57	35.32		
4		34.68	55.43		
5		42.04	62.79		
6		47.10	67.85		
B - 1					
2					
3					
4					
5					
6					



Schematic of Stack Cross-Section

Data Summary:

P(S) ____ inches Hg
AREA (FT^2) ____
M(D) ____
M(S) ____
@ TS ____ °F
@ √^P ____
V(S) ____ FPS
ACFM ____
DSCFM ____

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Mac Boiler Inc. Stack
Date 11-11-88 Test 2 Run 1
Operators DBS & TMR

Train No. C-2
Meter Coef. γ .9969
ΔH @ 2.05
Nozzle No. 1-4 Dn .310

Pitot Tube No. 4 Cp .835
Bar. Pres. 28.95 Ins. Hg
Static Pres. -.16 Ins. H_2O
Estimated MC 6 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 5 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head–ΔP Ins. H_2O	Orifice Meter–ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %
	(0620)	(533.00)												
B-6	5	536.06	.17	1.39	306	606	3.0	760	236	231	32	36	34	N.F
5	10	539.41	.21	1.68	336	941		759				42	33	
4	15	542.97	.23	1.90	358	294		756				46	33	
3	20	546.70	.25	2.09	376	676	3.8	745	246	242	32	48	33	
2	25	550.50	.24	2.01	669	0415		746				50	34	
1	30	553.90	.21	1.74	344	390		761				52	35	
A-6	35	557.15	.19	1.60	330	720	3.6	750	235	241	37	48	35	
5	40	560.83	.23	1.91	366	080		760				53	36	
4	45	564.58	.24	2.05	374	454		732				55	37	
3	50	568.39	.25	2.06	376	831	4.1	777	245	235	41	54	38	
2	55	572.01	.24	2.00	371	201		769				56	39	
1	60	575.37	.20	1.64	336	537	3.6	787				57	40	
	(0722)													

θ = 60 V_m = 42.37 $\overline{\Delta H}$ = 1.84 $\overline{T_s}$ = 761.0 $\overline{T_m}$ = 42.8

Samples Recovered: Filter Number 824 ; [X] Probe Wash ; [X] Wet Catch ; [ ] _____

Gas Sampling Data:

Box No. B-2
Bag No. 1
Bag Vol. 30 Liters

Bag Material Tedlar
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. _____

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	120	113	2		1190.0	
Initial Vol.	100	100	0		1170.0	
Difference	20	13	2		20.0	45

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Morse Bushar Inc. Stack
Date 11-11-88 Test 2 Run 2
Operators DBS + TMR

Train No. C-2 S-1 P-2 D-2
Meter Coef. γ .1969
ΔH @ 2.05
Nozzle No. 1-4 Dn .310

Pitot Tube No. 4 Cp .835
Bar. Pres. 28.95 Ins. Hg
Static Pres. -.16 Ins. H_2O
Estimated MC 5.5 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 5 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head–ΔP Ins. H_2O	Orifice Meter–ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %
	(0740)	(575.60)												
A-6	5	579.12	.21	1.79	350	910	3.3	718				47	40	NA
5	10	582.67	.23	1.56	356	266		755				55	42	
4	15	586.23	.22	1.82	355	621		769	227	244	32	57	42	
3	20	589.92	.23	1.90	362	983		779				61	43	
2	25	593.38	.22	1.55	354	342	3.8	753				61	45	
1	30	596.64	.16	1.48	321	663		648	245	241	47	61	46	
B-6	35	599.87	.18	1.53	327	990		750				59	46	
5	40	603.40	.22	1.18	352	342		805				61	45	
4	45	607.05	.23	1.84	363	105		786	251	230	42	62	46	
3	50	610.75	.24	1.94	365	873	4.1	812				62	47	
2	55	614.21	.21	1.76	350	423		771				65	48	
1	60	617.54	.19	1.57	334	757		778	233	234	45	61	44	
	(0842)													

θ = 60 V_m = 41.94 $\overline{\Delta H}$ = 1.77 $\overline{T_s}$ = 762.7 $\overline{T_m}$ = 52.5

Samples Recovered: Filter Number 840 ; ☒ Probe Wash ; ☑ Wet Catch ; ☐ _____

Gas Sampling Data:

Box No. B-2
Bag No. 2
Bag Vol. 30 Liters

Bag Material Teflon
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. 119

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	132	106	2		1168.0	
Initial Vol.	100	100	0		1158.0	
Difference	32	6	2		10	50

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Mayo Boiler Incinerator Stack
Date 11-11-88 Test 2 Run 3
Operators DGS + TMR

Train No. C-2 S-1 P-2 D-2
Meter Coef. γ .9969
ΔH @ 2.05
Nozzle No. 1-4 Dn .310

Pitot Tube No. 4 Cp .835
Bar. Pres. 28.95 Ins. Hg
Static Pres. -.16 Ins. H_2O
Estimated MC 5.5 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 6 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head–ΔP Ins. H_2O	Orifice Meter–ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %
	(0918)	(617.80)												
B-6	5	620.95	.17	1.44	316	016	3.0	751	246	258	47	62	56	NA
5	10	624.65	.23	1.91	366	463		793				70	56	
4	15	628.34	.24	1.95	372	834	4.0	830				72	57	
3	20	632.04	.23	1.92	370	204		797	256	243	43	72	57	
2	25	635.52	.21	1.73	351	554		816				73	57	
1	30	639.01	.20	1.70	348	903		772				74	59	
A-6	35	642.52	.20	1.71	349	252	3.8	770	237	249	47	71	59	
5	40	646.10	.22	1.80	358	610		827				73	60	
4	45	649.71	.22	1.83	362	971	3.9	806				74	61	
3	50	653.20	.21	1.67	346	317		863	233	231	54	73	61	
2	55	656.56	.20	1.64	343	660		823				73	60	
1	60	654.78	.18	1.44	321	981	3.5	855				75	60	
	(1020)													

θ = 60 V_m = 41.98 $\overline{\Delta H}$ = 1.23 $\overline{T_s}$ = 808.6 $\overline{T_m}$ = 65.2

Samples Recovered: Filter Number 841 ; [X] Probe Wash ; [X] Wet Catch ; [ ] _____

Gas Sampling Data:

Box No. B-2
Bag No. 3
Bag Vol. .30 Liters

Bag Material Tedlar
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. NA

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	128	108	2		1159.0	
Initial Vol.	100	100	0		1148.0	
Difference	28	8	2		11.0	49

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AIR SAMPLING DIVISION

PROJECT Mayo Research Institute
SOURCE Morse Boulger Incinerator
OPERATOR D. Stock

DATE 11-11-88
TEST NO. 1

INITIALIZATION PARAMETERS	
(G) γ =	.9969
(S) $\Delta H@$ =	2.05
(C) C_p =	.835
(D) D_n =	.370
(I) P_b =	28.95
(J) Δt =	5
(W) MC =	6
(O) B'_{O2} =	12
(E) t_m =	25
(Z) P_g =	-.16

INPUT PARAMETERS

	RUN 1	RUN 2	RUN 3	RUN 4
V/O	533.00	575.60	617.80	
NO. OF POINTS	12	12	12	
MC	6	5.5	5.5	
V/F	575.37	617.54	659.78	
G-H_2O	45	50	49	
RUN TIME	60	60	60	
1-RND/2-RECT	1	1	1	
DIA(INS)	49.25	49.25	49.25	
L(INS)	X	X	X	
W(INS)	X	X	X	

END OF RUN SUMMARY

$\sqrt{\Delta P}$	.4701	.4594	.4588	
$\overline{\Delta H}$	1.84	1.77	1.73	
$\overline{TS}$	761.00	762.67	808.58	
$\overline{TM}$	42.75	52.54	65.17	
V/STD	43.12	41.86	40.89	
MC	4.68	5.32	5.39	
VEL	40.26	39.41	39.92	
ISO%	100.0	100.0	100.1	
ACFM	31454	31280	31685	
DSCFM	12739	12369	12074	

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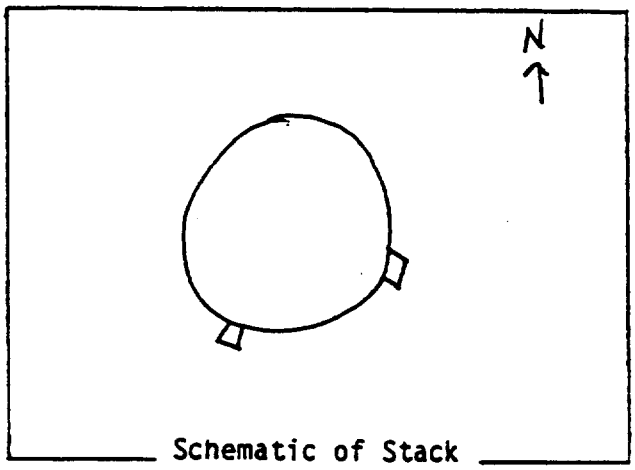
EPA METHOD 2
FIELD DATA SHEET

Project Mayo Research Institute
Test Location Morse Boiler Inc. Stack
Date 11-11-88 Test 3 Run O
Operators D. Stock + T. Russell
Barometric Pressure 29.95 inches Hg
Static Pressure -.16 inches H_2O

Pitot Tube No. 4 Cp .835
Duct Dimensions 49.25 inches
Port Length 20.75 inches
Wet Bulb Temp. ____ °F
Dry Bulb Temp. ____ °F
Moisture Content ____ %

Traverse Point				Velocity Head P "H_2O	Stack Temp °F
Number	% Dia.	Inches from: Wall	Inches from: Port		
A - 1		2.15	22.90		
2		7.21	27.96		
3		14.57	35.32		
4		34.65	55.43		
5		42.04	62.79		
6		47.16	67.85		
B - 1					
2					
3					
4					
5					
6					



Schematic of Stack Cross-Section

Data Summary:

P(S) ____ inches Hg
AREA (FT^2) ____
M(D) ____
M(S) ____
@ TS ____ °F
@ √^P ____
V(S) ____ FPS
ACFM ____
DSCFM ____

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Nuse Boiler Inc. Stack
Date 11-11-88 Test 3 Run 1
Operators DBS TMR

Train No. C-2 A-2 S-1 D-2
Meter Coef. γ .9969
ΔH @ 2.05
Nozzle No. 1-4 Dn .370

Pitot Tube No. 4 Cp .835
Bar. Pres. 28.95 Ins. Hg
Static Pres. -.16 Ins. H_2O
Estimated MC 5.5 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 5 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head–ΔP Ins. H_2O	Orifice Meter–ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %
	(1053)	(660.00)												
A-6	5	663.65	.23	1.42	370	370	3.4	799	231	240	50	61	57	N/A
5	10	667.40	.23	1.86	362	732		822				68	55	
4	15	670.10	.22	1.83	360	092		791				64	56	
3	20	674.89	.20	1.60	337	429		845	229	237	47	69	58	
2	25	677.63	.19	1.57	334	763	3.2	803				64	56	
1	30	680.90	.17	1.51	327	090		720				66	54	
B-6	35	684.27	.19	1.62	338	427		761	242	240	50	63	53	
5	40	687.82	.22	1.79	354	782	3.7	816				64	53	
4	45	691.58	.24	2.02	377	158		775				64	52	
3	50	695.20	.22	1.84	354	517		781	252	231	47	63	57	
2	55	698.45	.18	1.53	328	845	3.2	757				62	49	
1	60	701.40	.15	1.27	298	143		756				60	48	
	(1154)													

θ = 60 V_m = 41.40 $\overline{\Delta H}$ = 1.70 $\overline{T_s}$ = 785.5 $\overline{T_m}$ = 59.1

Samples Recovered: Filter Number 847 ; ☒ Probe Wash ; ☒ Wet Catch ; ☐ _____

Gas Sampling Data:

Box No. B-2
Bag No. 1
Bag Vol. 30 Liters

Bag Material Tedlar
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. N/A

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	127	110	1		1177.0	
Initial Vol.	100	100	0		1165.0	
Difference	27	10	1		9	47

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Mayo Boiler Inc. Stack
Date 11-11-88 Test 3 Run 2
Operators DBS + TMR

Train No. C-2 S-1 P-2 D 2
Meter Coef. γ 9969
ΔH @ 2.05
Nozzle No. 1-4 Dn .370

Pitot Tube No. 4 Cp .835
Bar. Pres. 28.55 Ins. Hg
Static Pres. -.16 Ins. H_2O
Estimated MC 5.5 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 5 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head – ΔP Ins. H_2O	Orifice Meter – ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %	
	(1213)	(701.60)													
B-6	5	704.85	.18	1.52	327	487	3.1	772	228	232	38	49	43	NA	
5	10	708.27	.21	1.68	340	827		803				54	43		
4	15	711.87	.23	1.89	361	187		781				55	43		
3	20	715.47	.23	1.87	359	547	3.5	792	244	231	42	57	43		
2	25	718.88	.20	1.71	344	890		735				56	43		
1	30	721.77	.16	1.36	306	197		740				57	43		
A-6	35	725.39	.20	1.69	342	539	3.7	745	229	242	42	58	43		
5	40	728.98	.22	1.86	358	897	4.0	747				57	44		
4	45	732.65	.23	1.93	365	263	4.2	760				58	44		
3	50	736.13	.21	1.77	350	613		752	227	229	54	59	44		
2	55	739.60	.21	1.74	347	960		777				59	45		
1	60	742.79	.17	1.49	317	277	3.3	745				59	45		
	(1315)														

θ = 60 V_m = 41.19 $\overline{\Delta H}$ = 1.70 $\overline{T_s}$ = 762.4 $\overline{T_m}$ = 50.0

Samples Recovered: Filter Number 843 ; [X] Probe Wash ; [X] Wet Catch ; [ ] _____

Gas Sampling Data:

Box No. B-2
Bag No. 2
Bag Vol. 30 Liters

Bag Material Tedlar
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. N/A

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	128	110	3		1167	
Initial Vol.	100	100	0		1159	
Difference	28	10	2		8	48

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EPA Method 5 Field Data Sheet

Project Mayo Research Institute
Sample Location Morse Boiler Inc. stack
Date 11-11-88 Test 3 Run 3
Operators DBS + TMR

Train No. C-2 P-2 S-1 D-2
Meter Coef. γ .9964
ΔH @ 2.05
Nozzle No. 1-4 Dn .370

Pitot Tube No. 4 Cp .835
Bar. Pres. 25.45 Ins. Hg
Static Pres. -.16 Ins. H_2O
Estimated MC 5.5 %

Leak Check:
Pretest: 0 @ 15 Ins. Hg
Post-test: 0 @ 6 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head–ΔP Ins. H_2O	Orifice Meter–ΔH Ins. H_2O	Desired ΔVm	Desired Running Vm	Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F: Filter	Probe	Imp. Out	M/In	M/Out	Oxygen 320 P %
	(1333)	(743.00)												
A-6	5	746.51	.21	1.60	353	653		727	224	225	46	50	43	NA
5	10	750.09	.23	1.85	356	010	3.8	800				55	43	
4	15	753.75	.23	1.91	363	373		768				56	43	
3	20	757.20	.22	1.74	347	720		825	234	224	47	57	43	
2	25	760.55	.20	1.63	335	055		795				56	43	
1	30	763.74	.18	1.47	319	374	3.2	789				57	43	
B-6	35	767.19	.21	1.72	345	719	3.8	788	230	243	49	55	44	
5	40	770.66	.22	1.75	348	066		820				57	44	
4	45	774.17	.21	1.78	351	417		747				58	44	
3	50	777.77	.22	1.88	354	776	4.1	750	254	247	45	59	44	
2	55	781.00	.17	1.51	324	100		613				55	45	
1	60	784.05	.16	1.35	306	405		755				56	45	
	~~(1434)~~													
	(1434)													

θ = 60 V_m = 41.05 $\overline{\Delta H}$ = 1.70 $\overline{T_s}$ = 771.4 $\overline{T_m}$ = 49.9

Samples Recovered: Filter Number 844 ; ☒ Probe Wash ; ☒ Wet Catch ; ☐ _____

Gas Sampling Data:

Box No. B-2
Bag No. 3
Bag Vol. 30 Liters

Bag Material Tedlar
Leak Check 0 cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. NA

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	201	110	1		1186.0	
Initial Vol.	100	100	0		1177.0	
Difference	24	10	1		9.0	44

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AIR SAMPLING DIVISION

PROJECT Mayo Research Institute
SOURCE Morse Boulger Incinerator stack
OPERATOR D. Stock

DATE 11-11-88
TEST NO. 3

INITIALIZATION PARAMETERS	
Carry from test 2	
(G) γ =	
(S) $\Delta H@$ =	
(C) C_p =	
(D) D_n =	
(I) P_b =	
(J) Δt =	
(W) MC =	
(O) B'_{O2} =	
(E) t_m =	
(Z) P_g =	

INPUT PARAMETERS

	RUN 1	RUN 2	RUN 3	RUN 4
V/O	660.00	701.60	743.00	
NO. OF POINTS	12	12	12	
MC	5.5	5.5	5.5	
V/F	701.40	742.79	784.05	
G-H_2O	47	48	44	
RUN TIME	60	60	60	
1-RND/2-RECT	1	1	1	
DIA(INS)	49.25	49.25	49.25	
L(INS)	X	X	X	
W(INS)	X	X	X	

END OF RUN SUMMARY

$\sqrt{\Delta P}$	.4449	.4511	.4524	
$\overline{\Delta H}$	1.70	1.70	1.70	
$\overline{TS}$	785.5	762.42	771.42	
$\overline{TM}$	59.08	49.96	49.92	
V/STD	40.79	41.31	41.18	
MC	5.14	5.14	4.79	
VEL	38.96	38.70	38.42	
ISO%	100.2	100.3	99.7	
ACFM	30921	30715	30893	
DSCFM	12026	12166	12148	

Appendix D
Laboratory Data Sheets

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AIR SAMPLING DIVISION

EPA METHOD 3
LABORATORY REPORT
SUMMARY OF ORSAT DATA

Project Name HDR-Mayo Foundation
Sampling Location Morse Boulger Inc
Sampling Date 11-4-88

Project Number 881003.403
Analysis Date 11-5-88
Analyst D. Wold

TEST NO. AND DATE	RUN NO.	RESULTS				
		☒ INTEGRATED (BAG) ☐ GRAB (BULB)			O_2 ANALYZER	F_o
		% CO_2	% O_2	% CO	% O_2	
BLANK	0	0.00	20.90		20.90	—
1 11-4-88	1	2.93	17.13		17.0	1.29
	2	2.78	17.05		17.2	1.38
	3	2.98	16.98		17.0	1.32
2	1	2.03	17.80			1.53
	2	2.50	17.53			1.35
	3	2.68	17.28			1.35
3	1	2.35	17.70		17.7	1.36
	2	2.08	18.10		18.1	1.35
	3	2.33	17.78		17.7	1.34

Calculate F_o before evacuating any samples. Compare F_o to expected fuel values. If discrepency exists, reanalyze samples

$$F_o = \frac{20.9 - \% O_2}{\% CO_2}$$

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Air Sampling Department

EPA Method 3 (Orsat)
Laboratory Data Sheet

Project Name HDR-Mayo Foundation
Sampling Location Morse Boulger Incinerator
Sampling Date 11-4-88
Project Number 881003.403
Analysis Date 11-5-88
Analyst D. Wold
Apparatus Leak Check ✓

	Sample Volume	CO_2	O_2
Test ____ Run ____ Blank.	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 0.00 ml Volume CO_2 0.00 ml % CO_2 0.00 %	Initial Reading 0.00 ml Final Reading 20.90 ml Volume 20.90 ml % O_2 20.90 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 0.00 ml Volume CO_2 0.00 ml % CO_2 0.00 %	Initial Reading 0.00 ml Final Reading 20.90 ml Volume 20.90 ml % O_2 20.90 %
Test 1 Run 1	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 Final Reading 2.95 Volume CO_2 2.95 % CO_2 2.95	Initial Reading 2.95 ml Final Reading 20.10 ml Volume 17.15 ml % O_2 17.15 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.90 ml Volume CO_2 2.90 ml % 2.90 %	Initial Reading 2.90 ml Final Reading 20.00 ml Volume 17.10 ml % O_2 17.10 %

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Air Sampling Department

EPA Method 3 (Orsat)
Laboratory Data Sheet

Project Name: HDR - Mayo Foundation
Project Number: 881003.403
Sampling Location: Morse Boulger Incinerator
Analysis Date: 11-5-88
Analyst: D. Wold
Sampling Date: 11-4-88
Apparatus Leak Check: ✓

	Sample Volume	CO_2	O_2
Test 1 Run 2	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.75 ml Volume CO_2 2.75 ml % CO_2 2.75 %	Initial Reading 2.75 ml Final Reading 19.75 ml Volume 17.00 ml % O_2 17.00 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.80 ml Volume CO_2 2.80 ml % CO_2 2.80 %	Initial Reading 2.80 ml Final Reading 19.90 ml Volume 17.10 ml % O_2 17.10 %
Test 1 Run 3	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 Final Reading 2.95 Volume CO_2 2.95 % CO_2 2.95	Initial Reading 2.95 ml Final Reading 19.90 ml Volume 16.95 ml % O_2 16.95 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 3.00 ml Volume CO_2 3.00 ml % 3.00 %	Initial Reading 3.00 ml Final Reading 20.00 ml Volume 17.00 ml % O_2 17.00 %

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Air Sampling Department

EPA Method 3 (Orsat)
Laboratory Data Sheet

Project Name HDR-Mayo Foundation
Sampling Location Morse Boulger Incinerator
Sampling Date 11-11-88

Project Number 881003.403
Analysis Date 11-15-88
Analyst Dirk Wold
Apparatus Leak Check ✓

	Sample Volume	CO_2	O_2
Test ____ Run ____ Blank	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 0.00 ml Volume CO_2 0.00 ml % CO_2 0.00 %	Initial Reading 0.00 ml Final Reading 20.90 ml Volume 20.90 ml % O_2 20.90 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 0.00 ml Volume CO_2 0.00 ml % CO_2 0.00 %	Initial Reading 0.00 ml Final Reading 20.90 ml Volume 20.90 ml % O_2 20.90 %
Test 2 Run 1	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 Final Reading 2.00 Volume CO_2 2.00 % CO_2 2.00	Initial Reading 2.00 ml Final Reading 19.80 ml Volume 17.80 ml % O_2 17.80 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.05 ml Volume CO_2 2.05 ml % 2.05 %	Initial Reading 2.05 ml Final Reading 19.85 ml Volume 17.80 ml % O_2 17.80 %

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Air Sampling Department

EPA Method 3 (Orsat)
Laboratory Data Sheet

Project Name HDR-Mayo Foundation
Sampling Location Morse Boulger Incinerator
Sampling Date 11-11-88

Project Number 881003.403
Analysis Date 11-15-88
Analyst Dirk Wold
Apparatus Leak Check ✓

	Sample Volume	CO_2	O_2
Test 2 Run 2	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.50 ml Volume CO_2 2.50 ml % CO_2 2.50 %	Initial Reading 2.50 ml Final Reading 20.00 ml Volume 17.50 ml % O_2 17.50 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.50 ml Volume CO_2 2.50 ml % CO_2 2.50 %	Initial Reading 2.50 ml Final Reading 20.05 ml Volume 17.55 ml % O_2 17.55 %
Test 2 Run 3	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 Final Reading 2.70 Volume CO_2 2.70 % CO_2 2.70	Initial Reading 2.70 ml Final Reading 20.00 ml Volume 17.30 ml % O_2 17.30 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.65 ml Volume CO_2 2.65 ml % 2.65 %	Initial Reading 2.65 ml Final Reading 19.90 ml Volume 17.25 ml % O_2 17.25 %

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Air Sampling Department

EPA Method 3 (Orsat)
Laboratory Data Sheet

Project Name HDR - Mayo Foundation
Project Number 88/003.403
Sampling Location Morse Boulger Incinerator
Analysis Date 11-15-88
Analyst Dirk Wold
Sampling Date 11-11-88
Apparatus Leak Check ✓

Test 3 Run 1	Sample Volume Zero Point 0.00 ml Sample Volume 100 ml	CO_2 Initial Reading 0.00 ml Final Reading 2.35 ml Volume CO_2 2.35 ml % CO_2 2.35 %	O_2 Initial Reading 2.35 ml Final Reading 20.10 ml Volume 17.75 ml % O_2 17.75 %
Duplicate	Sample Volume Zero Point 0.00 ml Sample Volume 100 ml	CO_2 Initial Reading 0.00 ml Final Reading 2.35 ml Volume CO_2 2.35 ml % CO_2 2.35 %	O_2 Initial Reading 2.35 ml Final Reading 20.00 ml Volume 17.65 ml % O_2 17.65 %
Test 3 Run 2	Sample Volume Zero Point 0.00 ml Sample Volume 100 ml	CO_2 Initial Reading 0.00 Final Reading 2.05 Volume CO_2 2.05 % CO_2 2.05	O_2 Initial Reading 2.05 ml Final Reading 20.20 ml Volume 18.15 ml % O_2 18.15 %
Duplicate	Sample Volume Zero Point 0.00 ml Sample Volume 100 ml	CO_2 Initial Reading 0.00 ml Final Reading 2.10 ml Volume CO_2 2.10 ml % 2.10 %	O_2 Initial Reading 2.10 ml Final Reading 20.15 ml Volume 18.05 ml % O_2 18.05 %

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Air Sampling Department

EPA Method 3 (Orsat)
Laboratory Data Sheet

Project Name: HDR-Mayo Foundation
Project Number: 881003.403
Sampling Location: Morse Boulger Incinerator
Analysis Date: 11-15-88
Analyst: Dirk Wold
Sampling Date: 11-11-88
Apparatus Leak Check: ✓

	Sample Volume	CO_2	O_2
Test 3 Run 3	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.35 ml Volume CO_2 2.35 ml % CO_2 2.35 %	Initial Reading 2.35 ml Final Reading 20.15 ml Volume 17.80 ml % O_2 17.80 %
Duplicate	Zero Point 0.00 ml Sample Volume 100 ml	Initial Reading 0.00 ml Final Reading 2.30 ml Volume CO_2 2.30 ml % CO_2 2.30 %	Initial Reading 2.30 ml Final Reading 20.05 ml Volume 17.75 ml % O_2 17.75 %
Test ____ Run ____	Zero Point ____ ml Sample Volume ____ ml	Initial Reading ____ Final Reading ____ Volume CO_2 ____ % CO_2 ____	Initial Reading ____ ml Final Reading ____ ml Volume ____ ml % O_2 ____ %
Duplicate	Zero Point ____ ml Sample Volume ____ ml	Initial Reading ____ ml Final Reading ____ ml Volume CO_2 ____ ml % ____ %	Initial Reading ____ ml Final Reading ____ ml Volume ____ ml % O_2 ____ %

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Entered by
IM 11/15/88

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
ORGANIC CONDENSIBLES

Project Name: Mayo Research Inst.
Project No.: 881003.403
Sampling Location: Morse Boulger Incinerator - Stack
Test No.: 1

Sampling Date: 11/4/88
Sampling Reagent: DI water
Analysis Date:
Analyst:

	250 ml	250 ml	250 ml
Run No.	1	2	3
PACE Sample No.	40158	40159	40160
Dish No.	14	16	28
Date/Time	11/15/88 3:40	11/15/88 3:40	11/15/88 3:40
*Gross Wt.	101.4624 g	105.~~1017~~ 1030 g	98.7222 g
Date/Time	11/15/88 11:00	11/15/88 11:00	11/15/88 11:00
*Gross Wt.	101.4625 g	105.~~1019~~ 1033 g	98.7224 g
Avg Gross Wt.	101.4624 g	105.1032 ~~105.1018~~ g	98.7223 g
Dish Tare Wt.	101.4587 g	105.1011 g	98.7185 g
Blank Wt.	0.0006 g	0.0006 g	0.0006 g
Wt. of condensed organics	0.0031 g	~~0.0023~~ 0.0015 g	0.0032 g
Transfer "Wt. of condensed organics" to box No. 1.		Transfer "Wt. of condensed organics" to box No. 2.	Transfer "Wt. of condensed organics" to box No. 3.
WC's	1 0.0031 g	2 0.~~0035~~ 0015 g	3 0.0032 g

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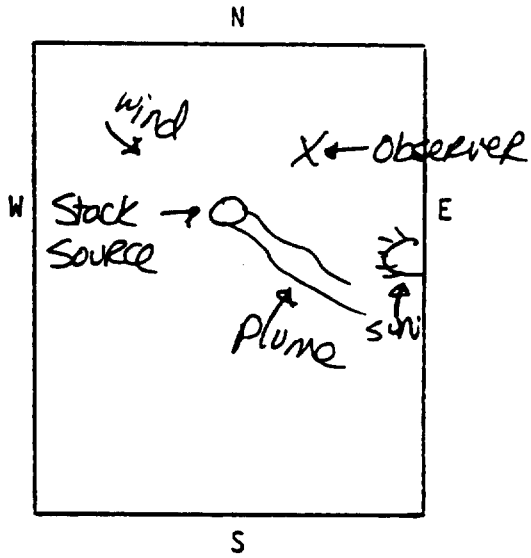
EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR - Mayo
Test No. 1-3
Source No. 1 Morse Boulder
Observer Dirk Wold
Source No. 2
Last Certification Date 10-20-88
Date 11-4-88

Location of Observer (Direction & Distance) 80 feet from Stack on the Northeast side
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) White and grey attached plume
Background Description (include color) Overcast and Clouds - Grey and White Clouds
Meteorlogical Conditions Overcast and raining 10% cloud cover
Ambient Temperature 35 °F
Wind Direction Northwest
Wind Speed 1-4 mph
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital Waste
No. 2
Load, No. 1
No. 2
Personnel Present at Time of Observation:
Dirk Wold

Observers Position in Relation to the Source, Plume and Sun



- COMMON STACK -

Unit No. Unit No. Unit No. Unit No.
Unit Load:

Fuel Type & Quantity

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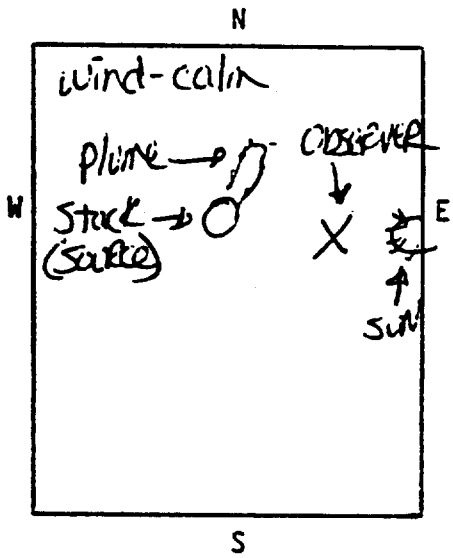
EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR - Mayo
Test No. 2-1
Source No. 1 Morse Boulger Incinerator
Observer Dirk Wold
Source No. 2
Last Certification Date 10-20-88
Date 11-11-88

Location of Observer (Direction & Distance) 150 feet East of Stack (source)
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) ~~[illegible]~~ ~~plume~~ brown attached plume
Background Description (include color) Blue sky

Observers Position in Relation to the Source, Plume and Sun



Meteorlogical Conditions Clear with a few clouds - 1/10 cloud cover
Ambient Temperature 30 °F
Wind Direction Calm
Wind Speed 0 mph
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital Waste
No. 2
Load, No. 1
No. 2
Personnel Present at Time of Observation:
Dirk Wold

- COMMON STACK -

Unit No. Unit No. Unit No. Unit No.
Unit Load:

Fuel Type & Quantity

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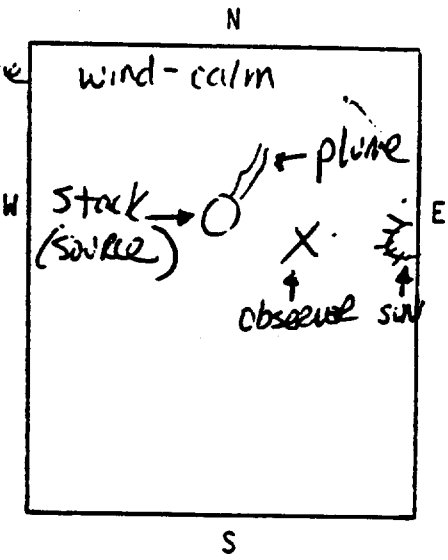
EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR-Mayo Test No. 2-2
Source No. 1 Morse Boulger Incinerator Observer Dirk Wold
Source No. 2 Last Certification Date 10-20-88
Date 11-11-88

Location of Observer (Direction & Distance) 150 feet East of Stack (Source)
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) Brown attached plume during sun changed to detached plume
Background Description (include color) Blue sky with an occassional white cloud
Meteorlogical Conditions Clear with a few clouds 1/10 cloud cover Ambient Temperature 30 °F
Wind Direction Calm (south) during sun Wind Speed 0 (2-4) mph
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital waste No. 2
Load, No. 1 No. 2
Personnel Present at Time of Observation:
Dirk Wold

Observers Position in Relation to the Source, Plume and Sun



- COMMON STACK -

Unit No. Unit No. Unit No. Unit No.
Unit Load:

Fuel Type & Quantity

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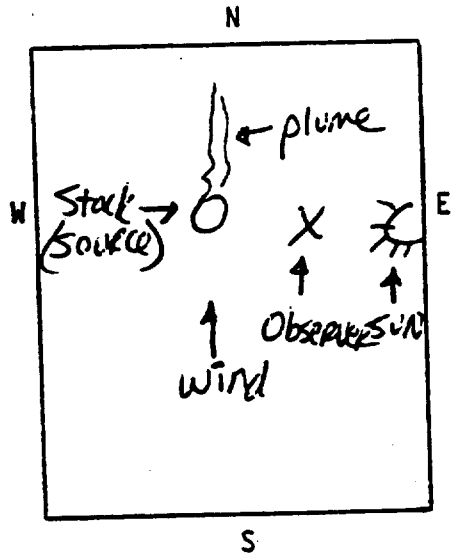
EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR-Mayo
Test No. 2-3
Source No. 1 Morse Boulger Incinerator
Observer Dirk Wold
Source No. 2
Last Certification Date 10-20-88
Date 11-11-88

Location of Observer (Direction & Distance) 150 feet East of Stack (Source)
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) brown attached plume
Background Description (include color) blue sky with no clouds
Meteorlogical Conditions Clear and Sunny NO clouds
Ambient Temperature 30 °F
Wind Direction South
Wind Speed 4-9 mph
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital Waste No. 2
Load, No. 1 No. 2
Personnel Present at Time of Observation:
Dirk Wold

Observers Position in Relation to the Source, Plume and Sun



- COMMON STACK -

Unit No. Unit No. Unit No. Unit No.
Unit Load:
Fuel Type & Quantity

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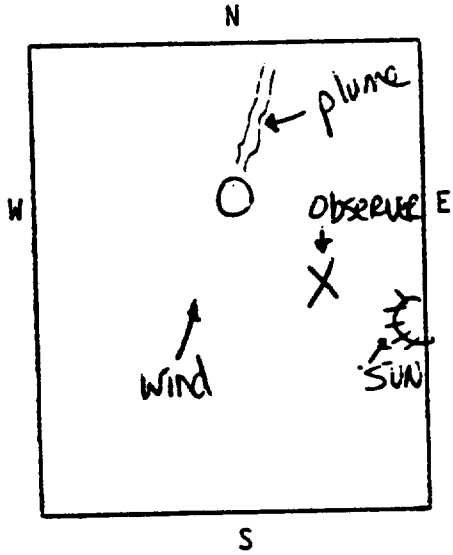
EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR - Mayo Test No. 3-1
Source No. 1 Morse Boulger Incinerator Observer Dirk Wold
Source No. 2 Last Certification Date 10-20-88
Date 11-11-88

Location of Observer (Direction & Distance) 150 feet East Southeast of the Stack (Source)
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) Brown attached plume
Background Description (include color) Clear blue sky - no clouds
Meteorlogical Conditions Clear and sunny no clouds Ambient Temperature 30 °F
Wind Direction South Southwest Wind Speed 4-9 mph
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital waste No. 2
Load, No. 1 No. 2
Personnel Present at Time of Observation:
Dirk Wold

Observers Position in Relation to the Source, Plume and Sun



- COMMON STACK -

Unit No. Unit No. Unit No. Unit No.
Unit Load:
Fuel Type & Quantity

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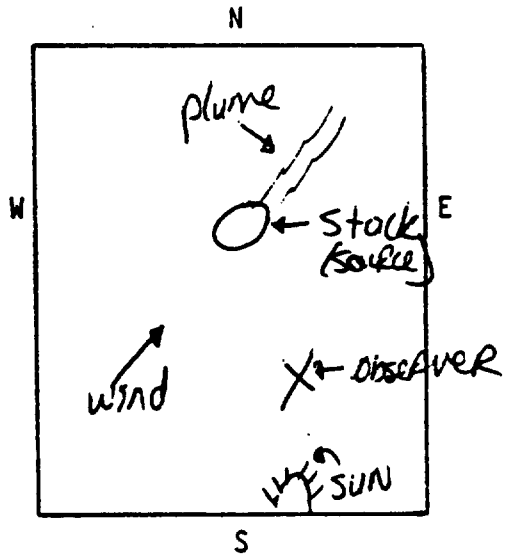
EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR - Mayo
Test No. 3-2
Source No. 1 Morse Boulger
Observer Dirk Wold
Source No. 2
Last Certification Date 10-20-88
Date 11-11-88

Location of Observer (Direction & Distance) 100 feet South Southeast of the stack (Source)
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) brown attached plume
Background Description (include color) Blue sky with a few clouds
Meteorlogical Conditions Mostly Clear and sunny
Ambient Temperature 35 °F
Wind Direction Southwest
Wind Speed 5-10 mph
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital Waste
No. 2
Load, No. 1
No. 2
Personnel Present at Time of Observation:
Dirk Wold

Observers Position in Relation to the Source, Plume and Sun



- COMMON STACK -

Unit No. Unit No. Unit No. Unit No.
Unit Load:

Fuel Type & Quantity

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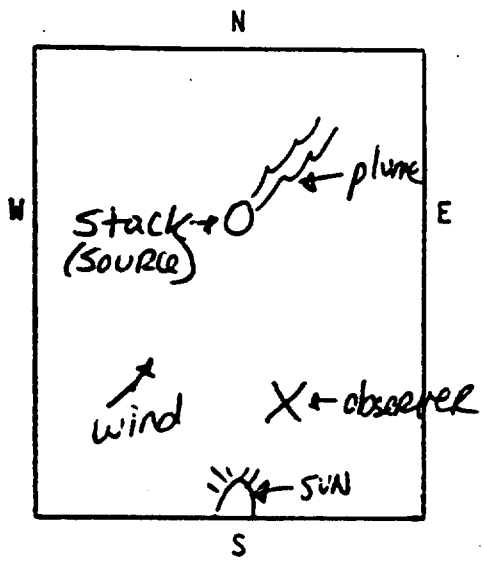
EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR - Mayo
Test No. 3-3
Source No. 1 [redacted]
Observer Dirk Wold
Source No. 2 Morse Boulger Incinerator
Last Certification Date 10-20-88
Date 11-11-88

Location of Observer (Direction & Distance) 100 feet South Southeast of Stack (Source)
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) brown attached plume
Background Description (include color) blue hazy sky - some cloudy
Meteorlogical Conditions Mostly clear but hazy - 3/10 Cloud cover
Ambient Temperature 35 °F
Wind Direction Southwest
Wind Speed 5-10 mph
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital Waste
No. 2
Load, No. 1
No. 2
Personnel Present at Time of Observation:
Dirk Wold

Observers Position in Relation to the Source, Plume and Sun



- COMMON STACK -

Unit No. ____ Unit No. ____ Unit No. ____ Unit No. ____
Unit Load:
____ ____ ____ ____
Fuel Type & Quantity
____ ____ ____ ____

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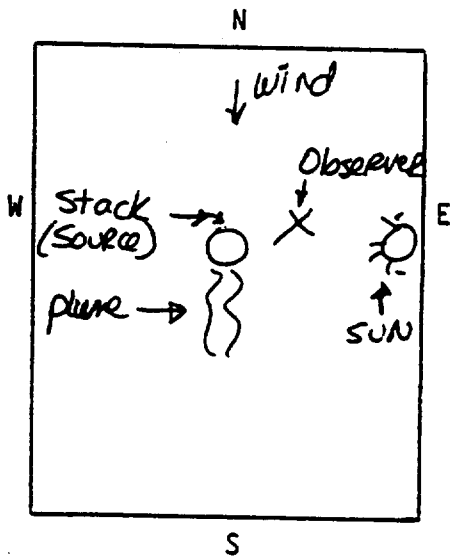
EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR-Mayo
Test No. 1-1
Source No. 1 Morse Boulder
Observer Dirk Wold
Source No. 2
Last Certification Date 10-20-88
Date 11-4-88

Location of Observer (Direction & Distance) 120 Feet East of Stack
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) White and grey attached plume
Background Description (include color) Overcast and Clouds-white and grey Clouds
Meteorlogical Conditions Overcast and Raining 10% Cloud cover
Ambient Temperature 40 °F
Wind Direction North
Wind Speed 1-4 mph
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital Waste No. 2
Load, No. 1 No. 2
Personnel Present at Time of Observation:
Dirk Wold

Observers Position in Relation to the Source, Plume and Sun



- COMMON STACK -

Unit No. Unit No. Unit No. Unit No.
Unit Load:

Fuel Type & Quantity

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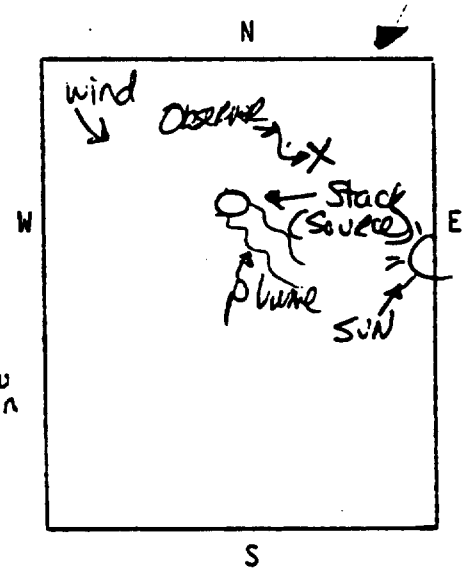
~~[illegible]~~ * wind start up - part way then run - redraw Positions
wind start - calm
10 min - Northwest

EPA METHOD 9 FIELD DATA SHEET
VISIBLE EMISSIONS

Project HDR - Mayo
Test No. 1-2
Source No. 1 Morse Boulder
Observer Dirk Wold
Source No. 2
Last Certification Date 10-20-88
Date 11-4-88

Location of Observer (Direction & Distance) 80 feet from Stack on the Northeast side
Source Height 50 feet
Source Outlet Dimension 4 feet
Plume Description (Type, color, etc.) white and grey attached plume
Background Description (include color) Overcast and Cloudy - Grey and white Clouds
Meteorlogical Conditions Overcast and Raining 10/10 Cloud Cover
Ambient Temperature 40 °F
Wind Direction Calm - Northwest
Wind Speed 0 (1-4) mph part way thru run
Type of Source, No. 1 Waste Incinerator
Type of Source, No. 2
Fuel Type, No. 1 Hospital waste
No. 2
Load, No. 1
No. 2
Personnel Present at Time of Observation:
Dirk Wold

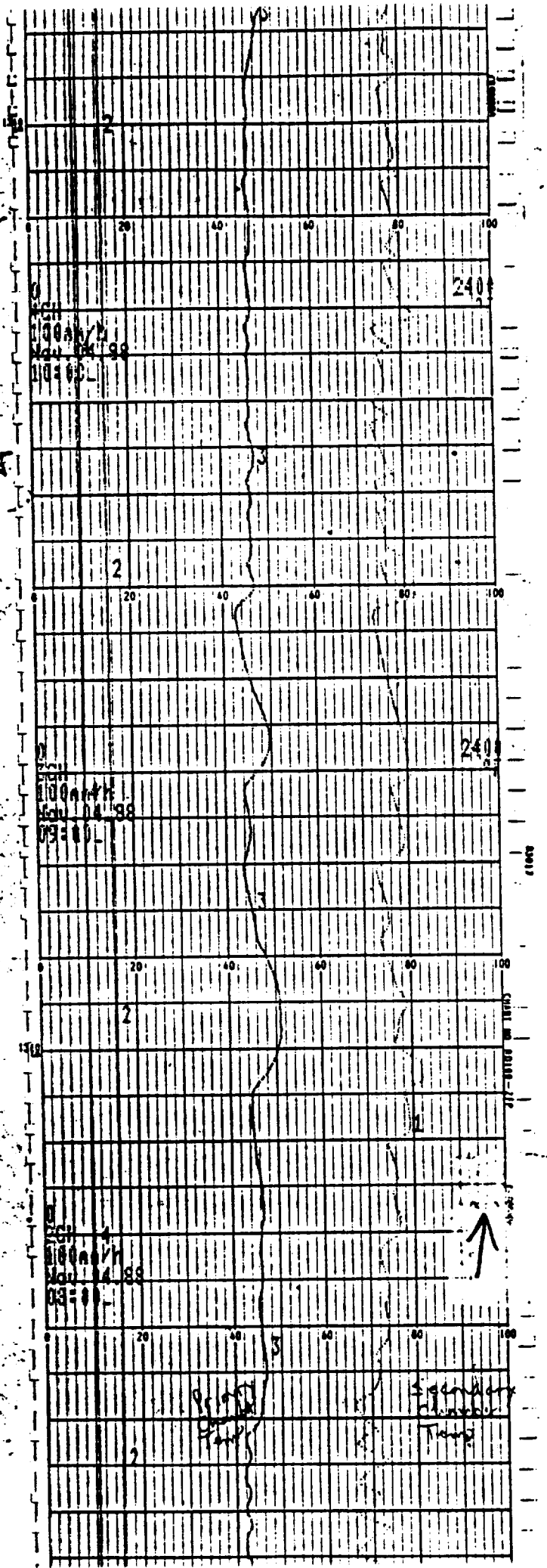
Observers Position in Relation to the Source, Plume and Sun



- COMMON STACK -

Unit No. ____ Unit No. ____ Unit No. ____ Unit No. ____
Unit Load:
Fuel Type & Quantity

Appendix E
EPA Method 9 Field Data Sheets

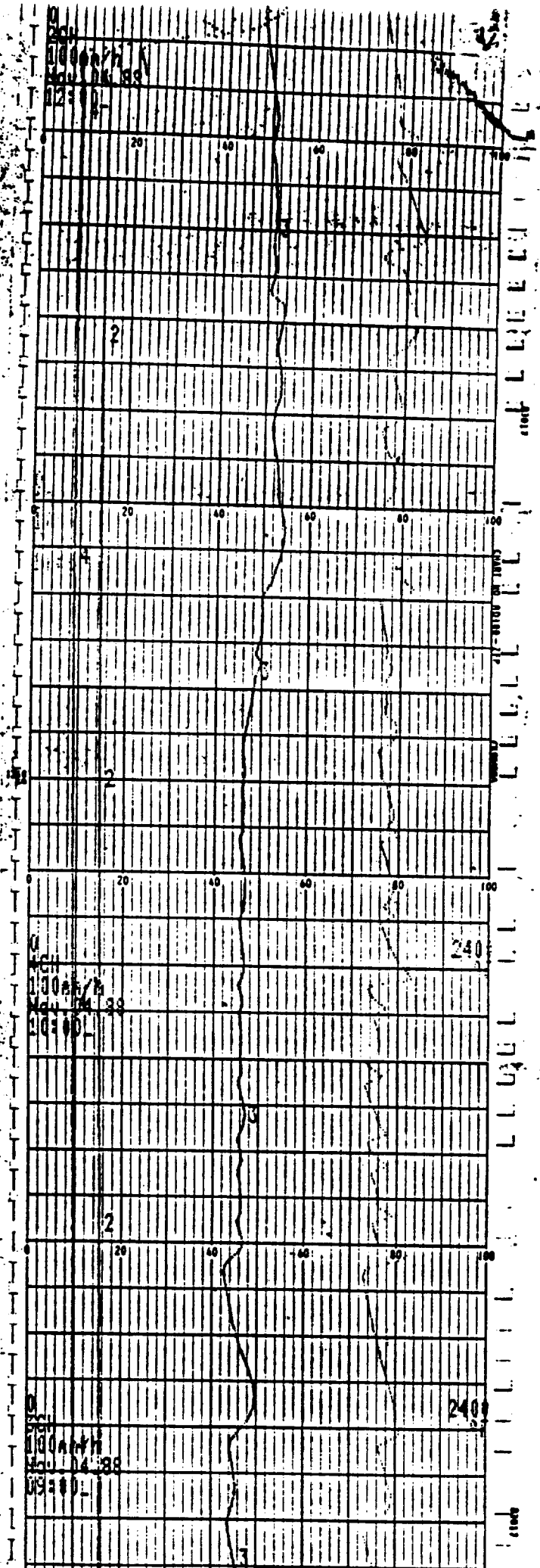


Mayo Foundation Research Inc.
Morse Boulger Incinerator
11/4/88

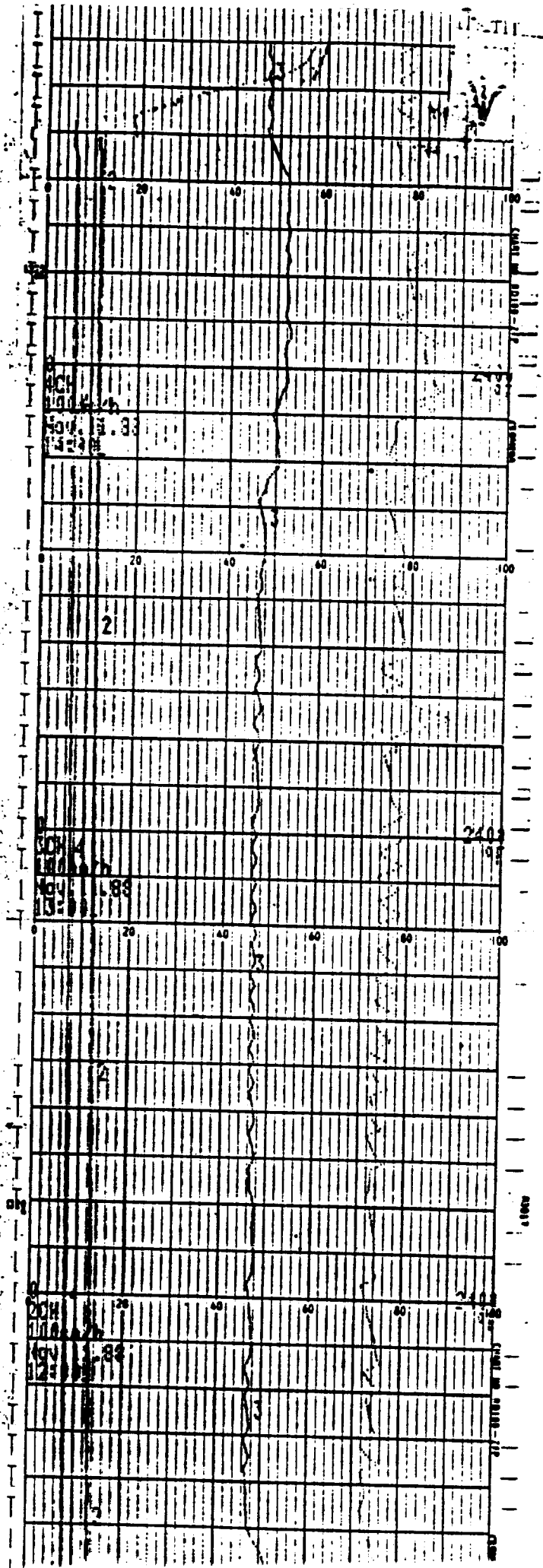
0-2000°F F.S.

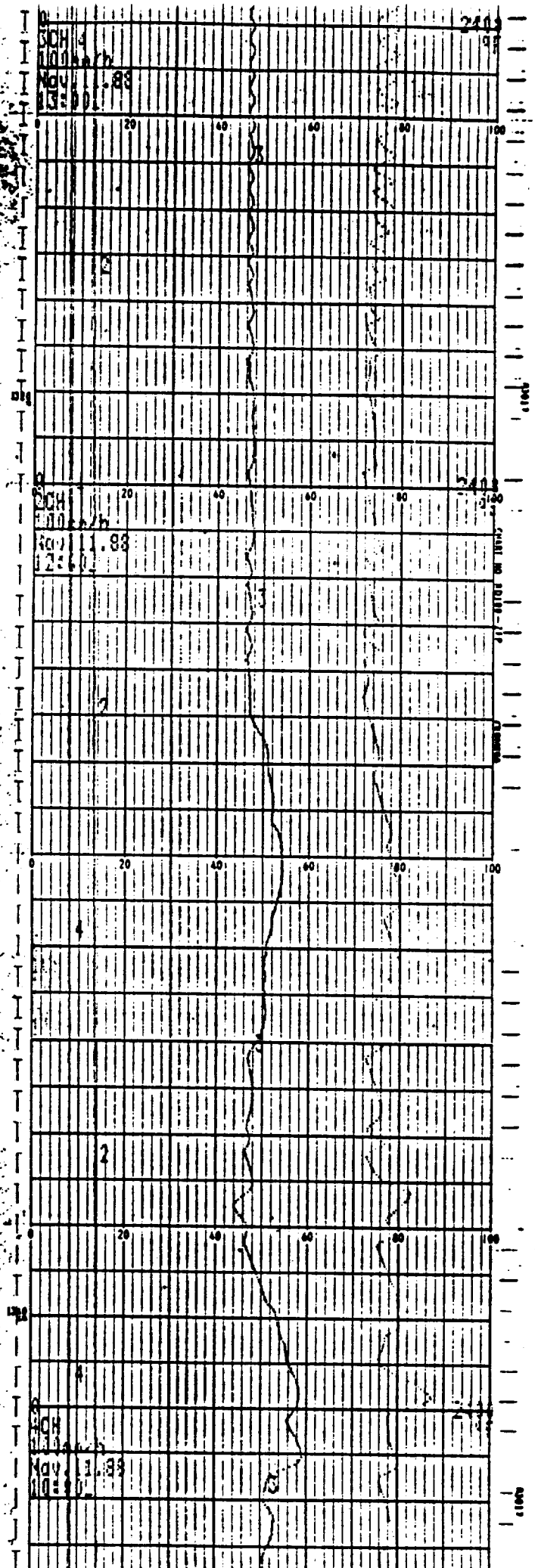
#1 = Secondary Chamber
#3 = Primary Chamber

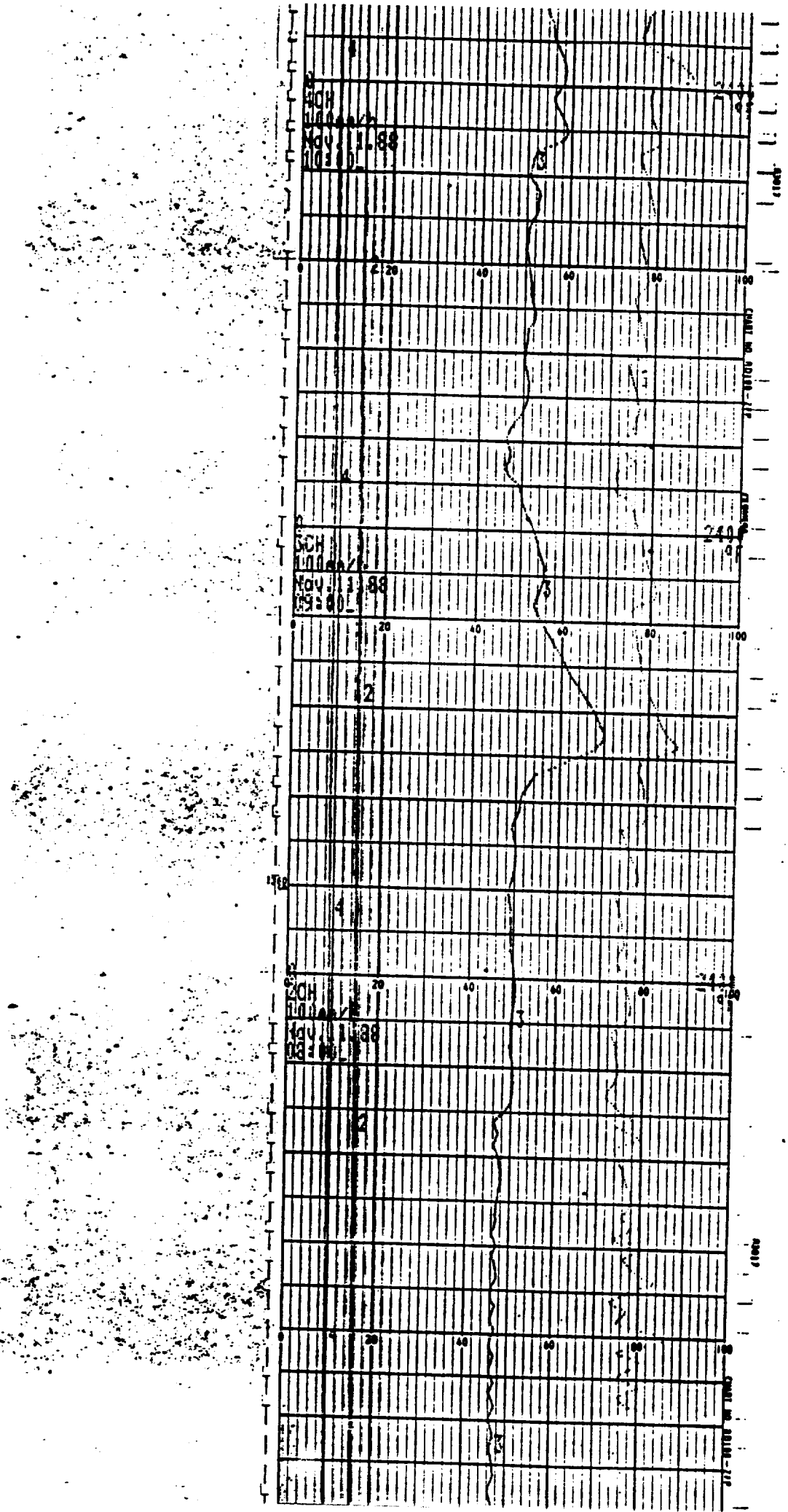
#2+4 are for Environmental Inc.
Not operating

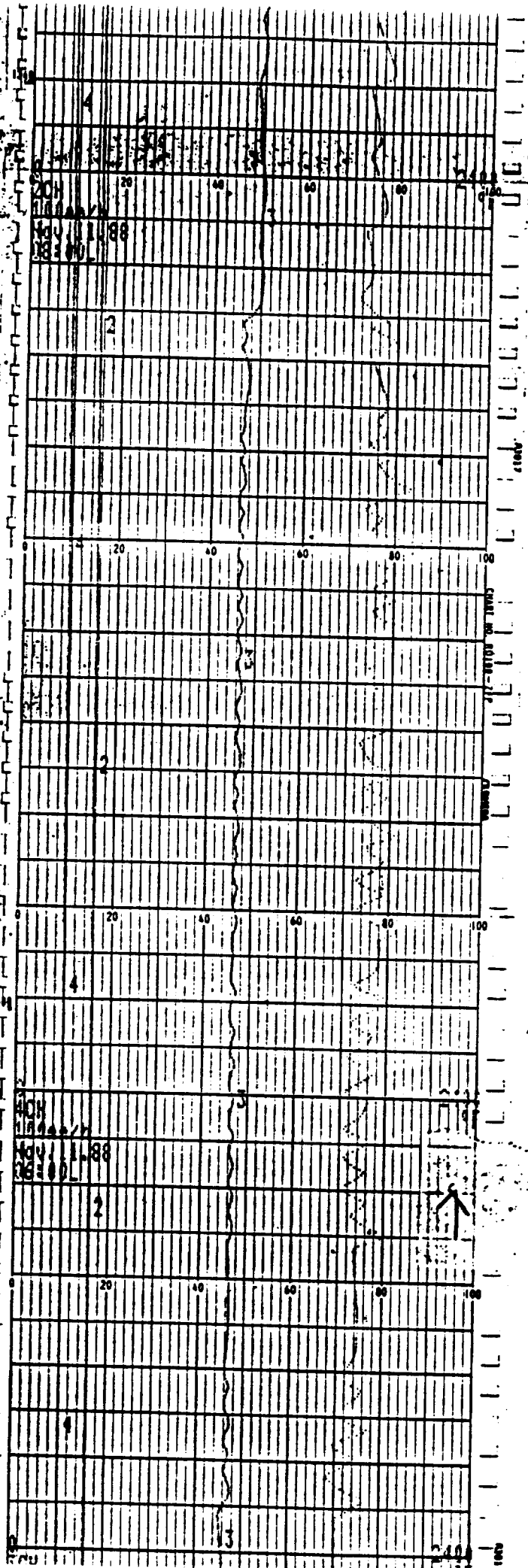

0
100m/h
Mai 04.88
12:00
0
20
40
60
80
100
2
3
240
0
100m/h
Mai 04.88
10:00
0
20
40
60
80
100
2
3
240
0
100m/h
Mai 04.88
08:00
0
20
40
60
80
100
3

Murse Boulder
11/11/85




0
20
40
60
80
100
2400
CH 4
100cm/h
Nov 11.83
12:40
CH 4
100cm/h
Nov 11.83
10:40


SCH
Nov. 11.88
0
20
40
60
80
100
240
SCH
Nov. 11.88
0
20
40
60
80
100
SCH
Nov. 11.88
0
20
40
60
80
100
SCH
Nov. 11.88
0
20
40
60
80
100


20H
Nov 11 88
0
20
40
60
80
100
CHART NO. 00108-77
4
2
3

Appendix F
Visible Emission Evaluator Certification

Dirk Wold attended the October 19, 1988 Visible Emission Evaluation Certification Course sponsored by the Minnesota Pollution Control Agency and the Upper Midwest Section of the Air Pollution Control Association On October 20, 1988 he completed the course by evaluating generated smoke.

During the course of the test an average deviation of less than 7 5% for a set of 25 white smoke and a set of 25 black smoke was maintained and none of the readings deviated by 20% or more.

As of November 29, 1988, his certificate of completion had not been received. If this document is required to complete the review of this test report, notify PACE Laboratories, Inc. in writing and a copy of his certification will be forwarded upon receipt.

Appendix G
Fuel Input Data

pace laboratories, inc.

Entered by IM
~ 11/22/88

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
ORGANIC CONDENSIBLES

Project Name: HDR Mayo
Project No.: 881003.403
Sampling Location: Morse Boulger

Test No.: 2

Sampling Date: 11-11-88
Sampling Reagent: DI water
Analysis Date:
Analyst:

225 ml		225 ml		225 ml	
Run No.	1	Run No.	2	Run No.	3
PACE Sample No.	40919	PACE Sample No.	40920	PACE Sample No.	40921
Dish No.	40	Dish No.	41	Dish No.	44
Date/Time	11/18/88 3:30	Date/Time	11/18/88 3:30	Date/Time	11/18/88 3:30
*Gross Wt.	100.7194 g	*Gross Wt.	101.6113 g	*Gross Wt.	102.3390 g
Date/Time	11/18/88 9:00 g	Date/Time	11/18/88 9:00	Date/Time	11/18/88 9:00
*Gross Wt.	100.7197 g	*Gross Wt.	101.6117 g	*Gross Wt.	102.3394 g
Avg Gross Wt.	100.7196 g	Avg Gross Wt.	101.6115 g	Avg Gross Wt.	102.3392 g
Dish Tare Wt.	100.7183 g	Dish Tare Wt.	101.6088 g	Dish Tare Wt.	102.3374 g
Blank Wt.	0.0007 g	Blank Wt.	0.0007 g	Blank Wt.	0.0007 g
Wt. of condensed organics	0.0006 g	Wt. of condensed organics	0.0020 g	Wt. of condensed organics	0.0011 g
Transfer "Wt. of condensed organics" to box No. 1.		Transfer "Wt. of condensed organics" to box No. 2.		Transfer "Wt. of condensed organics" to box No. 3.	
WC's 1	0.0006 g	2	0.0020 g	3	0.0011 g

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AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
PARTICULATE IN PROBE WASH

Project Name Mayo Research Inst.
Project No. 881003.403
Sampling Location Morse Boulger Incinerator ~~Incinerator~~ -Stack
Test No. 1

Sampling Date 11/4/88
Clean-up Reagent Acetone
Analysis Date
Analyst

Run No. 1 ~~125 ml~~	Run No. 2 135 ml	Run No. 3 125 ml
PACE Sample No. 40158	PACE Sample No. 40159	PACE Sample No. 40160
Evap. Dish No. 1	Evap. Dish No. Bite	Evap. Dish No. 7
Reagent Density	Reagent Density	Reagent Density
Blank Conc.	Blank Conc.	Blank Conc.
Reagent Vol. 125 ml	Reagent Vol. 135 ml	Reagent Vol. 125 ml
Date/Time 11/15/88 11:15	Date/Time 11/15/88 11:15	Date/Time
*Gross Wt. 125.7737 g	*Gross Wt. 126.7959 g	*Gross Wt. 126.7101 g
Date/Time 11/16/88 8:00	Date/Time 11/16/88 8:00	Date/Time
*Gross Wt. 125.7742 g	*Gross Wt. 126.7962 g	*Gross Wt. 126.7106 g
Avg Gross Wt. 125.7740 ~~11/14/88 8:00~~ g	Avg Gross Wt. 126.7960 g	Avg Gross Wt. 126.7104 g
Dish Tare Wt. 125.7085 g	Dish Tare Wt. 126.7485 g	Dish Tare Wt. 126.6664 g
Blank Wt. ~~0.0655~~ 0.0007 g	Blank Wt. ~~0.0475~~ 0.0007 g	Blank Wt. 0.0007 g
Particulate in Rinse 0.0648 g	Particulate in Rinse : 0.0468 g	Particulate in Rinse 0.0433 g
Transfer "Particulate in Rinse" to box No. 1.	Transfer "Particulate in Rinse" to box No. 2.	Transfer "Particulate in Rinse" to box No. 3.
PW's 1 0.0648 g	2 0.0468 g	3 0.0433 g

pace laboratories, inc

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
PARTICULATE ON FILTERS

Project Name: Mayo Research Inst.
Project No.: 881003.403
Sampling Location: Morse Boulger Incinerator
Test No.: 1

Sampling Date: 11/4/88
Filter Type: Fiberglass
Analysis Date:
Analyst:

	Run 1	Run 2	Run 3
PACE Sample No.	40158	40159	40160
Filter No.	800	801	815
Date/Time	11/10/88 10:45	11/10/88 10:45	11/10/88 10:45
*Gross Wt.	0.66313 g	0.63638 g	0.66191 g
Date/Time	11/11/88 8:30	11/11/88 8:30	11/11/88 8:30
*Gross Wt.	0.66342 g	0.63646 g	0.66213 g
Avg Gross Wt.	0.66328 g	0.63642 g	0.66202 g
Tare Wt.	0.58656 g	0.58372 g	0.57605 g
Particulate on Filter	0.07672 g	0.05270 g	0.08597 g
Transfer "Particulate on Filter" to box No. 1.		Transfer "Particulate on Filter" to box No. 2.	Transfer "Particulate on Filter" to box No. 3.
Sum values from each box labelled 1 and record in box No. T1.		Sum values from each box labelled 2 and record in box No. T2.	Sum values from each box labelled 3 and record in box No. T3.
Filters	1 0.07672 g	2 0.05270 g	3 0.08597 g
Totals	T1 0.14462 g	T2 0.10100 g	T3 0.13947 g

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
REAGENT BLANKS

Project Name: Mayo Research Inst
Project No.: 881003.403
Sampling Location: Morse Boulger Incinerator - Stack
Test No.: 1

Sampling Data: 11/4/88
Analysis Date:
Analyst:

WET CATCH

Type: ☑ Organic (Extraction)
☐ Inorganic
☐ Gravimetric Only
☐ SO_2 to be conducted BEFORE any other analysis
☐ other

Reagent: DI Water
Volume: 250 ml ml
Dish No.: 31
Date/Time: 11/15/88 3:40
*Gross Wt.: 99.5585 g
Date/Time: 11/15/88 11:00
*Gross Wt.: 99.5590 g
Avg Gross Wt.: 99.5589 g
Dish Tare Wt.: 99.5583 g

Total Blank Weight: 0.0006 g

WET CATCH

PROBE WASH

Type: ☒ Gravimetric
☐ Retain for further analyses

Other instructions:

Reagent: Acetone
Volume: 125 ml ml
Dish No.: FP
Date/Time: 11/15/88 11:15
*Gross Wt.: 122.1935 g
Date/Time: 11/16/88 8:00
*Gross Wt.: 122.1938 g
Avg Gross Wt.: 122.1936 g
Dish Tare Wt.: 122.1929 g

Total Blank Weight: 0.0007 g

PROBE WASH

pace laboratories, inc.

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
PARTICULATE IN PROBE WASH

Project Name HOR Mayo
Project No. 881023.403
Sampling Location Morse Boulger

Test No. 2

Sampling Date 11/11/88
Clean-up Reagent Acetone
Analysis Date
Analyst

	Run No. 1	Run No. 2	Run No. 3
PACE Sample No.	40919	40920	40921
Evap. Dish No.	DICK	OPI	157
Reagent Density			
Blank Conc.			
Reagent Vol.	135 ml	130 ml	130 ml
Date/Time	11/18/88 3:30	11/18/88 3:30	11/18/88 3:30
*Gross Wt.	81.1332 g	85.6490 g	84.7513 g
Date/Time	11/18/88 9:00	11/18/88 9:00	11/18/88 9:00
*Gross Wt.	81.1327 g	85.6494 g	84.7511 g
Avg Gross Wt.	81.1330 g	85.6492 g	84.7512 g
Dish Tare Wt.	81.1062 g	85.6103 g	84.7014 g
Blank Wt.	0.0003 g	0.0003 g	0.0003 g
Particulate in Rinse	0.0265 g	0.0386 g	0.0495 g
Transfer "Particulate in Rinse" to box No. 1.		Transfer "Particulate in Rinse" to box No. 2.	Transfer "Particulate in Rinse" to box No. 3.
PW's	1 0.0265 g	2 0.0386 g	3 0.0495 g

pace laboratories, inc

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
PARTICULATE ON FILTERS

Project Name HDR Mayo
Project No. 881003.403
Sampling Location Morse Boulevr
Test No. 2

Sampling Date 11/11/88
Filter Type Fiberglass
Analysis Date
Analyst

Run No. 1	Run No. 2	Run No. 3
PACE Sample No. 40919	PACE Sample No. 40920	PACE Sample No. 40921
Filter No. 824	Filter No. 840	Filter No. 841
Date/Time 11/16/88 9:15	Date/Time 11/16/88 9:15	Date/Time 11/16/88 9:15
*Gross Wt. 0.64139 g	*Gross Wt. 0.71548 g	*Gross Wt. 0.70682 g
Date/Time 11/16/88 3:30	Date/Time 11/16/88 3:30	Date/Time 11/16/88 3:30
*Gross Wt. 0.64126 g	*Gross Wt. 0.71535 g	*Gross Wt. 0.70666 g
Avg Gross Wt. 0.64132 g	Avg Gross Wt. 0.71542 g	Avg Gross Wt. 0.70674 g
Tare Wt. 0.58673 g	Tare Wt. 0.63490 g	Tare Wt. 0.63426 g
Particulate on Filter 0.05459 g	Particulate on Filter 0.08052 g	Particulate on Filter 0.07248 g
Transfer "Particulate on Filter" to box No. 1.	Transfer "Particulate on Filter" to box No. 2.	Transfer "Particulate on Filter" to box No. 3.
Sum values from each box labelled 1 and record in box No. T1.	Sum values from each box labelled 2 and record in box No. T2.	Sum values from each box labelled 3 and record in box No. T3.
Filters 1 0.05459 g	2 0.08052 g	3 0.07248 g
Totals T1 0.08169 g	T2 0.12112 g	T3 0.12308 g

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
REAGENT BLANKS

Project Name HDR Mayo

Sampling Data 11/11/88

Project No. 881023.403.

Analysis Date

Sampling Location Morse Bowlger

Analyst

Test No.

WET CATCH

Type:
- ☐ Organic (Extraction)
- ☐ Inorganic
- ☐ Gravimetric Only
- ☐ SO_2 to be conducted BEFORE any other analysis
- ☐ other

Reagent DI water

Volume 225 ml ml

Dish No. TV

Date/Time 11/18/88 3:30

*Gross Wt. 105.8130 g

Date/Time 11/18/88 9:00

*Gross Wt. 105.8130 g

Avg Gross Wt. 105.8130 g

Dish Tare Wt. 105.8123 g

Total Blank Weight 0.0007 g

WET CATCH

PROBE WASH

Type:
- ☒ Gravimetric
- ☐ Retain for further analyses

Other instructions

Reagent Acetone

Volume 130 ml ml

Dish No. Tall

Date/Time 11/18/88 3:00

*Gross Wt. 73.2056 g

Date/Time 11/18/88 9:00

*Gross Wt. 73.2057 g

Avg Gross Wt. 73.2056 g

Dish Tare Wt. 73.2053 g

Total Blank Weight 0.0003 g

PROBE WASH

pace laboratories, inc.

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
ORGANIC CONDENSIBLES

Project Name: HDR Mayo
Project No.: 881003.403
Sampling Location: Morse Bontger
Test No.: 3

Sampling Date: 11/11/88
Sampling Reagent: DI water
Analysis Date:
Analyst:

225 ml	225 ml	225 ml
Run No. 1	Run No. 2	Run No. 3
PACE Sample No. 40922	PACE Sample No. 40923	PACE Sample No. 40924
Dish No. 2	Dish No. 5	Dish No. 6
Date/Time 11/18/88 3:30	Date/Time 11/18/88 3:30	Date/Time 11/18/88 3:30
*Gross Wt. 101.0984 g	*Gross Wt. 103.6429 g	*Gross Wt. 103.5341 g
Date/Time 11/18/88 9:00	Date/Time 11/18/88 9:00	Date/Time 11/18/88
*Gross Wt. 101.0989 g	*Gross Wt. 103.6434 g	*Gross Wt. 103.5345 g
Avg Gross Wt. 101.0986 g	Avg Gross Wt. 103.6432 g	Avg Gross Wt. 103.5343 g
Dish Tare Wt. 101.0971 g	Dish Tare Wt. 103.6411 g	Dish Tare Wt. 103.5327 g
Blank Wt. 0.0000 g	Blank Wt. 0.0000 g	Blank Wt. 0.0000 g
Wt. of condensed organics 0.0015 g	Wt. of condensed organics 0.0021 g	Wt. of condensed organics 0.0016 g
Transfer "Wt. of condensed organics" to box No. 1.	Transfer "Wt. of condensed organics" to box No. 2.	Transfer "Wt. of condensed organics" to box No. 3.
WC's 1 0.0015 g	2 0.0021 g	3 0.0016 g

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AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
PARTICULATE IN PROBE WASH

Project Name HDR Mayo
Project No. 881003.403
Sampling Location Morse Bowlger
Test No. 3

Sampling Date 11-11-88
Clean-up Reagent Acetone
Analysis Date
Analyst

	Run No. 1	Run No. 2	Run No. 3
PACE Sample No.	40922	40923	40924
Evap. Dish No.	KK	Plus	Stub
Reagent Density			
Blank Conc.			
Reagent Vol.	125 ml	130 ml	150 ml
Date/Time	11/18/88 3:30	11/18/88 3:30	11/18/88 3:30
*Gross Wt.	80.1527 g	81.1768 g	80.4679 g
Date/Time	11/18/88 9:00	11/18/88 9:00	11/18/88 9:00
*Gross Wt.	80.1530 g	81.1773 g	80.4680 g
Avg Gross Wt.	80.1528 g	81.1770 g	80.4680 g
Dish Tare Wt.	80.1220 g	81.1487 g	80.4362 g
Blank Wt.	0.0000 g	0.0000 g	0.0000 g
Particulate in Rinse	0.0308 g	0.0283 g	0.0318 g
Transfer "Particulate in Rinse" to box No.	1	2	3
PW's	1 0.0308 g	2 0.0283 g	3 0.0318 g

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AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
PARTICULATE ON FILTERS

Project Name: HDR Mayo
Project No.: 881003.403
Sampling Location: Morse Boulger
Test No.: 3

Sampling Date: 11/11/88
Filter Type: Fiberglass
Analysis Date:
Analyst:

Run No. 1	Run No. 2	Run No. 3
PACE Sample No. 40922	PACE Sample No. 40923	PACE Sample No. 40924
Filter No. 842	Filter No. 843	Filter No. 844
Date/Time 11/16/88 9:15	Date/Time 11/16/88 9:15	Date/Time 11/16/88 9:15
*Gross Wt. 0.67825 g	*Gross Wt. 0.65530 g	*Gross Wt. 0.67693 g
Date/Time 11/16/88 3:30	Date/Time 11/16/88 3:30	Date/Time 11/16/88 3:30
*Gross Wt. 0.67814 g	*Gross Wt. 0.65522 g	*Gross Wt. 0.67674 g
Avg Gross Wt. 0.67820 g	Avg Gross Wt. 0.65526 g	Avg Gross Wt. 0.67684 g
Tare Wt. 0.63603 g	Tare Wt. 0.62575 g	Tare Wt. 0.62084 g
Particulate on Filter 0.04217 g	Particulate on Filter 0.02951 g	Particulate on Filter 0.05600 g
Transfer "Particulate on Filter" to box No. 1.	Transfer "Particulate on Filter" to box No. 2.	Transfer "Particulate on Filter" to box No. 3.
Sum values from each box labelled 1 and record in box No. T1.	Sum values from each box labelled 2 and record in box No. T2.	Sum values from each box labelled 3 and record in box No. T3.
Filters 1 0.04217 g	2 0.02951 g	3 0.05600 g
Totals T1 0.07447 g	T2 0.05991 g	T3 0.08940 g

AIR SAMPLING DIVISION
GRAVIMETRIC DATA SHEET
REAGENT BLANKS

Project Name: HDR Mayo

Sampling Data: 11/11/88

Project No.: 881003.403

Analysis Date:

Sampling Location: Morse Boulger

Analyst:

Test No.: 3

WET CATCH

Type:
- ☐ Organic (Extraction)
- ☐ Inorganic
- ☐ Gravimetric Only
- ☐ SO_2 to be conducted BEFORE any other analysis
- ☐ other

Reagent: DI water

Volume: 325 ml

Dish No.: 66

Date/Time: 11/18/88 3:30

*Gross Wt.: 100.0465 g

Date/Time: 11/18/88 9:00

*Gross Wt.: 100.0466 g

Avg Gross Wt.: 100.0466 g

Dish Tare Wt.: 100.0467 g

Total Blank Weight: 0.0000 g

WET CATCH

PROBE WASH

Type:
- ☒ Gravimetric
- ☐ Retain for further analyses

Other instructions:

Reagent: Acetone

Volume: 130 ml

Dish No.: Stibs

Date/Time: 11/18/88 3:00

*Gross Wt.: 79.7629 g

Date/Time: 11/18/88 9:00

*Gross Wt.: 79.7630 g

Avg Gross Wt.: 79.7630 g

Dish Tare Wt.: 79.7631 g

Total Blank Weight: 0.0000 g

PROBE WASH

pace laboratories, inc

REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa
Novato, California

HDR Techserv
5401 Gamble Drive
Minneapolis, MN 55416-1518

December 02, 1988
PACE Project Number: 881003403

Attn: Mr. Jim Booty

HDR Mayo Foundation

Date Sample(s) Collected: 11/04/88, 11/11/88
Date Sample(s) Received: 11/07/88, 11/14/88

PACE Sample Number:

Parameter	Units	MDL	401580 Morse Boulger T1R1	401590 Morse Boulger T1R2	401600 Morse Boulger T1R3
Hydrochloric acid by ion chromatography	mg/L	1000	5000	5000	6000
Particulates, filter	g	0.0001	0.07672	0.05270	0.08597
Particulates, probe wash	g	0.0001	0.0648	0.0468	0.0433
Particulates, total condensibles	g	0.0001	0.0031	0.0015	0.0032
Particulates, total-EPA 5	g	0.0001	0.14462	0.10100	0.13247

MDL Method Detection Limit

pace laboratories, inc

REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa
Novato, California

Mr. Jim Booty
Page 4

December 02, 1988
PACE Project Number: 881003403

PACE Sample Number:			409190	409200	409210
			Morse Boulger	Morse Boulger	Morse Boulger
Parameter	Units	MDL	T2R1 11/11	T2R2 11/11	T2R3 11/11
Hydrochloric acid by ion chromatography	mg/L	1000	5000	6000	6000
Particulates, filter	g	0.0001	0.05459	0.08052	0.07248
Particulates, probe wash	g	0.0001	0.0265	0.0386	0.0495
Particulates, total condensibles	g	0.0001	0.0006	0.0020	0.0011
Particulates, total-EPA 5	g	0.0001	0.08169	0.12112	0.12308

MDL Method Detection Limit

pace laboratories, inc

REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa
Novato, California

Mr. Jim Booty
Page 5

December 02, 1988
PACE Project Number: 881003403

PACE Sample Number:

Parameter	Units	MDL	409220 Morse Boulger T3R1 11/11	409230 Morse Boulger T3R2 11/11	409240 Morse Boulger T3R3 11/11
Hydrochloric acid by ion chromatography	mg/L	1000	4000	4000	4000
Particulates, filter	g	0.0001	0.04217	0.02951	0.05600
Particulates, probe wash	g	0.0001	0.0308	0.0283	0.0318
Particulates, total condensibles	g	0.0001	0.0015	0.0021	0.0016
Particulates, total-EPA 5	g	0.0001	0.07447	0.05991	0.08940

MDL Method Detection Limit

Appendix H

O_2, CO_2 and CO Stripchart Data

pace laboratories, inc.

Mayo Foundation

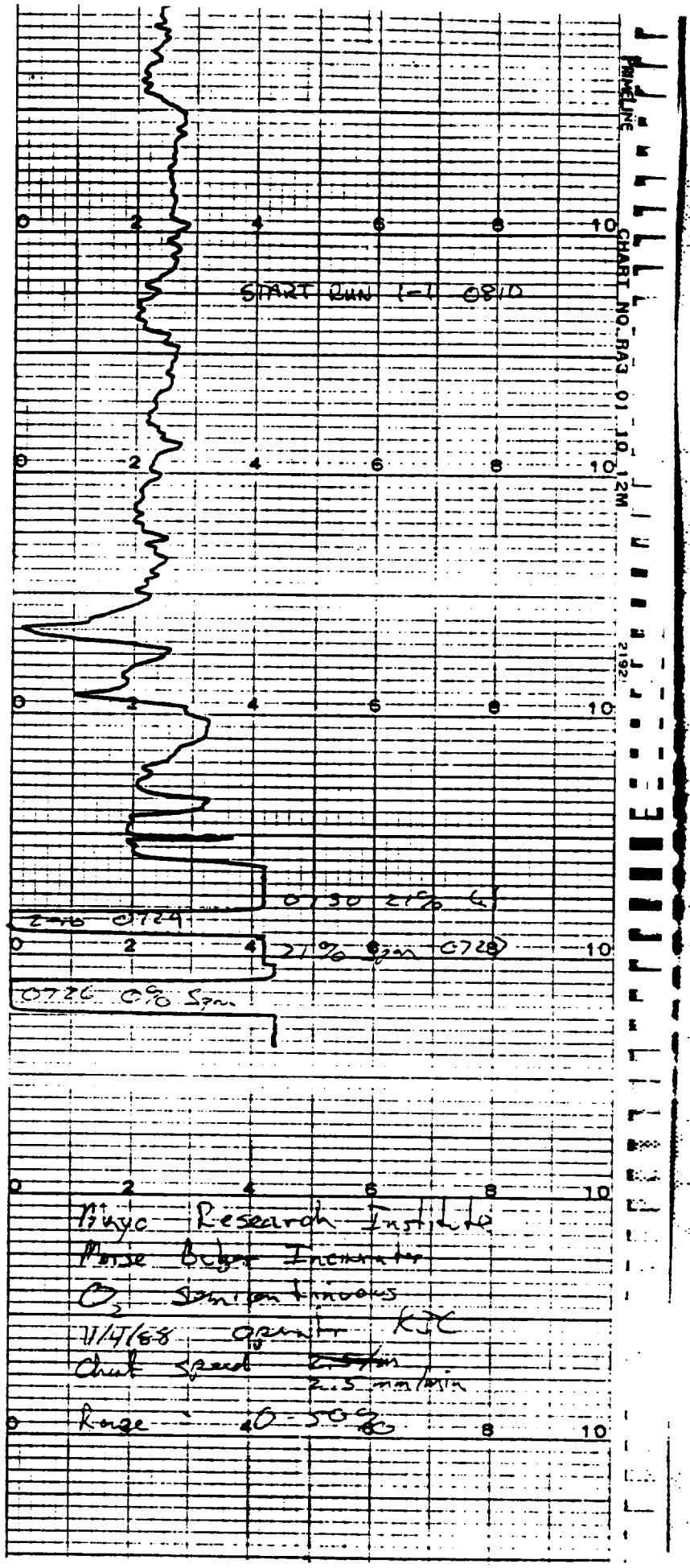
Institute Hills Research Facility

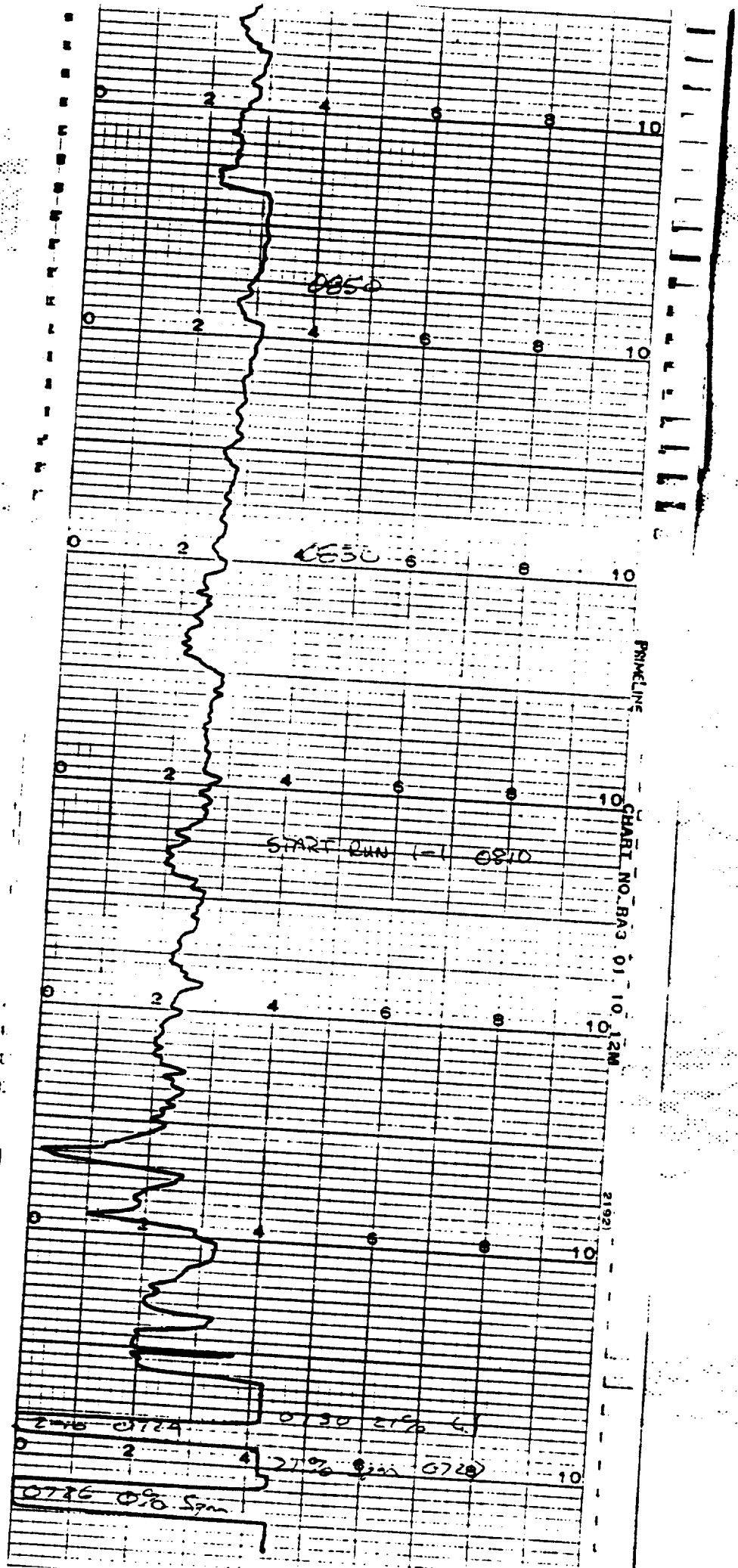
Morse Boulger Incinerator

Oxygen

Stripchart

Data


START RUN 1-1 0810
0730 21% 4
zero 0724
21% Span 0728
0726 0% Span
Tokyo Research Institute
Porse Boiler Incinerator
O2 Sensor Innovox
11/4/88 operator KJC
Chart speed 2.5 mm/min
Range 0-50%
PRIMELINE
CHART NO. RA3 01 10 12M
2192


0850
0830
START RUN 1-1 0810
PRIMELINE
CHART NO. BA3 01 10 12M
21921
0724
0730 2% G
2% Spin 0728
0726 0% Spin

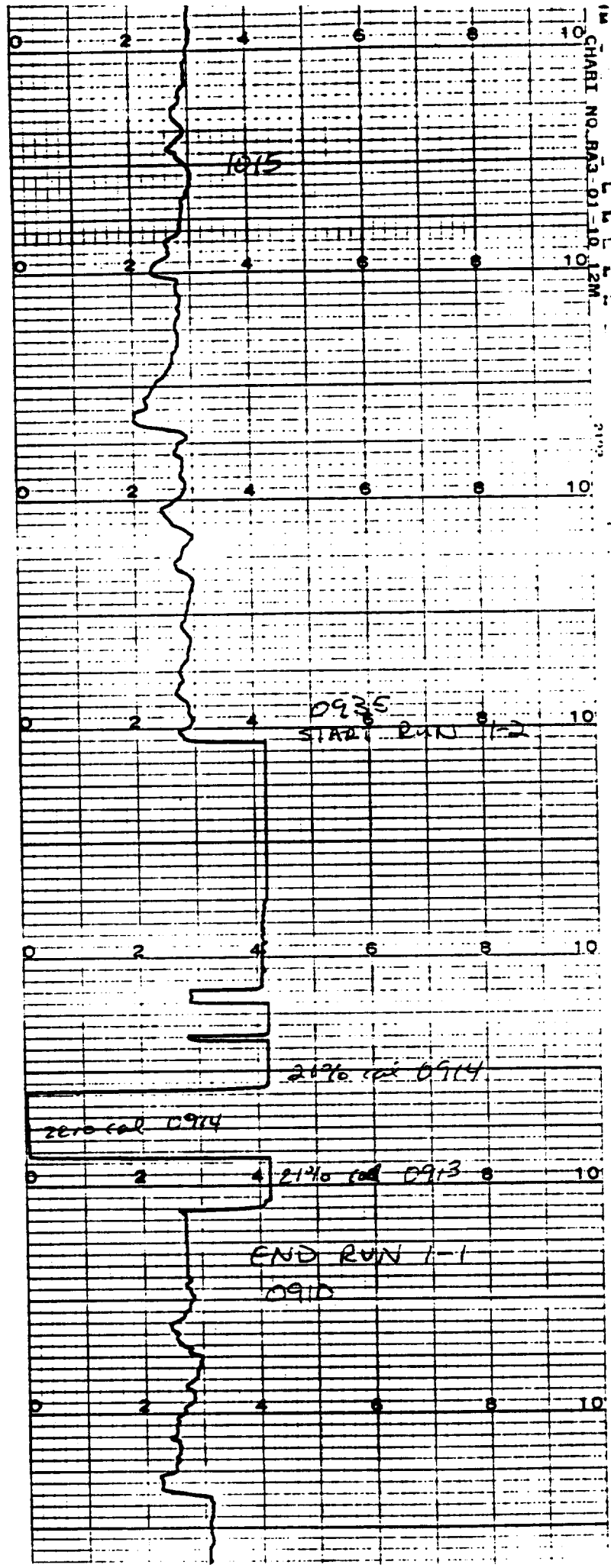
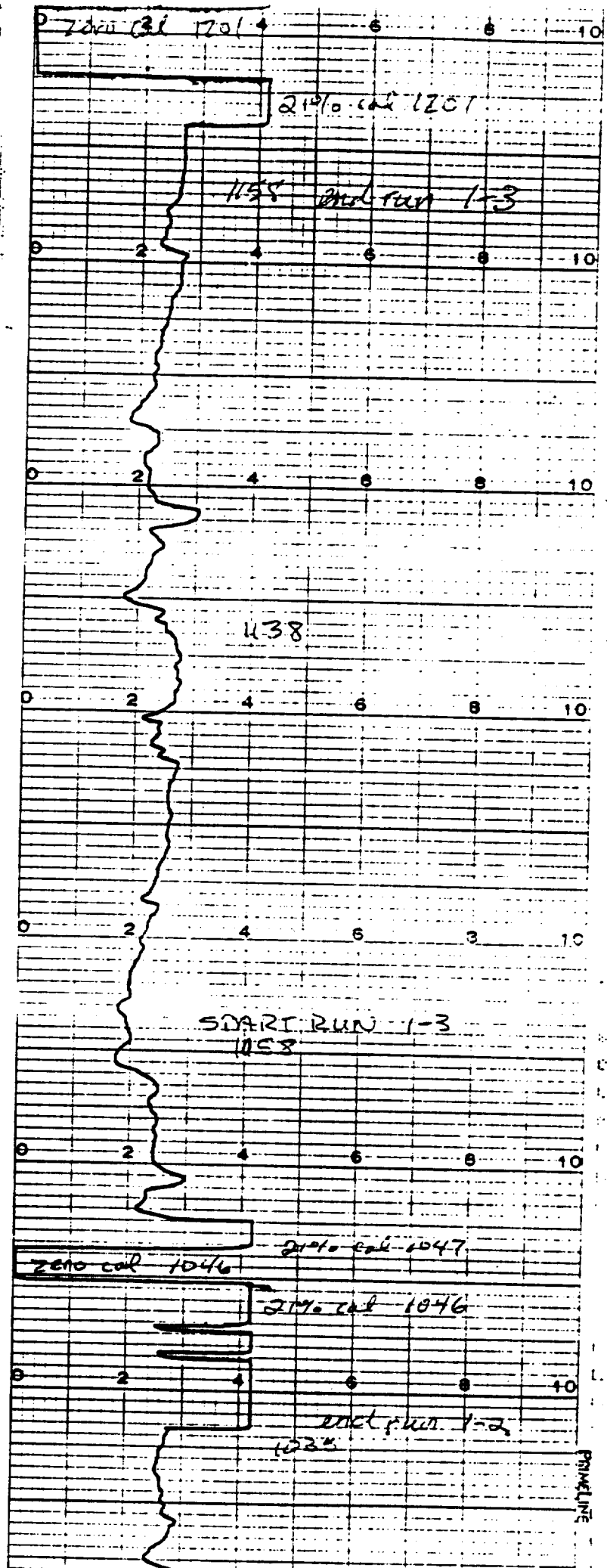
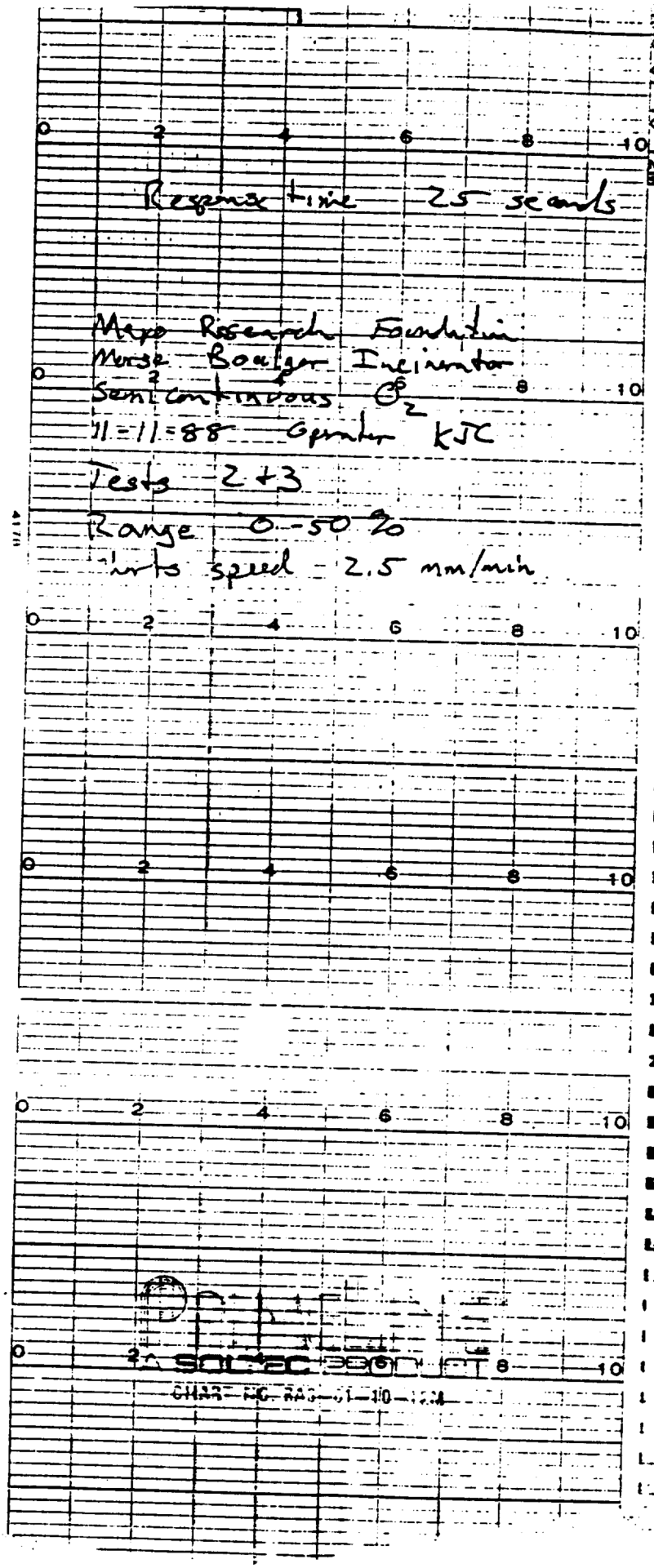
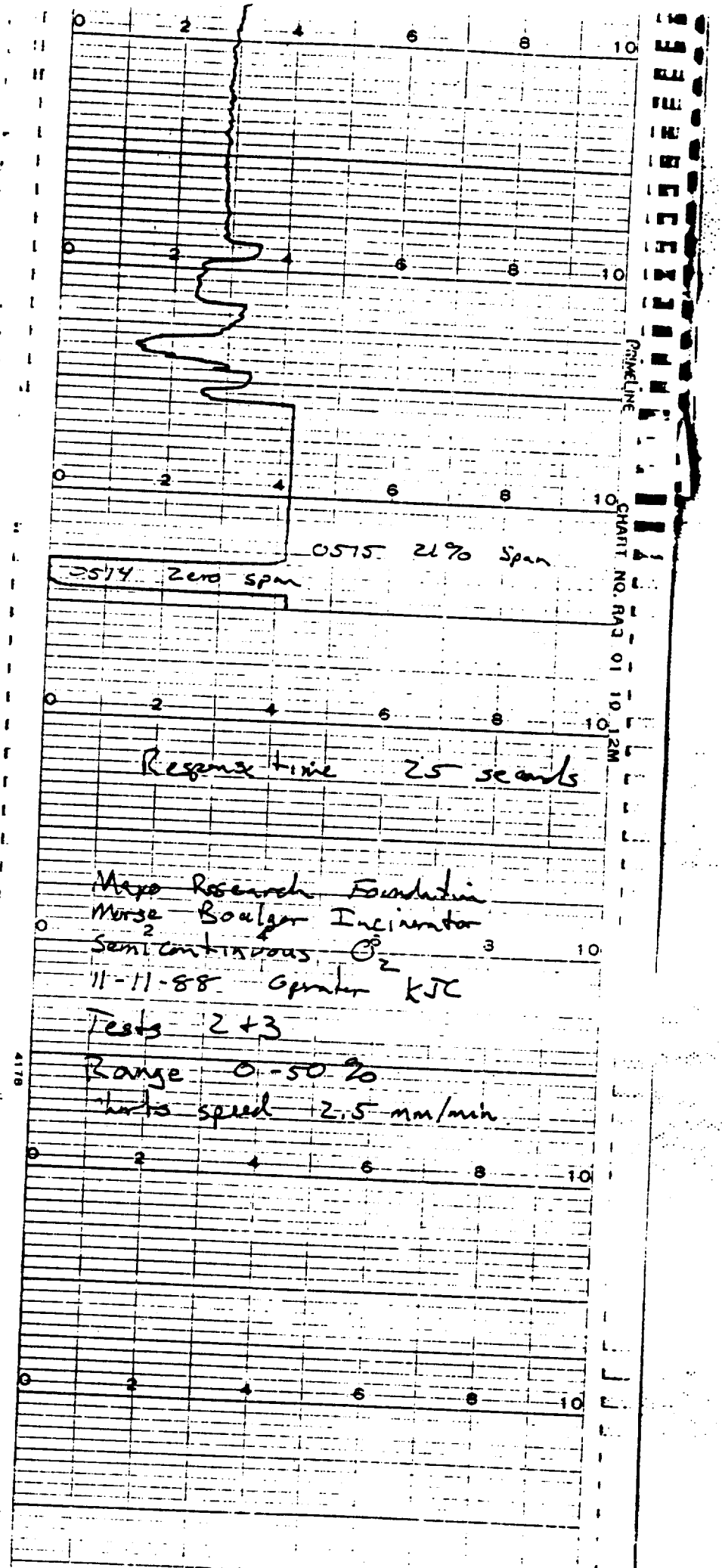
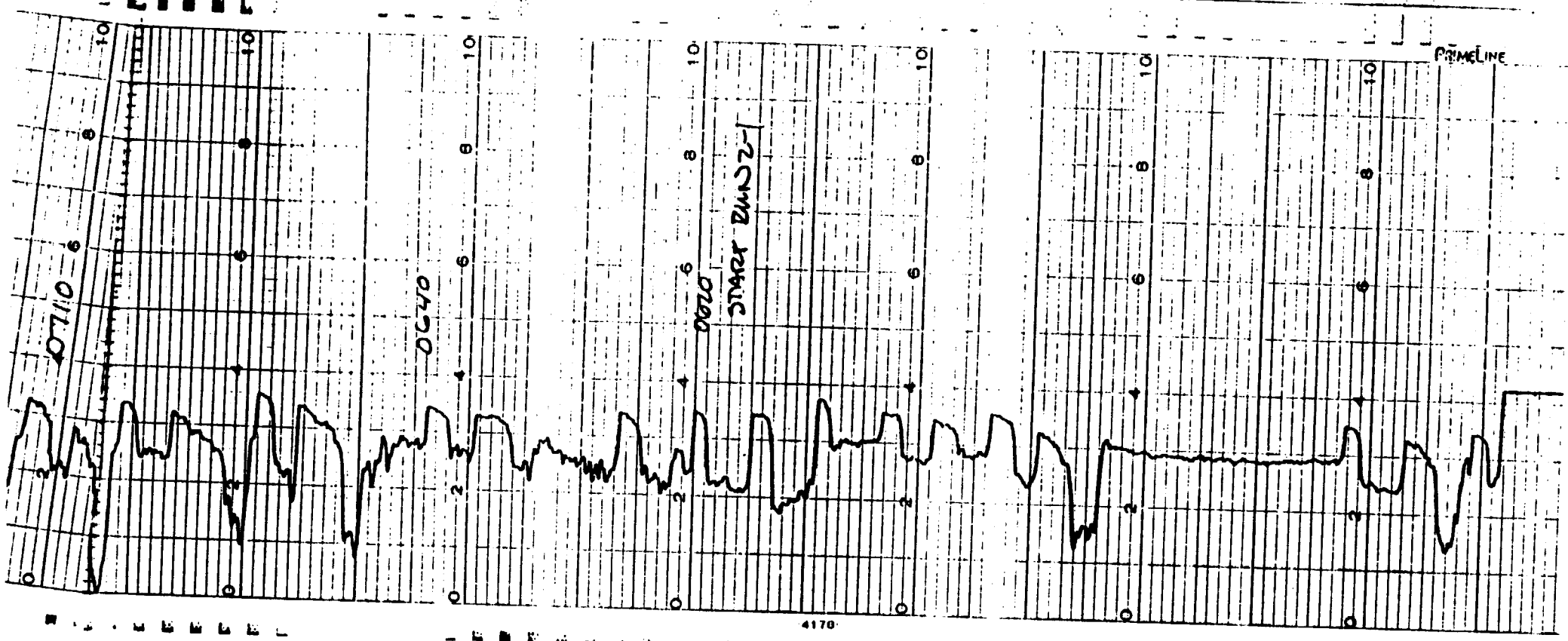


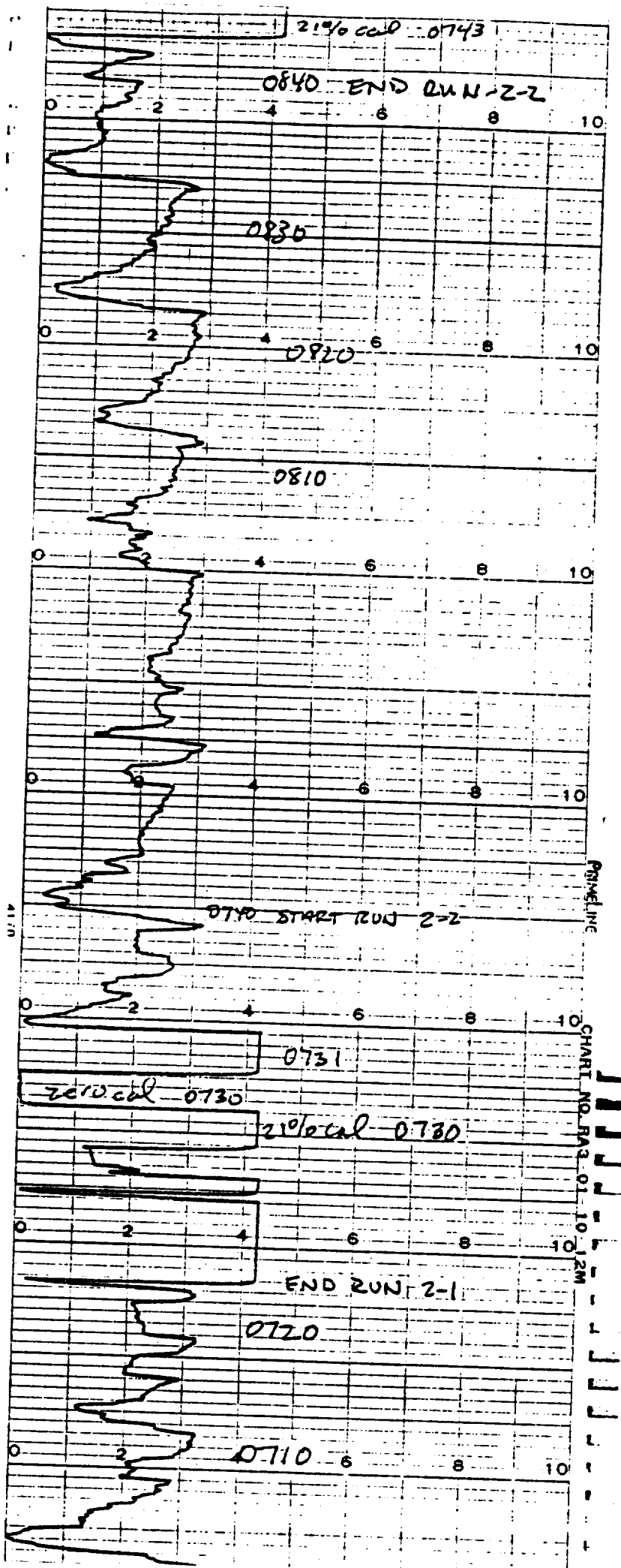
CHART NO. RA3-01-10 12M
1015
0935
START RUN 1-2
21% cal 0914
zero cal 0914
21% cal 0913
END RUN 1-1
0910

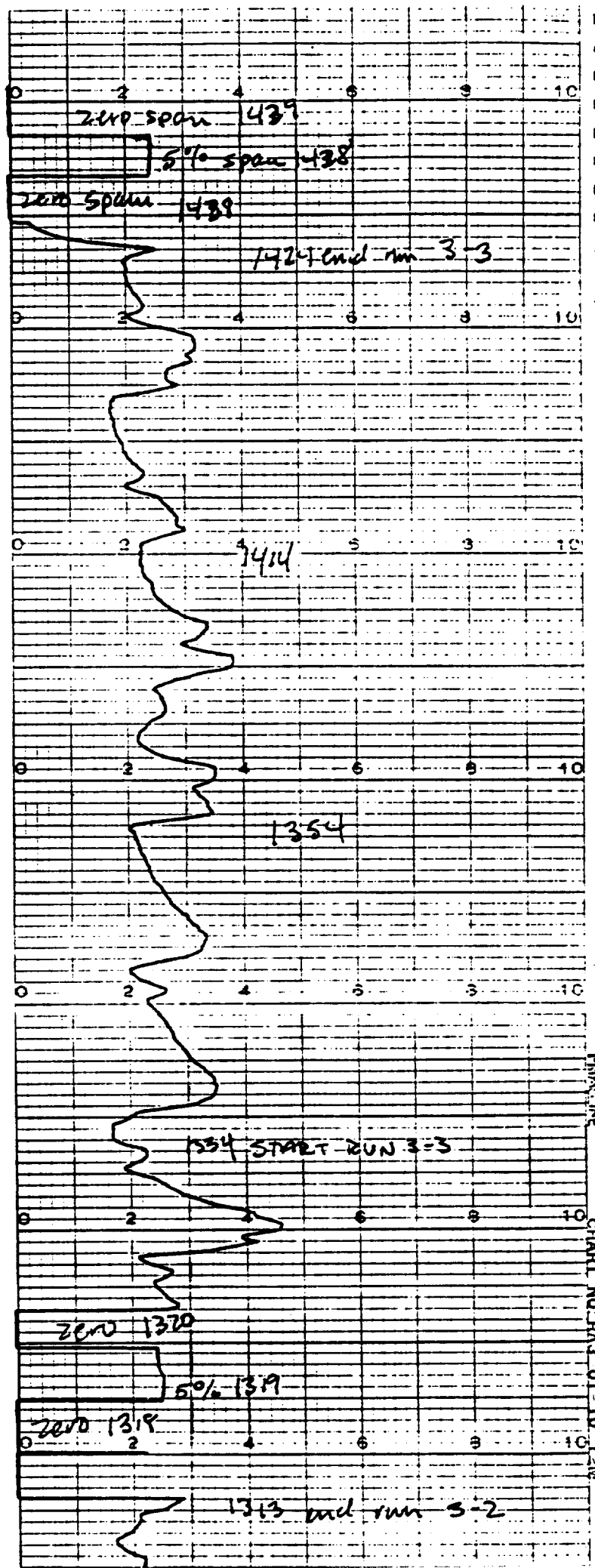

zero cal 1201
2 pt cal 1201
1155 end run 1-3
1138
START RUN 1-3
1058
2 pt cal 1047
zero cal 1046
2 pt cal 1046
end run 1-2
1023
PRIMELINE


RA3 01 10 12M
0 2 4 6 8 10
Response time 25 seconds
Mayo Research Foundation
Morse Bowger Incinerator
Semi Continuous O_2
11-11-88 Operator KJC
Tests 2+3
Range 0-50 %
Chart speed 2.5 mm/min
SOLTEC


0575 21% Span
0574 Zero span
Response time 25 seconds
Mayo Research Foundation
Morse Boulger Incinerator
Semi continuous O_2
11-11-88 Operator KJC
Tests 2+3
Range 0-50%
Chart speed 2.5 mm/min
PRIMELINE
CHART NO. RA3 01 10 12M


PRIMELINE
4170


21% cal 0743
0840 END RUN 2-2
0830
0820
0810
0740 START RUN 2-2
0731
zero cal 0730
21% cal 0730
END RUN 2-1
0720
0710
PRIMELINE
CHART NO. RA3 01 10 12M


0 2 4 6 8 10
zero span 1439
5% span 1438
zero span 1439
1424 end run 3-3
1414
1354
1354 START RUN 3-3
zero 1320
5% 1319
zero 1318
1313 end run 3-2
PRINCE INE
CHART NO. RA3 01 10 13M

pace laboratories, inc.

Mayo Foundation

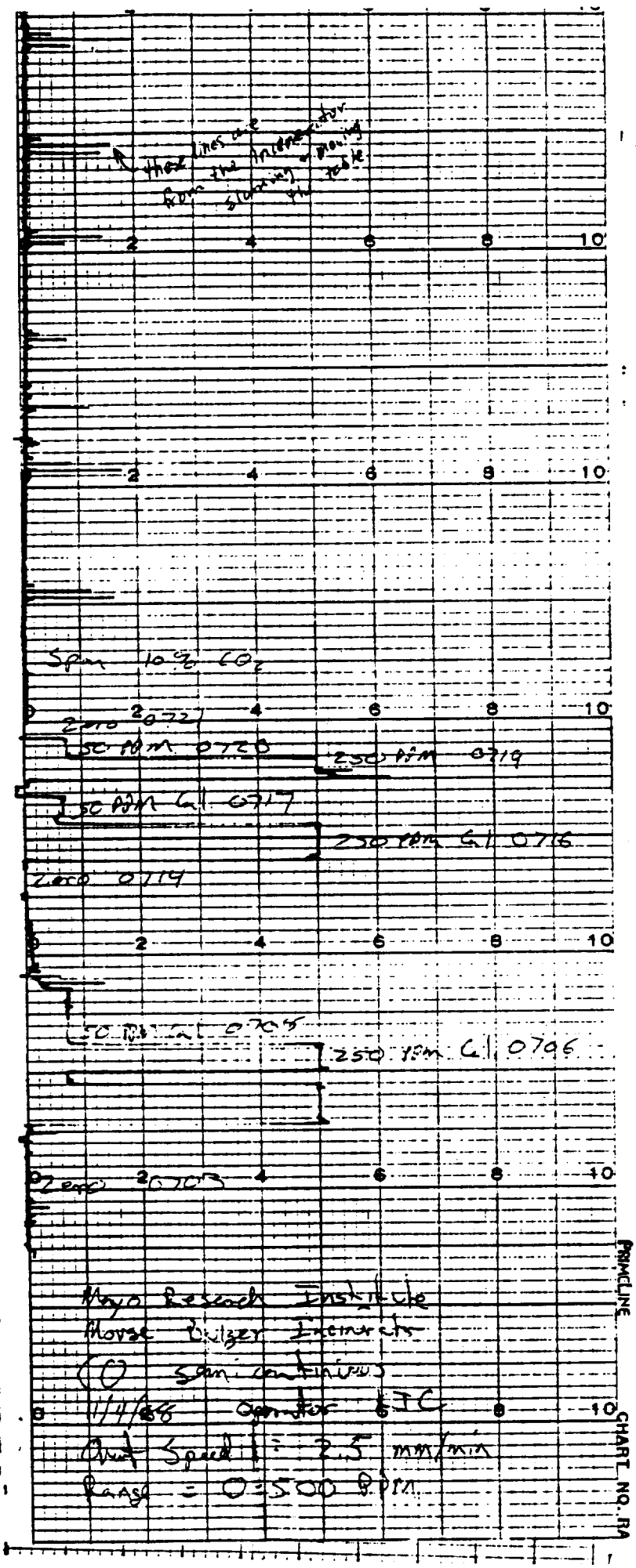
Institute Hills Research Facility

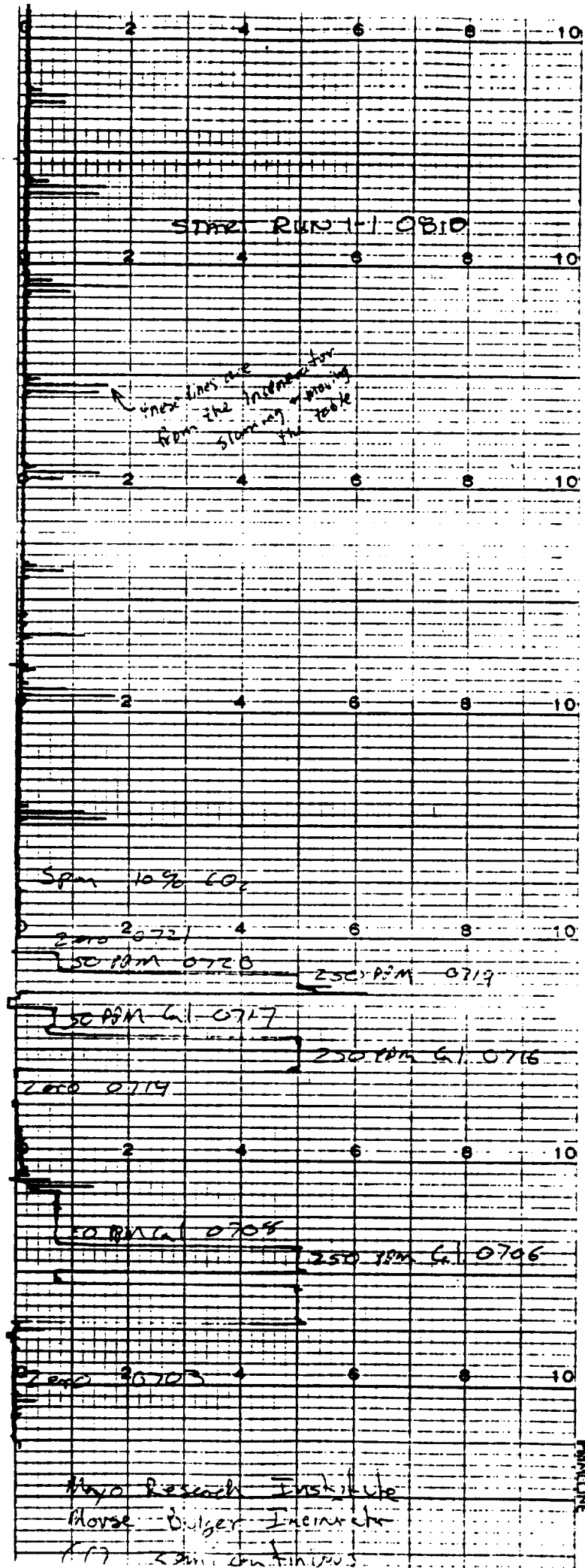
Morse Boulger Incinerator

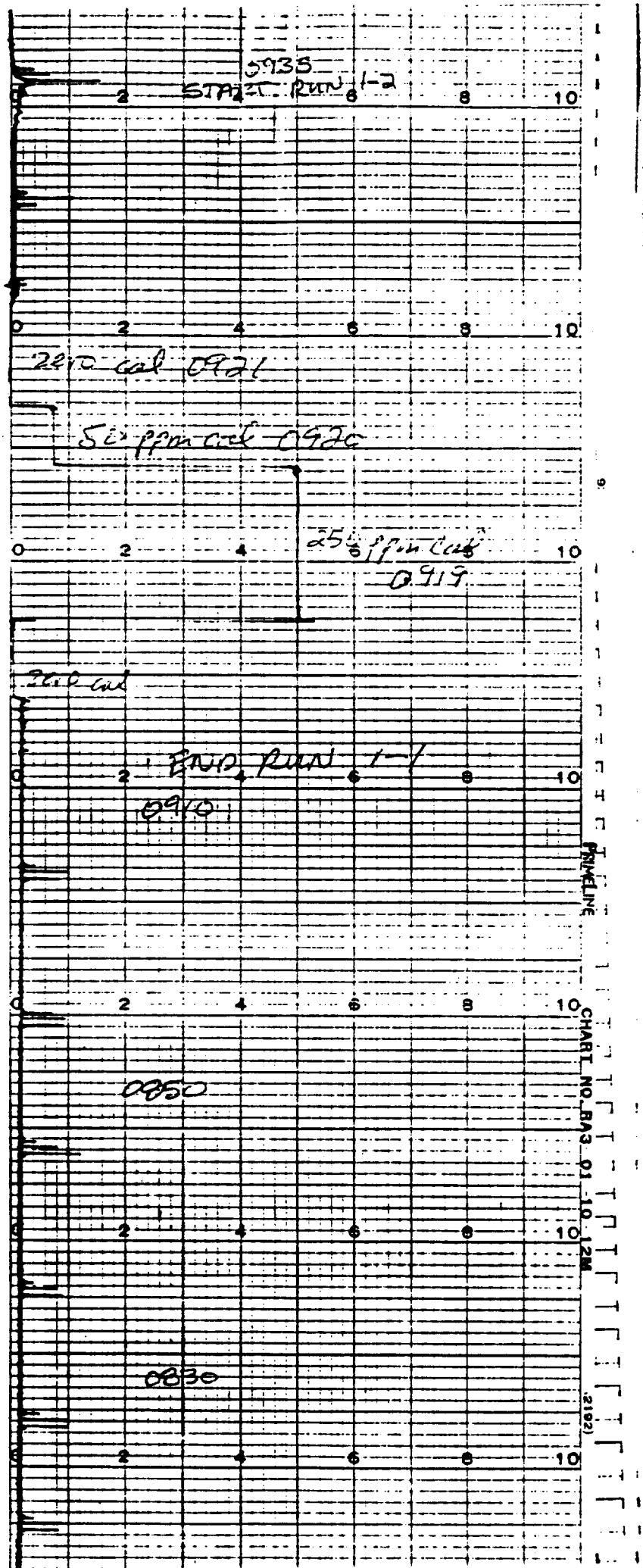
Carbon Monoxide

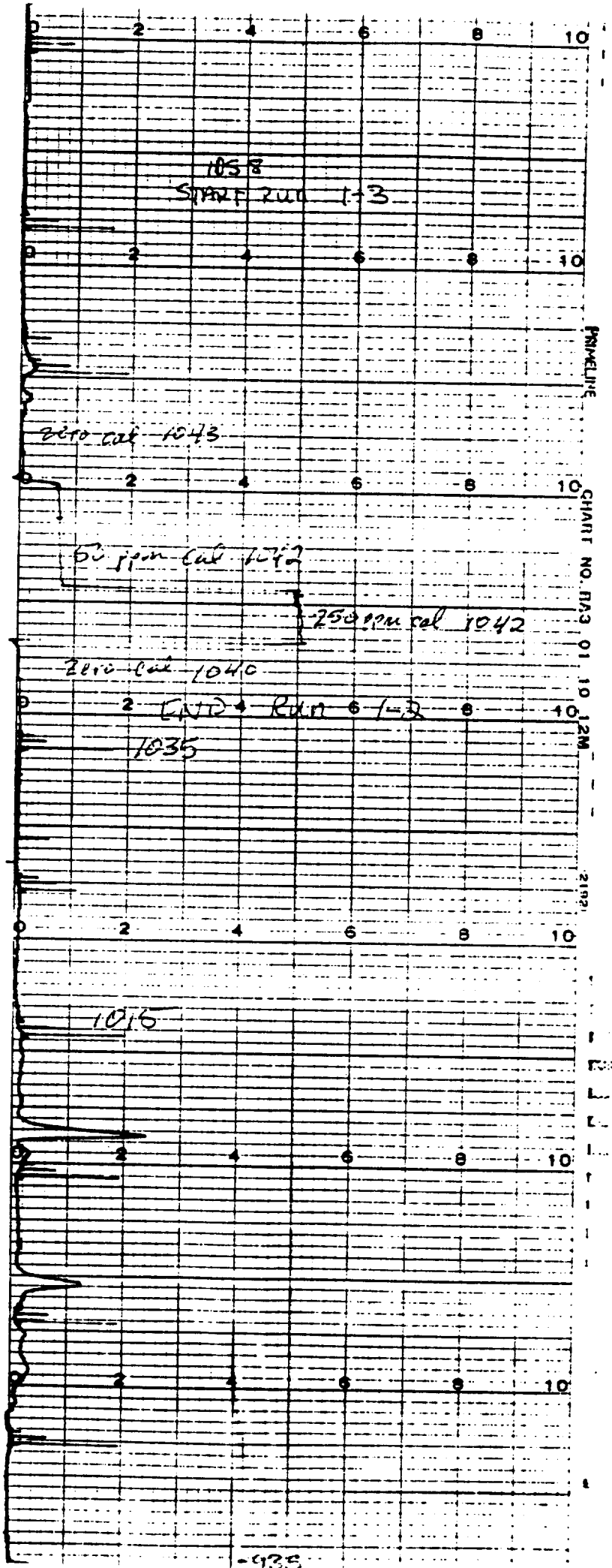
Stripchart

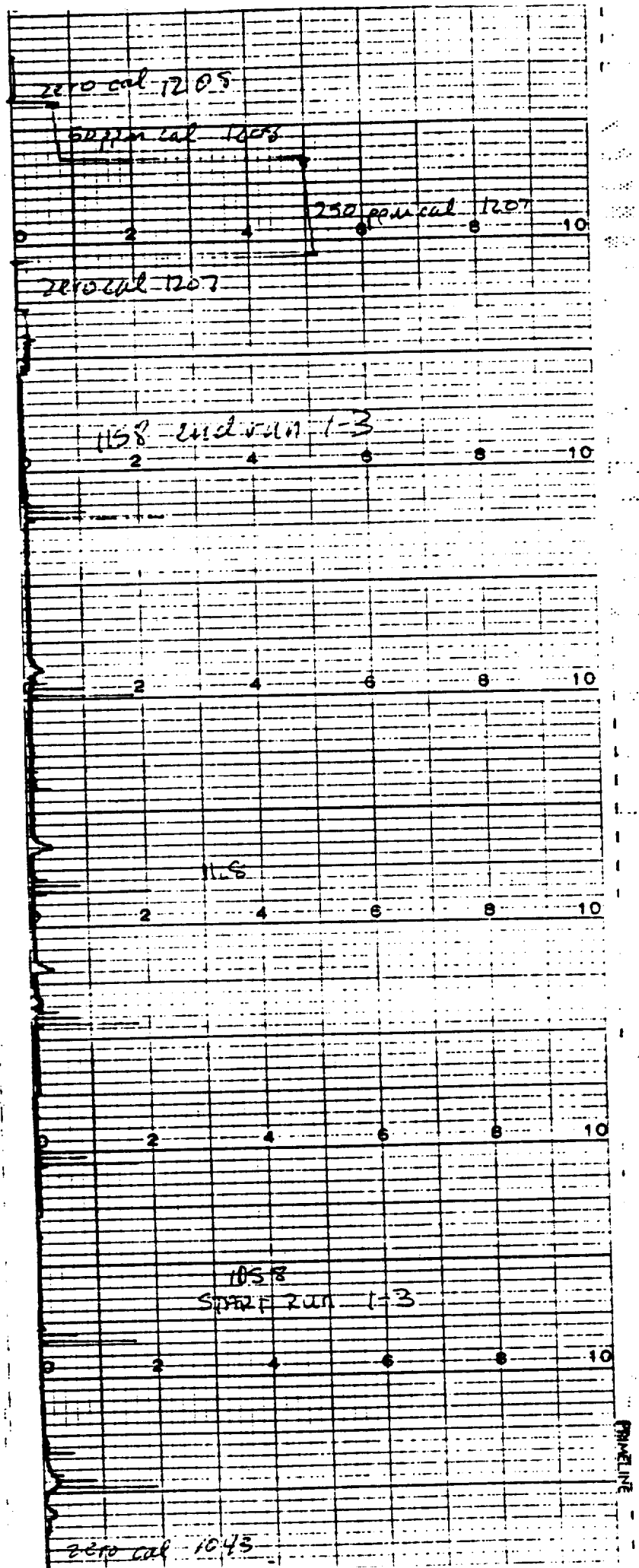
Data

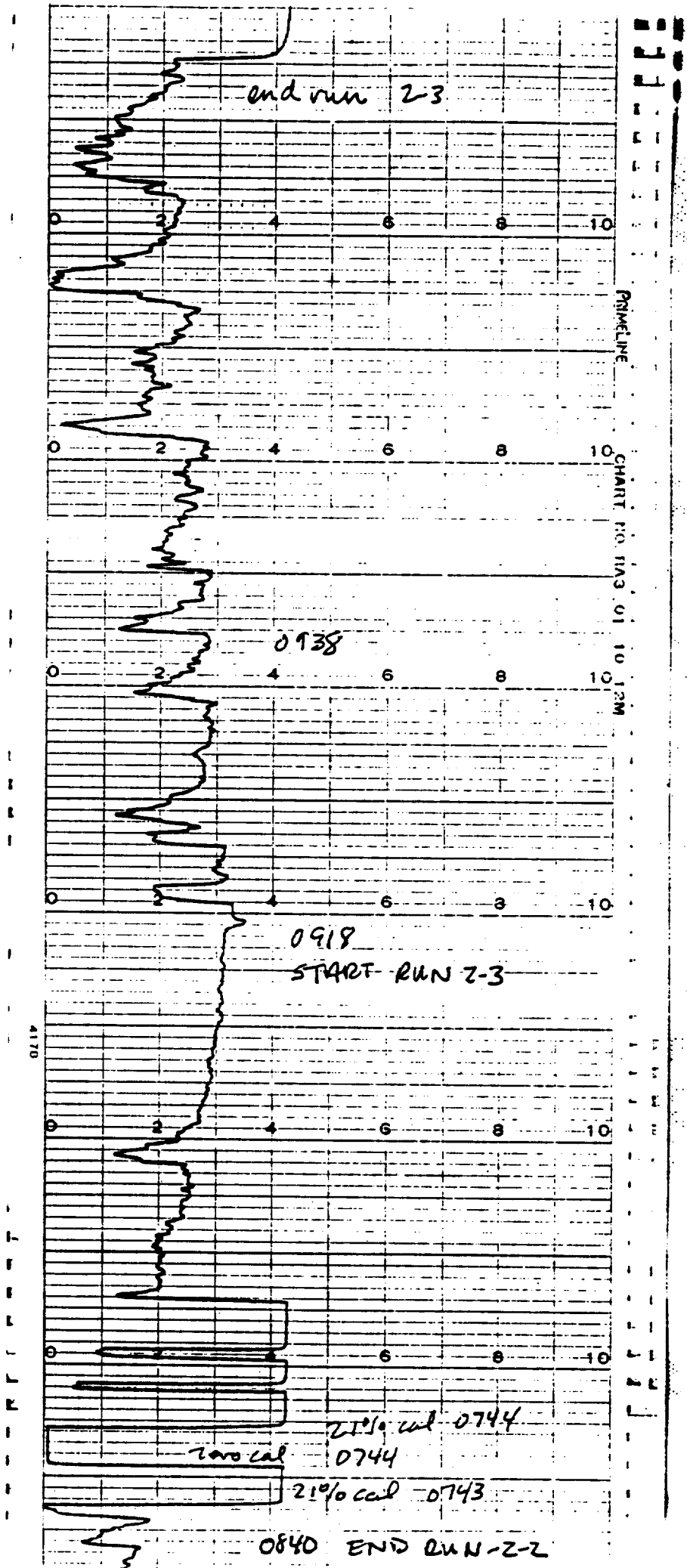

these lines are from the interference of moving the table
2 4 6 8 10
Span 10% CO_2
Zero 0722
50 ppm 0720
250 ppm 0719
50 ppm Cl 0717
250 ppm Cl 0716
Zero 0714
50 ppm Cl 0705
250 ppm Cl 0706
Zero 0703
Mayo Research Institute
Mouse Bulger Incinerator
CO span continuous
1/1/86 Operator JTC
Chart Speed = 2.5 mm/min
Range = 0-500 ppm
PRINCELINE
CHART NO. RA

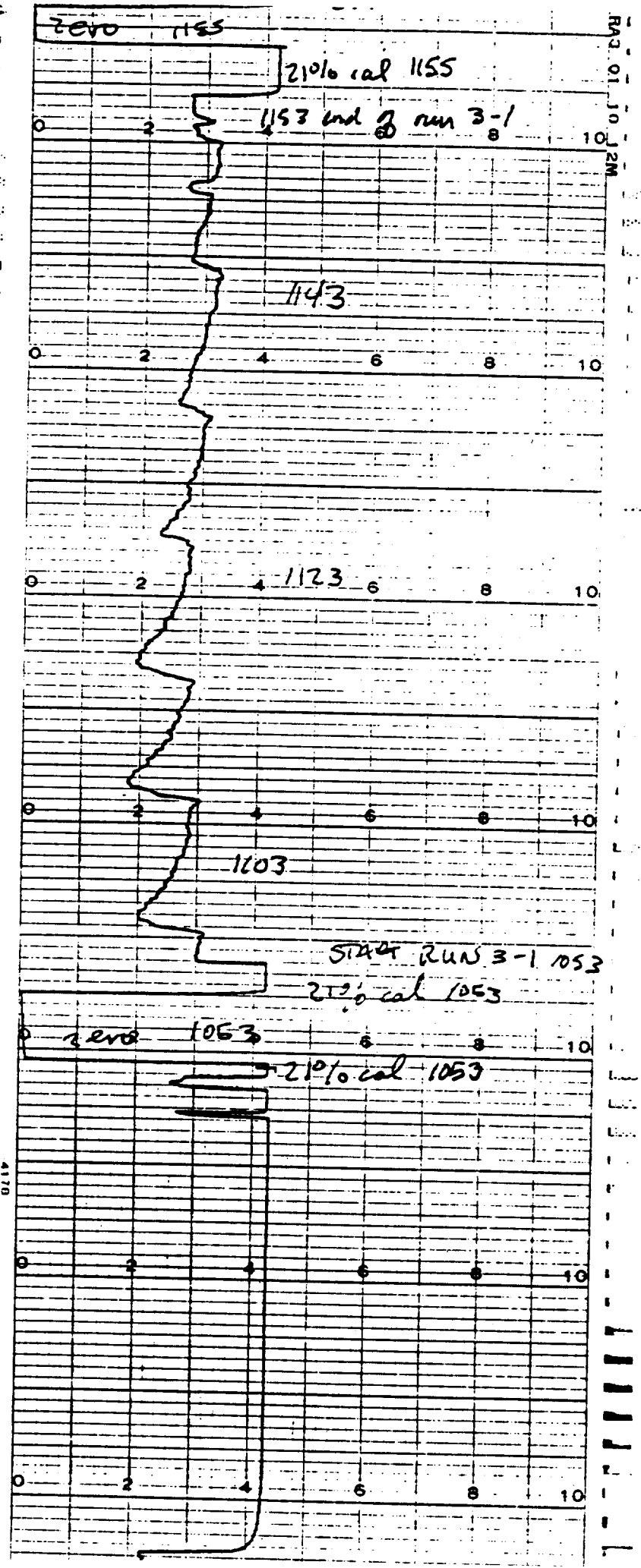

STAT RUN 1-1 0810
these lines are from the incinerator stopping the flow
Span 10% CO2
Zero 0721
50 PPM 0720
250 PPM 0719
50 PPM Cal 0717
250 PPM Cal 0716
Zero 0714
50 PPM Cal 0708
250 PPM Cal 0706
Zero 0703
Mayo Research Institute
Morse Dulger Incinerator
(17 Sam. continuous)

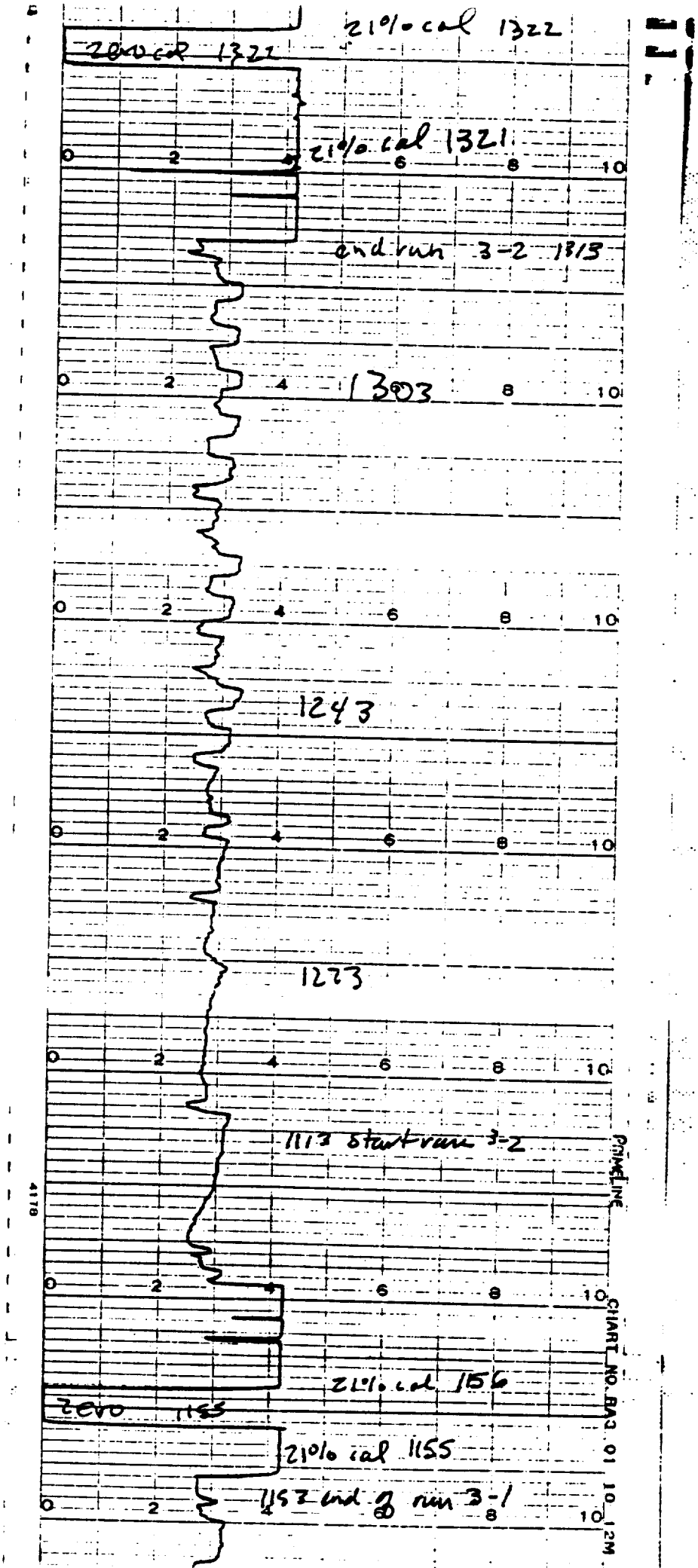

0935
START RUN 1-2
zero cal 0921
50 ppm cal 0920
25 ppm cal 0919
zero cal
END RUN 1-1
0910
0850
0830
PRIMELINE
CHART NO. BA3 01 10 12M
(2192)

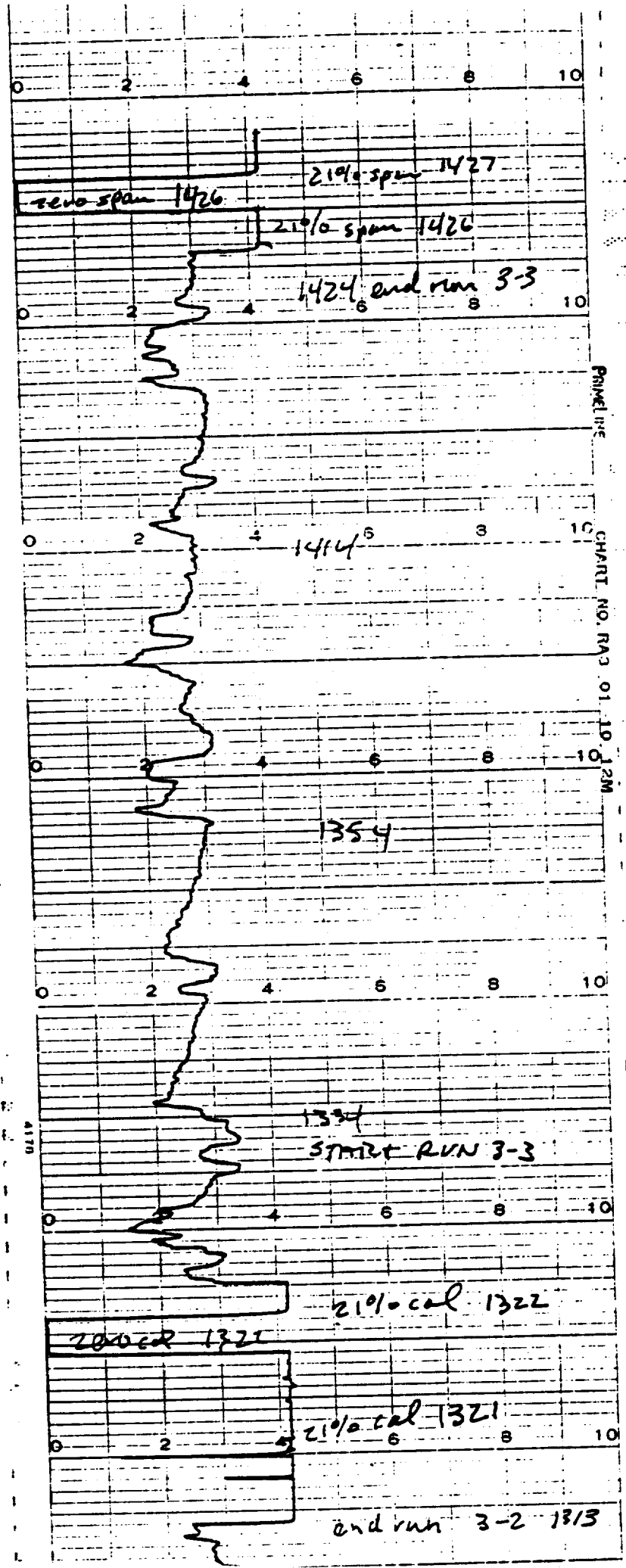

1058
START RUN 1-3
PRIMELINE
zero cal 1043
50 ppm cal 1042
250 ppm cal 1042
zero cal 1040
END RUN 1-3
1035
1015
CHART NO. 1183 01 10 12M
2192


zero cal 1205
50 ppm cal 1205
250 ppm cal 1207
zero cal 1207
1158 end run 1-3
1158
1058
start run 1-3
zero cal 1043
PRIMELINE


end run 2-3
PRIMELINE
CHART NO. HA3 01 10 12M
0938
0918
START RUN 2-3
4170
21% cal 0744
zero cal 0744
21% cal 0743
0840 END RUN-2-2


zero 1155
21% cal 1155
1153 end of run 3-1
1143
1123
1103
START RUN 3-1 1053
21% cal 1053
zero 1053
21% cal 1053
0 2 4 6 8 10


21% cal 1322
zero cal 1322
21% cal 1321
end run 3-2 1313
1303
1243
1233
1113 start run 3-2
21% cal 1156
zero 1155
21% cal 1155
1152 end of run 3-1
PRIMELINE
CHART NO. BA3 01 10 12M
4178


0 2 4 6 8 10
21% span 1427
zero span 1426
21% span 1426
1424 end run 3-3
0 2 4 6 8 10
1414
0 2 4 6 8 10
1354
0 2 4 6 8 10
1334
START RUN 3-3
0 2 4 6 8 10
21% cal 1322
zero cal 1321
21% cal 1321
0 2 4 6 8 10
end run 3-2 1313
PRIMELINE
CHART NO. RA3 01 10 12M

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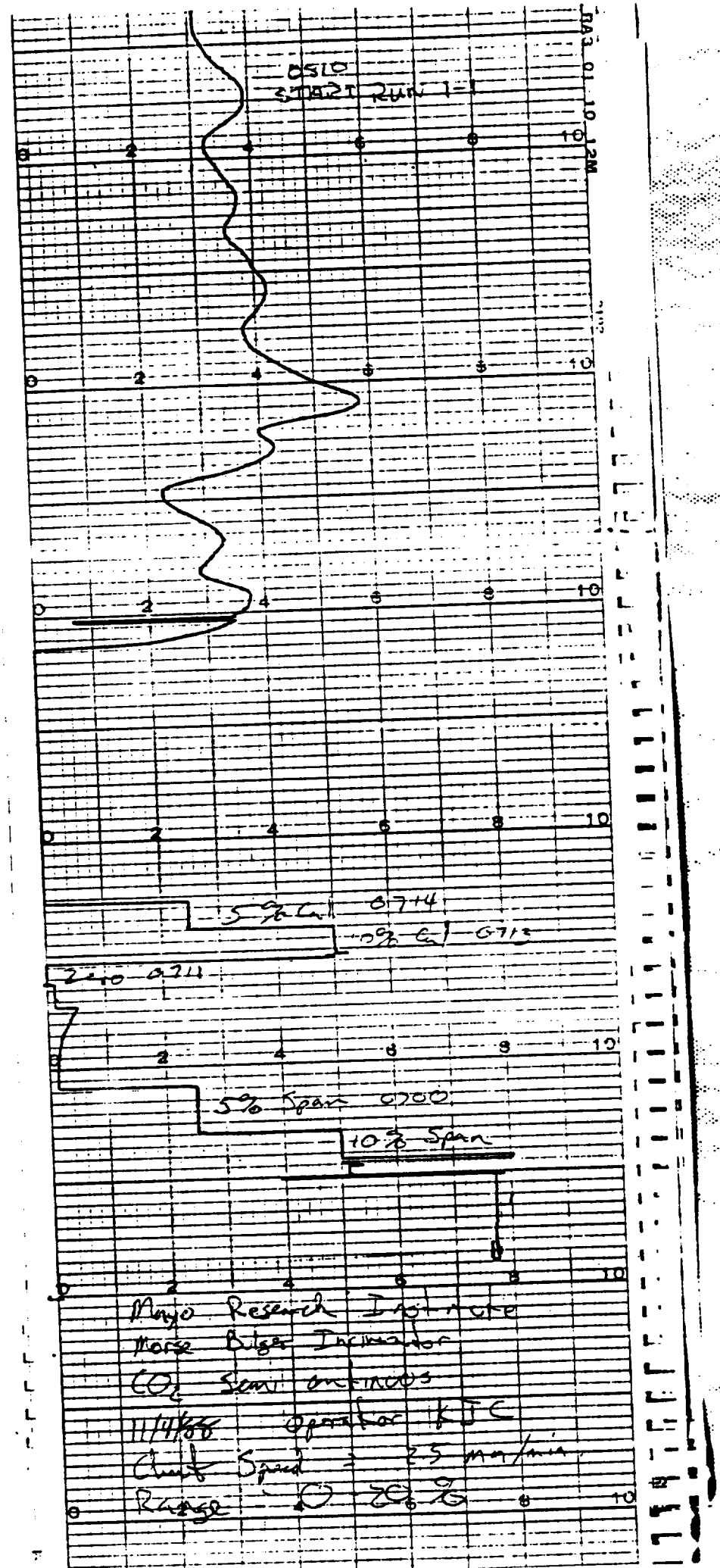
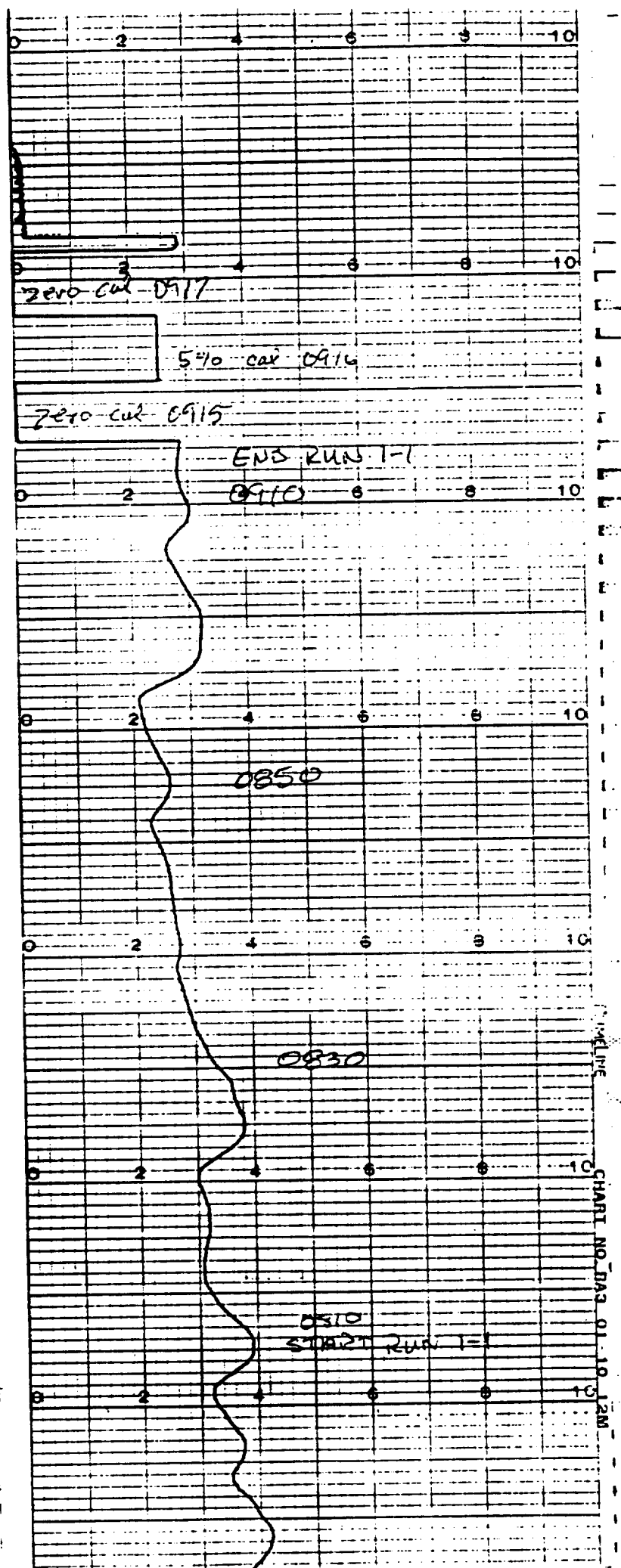
Morse Boulger Incinerator

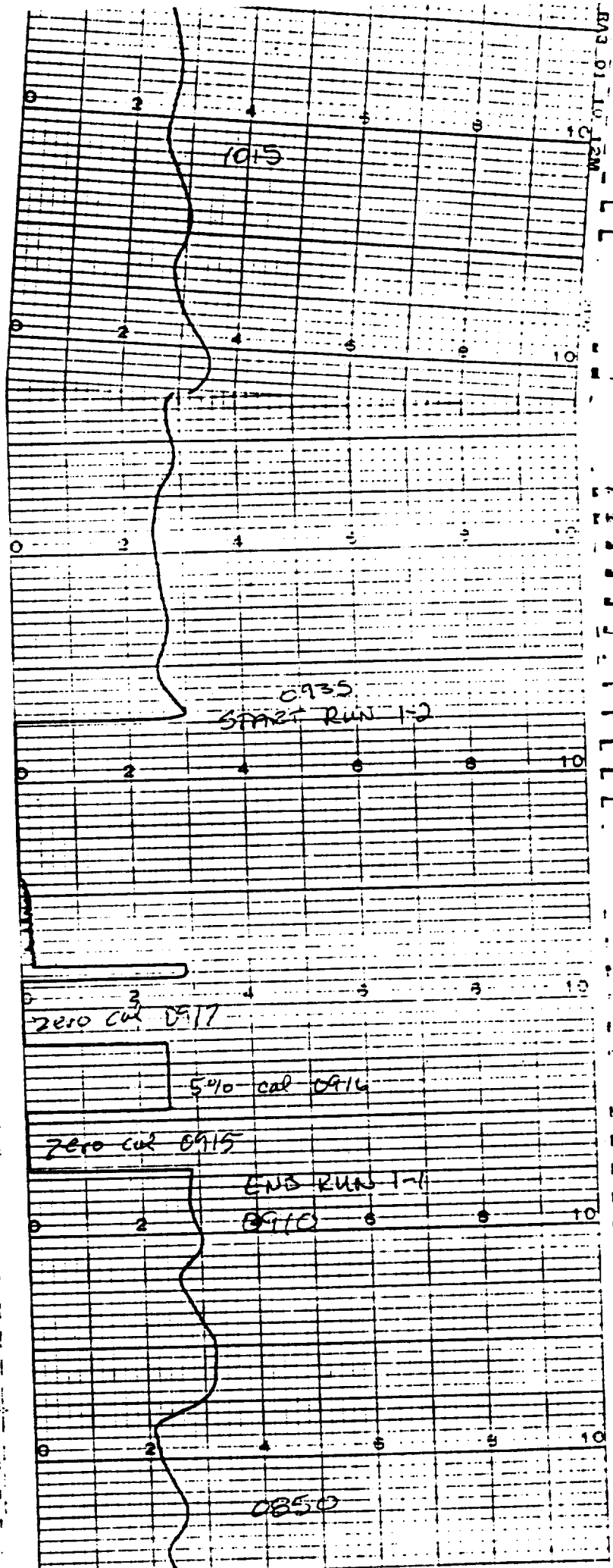
Carbon Dioxide

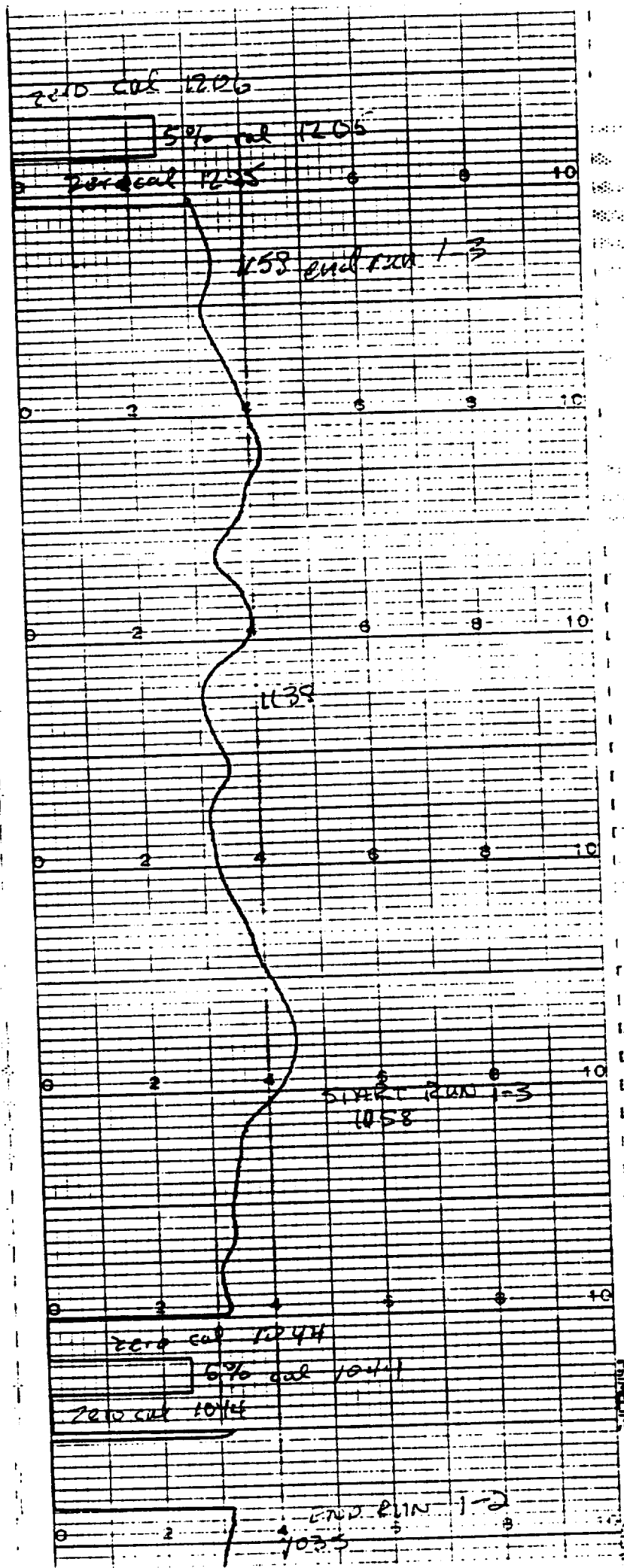
Stripchart

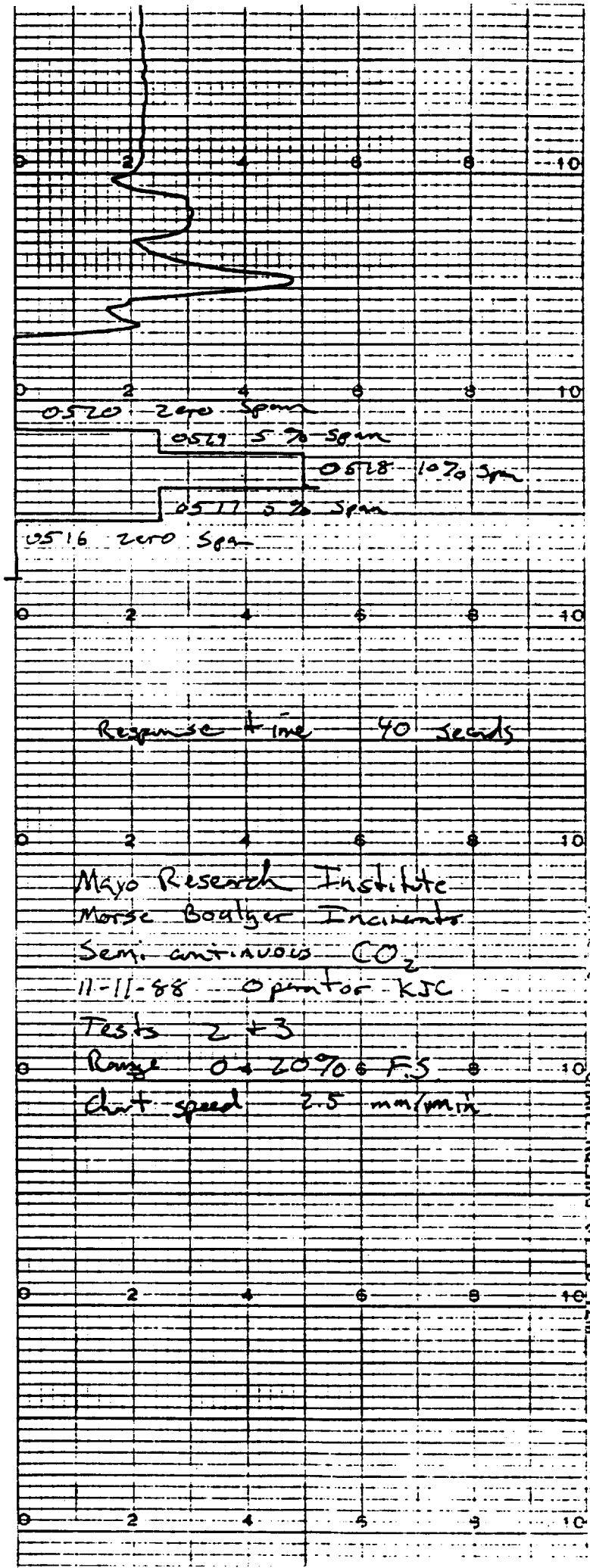
Data

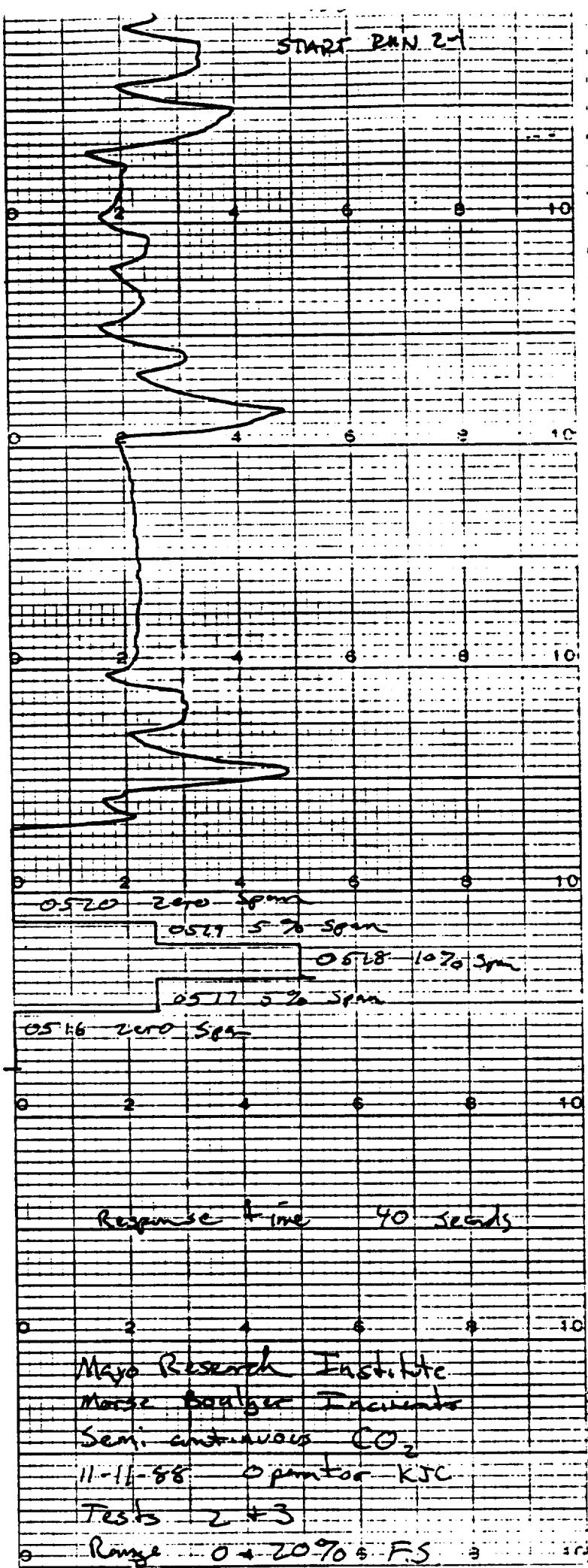

OSLO
START RUN 1-1
5% Cal 0714
-5% Cal 0712
Zero 0714
5% Span 0700
10% Span
Mayo Research Instrument
Morse Biser Incinerator
CO2 Semi continuous
11/4/88 Operator KJC
Chart Speed = 25 mm/min
Range 0 20 %

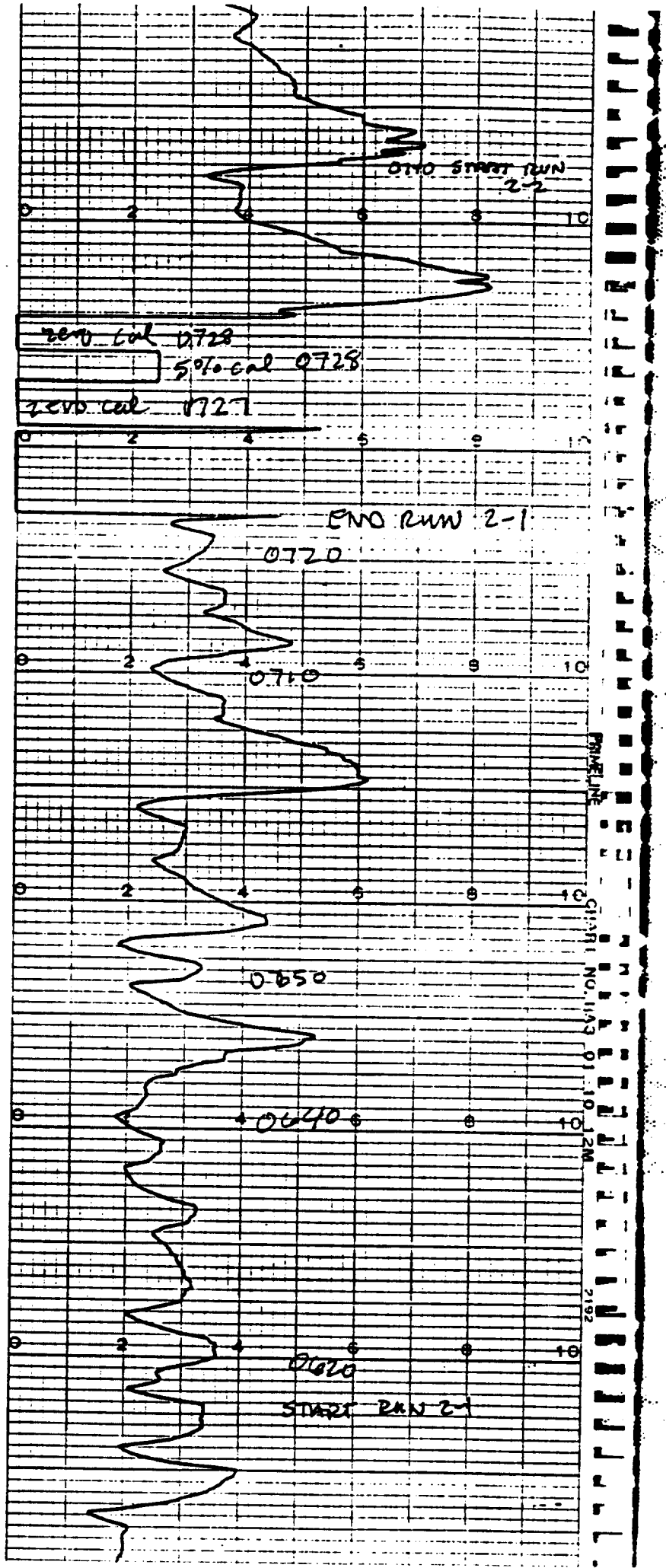

0 2 4 6 8 10
zero cal 0917
5% cal 0916
zero cal 0915
END RUN 1-1
0910
0850
0830
0810
START RUN 1-1
TIMELINE
CHART NO. DA3 01 10 12M

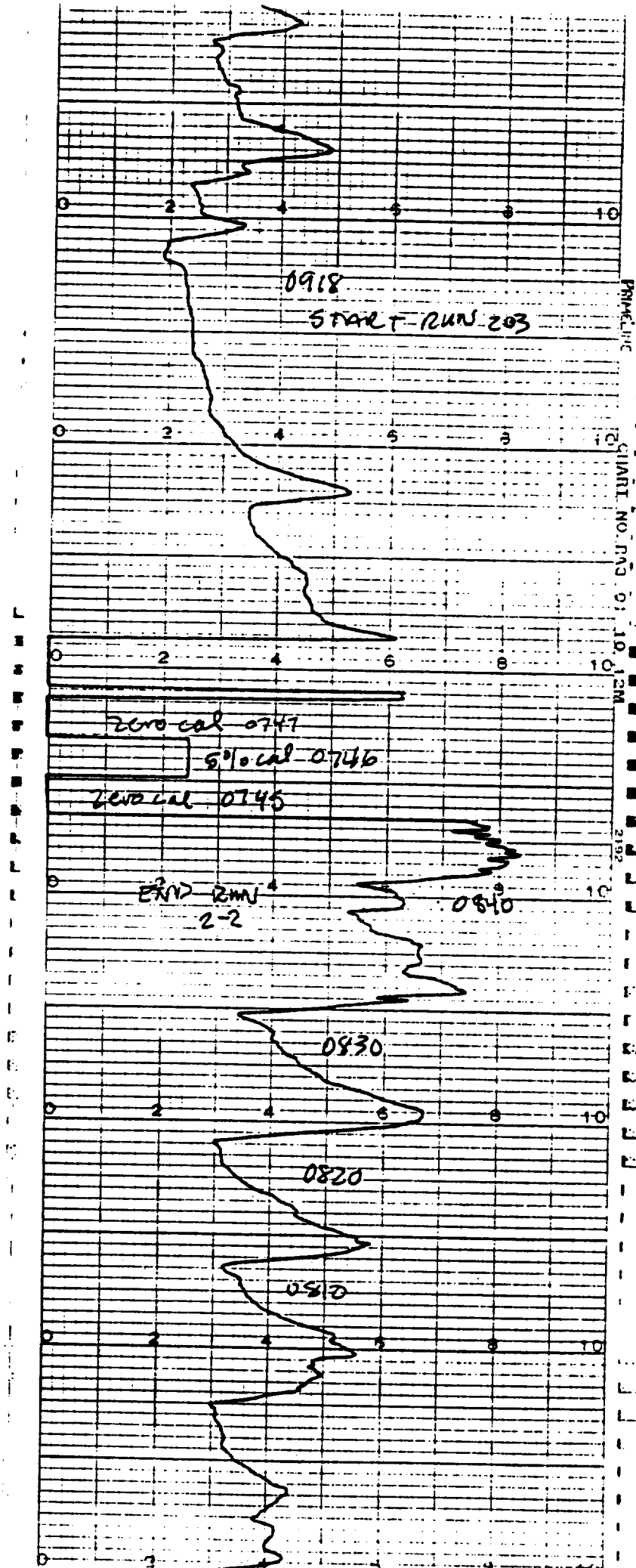

1015
0935
START RUN 1-2
zero cal 0917
5% cal 0916
zero cal 0915
END RUN 1-1
0910
0850

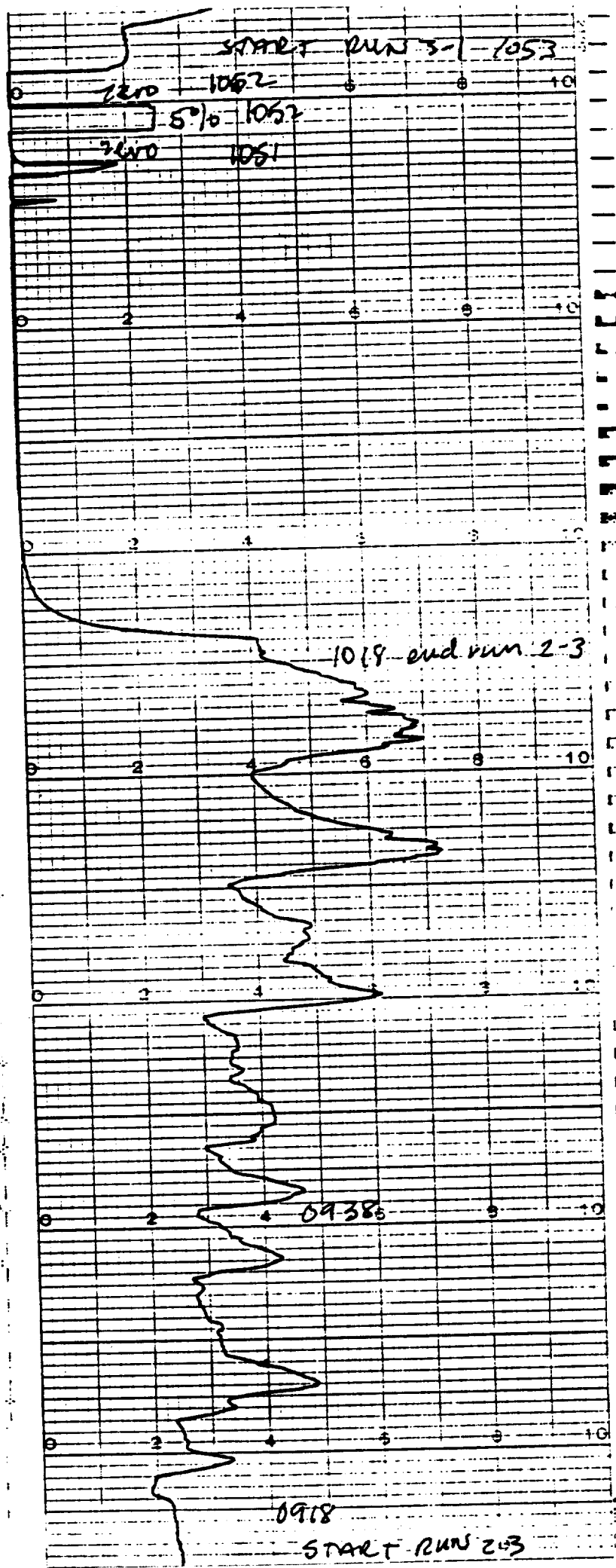

zero cal 1206
5% cal 1205
zero cal 1205
1158 end run 1-3
1138
start run 1-3
1058
zero cal 1044
6% cal 1044
zero cal 1044
end run 1-2
1035

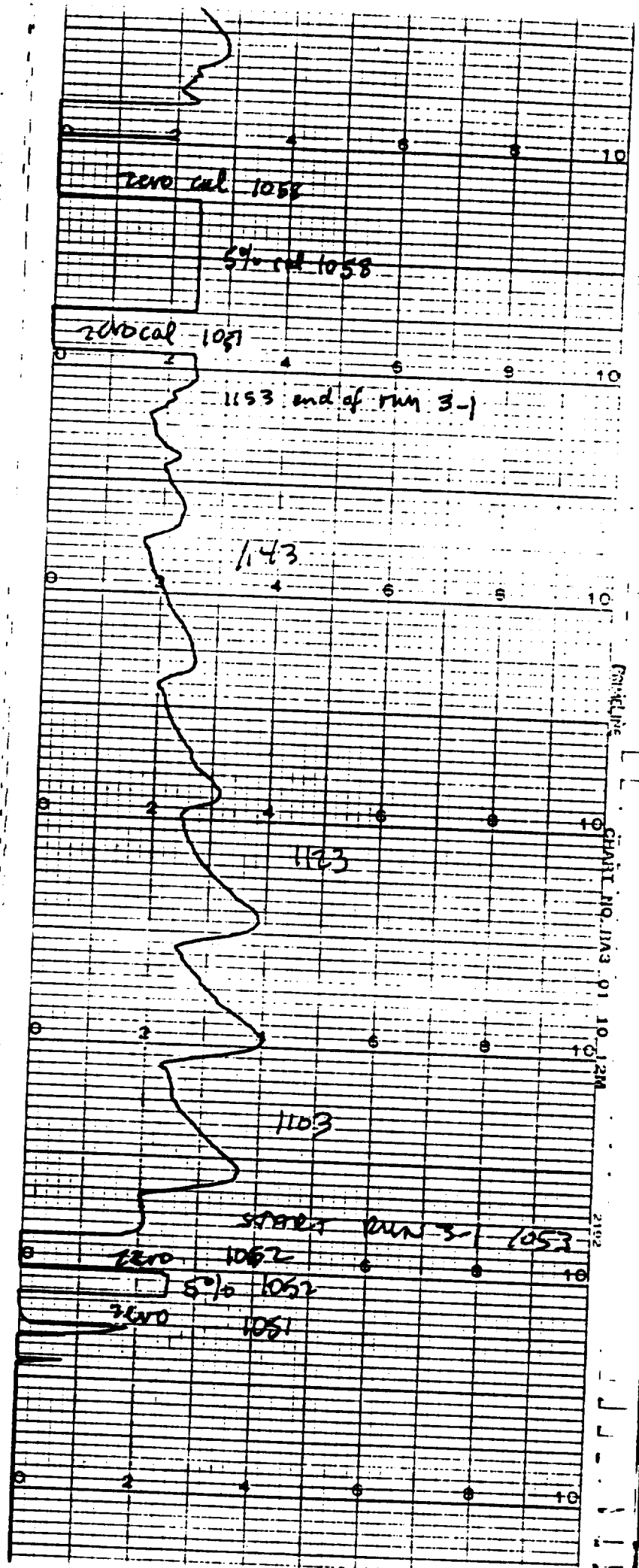

0520 zero span
0519 5% span
0518 10% span
0517 5% span
0516 zero span
Response time 40 seconds
Mayo Research Institute
Morse Boulger Incinerator
Semi continuous CO_2
11-11-88 Operator KJC
Tests 2 + 3
Range 0 + 20% F.S.
Chart speed 2.5 mm/min

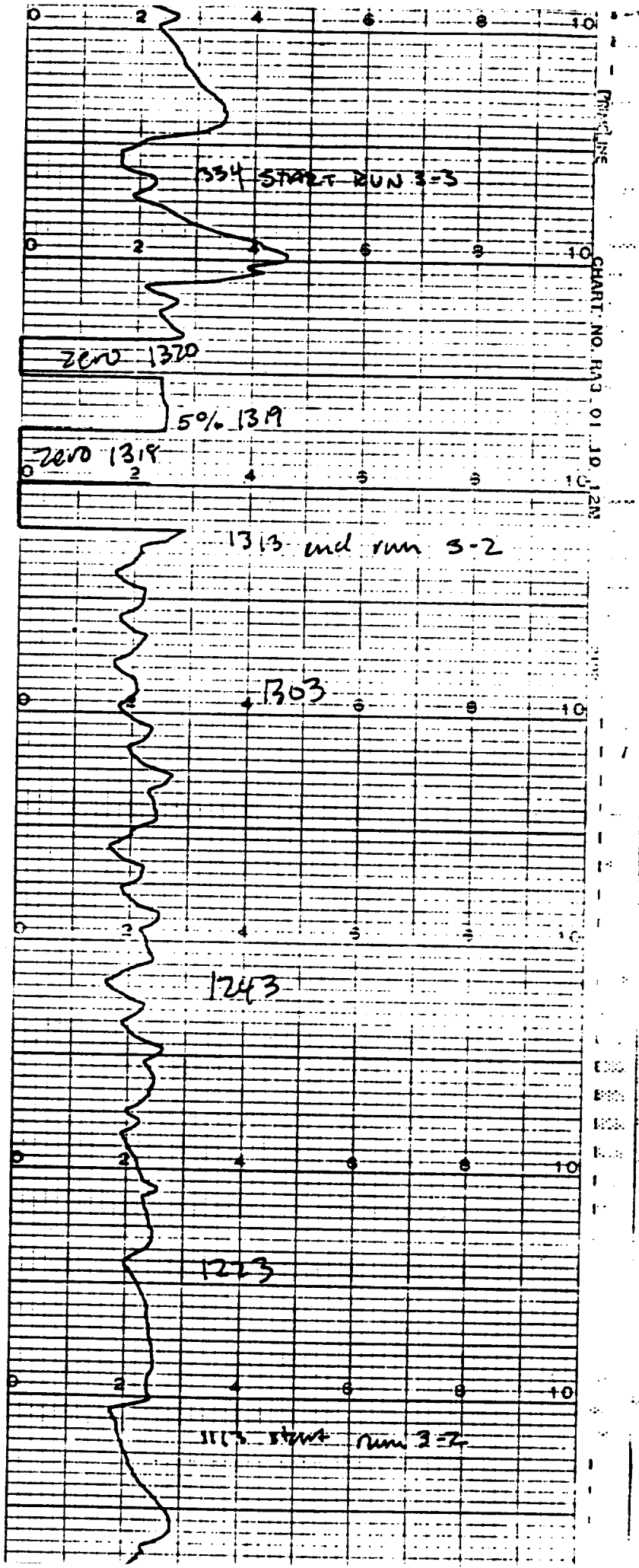

START RUN 2-1
0 2 4 6 8 10
0520 zero span
0519 5% span
0518 10% span
0517 5% span
0516 zero span
Response time 40 seconds
Mayo Research Institute
Morse Boulger Incubator
Semi continuous CO_2
11-11-88 Operator KJC
Tests 2 + 3
Range 0 + 20% FS

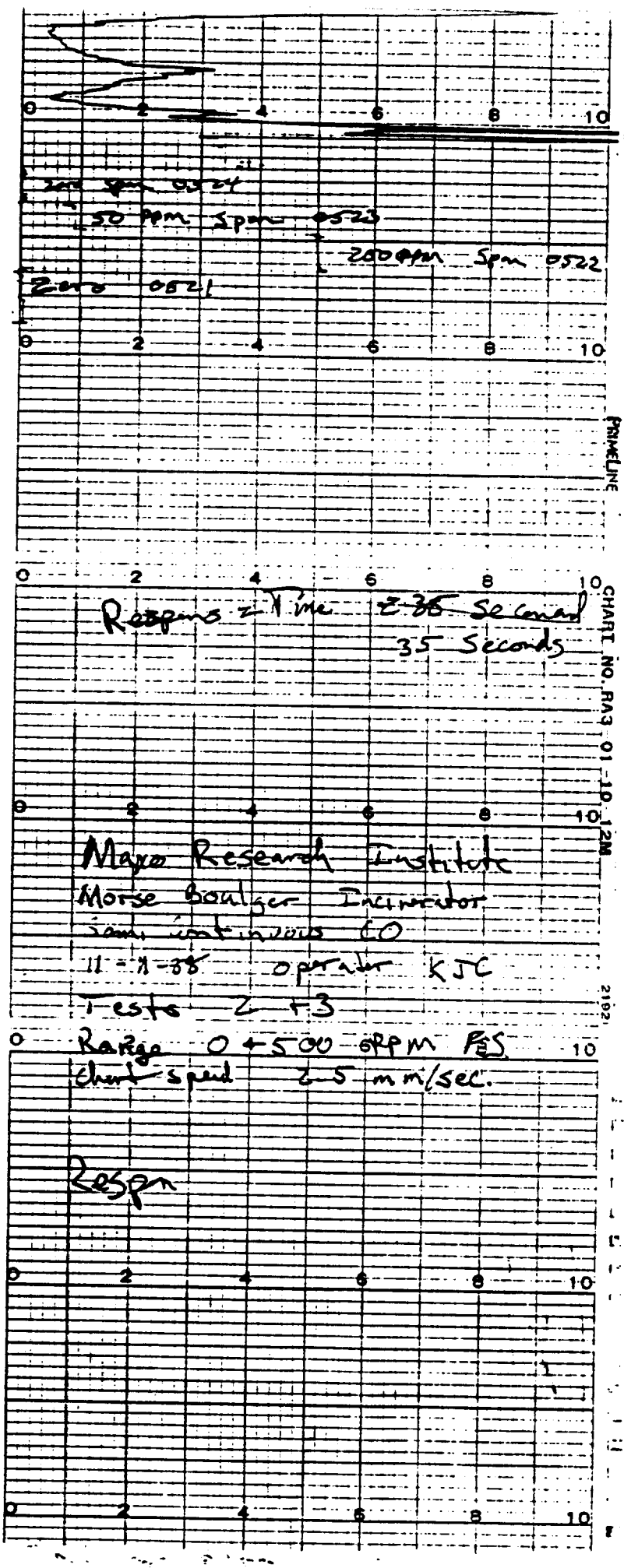

0710 START RUN 2-2
zero cal 0728
5% cal 0728
zero cal 0727
END RUN 2-1
0720
0710
0650
0640
0620
START RUN 2-1
PRIMELINE
CHART NO. 1143 01 10 12M
2182

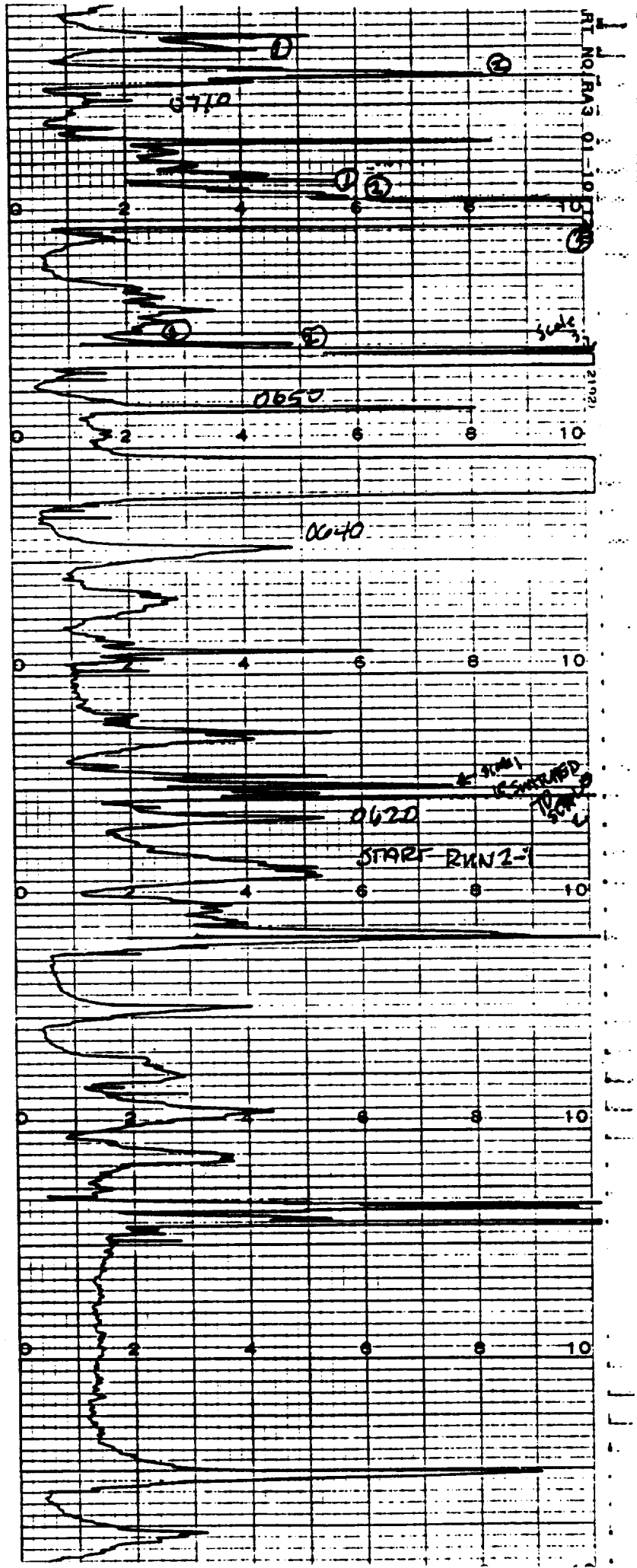

0918
START RUN 203
ZERO CAL 0747
5% CAL 0746
ZERO CAL 0745
END RUN 2-2
0840
0830
0820
0810

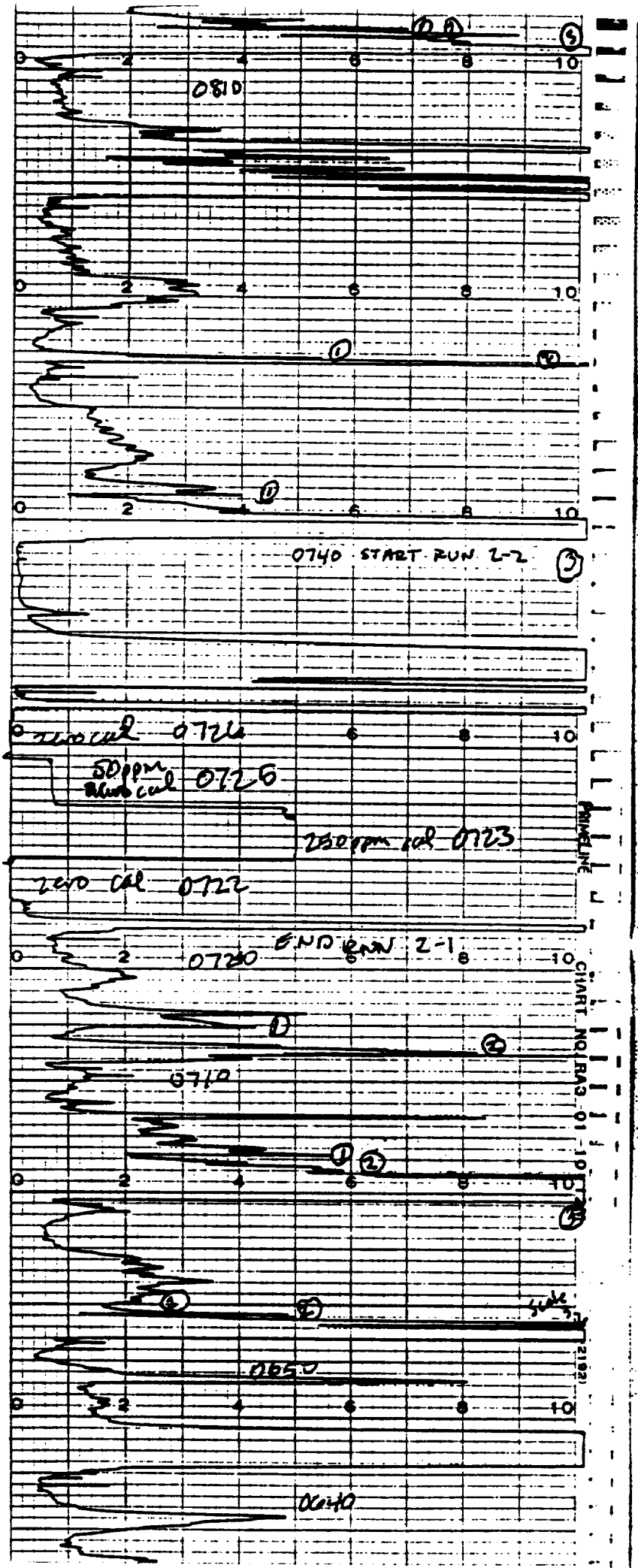

START RUN 3-1 1053
ZERO 1052
5% 1052
ZERO 1051
1018 end run 2-3
0938
0918
START RUN 2-3

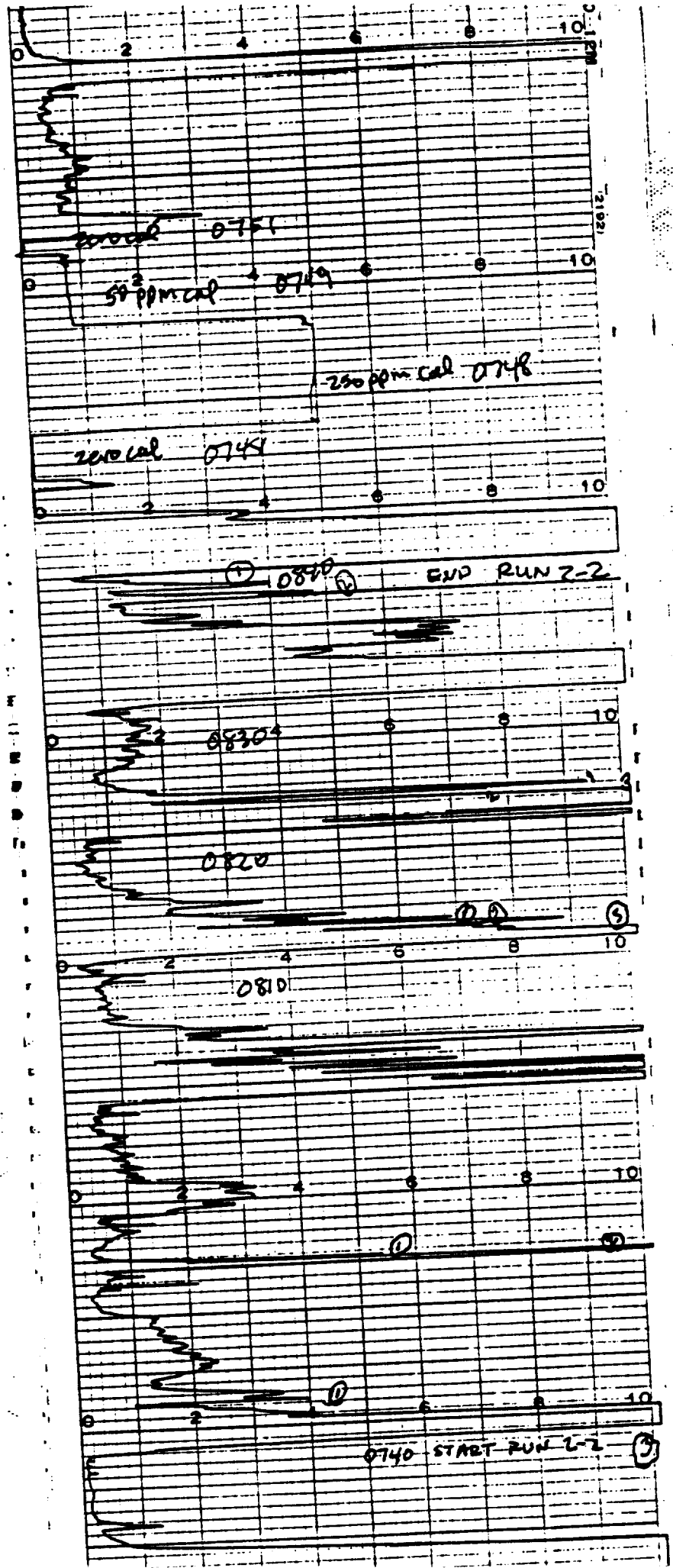

zero cal 1058
5% cal 1058
zero cal 1051
1153 end of run 3-1
1143
1123
1103
start run 3-1 1053
zero 1052
5% 1052
zero 1051

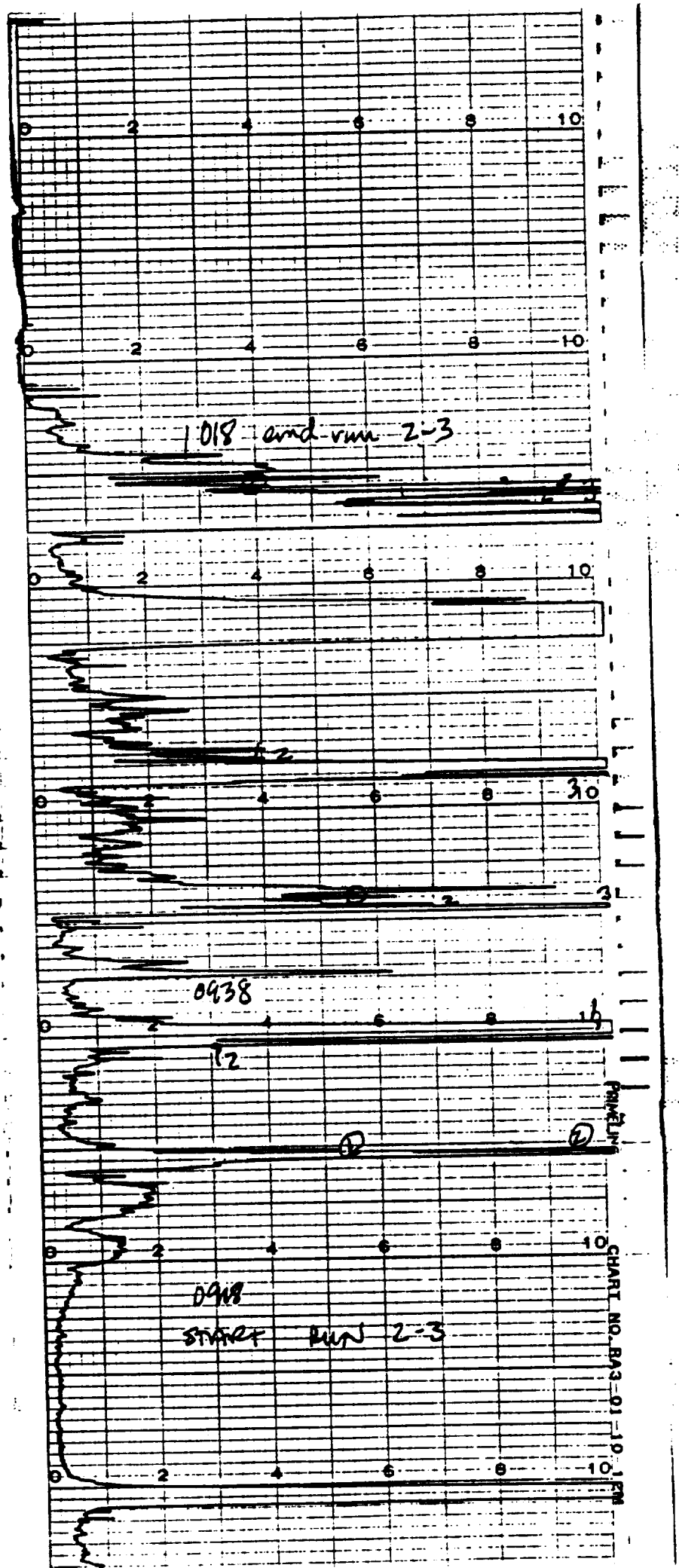

1334 START RUN 3-3
zero 1320
5% 1319
zero 1318
1313 end run 3-2
1303
1243
1223
1113 start run 3-2
CHART NO. RAD 01 10 12M

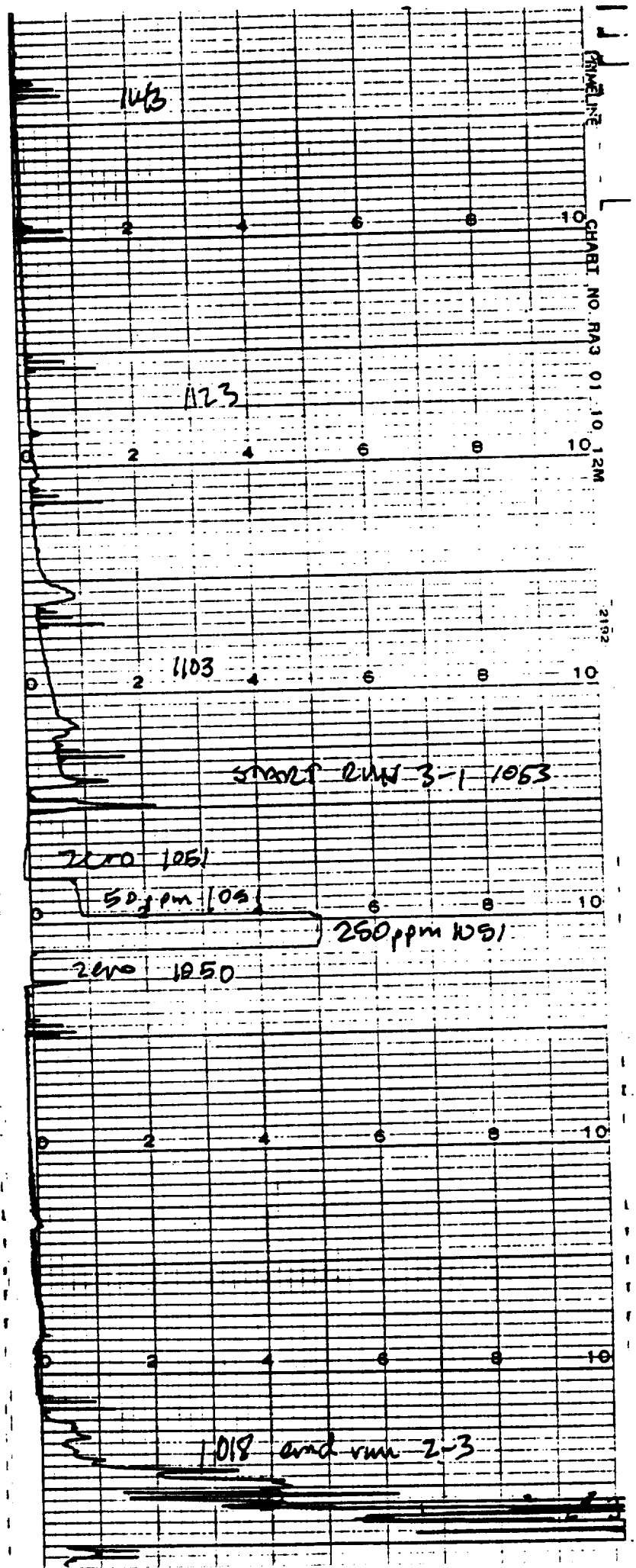

0 2 4 6 8 10
Zero 0524
50 ppm Span 0523
200 ppm Span 0522
Zero 0521
0 2 4 6 8 10
PRIMELINE
0 2 4 6 8 10
Response Time ~~~ 35 Seconds
CHART NO. RA3 01-10 12M
0 2 4 6 8 10
Mayo Research Institute
Morse Boulger Incinerator
Semi continuous CO
11-1-88 operator KJC
Tests 2 + 3
21921
0 Range 0 + 500 ppm PES 10
Chart speed 2.5 mm/sec.
Respn
0 2 4 6 8 10
0 2 4 6 8 10

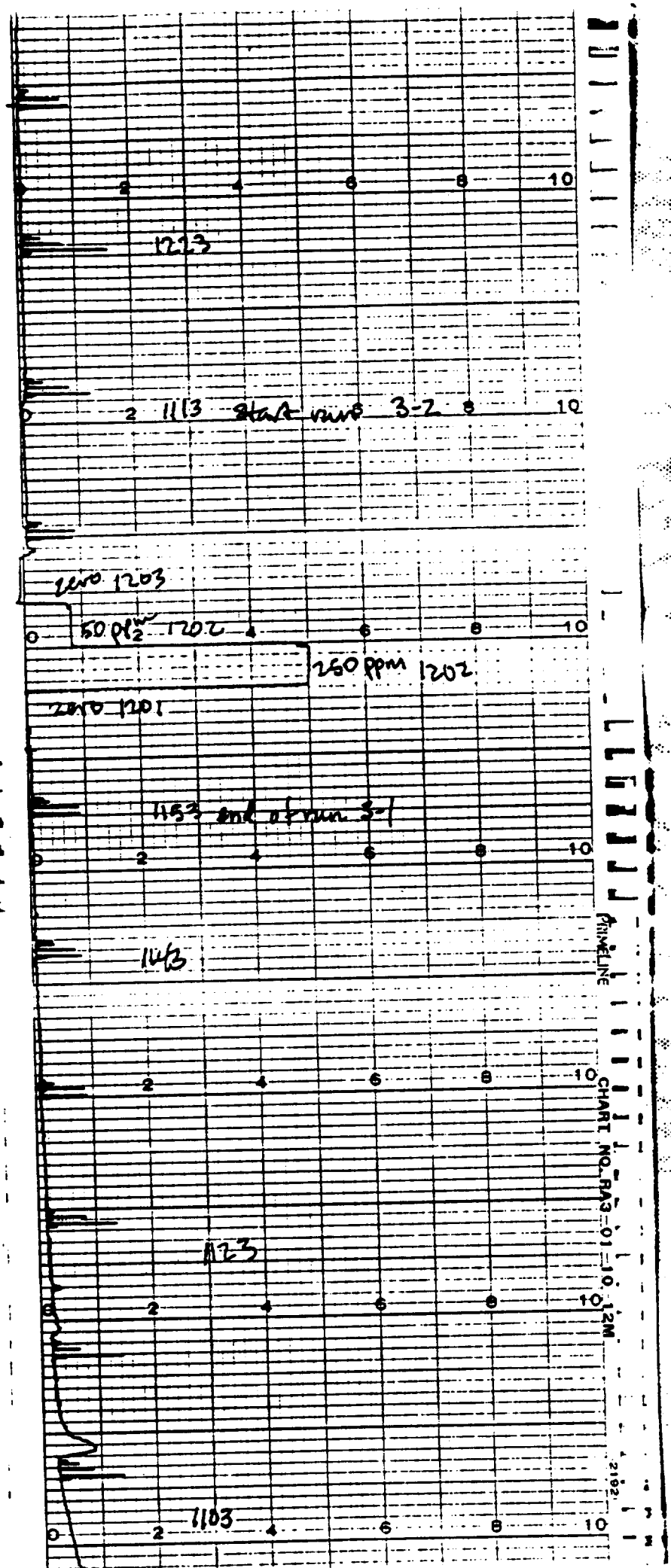

0710
0650
0640
0620
START RUN 2-1
scale
0
2
4
6
8
10


0810
0740 START RUN 2-2
zero cal 0724
50ppm span cal 0726
250ppm cal 0723
zero cal 0722
END RUN 2-1
0720
0710
0650
0640
CHART NO. RA3-01-10
PRIMELINE


0751
50 ppm cal 0749
250 ppm cal 0748
zero cal 0747
0840
END RUN 2-2
0830
0820
0810
0740 START RUN 2-2


1018 and run 2-3
0938
0918
START RUN 2-3
PRIMELINE
CHART NO. BA3-01-10-1 FM


TIMELINE
CHART NO. RA3 01 10 12M
1143
1123
1103
start run 3-1 1053
zero 1051
50 ppm 1051
250 ppm 1051
zero 1050
1018 and run 2-3


1223
1113 start run 3-2
zero 1203
50 ppm 1202
250 ppm 1202
zero 1201
1153 end of run 3-1
1143
1123
1103
PRIMELINE
CHART NO. RA3-01-10 12M

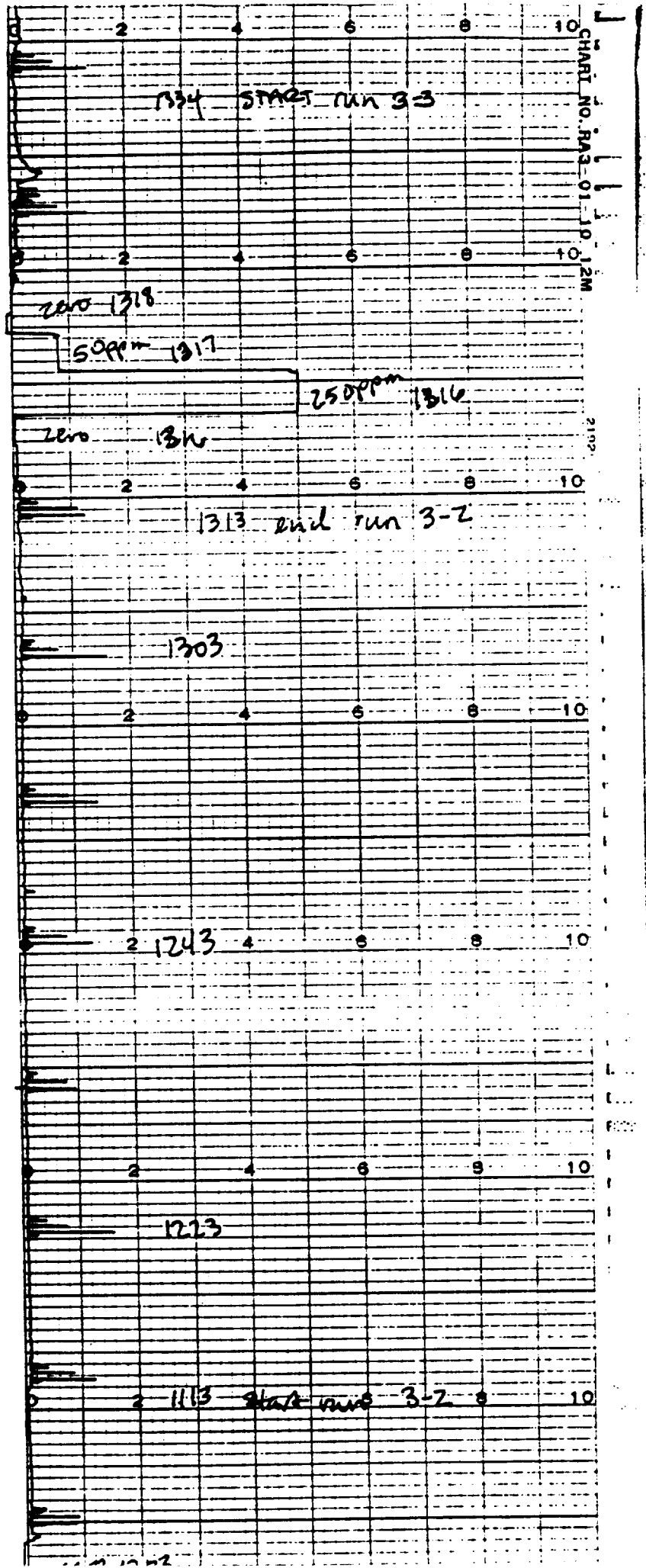
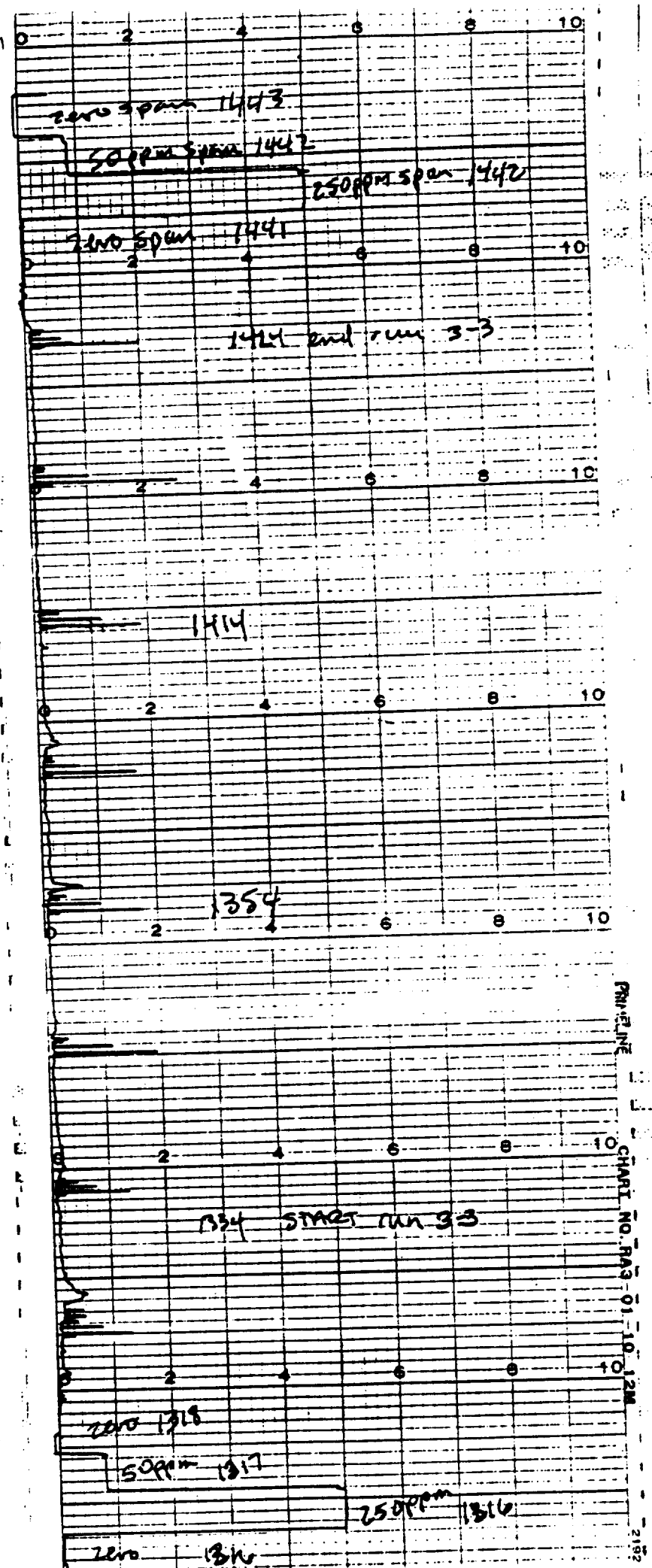


CHART NO. RA3-01-10-12M
1334 START run 3-3
zero 1318
50ppm 1317
250ppm 1316
zero 1314
1313 end run 3-2
1303
1243
1223
1113 start run 3-2


zero span 1443
50ppm span 1442
250ppm span 1442
zero span 1441
1414 end run 3-3
1414
1354
1354 START run 3-3
zero 1318
50ppm 1317
250ppm 1316
zero 1316
PRO-LINE
CHART NO. RA3-01-10 12M
2192

Appendix I
Temperature Stripchart Data

Appendix J

Incinerator Information Sheet

Appendix K

MPCA Exhibit C

Appendix L

Procedures

PARTICULATE LOADINGS AND EMISSION RATES

Particulate emission rates were determined in accordance with EPA methods 1-5, CFR 40, Part 60, Appendix A (July 1, 1985). Using traverse points determined with EPA Method 1, a preliminary velocity profile was obtained with respect to the velocity traverse, gas temperature, gas pressure and estimated moisture content. From this data sampling nozzles of the appropriate diameter to ensure isokinetic sampling were selected.

The particulate sampling train consists of a temperature controlled stainless steel lined probe equipped with a S-type pitot tube and Type K thermocouples to monitor stack temperature and probe liner temperature. The sampling probe is attached to a sample module which houses an all-glass in-line filter and cyclone assembly in a temperature controlled oven. The back half of the sampling train consists of a series of three glass impingers followed by a desiccant-packed drying column. The sample train is connected by means of a control and sampling umbilical cord to the control module. The control module houses a temperature monitored dry test gas meter, a calibrated orifice, dual inclined manometers, temperature controllers, and necessary flow rate control devices.

Particulate samples are collected by isokinetically extracting a sample gas stream from the flue by means of the sampling probe and passing the stream through the cyclone which collects larger, heavier particles. The sample gas stream then passes through a 4 inch diameter Gelman Type A/E glass fiber filter to collect finer particulates. The filter is followed by an ice-cooled impinger train and a desiccant packed drying column which quantitatively collects all moisture from the sample gas stream. The gas then passes through a leakless rotary vane sampling pump and the dry test gas meter which integrates the sampling flow throughout the course of the tests. A calibrated orifice is connected to the gas meter outlet to facilitate sample flow rate adjustment.

Representative particulate samples are collected by sampling the centroid of equal area sections of the duct for equal time periods. Sampling rate is adjusted at each sampling location so that isokinetic sampling prevails. Pre-programmed field computers are used to facilitate rapid determination of the correct sampling rate.

Integrated gas samples are collected concurrently with particulate samples so that a representative gas composition of the flue gas can be determined. Gas samples are collected in Tedlar bags throughout the course of the particulate run and analyzed with an Orsat gas analyzer.

At the end of each particulate run, the sampling train is disassembled and the samples recovered. The sampling filter is transferred from the filter holder to its specifically assigned petri dish. The probe nozzle is acetone rinsed, brushed, rinsed again and the washings placed in a labelled polyethylene container. The probe is similarlily cleaned; acetone rinsed, brushed several times, rinsed again and the washing transferred to the same polyethylene container. The filter holder and cyclone are wiped free of silicone grease, acetone rinsed, brushed, rinsed and these washings added to the probe wash container. The container is tightly capped and the liquid level marked for shipment. The impinger catch is determined volumetrically to the nearest 1 ml using a graduated cylinder. If the impinger catch is to be analyzed it is transfered to a separate polyethylene container, capped, and the liquid level marked. The desiccant-packed drying column is weighed in the field to the nearest .5 g and the weight of absorbed moisture added to the condensate for moisture calculations.

Particulate samples are transported back to the laboratory, logged in, and prepared for analyses. Filters are desiccated for 24 hours and weighed to a constant weight and the results recorded to the nearest .1 mg. Probe wash samples are evaporated at ambient temperatures to dryness in tared evaporating dishes. They are then desiccated for 24 hours and weighed to a constant weight. Results are reported to the nearest .1 mg.

Oxygen and Carbon Dioxide Concentration (Orsat)

Integrated gas samples are collected in a 30 liter Tedlar bags and ultimately transferred to an Orsat gas analyzer for oxygen and carbon dioxide analyses. A PACE sampling train which meets of exceeds the specifications of EPA Method 3, 40 CFR 60, Appendix A is used to collect gas samples. Normally, gas samples are collected at the exhaust of an EPA Method 4 or 5 sampling train since this stream is moisture conditioned. Method 4 and 5 sampling equipment is maintained and checked to assure no leaks occur between the flue and the integrated gas sampler.

Gas samples are collect by drawing a portion of the stream through a chemically resistant diaphragm pump and delivering it to the Tedlar bag at a constant, settable rate, depending on expected sampling time. At the conclusion of sampling, the bag and associated hardware is sealed and labelled. When multiple tests are to be performed, gas samples are often transferred to glass gas collection tubes for storage. A portable oxygen analyzer is used for this to ensure sample integrity.

Samples are analyzed by chemical absorbtion using an Orsat gas analyzer. Following positive and negative leak checks of the gas analyzer, the system is purged with the gas to be analyzed before filling the graduated burret with sample to be analyzed. The burret is filled with approximately 100 mls of sample gas and the exact volume recorded. The sample line stopcock is closed and the stopcock for the first bubbler containing CO_2 absorbent is opened. Several passes are made, bubbling the sample gas through the reagent and the CO_2 absorbent is returned to the mark. The new volume of the burret is recorded and an additional 1-2 passes are made to verify total absorbtion. Similar procedures are used to quantify oxygen with the same gas sample.

WET CATCH ANALYSIS - ORGANIC CONDENSIBLES

Particulate concentrations reported in this document include gravimetric results of both the dry catch and the organic wet catch. Organic condensibles were collected in a series of three ice-cooled all-glass impingers in the back half of the Method 5 sampling train. The first two impingers were intially prepared with 100 ml deionized distilled water in each and the third impinger was dry. After sampling, the volume of condensate in the impingers was determined and the contents transferred to an air-tight polyethylene sample container.

The wet catch was analyzed for condensible organic particulates with the chloroform-diethyl ether extraction. Three 25 ml portions of chloroform and three 25 ml portions of diethyl ether were used to extract condensed organics from the impinger catches (wet catch). The extractions were evaporated at room temperature and desiccated to a constant weight. Gravimetric results were then added to dry catch results to calculate particulate concentrations.

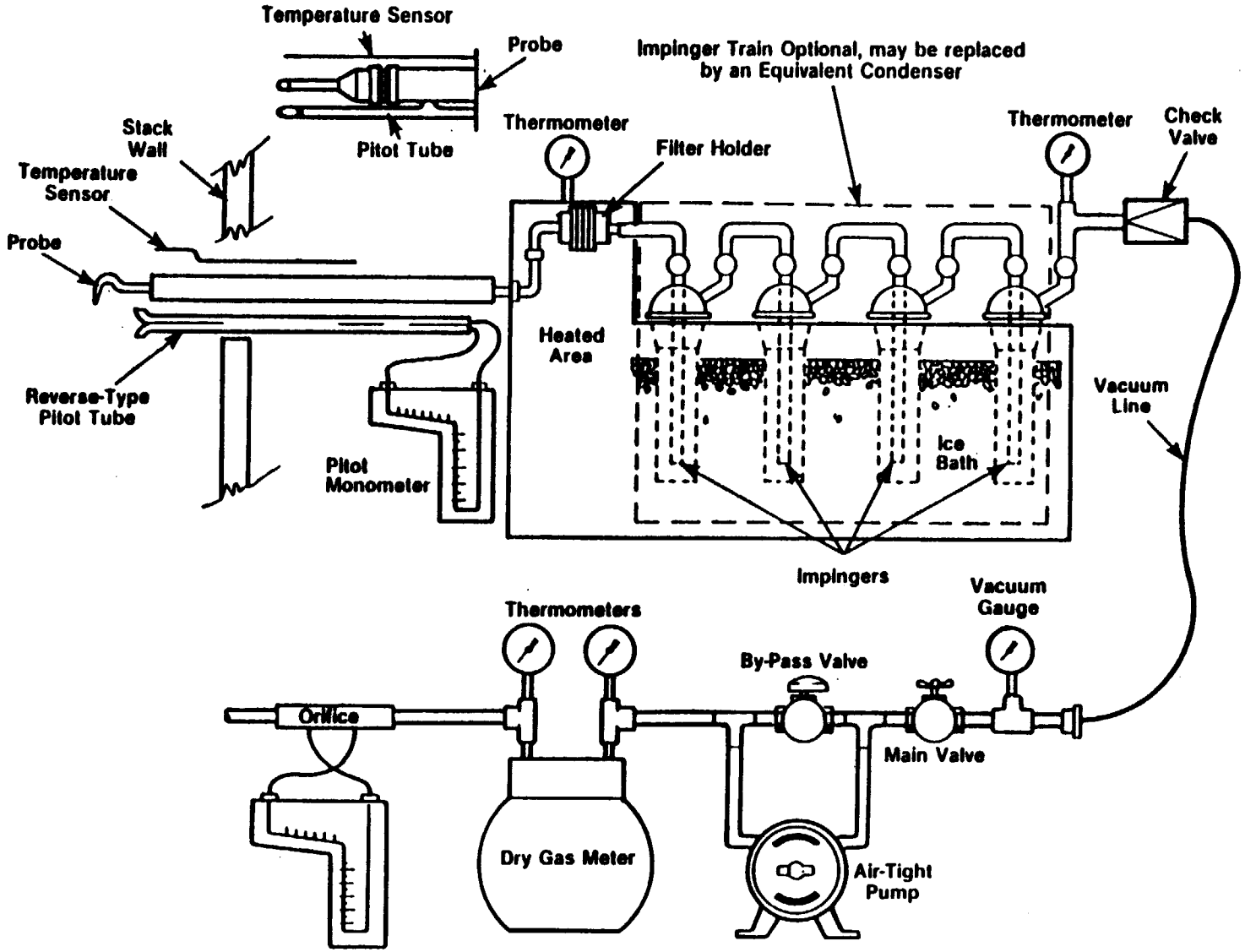


Figure 1. Method 5 Sampling Train

Appendix M
Calculation Equations

CALCULATION EQUATIONS

Method 2

$$V_s = 85.49\, C_p\, (\sqrt{\Delta P}\ (avg)) \sqrt{\frac{T_s}{P_s\, M_s}}$$

$$Q = 60\, V_s\, A$$

$$Q_{sd} = Q\,(1 - B_{ws}) \left(\frac{528}{T_s}\right)\left(\frac{P_s}{29.92}\right)$$

$$m_g = \frac{4.995\, Q_{sd}\, G_d}{1 - B_{ws}}$$

$$\rho = \frac{0.04585\, P_s M_s}{T_s}$$

CALCULATION EQUATIONS

<u>Method 3</u>

$$M_d = 0.44\ \%CO_2 + 0.32\ \%O_2 + 0.28\ (\%N_2 + \%CO)$$

$$M_s = M_d(1-B_{ws}) + 0.18\ B_{ws}$$

$$\%EA = 100\left(\frac{\%O_2 - 0.05\ \%CO}{0.264\ \%N_2 - \%O_2 + 0.5\%CO}\right)$$

$$F_o = \frac{20.9 - \%O_2}{\%CO_2}$$

CALCULATION EQUATIONS

Method 5

$$V_{std} = 17.647\, V_m\, Y \left(\frac{P_b + \Delta H/13.6}{\overline{T_m}} \right)$$

$$V_w = 0.047070\, V_{lc}$$

$$B_{ws} = \frac{V_w}{V_w + V_{std}}$$

$$C_s = 15.432 \left(\frac{M_n}{V_{std}} \right)$$

$$C_a = 272.22 \left(\frac{M_n P_s}{\overline{T_s}\, V_w + V_{std}} \right)$$

$$m_p = 0.00857\, C_s\, Q_{sd}$$

$$I = 0.09450 \left(\frac{\overline{T_s}\, V_m}{P_s\, V_s\, A_n\, \emptyset\, (1 - B_{ws})} \right)$$

NOMENCLATURE

A = Cross-sectional area of duct

A_n = Cross-sectional area of nozzle

B_{ws} = Water vapor in gas stream, proportion by volume

C_a = Particulate concentration, actual, wet basis - GR/ACF

C_s = Particulate concentration at dry standard conditions - GR/DSCF

%EA = Excess air, percent by volume

G_d = Specific gravity relative to air, dimensionless

I = Isokinetic variation, percent by volume

M_d = Molecular weight of flue gas, dry, lb/lb-mole

m_g = Mass flow of wet flue gas, LB/HR

m_n = Total particulate collected, grams

m_p = Particulate mass flow, LB/HR

M_s = Molecular weight of flue gas, wet, lb/lb-mole

P_b = Barometric pressure, uncompensated, inches of mercury

P_g = Static pressure of duct, inches of water

P_s = Absolute gas pressure of duct, inches of mercury

Q = Actual flue gas volumetric flow rate, ACFM

Q_{sd} = Dry flue gas volumetric flow rate corrected to standard conditions, DSCFM

$\overline{T_m}$ = Average dry gas meter temperature, °R

$\overline{T_s}$ = Average stack gas temperature, °R

$\emptyset$ = Total sampling time, minutes

V_{lc} = Total volume of liquid collected in impingers and desiccant, ml

V_m = Volume of gas sample measured by gas meter, cubic feet

V_{std} = Volume of gas sample corrected to standard conditions, dry standard cubic feet

V_w = Volume of water vapor in gas sample, corrected to standard conditions

V_s = Linear velocity of flue gas, feet per second

Y = Dry gas meter calibration factor

ΔH = Orifice meter differential pressure, inches of water

ΔP = Velocity pressure of flue gas, inches of water

ρ = Actual gas density, pounds per cubic foot

Appendix N
Sampling Train Calibration Data

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No.: 881003.403

PACE Laboratories, Inc.
November 29, 1988

AIR SAMPLING DEPARTMENT

NOZZLE CALIBRATION

DATA SHEET

Nozzle Number: 1-4

Date of Calibration: 10/27/88

Technician: D. Wold

Position		Diameter
1		0.370
2		0.370
3		0.371
4		0.370
5		0.369
	Average>	0.370

The sampling nozzle is rotated and measured at 36 degree increments. Dimensions are measured to the nearest 0.001" All measurements must be within a range of 0.004"

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No.: 881003.403

PACE Laboratories, Inc.
November 29, 1988

AIR SAMPLING DEPARTMENT

NOZZLE CALIBRATION

DATA SHEET

Nozzle Number: 1-5

Date of Calibration. 10/27/88

Technician: D. Wold

Position		Diameter
1		0.501
2		0.503
3		0.503
4		0.503
5		0.502
	Average>	0.502

The sampling nozzle is rotated and measured at 36 degree increments. Dimensions are measured to the nearest 0.001". All measurements must be within a range of 0.004"

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No.: 881003.403

PACE Laboratories, Inc.
November 29, 1988

PITOT TUBE CALIBRATION DATA SHEET

Pitot Tube No.: 4

Calibration Date: 9/16/88

Technician: D. Wold

Side "A" Calibration

Trial No.	Delta P(std)	Delta P(S-type)	Coefficient
1	0.465	0.658	0.832
2	0.460	0.650	0.833
3	0.460	0.652	0.832
		Side "A" Average>	0.832

Side "B" Calibration

Trial No.	Delta P(std)	Delta P(S-type)	Coefficient
1	0.460	0.650	0.833
2	0.460	0.640	0.839
3	0.460	0.638	0.841
		Side "B" Average>	0.838
		Overall Average>	0.835

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No.: 881003.403

PACE Laboratories, Inc.
November 29, 1988

DRY TEST METER CALIBRATION REPORT

Control Module No.: C-3
Date: 10/31/88
Technician: D. Wold
Bar. Press 28.91

Orifice Diff. Pressure Inches WC	Dry Gas Meter Volume Cubic Feet	Wet Test Meter Volume Cubic Feet	Dry Gas Meter Temperatures (°F)		Wet Test Meter Temp (°F)	Time Minutes	Meter Coef.	Orifice Coef.
			Inlet	Outlet				
0.50	5.161	5.000	90.5	79.0	70.0	11.963	0.9945	1.622
1.00	6.240	6.000	98.5	85.5	70.0	10.515	0.9989	1.717
1.75	10.228	10.000	90.0	75.0	70.0	13.890	0.9963	1.921
2.50	10.380	10.000	102.5	87.0	70.0	11.703	1.0020	1.905
3.50	10.285	10.000	101.0	83.0	70.0	10.030	1.0037	1.969

Average Orifice Coefficient: 1.827

Average Meter Coefficient: 0.9991

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No.: 881003.403

PACE Laboratories, Inc.
November 29, 1988

DRY TEST METER CALIBRATION REPORT

Control Module No.: C-2
Date: 10/3/88
Technician: D. Wold
Bar. Press 29.24

Orifice Diff. Pressure Inches WC	Dry Gas Meter Volume Cubic Feet	Wet Test Meter Volume Cubic Feet	Dry Gas Meter Temperatures (°F)		Wet Test Meter Temp. (°F)	Time Minutes	Meter Coef.	Orifice Coef.
			Inlet	Outlet				
0.50	5.147	5.000	87.0	77.5	69.5	12.976	0.9936	1.888
1.00	10.300	10.000	92.0	79.0	69.5	18.743	0.9977	1.957
1.75	10.177	10.000	79.0	75.0	69.5	14.426	0.9922	2.061
2.50	10.319	10.000	99.0	83.0	69.5	12.341	1.0021	2.100
3.50	10.152	10.000	87.5	76.0	69.5	10.720	0.9990	2.257

Average Orifice Coefficient: 2.053

Average Meter Coefficient: 0.9969

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No.: 881003.403

PACE Laboratories, Inc.
November 29, 1988

Temperature Sensor
Calibration Report

Digital Number: D-2
Make/Model : Omega 871
Date of Cal. : 9/16/88

Ref. Standard : Omega CL-300 Calibrator
Technician : D. Wold

Reference Temperature °F	Thermocouple Temperature °F	Temperature Difference Percent	Reference Temperature °F	Thermocouple Temperature °F	Temperature Difference Percent
-25	-27.2	0.51	425	423	0.23
0	-1.4	0.30	450	448	0.22
25	23.9	0.23	475	472	0.32
50	49.2	0.16	500	497	0.31
75	74.2	0.15	600	599	0.09
100	99.8	0.04	700	699	0.09
125	124.5	0.09	800	799	0.08
150	149.8	0.03	900	898	0.15
175	174.8	0.03	1000	998	0.14
200	199	0.15	1100	1098	0.13
225	224	0.15	1200	1196	0.24
250	249	0.14	1300	1298	0.11
275	274	0.14	1400	1398	0.11
300	299	0.13	1500	1498	0.10
325	324	0.13	1600	1597	0.15
350	349	0.12	1700	1699	0.05
375	373	0.24	1800	1799	0.04
400	399	0.12	1900	1898	0.08

Mayo Foundation Research Institute
Rochester, Minnesota
PACE Project No.: 881003 403

PACE Laboratories, Inc.
November 29, 1988

Temperature Sensor
Calibration Report

Digital Number: D-5
Make/Model : Omega HH-79 KF
Date of Cal. : 9/16/88

Ref. Standard : Omega CL-300 Calibrator
Technician : D. Wold

Reference Temperature °F	Thermocouple Temperature °F	Temperature Difference Percent	Reference Temperature °F	Thermocouple Temperature °F	Temperature Difference Percent
-25	-25	0.00	425	425	0.00
0	0	0.00	450	449	0.11
25	23	0.41	475	474	0.11
50	48	0.39	500	497	0.31
75	73	0.37	600	597	0.28
100	99	0.18	700	698	0.17
125	124	0.17	800	799	0.08
150	150	0.00	900	900	0.00
175	176	-0.16	1000	1001	-0.07
200	202	-0.30	1100	1101	-0.05
225	227	-0.29	1200	1199	0.06
250	253	-0.42	1300	1300	0.00
275	277	-0.27	1400	1396	0.22
300	302	-0.26	1500	1492	0.41
325	326	-0.13	1600	1586	0.68
350	352	-0.25	1700	1679	0.97
375	375	0.00	1800	1770	1.33
400	401	-0.12	1900	1860	1.69

CHARGING LOG

Date: 11-4-80
Shift:
Supervisor:
Day Shift: _____ Evening Shift: _____
Instructor:
Issues:

TIME	QUANTITY (YARDS)	PRIMARY TEMP. °F	SECONDARY TEMP. °F	REMARKS
7.00	#100 RB	830	1540	
7:09	#100 RB	1029	1697	
7:21	60 RB	1014	1661	85# Trash
7:29	66 RB	1002	1631	↓
7:37	152# RB	1002	1597	↑
7:46	212# RB	1082	1589	116#
7:54	144# RB	1113	1700	165# Trash
7:59	167# RB	1085	1753	↓
8.07	160# RB	1093	1727	75# trash
8.14	200# RB	1103	1820	110# Trash
8:21	143# RB	1077	1785	75# Trash
8:29	226# RB	1066	1876	60# Trash
8:37	180# RB	1213	1844	62# Trash
8:47	184# RB	1119	1764	50# Trash
8:55	195# RB	1044	1744	65# Trash
9:06	150# RB	1055	1831	90# Trash
9:29	151# RB	1024	1746	67# Trash
9:38	92# RB	1097	1887	100# Trash
9:46	105# RB	1087	1785	35# Trash
9:56	73# RB	1103	1796	90# Trash
10:06	191# RB	1090	1762	No Trash
10:17	81# RB	1109	1861	130# Trash
10.28	117# RB	1101	1910	148# Trash
10:37	81# RB	1103	1889	100# Trash
10:46	130# RB	1153	1846	49# Trash
10:56	166# RB	1191	1811	5# Trash
11:10	103# RB	1266	1836	No trash
11:20	173# RB	1231	1809	No Trash
11.29	208# RB	1227	1811	No Trash
11:43	200# RB	1224	1805	No Trash
11:54	196# RB	1207	1819	No Trash

TIME	QUANTITY (YARDS)	PRIMARY TEMP. °F	SECONDARY TEMP. °F	REMARKS
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
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43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				
43# water				

CHARGING LOG

Date: 11-11-88
Start-up:
Operator:
Day Shift: ________ Evening Shift: ________

Instructor: M.B.
Source:

TIME	QUANTITY (YARDS)	PRIMARY TEMP. °F	SECONDARY TEMP. °F	REMARKS	TIME
5:16	118# RB	1075	1675	50# Trash	43# water
5:27	130# RB	1103	1657	79# Trash	43# "
5:51	89# RB	1103	1759	95# Trash	43# "
6:02		1112	1782	110# Trash	43# "
6:13	102# RB	1115	1791		43# "
6:23	138# RB	1091	1744	80# Trash	43# "
6:33	85# RB	1104	1870	84# Trash GHW	43# "
6:43	114# RB	1114	1877	76# GHW	43# "
6:51	75# RB	1102	1866	87# GHW	43# "
7:02	91# RB	1105	1766	119 GHW	43# "
7:12	205# RB	1104	1771	68# GHW	43# "
7:23	[illegible]	1116	1878	140# GHW [illegible]	43# "
7:30	91# RB	1097	1816	135# GHW	43# "
7:40	140# RB	1119	1808	120# GHW	43# "
7:52		1107	1780	Long Stroke	
7:55	65# RB	1194	1733	126# GHW	43# water
8:04	75# RB	1185	1745	115# GHW	43# "
8:14	250# RB	1191	1780	135# GHW	43# "
8:24	43# RB	1164	1753	140# GHW	43# "
8:33	290# RB	1180	1787	115# GHW	43# "
8:42	175# RB	1449	1874	125# GHW	43# "
9:03	125# RB	1270	1812	135# GHW	43# "
9:26	75# RB	1112	1775	65# GHW	43# "
9:35	45# RB	1204	1779	65# GHW	43# "
9:44	70# RB	1229	1800	95# GHW	43# "
9:52	85# RB	1204	1817	105# GHW	43# "
10:02	85# RB	1219	1823	110# GHW	43# "
10:12	95# RB	1350	1857	90# GHW	43# "
10:22	85# RB	1301	1839	150# GHW	43# "
10:48	103# RB	1714	1751	190# GHW	43# "
10:56	85# RB	1131	1744	130# GHW	43# "
11:07	93# RB	1199	1785	120# GHW	43# "
11:16	160# RB	1236	1791		43# "
11:[illegible]	113# RB	1287	1776		43# "
11:[illegible]	122# RB	1231	1787		43# "
11:[illegible]	95# RB	1123	17[illegible]		43# "
					43#

CHARGING LOG

Date: 11/1/88
Start-up:
Signature:
Day Shift: _____ Evening Shift: _____
Inspector: M B
Secure:

TIME	QUANTITY (YARDS)	PRIMARY TEMP. °F	SECONDARY TEMP. °F	REMARKS
11:56	115# RB	1107	1736	
12:03	165# RB	1106	1762	
12:13	110# RB	1109	1710	
12:25	170# RB	1131	1742	
12:35	160# RB	1114	1754	
12:44	132# RB	1105	1746	
12:57	155# RB	1101	1775	
1:07	130# RB	1102	1819	
1:15	125# RB	1106	1853	100 G.H.W.
1:24	[illegible]	1126	1838	OK G.H.W.
1:34	205 RB	1104	1768	
1:45	175# RB	1128	1851	
[illegible]:54	235# RB	1113	17[illegible]	
2:05	250#	1176	1803	
2:15	[illegible]#	1231	1958	
2:25	75# RB	1233	1869	
2:35	95# RB	1235	1909	

TIME	QUANTITY (YARDS)	PRIMARY TEMP. °F	SECONDARY TEMP. °F	REMARKS
43#	[illegible]			
43#	"			
43#	"			
43#	"			
43#	"			
43#	[illegible]			
43#	"			
43#	"			
43#	"			
43#	"			
43#	"			
43#	"			
43#	"			
43#	"			
43#	"			
43#	"			
43#	"			
43#	"			

pace laboratories, inc.
Air Sampling Department

Incinerator Operating Log

Mayo Foundation Research Institute

Morse Boulger Incinerator

Clock Time	Secondary Chamber Temperature (°F) 1	Primary Chamber Temperature (°F) 3	Carbon Monoxide (PPM, dry)	Carbon Dioxide (% v/v, dry)	Oxygen (% v/v, dry)
0809	N.G. 894700	TEST 1-1			
0810	1823	1112	9	6.4	13
0820	1830	1072	6	6.3	13.2
0830	1918	1180	7	6.5	12.6
0840	1834	1204	7	5.4	13.9
0850	1789	1076	7	5.2	15.2
0900	1875	1079	8	6.4	12.6
0910	1916	1160	8	5.98	14.1
0912	N.G. 894706				
0934	N.G. 894708	TEST 1-2			
0935	1887	1100	2	5.3	14.3
0945	1828	1089	0	5.07	14.7
0955	1805	1096	4	5.58	13.6
1005	1757	1084	5	6.01	13.7
1015	1861	1114	3	5.22	13.7
1025	1867	1104	6	5.1	14.8
1035	1803	1181	2	6.22	12.9
1036	N.G. 894713				
1056	N.G. 894714	TEST 1-3			
1058	1955	1232	1	8.4	9.4
1108	1798	1273	3	8.25	12
1118	1860	1233	5	6.26	12.2
1128	1829	1251	2	6.13	13
1138	1911	1221	3	6.75	11
1148	1909	1219	4	7.72	12.1
1158	1848	1214	1	6.4	13
1200	N.G. 894719				

pace laboratories, inc.
Air Sampling Department

Incinerator Operating Log

Mayo Foundation Research Institute

Morse Boulger Incinerator

Clock Time	Secondary Chamber Temperature (°F) 1	Primary Chamber Temperature (°F) 3	Carbon Monoxide (PPM, dry)	Carbon Dioxide (% v/v, dry)	Oxygen (% v/v, dry)
0619	N.G 895717	TEST 2-1			
0620	1731	1093	97	5.18	13.7
0630	1871	1105	55	5.79	13.6
0640	1804	1102	13	3.97	13.8
0650	1883	1114	236	6.29	10.6
0700	1794	1111	30	5.55	16.1
0710	1787	1103	66	5.18	16.0
0720	1915	1112	44	6.30	11.0
0722	N.G. 895723				
0739	N.G. 895725	TEST 2-2			
0740	1845	1122	4736	11.13	4.0
0750	1817	1107	40	5.78	13.5
0800	1776	1193	46	7.08	12.8
0810	1765	1185	44	7.10	12.4
0820	1772	1171	42	7.02	13.2
0830	1801	1189	68	8.42	10.7
0840	1869	1300	61	11.53	4.3
0841	N.G. 895730	~~[illegible]~~			
0916	NG. 895733	TEST 2-3			
0918	1718	1156	27	4.58	15.6
0928	1829	1200	24	7.78	12.8
0938	1841	1209	22	5.95	14.2
0948	1847	1201	42	6.98	12.8
0958	1861	1236	90	9.6	8.8
1008	1866	1359	44	9.24	10.8
1018	1812	1318	25	8.33	11.2
1018	N.G. 895738				

Natural Gas is reading x 1000

Pace laboratories, inc.
Air Sampling Department

Incinerator Operating Log

Mayo Foundation Research Institute

Morse Boulger Incinerator

Clock Time	Secondary Chamber Temperature (°F)	Primary Chamber Temperature (°F)	Carbon Monoxide (PPM, dry)	Carbon Dioxide (% v/v, dry)	Oxygen (% v/v, dry)
1053	N.G. 895740	TEST 3-1			
1053	1751	1125	26	4.15	15.2
1103	1825	1202	76	5.7	13.7
1113	1839	1239	8	5.71	13.5
1123	1871	1290	6	5.46	13.5
1133	1773	1228	3	4.25	15.0
1143	1712	1121	10	3.57	16.1
1153	1722	1106	3	4.32	15.2
1154	N.G. 895745				
1212	N.G. 895746	TEST 3-2			
1213	1707	1109	2	3.79	15.8
1223	1724	1127	4	4.15	15.3
1233	1724	1107	2	3.96	15.4
1243	1747	1102	3	3.41	16.7
1253	1770	1106	5	3.65	16.2
1303	1783	1101	7	3.62	16.0
1313	1861	1111	8	4.16	13.9 ~~[illegible]~~
1315	N.G. 895752				
1333	N.G. 895753	TEST 3-3			
1334	1820	1110	5	3.65	13.9
1344	1832	1126	4	4.52	15.4
1354	1781	1109	5	4.13	15.4
1404	1813	1184	5	5.32	13.5
1414	1958	1231	6	4.55	14.4
1424	1877	1236	3	3.5	15.9
1434	1910	1239	5	4.1	15.2
	N.G. 895758				

Natural Gas reading X/000

pace laboratories, inc.

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa

Client _____ By _____ Date _____

Project _____ Sheet No. _____ of _____

Subject _____ Project No. _____

NOTES

11-10 RUN 3-2

10:04 AM – CO_2 shot up, CO shot up, O_2 decreased
an extra charge was put in. charge
contained 3 large foam mattress pads.

11-11 CO reading very high occassionally.
switched location of probe after run 2-3.
CO reading steady for run 3-1.