~~AWS~~
ESS

Truck & Bus Group
Fort Wayne Assembly
General Motors Corporation
12200 Lafayette Center Road
Roanoke, Indiana 46783-9668

March 17, 1993

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State of Indiana
Department of Environmental Management
Office of Air Management

CERTIFIED MAIL P 360 683 547
RETURN RECEIPT REQUESTED

Mr. ~~Ed~~ Surla, Chief
Enforcement Section
Office of Air Management
Indiana Department of Environmental Management
105 South Meridian Street
P. O. Box 6015
Indianapolis, Indiana 46225-6015

Dear Mr. Surla:

General Motors Fort Wayne Assembly Plant located at 12200 Lafayette Center Road, Roanoke, Indiana, is submitting results of compliance stack testing pursuant to 40 CFR 60.8 and continuous emissions monitor and opacity monitor certification pursuant to 40 CFR 60.13. Testing was conducted on February 2 and February 3, 1993, for natural gas/oil-fired boiler #4.

Please contact me at (219) 673-2480 should you have questions relative to the test results.

Sincerely,

Kim Kurtz-Seslar

219-673-2505

Kim Kurtz-Seslar
Environmental Engineer

#4TSTRLT/kks

Clean Air Engineering

500 W Wood St. • Palatine, IL 60067 • 708-991-3300

REPORT ON
COMPLIANCE TESTING
Including Continuous Emissions Monitor and Continuous Opacity Monitor Certification

Performed for:
GENERAL MOTORS CORPORATION
NORTH AMERICAN TRUCK PLATFORMS
FORT WAYNE ASSEMBLY PLANT
ROANOKE, INDIANA

CAE Project No: 6520
March 16, 1993

GENERAL MOTORS CORPORATION
CAE Project No: 6520

CONTENTS

SUMMARY

INTRODUCTION

Clean Air Engineering was contracted by General Motors Corporation to perform monitor certification testing and to determine levels of nitrogen oxides and visible emissions at their facility located in Roanoke, Indiana for compliance purposes.

The testing took place at the Boiler #4 Stack on February 2 and 3, 1993. Coordinating the field testing were:

219-673-2480

B. Smid - General Motors Corporation
K. Kurtz-Seslar - General Motors Corporation
G. Santorilla - General Motors Corporation
S. Bailey - pH Environmental Service
J. Bojan - Clean Air Engineering

To the best of our knowledge, the data presented in this report are accurate and complete.

Respectfully submitted,

CLEAN AIR ENGINEERING

Patrick Sheehy
Project Manager

David Perkins
Manager, Technical Communications

SUMMARY OF TEST RESULTS

Relative Accuracy

The carbon dioxide monitor at the Boiler #4 Stack demonstrated a relative accuracy of 5.0 percent based on CO_2 (percent, wet) over nine runs on February 2, 1993.

The nitrogen oxides monitor at the Boiler #4 Stack demonstrated a relative accuracy of 8.2 percent based on lb/mmBtu NOx over nine runs on February 2, 1993.

Nitrogen Oxides

The nitrogen oxides concentration at the Boiler #4 Stack averaged 64 ppm over three runs on February 2, 1993. This corresponds to an average emission rate of 20.35 lb/hr and 0.087 lb/mmBtu. Natural gas was used as fuel during these three runs.

The nitrogen oxides concentration at the Boiler #4 Stack averaged 71 ppm over three runs on February 3, 1993. This corresponds to an average emission rate of 22.49 lb/hr and 0.094 lb/mmBtu. No. 2 Fuel Oil was used as fuel for these three runs.

Opacity

The opacity at the Boiler #4 Stack ranged from 0 percent to 10 percent, and averaged 5 percent over three runs on February 3, 1993.

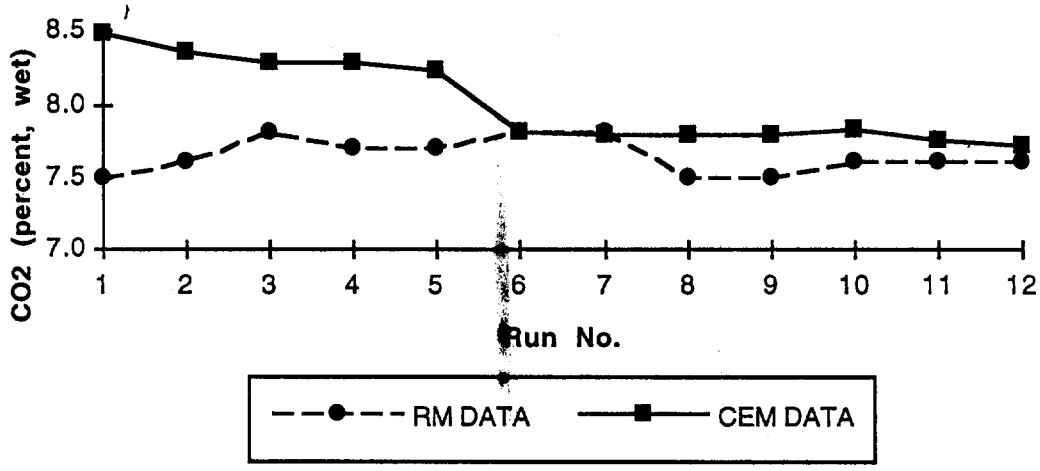
The test conditions and results of analysis are presented in Tables 1 through 4 on pages 1-3 through 1-6.

SUMMARY OF TEST RESULTS Table 1

EPA Method 3
Carbon Dioxide, Relative Accuracy
Boiler #4 Stack

Run No.		Start Time	CO2 RM (percent, wet)	CO2 CEM (percent, wet)	Difference (percent, wet)
1	*	10:00 AM	7.5	8.5	-1.0
2	*	10:30 AM	7.6	8.4	-0.8
3		11:45 AM	7.8	8.3	-0.5
4	*	12:15 PM	7.7	8.3	-0.6
5		12:45 PM	7.7	8.2	-0.5
6		1:15 PM	7.8	7.8	0.0
7		1:45 PM	7.8	7.8	0.0
8		2:30 PM	7.5	7.8	-0.3
9		3:00 PM	7.5	7.8	-0.3
10		3:30 PM	7.6	7.8	-0.2
11		4:00 PM	7.6	7.8	-0.2
12		4:30 PM	7.6	7.7	-0.1
Average			7.7	7.9	-0.2
Total			68.9	71.0	-2.1

Standard Deviation	0.1898
Confidence Coefficient	0.1459
Relative Accuracy	5.0%



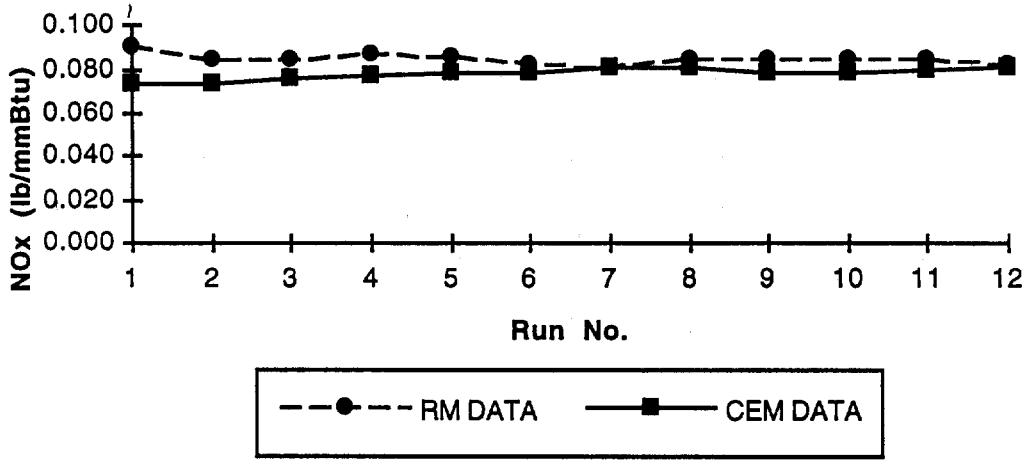
RM = Reference Method (Clean Air Engineering Data)
CEM = Continuous Emissions Monitoring Method (General Motors Corporation.)
* Indicates that the run was not included in the calculations.

SUMMARY OF TEST RESULTS - Table 2

EPA Method 7E
Nitrogen Oxides, Relative Accuracy
Boiler #4 Stack

Run No.		Start Time	NOx RM (lb/mmBtu)	NOx CEM (lb/mmBtu)	Difference (lb/mmBtu)
1	*	12:25	0.091	0.073	0.018
2	*	13:35	0.084	0.074	0.010
3		14:45	0.085	0.076	0.009
4	*	16:20	0.087	0.077	0.010
5		16:47	0.086	0.078	0.008
6		17:48	0.082	0.079	0.003
7		18:17	0.081	0.081	0.000
8		18:44	0.084	0.081	0.003
9		19:11	0.085	0.079	0.006
10		19:40	0.085	0.079	0.006
11		20:06	0.085	0.080	0.005
12		20:35	0.082	0.081	0.001
Average			0.084	0.079	0.005
Total			0.755	0.714	0.041

Standard Deviation	0.0030
Confidence Coefficient	0.0023
Relative Accuracy	8.2%



RM = Reference Method (Clean Air Engineering Data)
CEM = Continuous Emissions Monitoring Method (General Motors Corporation.)
* Indicates that the run was not included in the calculations.

SUMMARY OF TEST RESULTS - Table 3

EPA Method 7E
Nitrogen Oxides
Boiler #4 Stack, Natural Gas, Compliance Runs

Run No.	1	2	3	Average
Date (1993)	February 2	February 2	February 2	
Start Time (approx.)	12:25	13:35	14:45	
Stop Time (approx.)	13:25	14:35	15:45	
Gas Conditions				
Temperature (° F)	362	363	363	**363**
Moisture (volume %)	15.4	16.9	15.2	**15.8**
O_2(dry volume %)	4.8	4.2	4.6	**4.5**
CO_2(dry volume %)	8.9	9.2	9.2	**9.1**
Volumetric Flow Rate				
acfm	84,060	83,930	84,040	**84,010**
dscfm	45,060	44,150	45,050	**44,750**
Nitrogen Oxides Results				
ppm	65	63	63	**64**
lb/dscf	7.76E-06	7.47E-06	7.50E-06	**7.58E-06**
lb/hr	20.99	19.80	20.27	**20.35**
lb/mmBtu	0.091	0.084	0.085	**0.087**

SUMMARY OF TEST RESULTS - Table 1

EPA Methods 7E and 9
Nitogen Oxides and Opacity
Boiler #4 Stack, No. 2 Fuel Oil, Compliance Runs

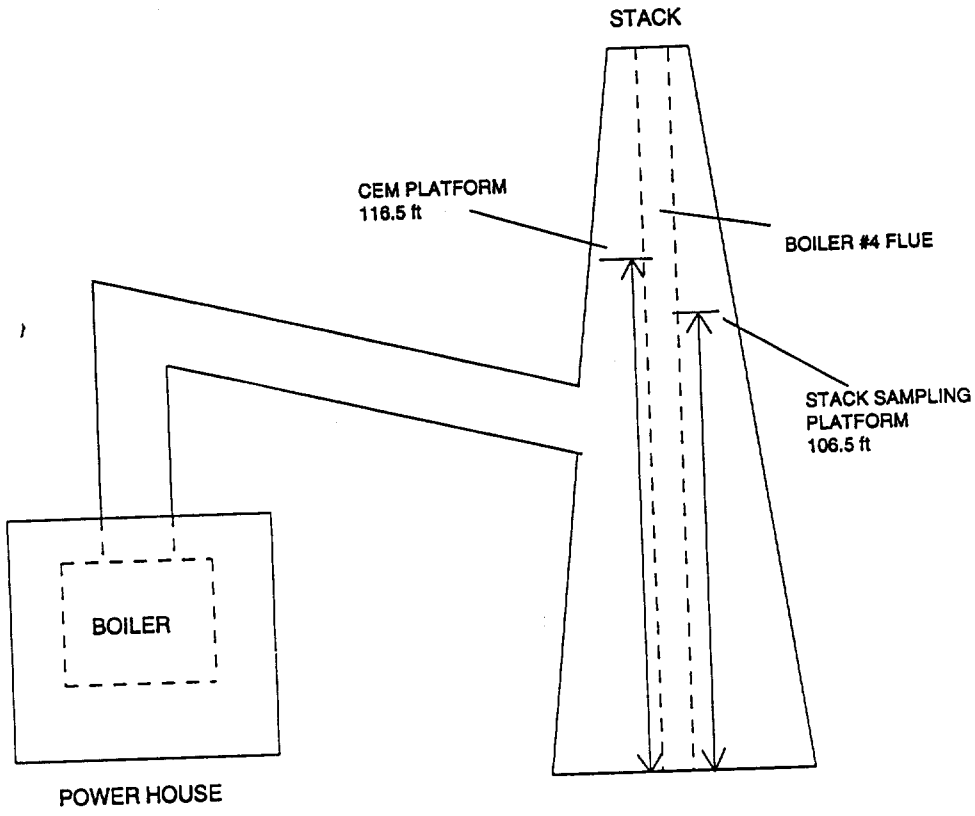
Run No.	1	2	3	Average
Date (1993)	February 3	February 3	February 3	
Start Time (approx.)	9:36	10:47	11:58	
Stop Time (approx.)	10:36	11:47	12:58	
Gas Conditions				
Temperature (° F)	370	375	374	**373**
Moisture (volume %)	12.5	12.6	11.8	**12.3**
O_2 (dry volume %)	3.4	3.6	3.2	**3.4**
CO_2 (dry volume %)	12.6	13.0	12.8	**12.8**
Volumetric Flow Rate				
acfm	80,550	81,680	81,210	**81,150**
dscfm	44,000	44,280	44,490	**44,260**
Nitrogen Oxides Results				
ppm	76	69	68	**71**
lb/dscf	9.04E-06	8.29E-06	8.08E-06	**8.47E-06**
lb/hr	23.88	22.04	21.56	**22.49**
lb/mmBtu	0.102	0.091	0.090	**0.094**
Opacity				
Minimum Reading	0	0	0	**0**
Maximum Reading	10	5	10	**10**
Average	5	5	5	**5**

DESCRIPTION OF INSTALLATION

General Motors Corporation's North American Truck Platforms Fort Wayne Assembly Plant, located in Roanoke, Indiana, assembles light-duty pickup trucks. GM operates a Riley Stoker boiler designated as Boiler #4. It is rated at 200,000 lbs steam per hour, and can run on natural gas or No. 2 fuel oil. The boiler uses flue gas recirculation and is vented through one of three flues in a radial brick chimney. A Lear Siegler In-Situ Continuous Emissions Monitor is installed on a flare within the stack. It reads on a wet basis with carbon dioxide as the diluent gas.

The testing reported in this document was performed at the Boiler #4 Stack.

A schematic of the process is shown below.



SAMPLING PROCEDURES

The sampling followed procedures as detailed in U.S. Environmental Protection Agency (EPA) Methods 1, 2, 3, 4, 7E and 9. These methods are titled:

- Method 1 — "Sample and Velocity Traverses for Stationary Sources;"
- Method 2 — "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube);"
- Method 3 — "Gas Analysis for the Determination of Dry Molecular Weight;"
- Method 4 — "Determination of Moisture Content in Stack Gases;"
- Method 7E - "Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure);"
- Method 9 — "Visual Determination of the Opacity of Emissions from Stationary Sources."

These methods appear in detail in Title 40 of the Code of Federal Regulations (CFR), Part 60, Appendix A.

Referenced with the above methods was U.S. EPA Performance Specification 2. This specification is titled: "Specifications and test procedures for SO_2 and NOx continuous emission monitoring systems in stationary sources."

This specification appears in detail in Title 40 of the CFR, Part 60, Appendix B.

The sampling apparatus are shown in Figures 1 through 3 on pages 3-3 through 3-5. All equipment was calibrated at the Clean Air Engineering laboratory prior to shipment to the job site.

SUMMARY OF PROCEDURES (Continued)

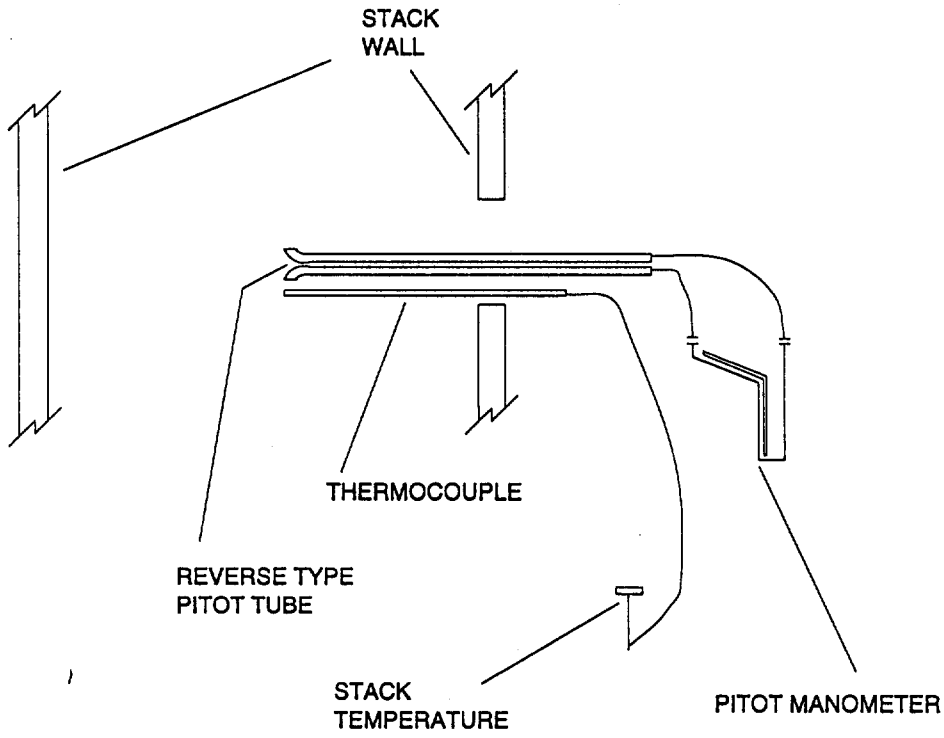
Sampling Locations

The Boiler #4 Stack has four ports, two of which were traversed. Six points were traversed in each port. The traverse point locations are shown in Figure 5 on page 3-7. The first three runs of the RATA performed on February 2, 1993 at the Boiler #4 Stack were 60 minutes in duration. These runs, in addition to the runs performed on February 3, 1993, were used to determine compliance with emissions standards.

For relative accuracy testing, three points were sampled in a single port of the Boiler #4 Stack. The sampling time per point was seven minutes for a total sampling time of 21 minutes. The sampling locations are shown in Figure 4 on page 3-6.

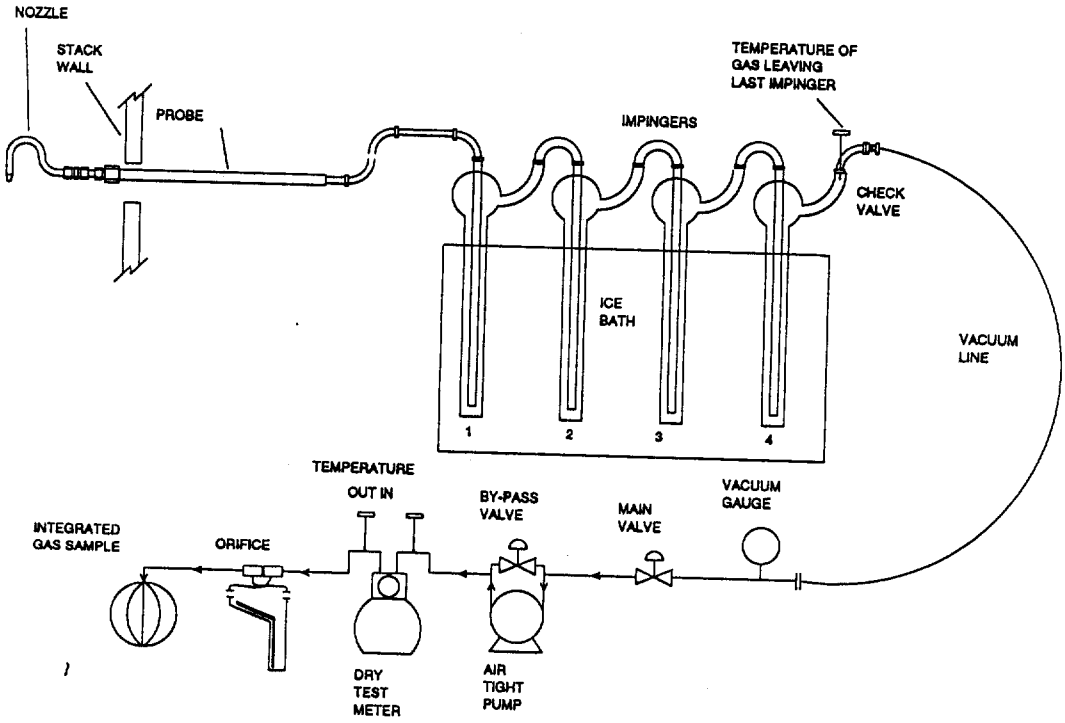
SUMMARY OF PROCEDURES - Figure 1

The EPA Methods 1 and 2 sampling apparatus is shown.



SUMMARY OF PROCEDURES - Figure 2

The EPA Methods 3 and 4 sampling apparatus is shown.

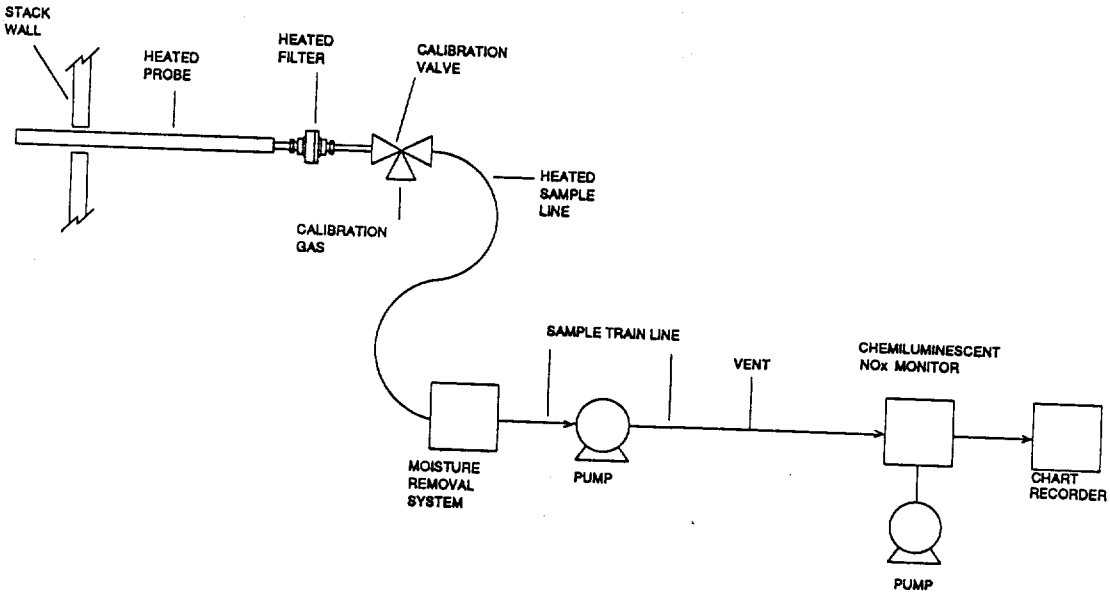


Impinger Contents

1) 100 ml distilled water
2) 100 ml distilled water
3) empty
4) 300 g silica gel

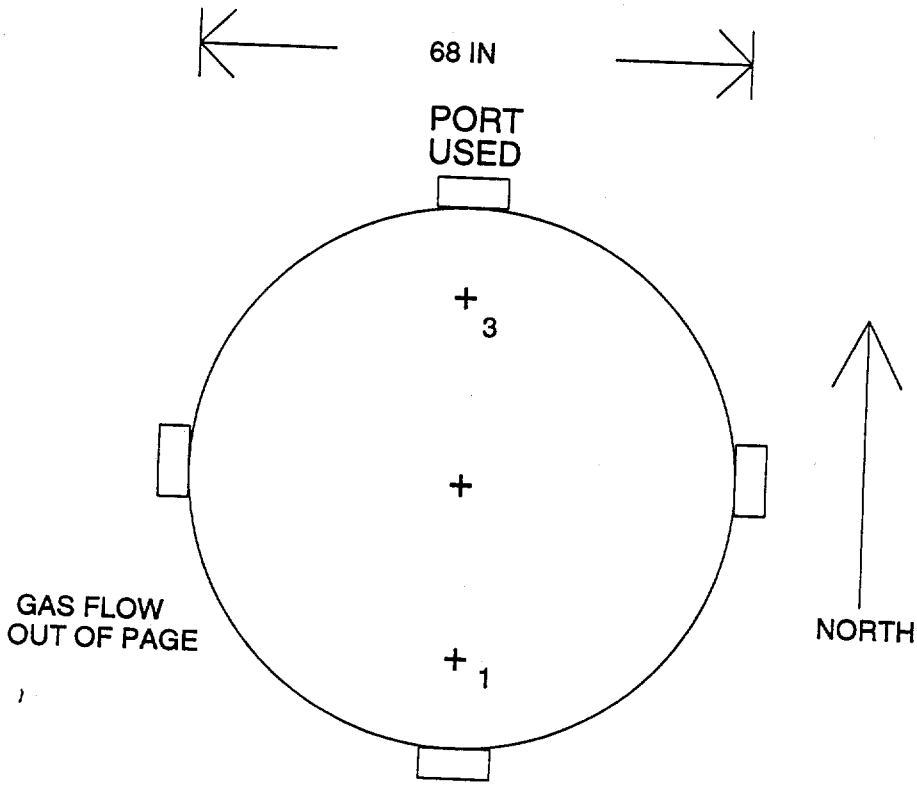
SUMMARY OF PROCEDURES - Figure 3

The EPA Method 7E sampling apparatus is shown.



SUMMARY OF PROCEDURES - Figure 4

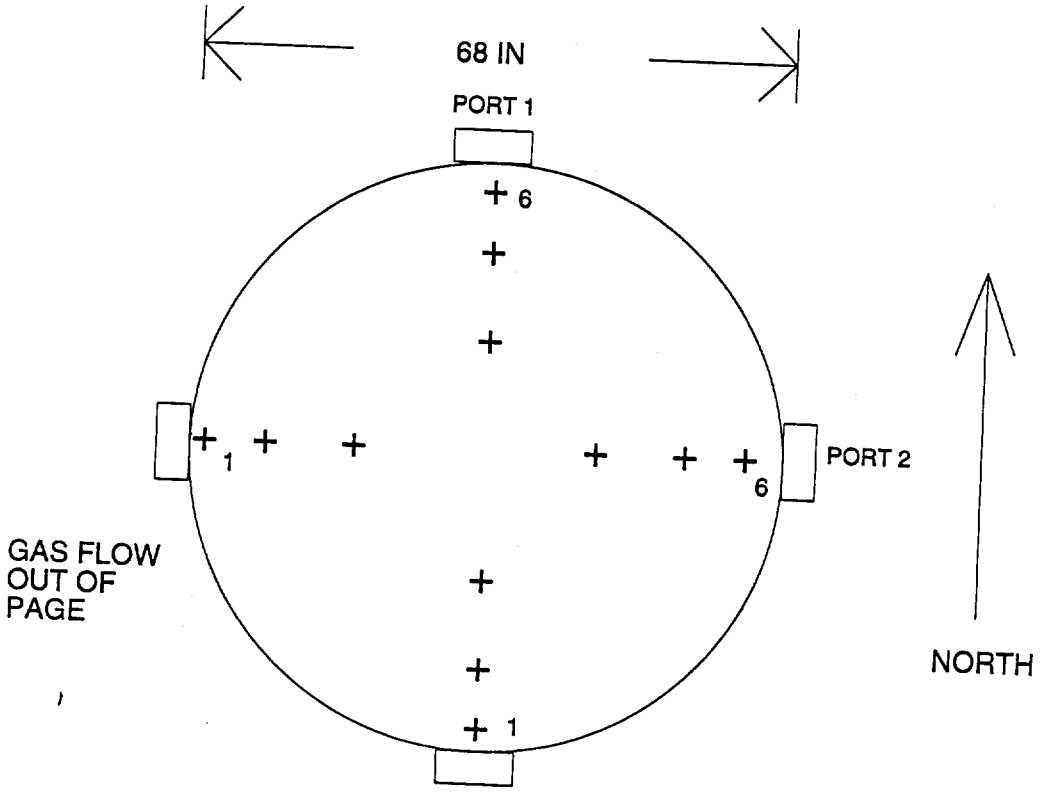
The cross section of the Boiler #4 Stack shows RATA sampling point locations.



SAMPLING POINT	PORT TO POINT DISTANCE (IN)
1	56.6
2	34.0
3	11.4

SUMMARY OF PROCEDURES - Figure 5

The cross section of the Boiler #4 Stack shows traverse point locations.



TRAVERSE POINT	PORT TO POINT DISTANCE (IN)
1	65.0
2	58.0
3	47.9
4	20.1
5	10.0
6	3.0

ANALYTICAL PROCEDURES

Continuous Emissions Monitoring

Nitrogen Oxides

The nitrogen oxides emission rate was determined using procedures detailed in EPA Method 7E. A sample was extracted continuously from the flue gas stream, and a portion was conveyed to a TECO chemiluminescent nitrogen oxides analyzer.

Before and after each run, the monitor was zeroed and calibrated with a certified calibration gas. These calibrations were used to correct the raw data for zero and calibration drift occurring during the test runs.

QUALITY CONTROL PROCEDURES

Quality control procedures for all aspects of field sampling; sample preservation and holding time; reagent quality; analytical method; analyst training and safety; and instrument cleaning, calibration and safety were followed. These procedures are generally consistent with EPA guidelines documented in "Quality Assurance Manuals for Air Pollution Measurement Systems," Vol 3, "Stationary Source Specific Methods" (EPA-600/4-77-027b).

COMMENTS

The times on the reference method data were ten minutes ahead of the plant CEM data.

No other deviations from standard U.S. EPA testing procedures were noted.

The S-Type Pitot was visually inspected before use and it was determined that no calibration was needed.

APPENDIX

NOMENCLATURE

Nomenclature

A	-	absorbance
A_n	-	cross sectional area of nozzle (ft^2)
A_s	-	cross sectional area of stack (ft^2)
B_{wo}	-	proportion of water vapor in the gas stream by volume
B_{ws}	-	proportion of water vapor in the gas stream by volume at saturated conditions
C_p	-	pitot tube coefficient (dimensionless)
D_f	-	dilution factor
F_d	-	ratio of dry gas generated to gross calories (dscf/MBtu)
F_c	-	ratio of gas generated
GCV	-	gross calorific value of fuel (Btu/lb)
$\overline{DH}$	-	average pressure drop across meter box orifice (in. H_2O)
$\overline{\sqrt{DP}}$	-	average square roots of velocity heads of stack gas ($\sqrt{\text{in. } H_2O}$)
DH@	-	meter orifice calibration coefficient (in. H_2O)
%I	-	percent of isokinetic sampling (acceptable: $90 \le \%I \le 110\%$)
K_p	-	pitot tube constant: 85.49 (ft/sec) $\frac{\sqrt{(lb/lb-mole)(in.\ Hg)}}{\sqrt{(°R)(in\ H_2O)}}$
K_c	-	spectrophotometer calibration factor
M_d	-	dry molecular weight of stack gas (lb/lb-mole)
M_s	-	molecular weight of stack gas, wet basis (lb/lb-mole)
M_n	-	total amount of particulate matter collected (gm)
mmBtu	-	millions of British Thermal Units (Btu)
N	-	normality of titrant (meq/ml)
P_b	-	barometric pressure (in. Hg)
P_f	-	final absolute pressure of flask (in. Hg)
P_i	-	initial absolute pressure of flask (in. Hg)
P_s	-	absolute stack gas pressure (in. Hg)
Q_a	-	volumetric flow rate, actual conditions
Q_{std}	-	volumetric flow rate, standard conditions, dry basis
std	-	standard conditions, 29.92 in. Hg, 68°F
T_f	-	final absolute temperature of flask (°R)
T_i	-	initial temperature of flask (°R)

T_m	-	average dry gas meter temperature (°F)
T_s	-	average stack temperature (°F)
T_{std}	-	absolute temperature, standard conditions (528°R)
Q	-	total sampling time (min)
V_a	-	volume of aliquot (ml)
V_f	-	volume of flask (ml)
V_{lc}	-	total volume of liquid collected in impingers and silica gel (ml)
V_m	-	volume of gas sample through the dry gas meter at meter conditions (ft^3)
V_{mstd}	-	volume of gas sample through the dry gas meter, standard conditions (ft^3)
V_{sc}	-	volume of flask sample, standard conditions (ml)
V_{soln}	-	total volume of solution (ml)
V_t	-	volume of titrant used to titrate aliquot (ml)
V_{tb}	-	volume of titrant used to titrate blank (ml)
V_{wstd}	-	volume of water collected, standard conditions (ft^3)
V_s	-	stack gas velocity (ft/sec)
Y_d	-	gas meter correction factor (dimensionless)

Nomenclature

CAL GAS	actual concentration of the upscale calibration gas
CAL I	initial system calibration bias check response for the upscale calibration gas, ppm
CAL F	final system calibration bias check response for the upscale calibration gas, ppm
ZERO I	initial system calibration bias check response for the zero gas, ppm
ZERO F	final system calibration bias check response for the zero gas, ppm
ppm	measured concentration as parts per million in the gas stream
ppm (drift calibrated)	concentration calibrated for drift as per Eq. 6C-1 of EPA Method 6C
DRE	destruction removal efficiency

SAMPLE CALCULATIONS

GENERAL MOTORS CORPORATION
CAE Project No : 6520

SAMPLE CALCULATIONS - RUN 1, BOILER #4 STACK

(Note : results are taken from computer analysis)

1. Volume of water collected

$$V_{wstd} = (0.04707\ ft^3/ml)\ (V_{lc})$$
$$= (0.04707)\ (117)$$
$$= 5.507\ wscf$$

2. Volume of gas metered, standard conditions

$$V_{mstd} = \frac{(17.64\ ^\circ R/in.\ Hg)\ (V_m)\left[P_b + \frac{DH}{13.6}\right]}{(460 + T_m)}(Y_d)$$
$$= \frac{(17.64)\ (32.08)\left[29.56 + \frac{1.0}{13.6}\right]}{(460 + 96)}(1.0054)$$
$$= 30.34\ dscf$$

3. Stack pressure (in. Hg)

$$P_s = P_b + \left(\frac{STATIC\ P}{13.6}\right)$$
$$= 29.56 + \left(\frac{-0.65}{13.6}\right)$$
$$= 29.51$$

4. Moisture content

$$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$$
$$= \frac{5.507}{30.34 + 5.507}$$
$$= 0.1536$$
$$= 15.4\ \%$$

5. Molecular weight of dry gas stream (lb/lb mole)

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%CO + \%N_2)$$
$$= 0.44(8.9) + 0.32(4.8) + 0.28(86.3)$$
$$= 29.61$$

6. Molecular weight of stack gas (lb/lb mole)

$$M_s = M_d\ (1 - B_{wo}) + 18(B_{wo})$$
$$= 29.61\ (1 - 0.1536) + 18(0.1536)$$
$$= 27.83$$

GENERAL MOTORS CORPORATION
CAE Project No : 6520

SAMPLE CALCULATIONS (Continued)

7. Velocity of stack gas

$$V_s = K_p C_p \overline{(DP)}^{\frac{1}{2}} \frac{[\overline{T_s} + 460]^{\frac{1}{2}}}{[(M_s)(P_s)]^{\frac{1}{2}}}$$

$$= 85.49\ (0.84)\ (0.774)\ \frac{[362+460]^{\frac{1}{2}}}{[(27.83)\ (29.51)]^{\frac{1}{2}}}$$

$$= 55.59 \text{ ft/sec}$$

8. Total flow of stack gas

$$Q_a = (60)\ (A_s)\ (V_s)$$
$$= (60)\ (25.2)\ (55.59)$$
$$= 84,060 \text{ acfm}$$

$$Q_{std} = \frac{Q_a P_s\ (17.64\ ^\circ R/\text{in. Hg})\ (1 - B_{wo})}{\overline{T_s} + 460}$$

$$= \frac{(84,060)\ (29.51)\ (17.64)\ (1 - 0.1536)}{362 + 460}$$

$$= 45,060 \text{ dscfm}$$

9. Carbon Dioxide

$$\%CO_2 \text{ wet} = (\%CO_2 \text{ dry})(1 - B_{wo})$$
$$= (8.9)\ (1 - 0.1536)$$
$$= 7.5$$

SAMPLE CALCULATIONS (Continued)

10. Method 7E - Nitrogen Oxides

$$ppm_{drift\ calibrated} = \left(C_{avg} - C_o\right)\frac{C_{ma}}{(C_m - C_o)}$$
$$= (65 - (-0.2))\frac{211.9}{(212.3 - (-0.2))}$$
$$= 65$$

C_{avg} = Average gas concentration indicated by gas analyzer, dry basis, ppm.
C_o = Average of initial and final system calibration bias check responses for the zero gas, ppm.
C_m = Average of initial and final system calibration bias check responses for upscale calibration gas, ppm.
C_{ma} = Actual concentration of the upscale calibration gas, ppm.

$$lb/dscf = \left(\frac{\left(ppm_{drift\ calibrated}\right)(MW)}{385.3 \times 10^6}\right)$$
$$= \left(\frac{(65)\ (46)}{385.3 \times 10^6}\right)$$
$$= 7.76 \times 10^{-6}$$

$$lb/hr = (lb/dscf)(dscfm)(60)$$
$$= (7.76 \times 10^{-6})(45,060)(60)$$
$$= 20.99$$

$$lb/mmBtu = \frac{(lb/dscf)(Fc)(100)}{\%\ CO_2,\ dry}$$
$$= \frac{(7.76 \times 10^{-6})(1,040\ ^*)(100)}{8.9}$$
$$= 0.091$$

* 1,040 is the standard Fc factor for natural gas.

GENERAL MOTORS CORPORATION
CAE Project No : 6520

SAMPLE CALCULATIONS (Continued)

11. Standard deviation of difference between NOx lb/MBtu monitor and NOx lb/MBtu reference method

$$Sdev = \sqrt{\frac{\sum_{i=1}^{n} d_i^2 - \frac{(\sum_{i=1}^{n} d_i)^2}{n}}{n-1}}$$
$$= \sqrt{\frac{0.000261 - \frac{0.001681}{9}}{9-1}}$$
$$= 0.0030$$

$\sum_{i=1}^{n} d_i^2$ = sum of difference squared
$\sum_{i=1}^{n} d_i$ = sum of differences
n = number of data sets

12. Confidence coefficient

$$cc = (t_{0.975})\left(\frac{Sdev}{\sqrt{n}}\right)$$
$$= (2.306)\left(\frac{0.0030}{\sqrt{9}}\right)$$
$$= 0.0023$$

$t_{0.975}$ = t - value (see table)

n	$t_{0.975}$ value	n	$t_{0.975}$ value	n	$t_{0.975}$ value
2	12.706	7	2.447	12	2.201
3	4.303	8	2.365	13	2.179
4	3.182	9	2.306	14	2.160
5	2.776	10	2.262	15	2.145
6	2.571	11	2.228	16	2.131

13. Relative accuracy

$$RA = 100\left(\frac{|Davg| + |cc|}{\text{reference method average } or \text{ applicable emission standard}}\right)$$
$$= 100\left(\frac{|0.0046| + |0.0023|}{0.084}\right)$$
$$= 8.2 \text{ percent}$$

|Davg| = absolute value of the mean of the differences
|cc| = absolute value of the confidence coefficient

PARAMETERS

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas, Compliance Runs

VELOCITY AND MOISTURE PARAMETERS

Run No.	1	2	3
Date (1993)	February 2	February 2	February 2
Start Time (approx.)	12:23	13:33	14:44
Stop Time (approx.)	13:23	14:34	15:44
O_2(dry volume %)	4.8	4.2	4.6
CO_2(dry volume %)	8.9	9.2	9.2
Pb	29.56	29.56	29.56
STATIC P	-0.65	-0.65	-0.65
Cp	0.84	0.84	0.84
As	25.2	25.2	25.2
Vlc	117	132	117
Vm	32.08	32.30	32.29
DH	1.00	1.00	1.00
Yd	1.0054	1.0054	1.0054
Tm	96	95	93
Θ	60	60	60
CALCULATED RESULTS			
Vwstd	5.507	6.213	5.507
Vmstd	30.34	30.58	30.68
Ps	29.51	29.51	29.51
Ts	362	363	363
Bwo	0.1536	0.1689	0.1522
DP1/2	0.774	0.770	0.774
Md	29.61	29.64	29.66
Ms	27.83	27.67	27.88
Vs	55.59	55.51	55.58
Qa (acfm)	84,060	83,930	84,040
Qstd (dscfm)	45,060	44,150	45,050

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas, RATA Runs

MOISTURE PARAMETERS

Run No's.	4&5	6&7	8&9	10&11	12
Date (1993)	February 2	February 2	February 2	February 2	February 2
Start Time (approx.)	16:18	17:46	18:42	19:40	20:34
Stop Time (approx.)	17:03	18:31	19:27	20:25	20:54
Pb	29.56	29.56	29.56	29.56	29.56
Vlc	119	125	124	116	55
Vm	31.03	31.18	30.95	30.74	15.09
DH	1.50	1.50	1.50	1.50	2.00
Yd	1.0054	1.0054	1.0054	1.0054	1.0054
Tm	95	97	96	97	96
CALCULATED RESULTS					
Vwstd	5.60	5.88	5.84	5.46	2.59
Vmstd	29.41	29.45	29.28	29.06	14.30
Bwo	0.1600	0.1665	0.1662	0.1582	0.1533

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas

CARBON DIOXIDE AND MOISTURE PARAMETERS

Run No.	%CO2 Dry	Bwo	%CO2 wet
1	8.9	0.1536	7.5
2	9.2	0.1689	7.6
3	9.2	0.1522	7.8
4	9.2	0.1600	7.7
5	9.2	0.1600	7.7
6	9.4	0.1665	7.8
7	9.4	0.1665	7.8
8	9.0	0.1662	7.5
9	9.0	0.1662	7.5
10	9.0	0.1582	7.6
11	9.0	0.1582	7.6
12	9.0	0.1533	7.6

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas, Compliance Runs

NITROGEN OXIDES PARAMETERS

RUN NO.	1	2	3
Date (1993)	February 2	February 2	February 2
Start Time (approx)	12:25	13:35	14:45
Stop Time (approx)	13:25	14:35	15:45
%CO2, dry	8.9	9.2	9.2
Fc	1,040	1,040	1,040
dscfm	45,060	44,150	45,050
ZERO I	0.0	-0.4	0.0
CAL I	212.0	212.5	209.0
ZERO F	-0.4	0.0	-0.2
CAL F	212.5	215.0	216.5
ppm	65	63	63
CAL GAS	211.9	211.9	211.9
ppm (drift calibrated)	65	63	63
lb/dscf	7.76E-06	7.47E-06	7.50E-06
lb/hr	20.99	19.80	20.27
lb/mmBtu	0.091	0.084	0.085

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas, RATA Runs

NITROGEN OXIDES PARAMETERS

RUN NO.	4	5	6	7	8
Date (1993)	February 2	February 2	February 2	February 2	February 2
Start Time (approx)	16:20	16:47	17:48	18:17	18:44
Stop Time (approx)	16:41	17:08	18:09	18:38	19:05
% CO2, dry	9.2	9.2	9.4	9.4	9.0
Fc	1,040	1,040	1,040	1,040	1,040
ZERO I	-0.2	0.0	-0.2	0.0	-0.1
CAL I	209.5	213.5	213.5	210.0	212.0
ZERO F	0.0	-0.2	0.0	-0.2	-0.4
CAL F	213.5	213.5	218.0	212.0	214.0
ppm	64	64	63	61	61
CAL GAS	211.9	211.9	211.9	211.9	211.9
ppm (drift calibrated)	64	64	62	61	61
lb/dscf	7.66E-06	7.59E-06	7.40E-06	7.32E-06	7.27E-06
lb/mmBtu	0.087	0.086	0.082	0.081	0.084

RUN NO.	9	10	11	12
Date (1993)	February 2	February 2	February 2	February 2
Start Time (approx)	19:11	19:40	20:06	20:35
Stop Time (approx)	19:32	20:01	20:27	20:56
% CO2, dry	9.0	9.0	9.0	9.0
Fc	1,040	1,040	1,040	1,040
ZERO I	-0.4	-0.2	-0.2	0.0
CAL I	214.0	215.0	209.0	210.0
ZERO F	-0.2	-0.2	0.0	-0.2
CAL F	215.0	218.0	210.0	209.0
ppm	62	63	61	59
CAL GAS	211.9	211.9	211.9	211.9
ppm (drift calibrated)	61	61	62	60
lb/dscf	7.34E-06	7.32E-06	7.37E-06	7.13E-06
lb/mmBtu	0.085	0.085	0.085	0.082

GENERAL MOTORS CORPORATION
CAE Project No: 6250
Boiler #4 Stack, No. 2 Fuel Oil, Compliance Runs

VELOCITY AND MOISTURE PARAMETERS

Run No.	**1**	**2**	**3**
Date (1993)	February 3	February 3	February 3
Start Time (approx.)	9:36	10:47	11:58
Stop Time (approx.)	10:36	11:47	12:58
O_2(dry volume %)	3.4	3.6	3.2
CO_2(dry volume %)	12.6	13.0	12.8
Pb	29.41	29.41	29.41
STATIC P	-0.65	-0.65	-0.65
Cp	0.84	0.84	0.84
As	25.2	25.2	25.2
Vlc	90	90	84
Vm	31.53	31.32	31.53
DH	1.0	1.0	1.0
Yd	1.0054	1.0054	1.0054
Tm	94	95	99
Θ	60	60	60
CALCULATED RESULTS			
Vwstd	4.236	4.236	3.954
Vmstd	29.78	29.49	29.51
Ps	29.36	29.36	29.36
Ts	370	375	374
Bwo	0.1245	0.1256	0.1181
DP1/2	0.747	0.755	0.752
Md	30.15	30.22	30.18
Ms	28.64	28.69	28.74
Vs	53.27	54.02	53.71
Qa (acfm)	80,550	81,680	81,210
Qstd (dscfm)	44,000	44,280	44,490

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, No. 2 Fuel Oil, Compliance Runs

NITROGEN OXIDES PARAMETERS

RUN NO.	1	2	3
Date (1993)	February 3	February 3	February 3
Start Time (approx)	9:36	10:47	11:58
Stop Time (approx)	10:36	11:47	12:58
%CO2, dry	12.6	13.0	12.8
Fc	1,420	1,420	1,420
dscfm	44,000	44,280	44,490
ZERO I	0.2	1.0	1.5
CAL I	210.0	213.0	215.0
ZERO F	1.0	1.5	1.0
CAL F	213.0	215.0	212.0
ppm	76	71	69
CAL GAS	211.9	211.9	211.9
ppm (drift calibrated)	76	69	68
lb/dscf	9.04E-06	8.29E-06	8.08E-06
lb/hr	23.88	22.04	21.56
lb/mmBtu	0.102	0.091	0.090

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, No. 2 Fuel Oil
February 3, 1993
Run 1, 9:35

Visible Emissions Parameters

minutes	seconds 0	15	30	45	60
1		5	10	5	5
2		10	5	5	5
3		5	5	10	5
4		5	10	5	5
5		5	10	5	5
6		5	10	5	5
7		5	5	5	5
8		5	10	5	5
9		10	5	5	5
10		5	5	5	5
11		5	10	5	5
12		5	5	5	5
13		5	5	5	5
14		5	10	5	5
15		5	5	5	5
16		5	5	5	10
17		5	5	5	5
18		5	5	5	5
19		5	5	5	5
20		5	5	5	5
21		5	5	5	5
22		5	5	5	5
23		5	5	5	5
24		5	5	5	5
25		5	5	5	5
26		5	5	5	5
27		5	5	5	5
28		5	5	5	5
29		5	5	5	5
30		5	5	5	5
Average		5			

minutes	seconds 0	15	30	45	60
31		5	5	5	5
32		5	5	5	5
33		5	10	5	5
34		5	5	5	5
35		5	5	10	5
36		5	5	5	5
37		5	5	10	5
38		5	5	5	5
39		5	5	5	5
40		5	5	5	5
41		5	5	5	5
42		0	5	5	5
43		5	5	5	0
44		5	5	5	5
45		5	5	5	5
46		5	5	5	5
47		5	5	5	5
48		5	5	5	5
49		5	5	5	5
50		0	0	5	5
51		0	5	5	5
52		5	5	5	5
53		5	0	5	5
54		0	0	5	5
55		5	0	0	0
56		5	5	5	5
57		5	5	5	0
58		0	5	0	5
59		5	5	0	5
60		5	5	5	0
61		0	5	5	5
62		5	5	5	5
Average		5			

Minimum Reading **0**
Maximum Reading **10**
Total Average **5**

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, No. 2 Fuel Oil
February 3, 1993
Run 2, 10:45

Visible Emissions Parameters

minutes	seconds 0	15	30	45	60
1	5	5	5	5	5
2	5	5	5	5	5
3	5	5	5	5	5
4	5	5	0	5	5
5	5	5	5	0	5
6	5	5	5	0	5
7	5	5	5	5	5
8	5	5	5	5	5
9	5	5	0	5	5
10	5	5	5	5	5
11	0	5	5	5	5
12	5	5	0	5	5
13	5	5	0	0	5
14	5	5	5	5	5
15	0	5	5	5	5
16	5	0	5	5	5
17	5	5	5	0	5
18	5	5	5	5	5
19	0	5	5	5	5
20	5	5	5	5	5
21	5	5	5	5	5
22	5	5	0	5	5
23	5	5	0	5	5
24	5	5	0	5	5
25	5	5	5	5	5
26	0	0	5	5	5
27	5	5	5	5	5
28	0	5	0	5	5
29	5	5	0	5	5
30	5	0	5	5	5
Average					5

minutes	seconds 0	15	30	45	60
31	5	5	5	5	5
32	5	5	5	5	0
33	5	5	5	5	5
34	0	0	0	0	5
35	0	5	0	0	5
36	0	0	5	0	0
37	5	0	0	0	5
38	5	5	0	0	5
39	0	5	0	0	5
40	0	5	5	0	5
41	0	5	0	0	5
42	0	5	0	0	0
43	0	0	5	0	5
44	0	0	0	0	0
45	0	0	0	0	0
46	5	5	0	0	0
47	5	0	0	0	5
48	0	5	5	0	0
49	0	5	0	0	0
50	0	0	5	0	0
51	5	0	0	0	5
52	0	5	5	0	5
53	5	5	5	0	5
54	5	0	0	0	5
55	5	5	0	0	5
56	5	5	5	0	5
57	5	5	5	0	5
58	5	5	5	0	5
59	0	5	5	0	5
60	0	5	5	0	5
Average					5

Minimum Reading 0
Maximum Reading 5
Total Average 5

GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, No. 2 Fuel Oil
February 3, 1993
Run 3, 11:55

Visible Emissions Parameters

minutes	seconds 0	15	30	45	60
1	5	5	0	5
2	5	5	5	5
3	5	5	10	5
4	5	5	5	5
5	5	5	5	5
6	5	5	0	5
7	5	5	5	5
8	5	5	5	5
9	5	5	5	5
10	5	0	0	5
11	5	5	5	5
12	5	5	5	5
13	0	5	0	0
14	5	5	5	5
15	5	5	5	5
16	5	5	5	5
17	0	5	5	0
18	0	5	5	5
19	5	5	0	5
20	5	0	5	5
21	5	0	5	5
22	5	5	5	5
23	5	5	5	5
24	5	5	5	5
25	5	5	5	5
26	5	5	0	5
27	5	5	5	5
28	5	5	5	5
29	0	5	5	5
Average				5

minutes	seconds 0	15	30	45	60
31	5	0	5	5
32	5	5	5	5
33	5	5	5	5
34	5	0	0	5
35	0	5	0	5
36	5	0	0	0
37	5	0	5	5
38	5	5	5	5
39	0	0	5	5
40	0	5	5	5
41	5	0	5	5
42	5	5	5	5
43	5	0	0	5
44	0	5	5	0
45	5	5	5	5
46	5	5	0	0
47	5	5	5	5
48	5	5	5	5
49	5	5	5	5
50	5	5	5	5
51	5	5	5	5
52	5	5	5	5
53	5	5	5	5
54	5	5	5	5
55	5	5	5	5
56	5	5	5	5
57	5	5	5	5
58	5	5	5	5
59	5	5	5	5
Average				5

Minimum Reading 0
Maximum Reading 10
Total Average 5

CALIBRATION DATA

Scott Specialty Gases

Scott Environmental Technology, Inc.

1290 COMBERMERE STREET, TROY, MICHIGAN 48084 (313) 589-2950

Our Project # : 539892

Your P.O. # : 6017-71500

Expiration Date : 2-3-94

Cylinder Number : ALM-022594

Cylinder Pressure 1900 psig

1 of 1 Component(s)

Customer :
C A E INSTRUMENT RENTAL
246 WOODWORK LANE
PALATINE IL 60067

CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES

PERFORMED ACCORDING TO SECTION 3.0.4

Certified Per Traceability Protocol # 1 Procedure # G1

File # FO-4295

Certified Accuracy 1 % NBS Traceable

ANALYZED CYLINDER

COMPONENT	CERTIFIED CONC.
NITRIC OXIDE	135.0 PPM

BALANCE GAS : NITROGEN

REFERENCE STD

SRM # (CRM #)	CYLINDER NUMBER	CONC.
1685	ALM-009716	250.3 PPM
1684	ALM-010464	95.26 PPM

INSTRUMENTATION

INSTR/MODEL/SERIAL #	LAST CALIBRATION DATE
BECKMAN 95[illegible] 270-[illegible]8	6-25-92

ANALYTICAL PRINCIPLE

CHEMILUMINESCENCE

NITROGEN DIOXIDE 0.00 PPM (FROM SECOND ANALYSIS)

CERTIFIED EPA PROTOCOL

FIRST ANALYSIS DATE : 7-27-92

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	53.90	134.9	250.3 PPM	100.00	250.3
0.00	53.90	134.9		100.00	250.3
0.00	53.90	134.9		100.00	250.3
CALCULATED RESULTS		134.9			
		134.9			
		134.9			
AVERAGE :		134.9 PPM			

SECOND ANALYSIS DATE : 9-3-92

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	54.00	135.2	250.3 PPM	100.00	250.3
0.00	54.00	135.2		100.00	250.3
0.00	54.00	135.2		100.00	250.3
0.00	54.00 NOX	135.2			
CALCULATED RESULTS		135.2			
		135.2			
		135.2	135.2 PPM NOX		
AVERAGE :		135.2 PPM			

CALIBRATION CURVE 1 st DEGREE

SRM # (CRM #)	CONC. PPM	SPLIT PT (%)	DVM (mV)	FITTED VALUE	PERCENT ERROR
1685	250.3	100	100.00	250.3	0.00
1684	95.26	38	38.05	95.24	-0.02
	0.0000	0	0.00	0.0000	0.00
		0		0.00	0.00
		0		0.00	0.00
		0		0.0000	0.00
		0		0.00	0.00
1685	250.3 HIGH	100.00		250.3	0.00
1684	95.26 LOW	38.05		95.24	-0.02

GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : F Dorn

Approved By : L Shapiro

Scott Specialty Gases

Scott Environmental Technology, Inc.

1290 COMBERMERE STREET, TROY, MICHIGAN 48084 (313) 589-2950

Our Project # : 539892

Your P.O. # : 6017-71500

Expiration Date : 2-10-94

Cylinder Number : ALM-030328

Cylinder Pressure 1900 psig

1 of 1 Component(s)

ustomer :
C A E INSTRUMENT RENTAL
246 WOODWORK LANE
PALATINE IL 60067

CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES
PERFORMED ACCORDING TO SECTION 3.0.4

Certified For Traceability Procedure # G1
Protocol # 1

File # PD-4296

Certified Accuracy 1 % NBS Traceable

ANALYZED CYLINDER		REFERENCE STD			INSTRUMENTATION		
COMPONENT	CERTIFIED CONC.	SRM # (CRM #)	CYLINDER NUMBER	CONC.	INSTR/MODEL/SERIAL #	LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
NITRIC OXIDE	211.9 PPM	1685	ALM-009716	250.3 PPM	BECKMAN 951 270-0828998	6-25-92	CHEMILUMINESCENCE
		1684	ALM-010464	95.26 PPM			

BALANCE GAS : NITROGEN

NITROGEN DIOXIDE 0.00 PPM (FROM SECOND ANALYSIS)

FIRST ANALYSIS DATE : 8-3-92

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	84.80	212.3	250.3 PPM	100.00	250.3
0.00	84.80	212.3		100.00	250.3
0.00	84.80	212.3		100.00	250.3
	CALCULATED RESULTS	212.3			
		212.3			
		212.3			
	AVERAGE :	212.3 PPM			

SECOND ANALYSIS DATE : 8-10-92

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	84.50	211.5	250.3 PPM	100.00	250.3
0.00	84.50	211.5		100.00	250.3
0.00	84.50	211.5		100.00	250.3
0.00	84.50 NOX	211.5			
	CALCULATED RESULTS	211.5			
		211.5			
		211.5	211.5 PPM NOX		
	AVERAGE :	211.5 PPM			

CALIBRATION CURVE 1 st DEGREE

SRM # (CRM #)	CONC. PPM	SPLIT PT (%)	DVM (mV)	FITTED VALUE	PERCENT ERROR
1685	250.3	100	100.00	250.3	0.00
1684	95.26	38	38.05	95.24	-0.02
	0.0000	0	0.00	0.0000	0.00
		0		0.00	0.00
		0		0.00	0.00
		0		0.0000	0.00
		0		0.00	0.00
1685	250.3 HIGH	100.00		250.3	0.00
1684	95.26 LOW	38.05		95.24	-0.02

† GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : F Dora

Approved By : J Shapiro

Pyrometer Calibration Data Sheet

Pyrometer #: F-84 | Office: PALATINE

Calibrated By: IL | Date: 12-23-92

Recalibration Due: 5-93 | Battery Replaced: Yes / No (circled: No)

Calibration Reference Setting	Pyrometer Reading
50°F	50°
100°F	100°
150°F	150°
200°F	200°
250°F	250°
300°F	300°
350°F	351°
400°F	401°
450°F	450°
500°F	501°
550°F	500°
600°F	600°

Calibration Reference Information (from calibration seal on reference)

Reference Used: Digimite (circled) / Other: ______

Serial Number: 029129

Calibrated By: EIL | Date Calibrated: 3-13-92

Calibration Report Number: 350884

A Copy of the Original
Couldn't Read [initials]

6' Probe - Pm10

DATE 9/28/90 PITOT NUMBER 9/28/90-3

TYPE S PITOT TUBE INSPECTION DATA

Pitot tube assembly level? ✓ yes ____ no

Pitot tube openings damaged? ____ yes (explain below) ✓ no

α_1 = 1 ° (<10°), α_2 = 1 ° (<10°), β_1 = 2 ° (<5°)

β_2 = 1 ° (<5°)

γ = 2 °, θ = 1 °; A = .724 cm (in.)

Z = A sin γ = .025 cm (in.); < 0.32 cm (< 1/8 in.),

W = A sin θ = .012 cm (in.); < 0.08 cm (< 1/32 in.)

P_a .360 cm (in.) P_b .364 cm (in.)

$P = \frac{(P_a + P_b)}{2}$ .362

D_t = .250 cm (in.)

$\frac{P}{D_t}$ = 1.44 (≥ 1.05 and ≤ 1.50)

COMMENTS: ____

Calibration required? ____ yes ____ no

Calibrated by: ____

METER BOX FULL-TEST CALIBRATION

Date: 1-14-92 Operator: D Rybarski

Meter Box No.:	Meter Box ΔH@:	Meter Box Yd:	Barometric Pressure:
D	1.9599	1.0054	29.15

				Standard Meter Gas Volume ft³			Meter Box Gas Volume ft³			Std. Meter Temperature °F			Meter Box Temperature °F					
Q	ΔH	ΔP	Yds	Initial	Final	Vds Net	Initial	Final	Vds Net	In	Out	Tds Avg	In	Out	Tds Avg	Time θ	Yd	ΔH@
.36	.5	-2.0	1.0000	Ø	5.003	5.003	652.108	657.306	5.198	63	63	63	98	92	95	13.38	1.0149	1.9166
.36	.5	-2.0	1.0000	Ø	5.005	5.005	657.306	663.506	5.2	63	63	63	99	93	96	13.41	1.0167	1.9202
.64	1.5	-2.5	1.0000	Ø	10.006	10.006	665.208	675.742	10.534	63	63	63	104	92	98	15.37	1.0032	1.8867
.64	1.5	-2.5	1.0000	Ø	10.002	10.002	675.742	686.282	10.54	63	63	63	104	94	99	15.36	1.0040	1.8824
.86	3.0	-3.1	1.0000	Ø	10.007	10.007	625.922	636.446	10.524	63	63	63	104	90	97	11.40	.9972	2.0791
.86	3.0	-3.1	1.0000	Ø	10.008	10.008	636.446	647.017	10.571	63	63	63	106	92	99	11.41	.9964	2.0749

Nomenclature

Pb	Barometric Pressure
Q	Flow Rate (cfm)
ΔH	Orifice Pressure Differential ("H_2O)
ΔP	Inlet Pressure Differential ("H_2O)
Vd	Volume Dry Gas Meter (ft^3)
Vds	Volume Dry Standard (ft^3)
Yd	Meter Correction Factor (unitless)
Yds	Standard Meter Correction Factor (unitless)
ΔH@	Orifice Pressure Differential that gave 0.75 cfm of air at 70°F and 29.92 "Hg ("H_2O)

Calculations

$$Yd = (Yds)\left[\frac{Vds}{Vd}\right]\left[\frac{Td + 460}{Tds + 460}\right]\left[\frac{Pb + \Delta P/13.6}{Pb + \Delta H/13.6}\right]$$

$$\Delta H@ = \frac{0.0317\,\Delta H}{Pb(Td + 460)}\left[\frac{(Tds + 460)\theta^2}{(Vds)(Yds)}\right]$$

$$Q = \frac{17.64\,(Vds)(Pb)}{(Tds + 460)\theta}$$

Vacuum Gauge Calibration

Standard (Hg)	Vacuum Gauge
5	5.2
10	10.2
15	15.3
20	20.1
25	25.3
27.2	MAX

Thermometer Calibration

Standard	Inlet	Outlet
40	40	40
60	60	60
80	80	80
100	100	100
120	120	120
140	140	140

POST TEST CALIBRATION CHECK

Client/Owner: General Motors

Project Number: 6520

Operator: M. KUGERA

Date: 2-9-93

Meter Box No.: D	Meter Box Vacuum: 3	Meter Box Yd: 1.0054	Barometric Press.: 29.44

				Standard Meter Gas Volume ft^3			Meter Box Gas Volume ft^3			Std. Meter Temperature °F			Meter Box Temperature °F					
Q	ΔH	ΔP	Yds	Initial	Final	Vds Net	Initial	Final	Vd Net	In	Out	Tds Avg	In	Out	Td Avg	Time 0	Yd	ΔH@
.57	1.3	-20	1.0000	0	10.001	10.001	676.121	686.629	10.508	64	64	64	90	82	86	17:28	.9835	2.1015
.57	1.3	-20	1.0000	0	10.001	10.001	686.629	697.207	10.578	64	64	64	100	84	93	17:34	.9895	2.0893
.57	1.3	-20	1.0000	0	10.001	10.001	697.207	707.840	10.633	64	64	64	100	86	94	17:36	.9862	2.0904

Nomenclature

Pb	Barometric Pressure
Q	Flow Rate (cfm)
ΔH	Orifice Pressure Differential ("H_2O)
ΔP	Inlet Pressure Differential ("H_2O)
Vd	Volume Dry Gas Meter (ft^3)
Vds	Volume Dry Standard (ft^3)
Yd	Meter Correction Factor (unitless)
Yds	Standard Meter Correction Factor (unitless)
ΔH@	Orifice Pressure Differential that gave 0.75 cfm of air at 70° F and 29.92 "Hg ("H_2O)

Calculations

$$Yd = (Yds)\left[\frac{Vds}{Vd}\right]\left[\frac{Td + 460}{Tds + 460}\right]\left[\frac{Pb + \Delta P/13.6}{Pb + \Delta H/13.6}\right]$$

$$\Delta H@ = \frac{0.0317\,\Delta H}{Pb\,(Td + 460)}\left[\frac{(Tds + 460)\,0}{(Vds)\,(Yds)}\right]^2$$

$$Q = \frac{17.64\,(Vds)\,(Pb)}{(Tds + 460)\,0}$$

FIELD DATA

Orsat Readings

Client GENERAL MOTORS	Project Number 6520
Plant BUS + TRUCK	Unit 4
Date 2-2-93	Fuel Type NATURAL GAS
Orsat ID 05	Leak Check? OK

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

F_o = 1.083 to 1.230 (for bituminous coal)

Run Number	Location	Bag ID	Trial	Percent CO_2	Percent $CO_2 + O_2$	Percent O_2	Fo	Sample Time	Analysis Time	Analyst
1	STACK	R1	1	9.0	13.8	4.8		12:25	13:30	JB
			2	8.8	13.6	4.8				
			3	8.8	13.6	4.8				
			Avg.	(8.9)		(4.8)				
2	STACK	R2	1	9.4	13.6	4.2		13:35	14:40	JB
			2	9.0	13.2	4.2				
			3	9.2	13.4	4.2				
			Avg.	(9.2)		(4.2)				
3	STACK	R3	1	9.2	13.8	4.6		14:45	15:50	JB
			2	9.2	13.8	4.6				
			3	9.2	13.8	4.6				
			Avg.	(9.2)		(4.6)				
4/5	STACK	R4/5	1	9.2	14.0	4.8		40 MIN	17:15	JB
			2	9.2	14.0	4.8				
			3	9.2	14.0	4.8				
			Avg.	(9.2)		(4.8)				
6/7	STACK	R6/7	1	9.4	14.0	4.6		40 MIN	18:40	JB
			2	9.4	14.0	4.6				
			3	9.4	14.0	4.6				
			Avg.	(9.4)		(4.6)				
8/9	STACK	R7/8	1	9.0	14.0	5.0		40 MIN	19:35	JB
			2	9.0	14.0	5.0				
			3	9.0	14.0	5.0				
			Avg.	(9.0)		(5.0)				
10/11	STACK	R10/11	1	8.6	14.4	~~5.8~~		40 MIN	20:30	JB
9.0 14.0 5.0			2	8.4	14.0	5.6				
9.0 14.0 5.0			3	8.4	14.0	5.6		REDO ANOTHER BAG, #'S TOO LOW CO_2		
(9.0) (5.0)			Avg.	(8.5)		(5.7)				
12	STACK	R12	1	9.0	14.0	5.0		20 MIN	21:00	JB
			2	9.0	14.0	5.0				
			3	9.0	14.0	5.0				
			Avg.	(9.0)		(5.0)				

Orsat Readings

Client	GM	Project Number	6520
Plant	ROANOKE	Unit	4
Date	2-3-93	Fuel Type	OIL
Orsat ID	05	Leak Check?	OK

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

F_o = 1.083 to 1.230 (for bituminous coal)

Run Number	Location	Bag ID	Trial	Percent CO_2	Percent $CO_2 + O_2$	Percent O_2	F_o	Sample Time	Analysis Time	Analyst
1	STACK	1	1	12.6	16.0	3.4		1 HR	10:40	JB
			2	12.6	16.0	3.4				
			3	12.6	16.0	3.4				
			Avg.	12.6		3.4				
2	STACK	2	1	13.0	16.6	3.6		1 HR	11:50	JB
			2	13.0	16.6	3.6				
			3	13.0	16.6	3.6				
			Avg.	13.0		3.6				
3	STACK	3	1	~~12.8~~	~~16.0~~	~~2.2~~		1 HR	13:00	JB
			2	12.5 12.8	16.0 16.0	3.2 3.2				
			3	12.8	16.0	3.2				
			Avg.	12.8		3.2				
			1							
			2							
			3							
			Avg.							
			1							
			2							
			3							
			Avg.							
			1							
			2							
			3							
			Avg.							
			1							
			2							
			3							
			Avg.							
			1							
			2							
			3							
			Avg.							

CAE

Location: Stack Run: Prelim

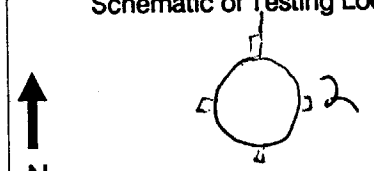
Moisture Determination Field Data Sheet

Client GM	Project Number 6526
Plant Fort Wayne IN	Unit Boiler # 4
Date 2/2/93	Inlet/outlet/stack
Meter Operator K.S.	
Probe Operator K.S.	

Sample Box Number K6	
Pyrometer Number F84	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before:	.006	cc/m cf/m @	23	"Hg
Leak Rate After:	.001	cc/m cf/m @	15	"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN (OUT)
Filter Material		

Ambient Temp. (°F) 60	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%) —	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number Prelim	
% O_2	% CO_2
H_2O (ml) 38	Silica Gel (gm) 4
Total V_{lc} 42	

Start Time: 11:22 (AM) PM Stop Time: 11:42 (AM) PM

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 283.85 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	2	N/A	40	2.0	287.96	95	90	N/A			
	10	3		45	2.0	291.77	108	91				
	15	3		50	2.0	295.58	114	92				
	20											
Average					(2.0)		(98)					
Total						(7.62)						

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Location: Stack Run: 1-3 Velocity

Moisture Determination Field Data Sheet

Client C.M	Project Number 6520
Plant Fort Wayne IN	Unit Boiler #4
Date 2/2/93	Inlet/outlet/stack
Meter Operator K.S.	
Probe Operator J.B.	

Sample Box Number —	
Pyrometer Number F84	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0059

Leak Rate Before: ✓	cc/m cf/m @	"Hg
Leak Rate After: ✓	cc/m cf/m @	"Hg

Schematic of Testing Location

First point all the way (IN) OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN (OUT)
Filter Material		

Ambient Temp. (°F) 60	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%) 22	

Heater Box Setting —	Probe Heater Setting —
Probe Length 7'	Probe Number 9-28-92-3
Probe Material SS	

IGS Bag ID Number —	
% O_2	% CO_2
H_2O (ml) —	Silica Gel (gm) —
Total V_{lc} —	

Start Time: 12:30	AM / (PM)	Stop Time: 12:35	AM / (PM)
1:50	PM	1:54	PM
3:08	PM	3:13	PM

Velocity Stack Temp

ΔPs Ts ΔPs Ts Static -.65 ΔPs Ts

Traverse Point Number	Min/pt / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
1.1	.58	364		.59	361		.48	360				
2	.66	364		.63	360		.64	360				
3	.69	364		.70	363		.71	363				
4	.67	364		.61	363		.69	365				
5	.56	364		.56	363		.58	365				
6	.52	355		.48	363		.44	361				
2.1	.51	361		.52	362		.55	363				
2	.64	362		.67	363		.67	363				
3	.66	363		.72	363		.71	365				
4	.65	365		.65	363		.70	364				
5	.60	363		.54	363		.58	368				
6	.47	355		.48	363		.48	364				
Average	.774	362		.770	363		.774	363				
Total												

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Location: Stack Run: 1

Moisture Determination Field Data Sheet

Client GM	Project Number 6520
Plant Fort Wayne IN	Unit Boiler #4
Date 2/2/93	Inlet/outlet/stack
Meter Operator K.S	
Probe Operator K.S	

Sample Box Number XO	
Pyrometer Number F-84	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before: .001	cc/m cf/m @	15	"Hg
Leak Rate After: .002	cc/m cf/m @	15	"Hg

Schematic of Testing Location

First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN OUT
Filter Material		

Ambient Temp. (°F) 60	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%) 22	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number R1	
% O_2 4.8	% CO_2 8.9
H_2O (ml) 109	Silica Gel (gm) 8
Total V_{lc} 117	

Start Time: 12:23 AM PM Stop Time: 1:23 AM PM

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 296.37 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
1-1	5	2	N/A	46	1.0	299.11	93	88	N/A			
2	10	2		48	1.0	301.77	100	89				
3	15	2		50	1.0	304.44	104	89				
4	20	2		50	1.0	307.21	104	89				
5	25	2		52	1.0	309.85	105	89				
6	30	2		54	1.0	312.43	105	89				
2-1	35	2		54	1.0	315.12	104	88				
2	40	2		54	1.0	317.78	105	88				
3	45	2		56	1.0	320.55	104	88				
4	50	2		56	1.0	323.12	104	88				
5	55	2		56	1.0	325.81	104	88				
6	60	2	v	58	1.0	328.45	104	88	v			
Average					(1.0)		(96)					
Total						(32.08)						

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Location: Stack Run: 2

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Moisture Determination Field Data Sheet

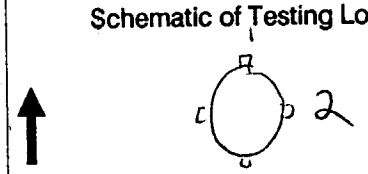
Client C.M	Project Number 6520
Plant Fort Wayne IN	Unit Boiler #4
Date 2/2/93	Inlet/outlet/stack
Meter Operator K.S.	
Probe Operator K.S.	

Ambient Temp. (°F) 60	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%) 22	

Sample Box Number K6	
Pyrometer Number E84	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN (OUT)
Filter Material		

IGS Bag ID Number R2	
% O_2 4.2	% CO_2 9.2
H_2O (ml) 116	Silica Gel (gm) 116
Total V_{lc} 132	

Leak Rate Before: .002 cc/m (cf/m) @ 15 "Hg	
Leak Rate After: .001 cc/m (cf/m) @ 12 "Hg	

Start Time: 1:33 AM (PM) Stop Time: 2:34 AM (PM)

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 328.78 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp, T_p (°F)			Notes
	5	2	N/A	56	1.0	331.48	96	87	N/A			
	10	2		52	1.0	334.17	101	88				
	15	2		52	1.0	336.87	104	85				
	20	2		52	1.0	339.57	104	86				
	25	2		52	1.0	342.27	104	88				
	30	2		50	1.0	344.95	104	88				
	35	2		50	1.0	347.65	103	88				
	40	2		50	1.0	350.35	102	88				
	45	2		50	1.0	353.04	102	88				
	50	2		56	1.0	355.72	103	88				
	55	2		50	1.0	358.41	102	88				
	60	2		50	1.0	361.08	103	88				
Average					1.0		95					
Total						32.30						

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Location: Stack Run: 3

Moisture Determination Field Data Sheet

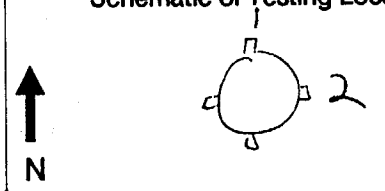
Page _____ of _____

Client GM	Project Number 6520
Plant Fort Wayne IN	Unit Boiler 4
Date 2/2/93	Inlet/outlet/stack
Meter Operator K.S.	
Probe Operator K.S.	

Sample Box Number	10
Pyrometer Number	F-84
Meter Box Number	D
Meter ΔH@ 1.959	Meter Y_d 1.0054

Leak Rate Before:	.002	cc/m cf/m @	13 "Hg
Leak Rate After:	.002	cc/m cf/m @	10 "Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN OUT
Filter Material		

Ambient Temp. (°F) 60	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%)	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number 123			
% O_2 4.6		% CO_2 9.2	
H_2O (ml) 113		Silica Gel (gm) 4	
Total V_{lc} 117			

Start Time: 2:44 AM PM Stop Time: 3:44 AM PM

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp. Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 361.35 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	2	N/A	52	1.0	364.15	95	86	N/A			
	10	2		52	1.0	367.07	100	86				
	15	2		52	1.0	369.52	101	86				
	20	2		52	1.0	372.20	102	87				
	25	2		50	1.0	374.88	101	87				
	30	2		50	1.0	377.57	101	87				
	35	2		50	1.0	380.26	100	87				
	40	2		50	1.0	382.94	100	86				
	45	2		50	1.0	385.62	100	87				
	50	2		50	1.0	388.28	100	86				
	55	2		52	1.0	390.95	100	86				
	60	2		52	1.0	393.64	100	86				
Average					1.0		93					
Total						32.29						

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Location: Stack Run: 4-5

Moisture Determination Field Data Sheet

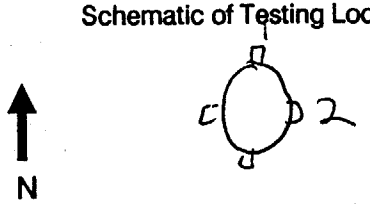
Page ____ of ____

Client GM	Project Number 6520
Plant Fort Wayne IN	Unit Boiler #4
Date 2/2/93	Inlet/outlet/stack
Meter Operator K.S.	
Probe Operator K.S.	

Sample Box Number KO	
Pyrometer Number F.S.C.	
Meter Box Number 15	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before: .001	cc/m (cf/m) @	10	"Hg
Leak Rate After: .003	cc/m (cf/m) @	13	"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN (OUT)
Filter Material		

Ambient Temp. (°F) 60	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%)	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number 124		
% O_2 4.8	% CO_2 9.2	
H_2O (ml) 112	Silica Gel (gm) 7	
Total V_{lc} 119		

Start Time: 4:18 AM (PM) Stop Time: 5:03 AM (PM)

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 394.11 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp, T_p (°F)			Notes
	5	2	N/A	44	1.5	397.58	92	84	N/A			
	10	2		44	1.5	401.04	102	84				
	15	2		46	1.5	404.59	105	86				
	20	2		46	1.5	407.94	106	86				
	25	2		48	1.5	411.38	106	87				
	30	2		48	1.5	414.83	106	87				
	35	2		50	1.5	418.26	106	88				
	40	2		50	1.5	421.70	106	88				
	45	2		50	1.5	425.14	106	88				
Average					(1.5)		(95)					
Total						(31.03)						

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Location: Stack Run: 5 67+

Moisture Determination Field Data Sheet

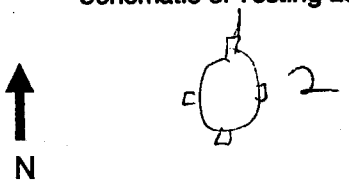
Page ____ of ____

Client GM	Project Number 6520
Plant Fort Wayne IN	Unit Boilers #4/
Date 2/2/93	Inlet/outlet/stack
Meter Operator K.S.	
Probe Operator K.S.	

Sample Box Number KO	
Pyrometer Number F-84	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before: .001	cc/m cf/m @	13	"Hg
Leak Rate After: .001	cc/m cf/m @	13	"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN OUT
Filter Material		

Ambient Temp. (°F) 60	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%) 16.66	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number R6-1			
% O_2 4.6		% CO_2 9.4	
H_2O (ml) 111		Silica Gel (gm) 14	
Total V_{lc} 125			

Start Time: 5:46 AM PM Stop Time: 6:31 AM PM

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 425.77 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	2	N/A	38	1.5	429.29	94	85	N/A			
	10	2		40	1.5	432.79	105	88				
	15	2		42	1.5	436.28	108	88				
	20	2		44	1.5	439.77	108	89				
	25	2		44	1.5	443.20	108	90				
	30	2		44	1.5	446.64	106	90				
	35	2		42	1.5	450.17	106	90				
	40	2		44	1.5	453.51	106	90				
	45	2		46	1.5	456.95	106	90	V			
Average					1.5		97					
Total						31.18						

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Location: Stack Run: 6 (8-1)

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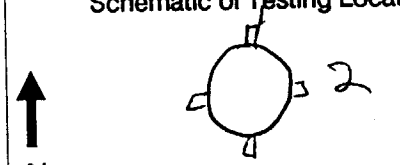
Moisture Determination Field Data Sheet

Client	GM	Project Number	6520
Plant	Fort Wayne IN	Unit	Boiler #4
Date	2/2/93	Inlet/outlet/stack	
Meter Operator	K.S.		
Probe Operator	K.S.		

Sample Box Number	KO		
Pyrometer Number	6.84		
Meter Box Number	D		
Meter ΔH@	1.9599	Meter Y_d	1.0054

Leak Rate Before:	.006	cc/m (cf/m) @	13	"Hg
Leak Rate After:	.001	cc/m (cf/m) @	13	"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN (OUT)
Filter Material		

Ambient Temp. (°F)	60	Bar. Press. (in. Hg)	29.56
Assumed Moisture (%)	16.62		

Heater Box Setting	—	Probe Heater Setting	—
Probe Length	3'	Probe Number	—
Probe Material	SS		

IGS Bag ID Number	R8-9		
% O_2	5.0	% CO_2	9.0
H_2O (ml)	108	Silica Gel (gm)	16
Total V_{lc}	124		

Start Time: 6:42 AM (PM) Stop Time: 7:27 AM (PM)

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 457.63 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp, T_p (°F)			Notes
	5	2	N/A	46	1.5	461.10	96	88	N/A			
	10	2		44	1.5	464.55	102	88				
	15	2		48	1.5	467.99	105	88				
	20	2		50	1.5	471.42	106	88				
	25	2		50	1.5	474.85	106	88				
	30	2		50	1.5	478.28	106	88				
	35	2		50	1.5	481.71	106	89				
	40	2		50	1.5	485.15	106	89				
	45	2		52	1.5	488.58	105	89				
Average					1.5		96					
Total						30.95						

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Location: Stack Run: 7

Moisture Determination Field Data Sheet

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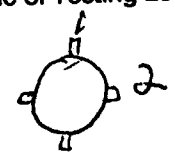
Client GM	Project Number 6520
Plant Fort Wayne IN	Unit Boiler # 4
Date 2/2/93	Inlet/outlet/stack
Meter Operator KS.	
Probe Operator	

Sample Box Number KO	
Pyrometer Number F-84	
Meter Box Number 0	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before: .001	cc/m cf/m @ 13	"Hg
Leak Rate After: .001	cc/m cf/m @ 13	"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN OUT
Filter Material		

Ambient Temp. (°F) (a)	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%)	15.81

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number R 10-11	
% O_2 5.7	% CO_2 8.5
H_2O (ml) 106	Silica Gel (gm) 10
Total V_{lc} 116	

Start Time: 7:40 AM / PM Stop Time: 8:25 AM / PM

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 489.05 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	2	N/A	44	1.5	492.51	94	86	N/A			
	10	2		44	1.5	495.95	104	88				
	15	2		46	1.5	499.36	106	89				
	20	2		44	1.5	502.76	106	89				
	25	2		46	1.5	506.17	106	89				
	30	2		46	1.5	509.56	106	89				
	35	2		48	1.5	512.95	106	90				
	40	2		48	1.5	516.35	106	90				
	45	2	✓	48	1.5	519.79	106	89				
Average					1.5		97					
Total						30.74						

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Location: stack Run: 8 12

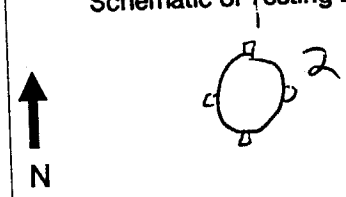
Moisture Determination Field Data Sheet

Client GM	Project Number 6520
Plant Fort Wayne IN	Unit Boiler # 4
Date 2/2/93	Inlet/outlet/stack
Meter Operator K.S.	
Probe Operator K.S.	

Sample Box Number KO	
Pyrometer Number F-84	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before: .001	cc/m (cf/m @	15	"Hg
Leak Rate After:	cc/m cf/m @		"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN (OUT)
Filter Material		

Ambient Temp. (°F) 60	Bar. Press. (in. Hg) 29.56
Assumed Moisture (%) 15.34	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number R12	
% O_2 5	% CO_2 9
H_2O (ml) 53	Silica Gel (gm) 2
Total V_{lc} 55	

Start Time: 8:34 AM (PM) Stop Time: 8:54 AM (PM)

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 520.5 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	3	N/A	44	2.0	524.01	96	88	N/A			
	10	3		46	2.0	527.77	104	89				
	15	3		50	2.0	531.52	106	89				
	20	3		50	2.0	535.27	107	89				
Average					2.0		96					
Total						15.09						

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Location: Stack Run: 1-3 vel

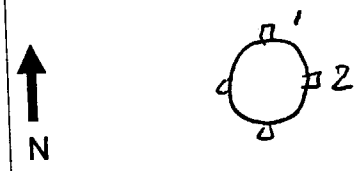
Moisture Determination Field Data Sheet

Client GM	Project Number 6520
Plant Ford Wayne IN	Unit Boiler 4
Date 2/3/93	Inlet/outlet/stack
Meter Operator KS	
Probe Operator JB	

Sample Box Number —	
Pyrometer Number F-8	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before: ✓	cc/m cf/m @	"Hg
Leak Rate After: —	cc/m cf/m @	"Hg

Schematic of Testing Location



First point all the way (IN) OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN (OUT)
Filter Material		

Ambient Temp. (°F) 61	Bar. Press. (in. Hg) 29.41
Assumed Moisture (%)	

Heater Box Setting —	Probe Heater Setting —
Probe Length 7'	Probe Number 9-22-90-2
Probe Material SS	

IGS Bag ID Number —	
% O_2	% CO_2
H_2O (ml) —	Silica Gel (gm) —
Total V_{lc} —	

Start Time: 9:47 (AM) / PM — Stop Time: 9:51 (AM) / PM
10:54 (AM) — 10:59 (AM)
12:01 (PM) — 12:05 (PM)

vel. head DPs — stack temp Ts — DPs — Ts — DPs — Ts

Traverse Point Number	Min/pt / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp, T_p (°F)			Notes
1-1	.50	371		.52	372		.48	372				
2	.62	370		.61	373		.59	375				
3	.65	370		.67	375		.63	374				
4	.64	370		.63	373		.63	375				
5	.57	370		.59	377		.56	376				
6	.37	370		.41	378		.40	362				
2-1	.51	370		.48	375		.49	373				
2	.58	370		.561	377		.61	374				
3	.67	370		.63	376		.666	375				
4	.65	370		.66	377		.67	376				
5	.57	370		.63	374		.61	377				
6	.41	370		.51	377		.50	377				
Average	(.747)	(370)		(.755)	(375)		(.752)	(374)				
Total												

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Location: Stack Run: 1-0.1

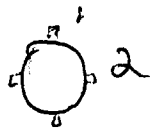
Moisture Determination Field Data Sheet

Client GAI	Project Number 6520
Plant Fort Wayne IN	Unit # 4 Boiler
Date 2/3/93	Inlet/outlet/stack
Meter Operator KS	
Probe Operator KS	

Sample Box Number X0	
Pyrometer Number —	
Meter Box Number 1	
Meter ΔH@ 1.4599	Meter Y_d 1.0054

Leak Rate Before: .001	cc/m (cf/m @)	14	"Hg
Leak Rate After: .001	cc/m (cf/m @)	15	"Hg

Schematic of Testing Location



First point all the way–IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow– IN (OUT)
Filter Material		

Ambient Temp. (°F) 61	Bar. Press. (in. Hg) 29.41
Assumed Moisture (%) 12.47	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number R1a	
% O_2 3.4	% CO_2 12.6
H_2O (ml) 80	Silica Gel (gm) 10
Total V_{lc} 90	

Start Time: 9:36 (AM) PM Stop Time: 10:36 (AM) PM

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 5360.05 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	2	N/A	34	1.0	5380	94	85	N/A			
	10	2		38	1.0	541.81	100	86				
	15	2		42	1.0	544.08	103	86				
	20	2		44	1.0	546.72	103	87				
	25	2		46	1.0	549.34	102	86				
	30	2		46	1.0	551.94	101	88				
	35	2		48	1.0	554.55	100	88				
	40	2		50	1.0	557.17	100	88				
	45	2		50	1.0	559.78	100	88				
	50	2		52	1.0	562.38	100	88				
	55	2		54	1.0	564.95	100	88				
	60	2		56	1.0	567.58	100	87				
Average					(1.0)		(94)					
Total						(31.53)						

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Location: Stack Run: 2-out

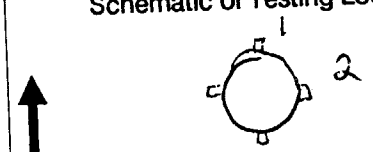
Moisture Determination Field Data Sheet

Client GM	Project Number 6520
Plant Fort Wayne IN	Unit # 4 Boiler
Date 2/3/93	Inlet/outlet/Stack
Meter Operator KS	
Probe Operator KS	

Sample Box Number KO	
Pyrometer Number —	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before: .001	cc/m (cf/m) @	15	"Hg
Leak Rate After: .003	cc/m (cf/m) @	18	"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 65	Gas Flow IN (OUT)
Filter Material		

Ambient Temp. (°F) 61	Bar. Press. (in. Hg) 29.41
Assumed Moisture (%) 12.58	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number K2			
% O_2 3.6		% CO_2 13.0	
H_2O (ml) 81		Silica Gel (gm) 9	
Total V_{lc} 90			

Start Time: 10:47 (AM) / PM Stop Time: 11:47 (AM) / PM

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 568.07 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	2	N/A	50	1.0	570.70	92	85	N/A			
	10	2		50	1.0	573.37	~~105~~ 98	86				
	15	2		54	1.0	575.88	102	86				
	20	2		56	1.0	578.45	103	86				
	25	2		56	1.0	581.10	104	87				
	30	2		56	1.0	583.80	105	87				
	35	2		56	1.0	586.33	105	88				
	40	2		58	1.0	588.94	106	88				
	45	2		54	1.0	591.56	106	88				
	50	2		54	1.0	594.17	106	89				
	55	2		50	1.0	596.78	107	90				
	60	2	↓	50	1.0	599.39	106	90				
Average					(1.0)		(96)					
Total						31.32						

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Location: Stack Run: 3 of 3

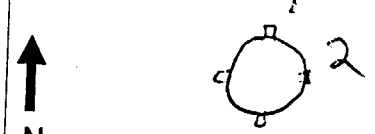
Moisture Determination Field Data Sheet

Client GM	Project Number 6520
Plant Fort Wayne IN	Unit # 4 Boiler
Date 2/3/95	Inlet/outlet/stack
Meter Operator KS	
Probe Operator KS	

Sample Box Number KD	
Pyrometer Number —	
Meter Box Number D	
Meter ΔH@ 1.9599	Meter Y_d 1.0058

Leak Rate Before:	.001	cc/m cf/m @	17	"Hg
Leak Rate After:	.003	cc/m cf/m @	14	"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN (OUT)
Filter Material —		

Ambient Temp. (°F) 61	Bar. Press. (in. Hg) 29.41
Assumed Moisture (%) 11.82	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number 123	
% O_2 3.2	% CO_2 12.8
H_2O (ml) 82	Silica Gel (gm) 2
Total V_{lc} 84	

Start Time: 11:58 (AM) / PM	Stop Time: 12:58 AM / (PM)

Traverse Point Number	Min/pt 5 Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 600.17 Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	2	N/A	48	1.0	602.05	99	90	N/A			
	10	2		44	1.0	605.49	106	90				
	15	2		46	1.0	608.13	107	91				
	20	2		46	1.0	610.74	108	91				
	25	2		46	1.0	613.34	108	91				
	30	2		48	1.0	615.96	107	91				
	35	2		46	1.0	618.62	107	91				
	40	2		46	1.0	621.25	107	91				
	45	2		48	1.0	KS 623.88	107	91				
	50	2		50	1.0	KS 626.50	107	91				
	55	2		50	1.0	629.11	107	91				
	60	2		50	1.0	631.70	107	91				
Average					(1.0)		(99)					
Total						31.53						

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Location: Stack Run: 4-So.1

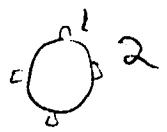
Moisture Determination Field Data Sheet

Client GM	Project Number 6520
Plant Fort Wayne IN	Unit Bo.Nr. 4
Date 2/3/92	Inlet/outlet/stack
Meter Operator KS	
Probe Operator KS	

Sample Box Number KO	
Pyrometer Number —	
Meter Box Number 1)	
Meter ΔH@ 1.9599	Meter Y_d 1.0054

Leak Rate Before:	.001	cc/m cf/m @	14	"Hg
Leak Rate After:	.001	cc/m cf/m @	14	"Hg

Schematic of Testing Location



First point all the way IN OUT	Method 4	
Area (ft^2) 25.2	Port Len. (in.) 6.5	Gas Flow IN OUT
Filter Material		

Ambient Temp. (°F) 61	Bar. Press. (in. Hg) 29.41
Assumed Moisture (%)	

Heater Box Setting —	Probe Heater Setting —
Probe Length 3'	Probe Number —
Probe Material SS	

IGS Bag ID Number K4So	
% O_2	% CO_2
H_2O (ml) 53	Silica Gel (gm) 5
Total V_{lc} 58	

Start Time: 1:57 AM PM Stop Time: 2:27 AM PM

Traverse Point Number	Min/pt 5 / Clock Time	Pump Vacuum (in. Hg)	Stack Temp, Ts (°F)	Bath Temp, (°F)	Orifice Setting ΔH (in. H_2O)	Initial Volume 632.50 / Gas Sample Volume V_m Circle one: (L) (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet $T_{m\,in}$ (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet $T_{m\,out}$ (°F)	Probe Temp. T_p (°F)			Notes
	5	3	N/A	44	1.5	635.88	97	90	N/A			
	10	2		42	1.5	639.23	109	92				
	15	3		48	1.5	642.52	112	92				
	20	3		50	1.5	645.83	112	93				
	25	3		52	1.5	649.10	112	93				
	30	3		52	1.5	651.95	112	94				
	35											stopped at 29:20
	40											
	45		↓		↓				↓			
Average					1.5		102					
Total						19.45						

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Run 1

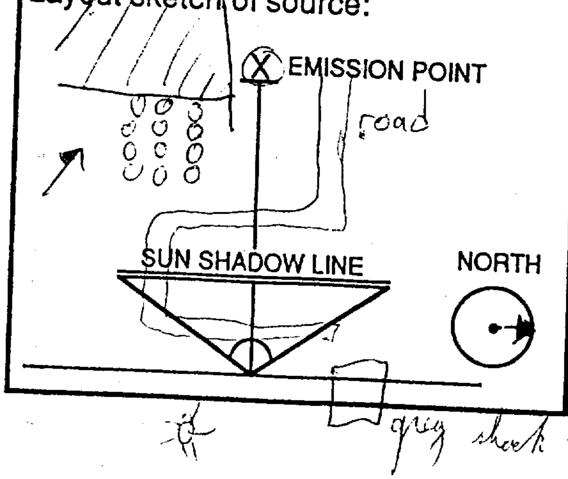
Visual Emissions Observation Form

Client/Owner: GM
Plant: Fort Wayne Unit: 4F
Observation Date: 2/3/93
Source/Process: Coal fired boiler
Control Equipment: None
Operating Mode: 200,000 lb/steam
Describe emission point: TALL and round, red+white striped brick stack
Emission point height above ground level (feet): 250'
Emission point height above relative to observer (feet): 250'
Distance to emission point:
Distance to emission point from observer:
Describe emission (Color,etc):

(Continuous) Fugitive Intermittent

Water vapor present? (No) Yes
If yes, is plume attached or detached?
Point where opacity was determined: 1 diameter from exit
Describe background: clear blue sky
Sky conditions: clear
Wind speed: 0-9 Wind direction:
Ambient temperature:
Relative humidity: 74%
Comments:

Layout sketch of source:



Observer's name: DAVID N[illegible]
Certified by: Carl Kastnitz
Start time: 9:35 am
Project Number: 6520
Date Certified: 10/7/92
Stop time: 10:35 am

0	15	30	45	60	0	15	30	45	60
0	5	10	5	5	30	5	5	5	5
1	10	5	5	5	31	5	5	5	5
2	5	5	10	5	32	5	10	5	5
3	5	10	5	5	33	5	5	5	5
4	5	10	10	5	34	5	5	10	5
5	5	10	10	5	35	5	5	5	5
6	5	5	5	5	36	5	5	10	5
7	5	10	5	5	37	5	5	5	5
8	10	5	5	5	38	5	5	5	5
9	5	5	5	5	39	5	5	5	5
10	5	10	5	5	40	0	5	5	5
11	5	5	5	5	41	5	5	5	0
12	5	5	5	5	42	5	5	5	5
13	5	10	5	5	43	5	5	5	5
14	5	5	5	5	44	5	5	5	5
15	5	5	5	10	45	5	5	5	5
16	5	5	5	5	46	5	5	5	5
17	5	5	5	5	47	0	0	5	5
18	5	5	5	5	48	0	5	5	5
19	5	5	5	5	49	5	5	5	5
20	5	5	5	5	50	5	0	5	5
21	5	5	0	5	51	0	0	5	5
22	5	5	5	0	52	5	0	0	0
23	5	5	5	10	53	5	5	5	5
24	5	5	5	5	54	5	5	5	0
25	5	5	10	5	55	0	5	0	5
26	5	5	5	10	56	5	5	0	5
27	5	5	5	5	57	5	5	5	0
28	5	5	5	5	58	0	5	5	5
29	5	5	5	5	59	5	5	5	5

Range of opacity: 0 % to 10 %

Observer's Signature: David N[illegible]

Date:

Visual Emissions Observation Form

DAVID NABRALA

Run 2

Client/Owner: GM	Observer's name:
Plant: Fort Wayne Unit: 4	Certified by: Carl Hunter
Observation Date: 2/3/93	Start time: 10:45
Source/Process: Oil Fired Boiler	Project Number: 6520
Control Equipment: none	Date Certified: 10/7/92
Operating Mode: 200,000 lb steam	Stop time: 11:45
Describe emission point: Tall, round, red/white stripe, Brick stack	
Emission point height above ground level (feet): 250'	
Emission point height above relative to observer (feet): 250'	
Distance to emission point:	
Distance to emission point from observer: 900'	
Describe emission (Color,etc):	
(Continuous) Fugitive Intermittent	
Water vapor present? (No) Yes	
If yes, is plume attached or detached?	
Point where opacity was determined: Diameter from exit	
Describe background: Blue/white sky	
Sky conditions: 10% overcast	
Wind speed: 0-5 Wind direction:	
Ambient temperature: ~~45~~ 40 AM	
Relative humidity: 80%	
Comments:	

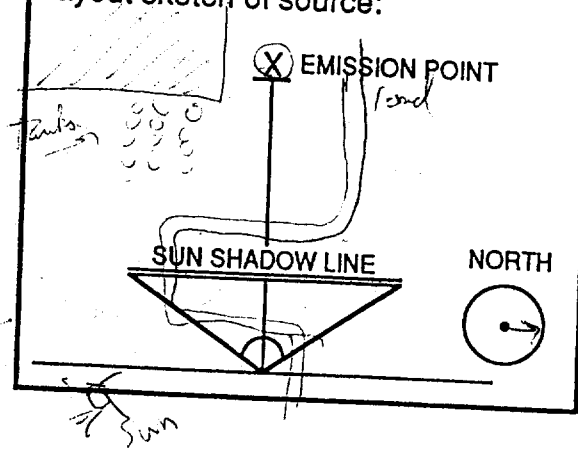
0	15	30	45	60	0	15	30	45	60
0	5	5	5	5	30	5	5	5	5
1	5	5	5	5	31	5	5	5	0
2	5	5	5	5	32	5	5	5	5
3	5	5	0	5	33	0	0	0	5
4	5	5	5	0	34	0	5	0	5
5	5	5	5	0	35	0	0	5	0
6	5	5	5	5	36	5	0	0	5
7	5	5	5	5	37	5	5	0	5
8	5	5	0	5	38	0	5	0	5
9	5	5	5	5	39	0	5	5	5
10	0	5	5	5	40	0	5	0	5
11	5	5	0	5	41	0	5	0	0
12	5	5	0	0	42	0	0	5	5
13	5	5	5	5	43	0	0	0	0
14	0	5	5	5	44	0	0	0	0
15	5	0	5	5	45	5	5	0	0
16	5	5	5	0	46	5	0	0	5
17	5	5	5	5	47	0	5	5	0
18	0	5	5	5	48	0	5	0	0
19	5	5	5	5	49	0	0	5	0
20	5	5	5	5	50	5	0	0	5
21	5	5	0	5	51	0	5	5	5
22	5	5	0	5	52	5	5	5	5
23	5	5	0	5	53	5	0	0	5
24	5	5	5	5	54	5	5	0	5
25	0	0	5	5	55	5	5	5	5
26	5	5	5	5	56	5	5	5	5
27	0	5	0	5	57	5	5	5	5
28	5	5	0	5	58	0	5	5	5
29	5	0	5	5	59	0	5	5	5

Range of opacity: 0 % to 5 %

Observer's Signature: Carl Hunter

Date: 2/3/93

Layout sketch of source:



Visual Emissions Observation Form

Run 3

DAVID WASRALLA

6520 DN

Client/Owner: GM	Observer's name:	Project Number: ~~6250~~	
Plant: Fort Wayne Unit: 4	Certified by: Earl Hoonte	Date Certified: 1/7/92	
Observation Date: 2/3/93	Start time: 11:55	Stop time: 12:55	
Source/Process: 04 Fuel Boiler			
Control Equipment: None			
Operating Mode: 200,000 lb/hr steam			
Describe emission point: TALL, Round, red + white striped Brick stack			
Emission point height above ground level (feet): 250			
Emission point height above relative to observer (feet): 250			
Distance to emission point:			
Distance to emission point from observer:			
Describe emission (Color,etc):			
(Continuous) Fugitive Intermittent			
Water vapor present? (No) Yes			
If yes, is plume attached or detached?			
Point where opacity was determined: 1 decimeter from exit			
Describe background: white			
Sky conditions: 20% overcast			
Wind speed: 5-10 Wind direction: South			
Ambient temperature: 41°F			
Relative humidity: 80%			
Comments:			

0	15	30	45	60	0	15	30	45	60
0	5	5	0	5	30	5	0	5	5
1	5	5	5	5	31	5	5	5	5
2	5	5	5	5	32	5	5	5	5
3	5	5	5	5	33	5	0	0	5
4	5	5	5	5	34	0	5	0	5
5	5	5	0	5	35	5	0	0	0
6	5	5	5	5	36	5	0	5	5
7	5	5	5	5	37	5	5	5	5
8	5	5	5	5	38	0	0	5	5
9	5	0	0	5	39	0	5	5	5
10	5	5	5	5	40	5	0	5	5
11	5	5	5	5	41	5	5	5	5
12	0	5	0	0	42	5	0	0	5
13	5	5	5	5	43	0	5	5	0
14	5	5	5	5	44	5	5	5	5
15	5	5	5	5	45	5	5	0	0
16	5	5	5	5	46	5	5	5	5
17	0	5	5	0	47	5	5	5	5
18	0	5	5	5	48	5	5	5	5
19	5	5	0	5	49	5	5	5	5
20	5	5	5	0	50	5	5	5	5
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22	5	5	5	5	52	5	5	5	5
23	5	5	5	5	53	5	5	5	5
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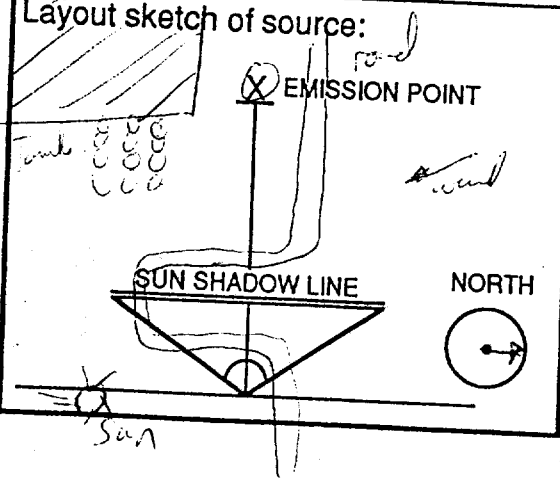
25	5	5	5	5	55	5	5	5	5
26	5	5	0	5	56	5	5	5	5
27	5	5	5	5	57	5	5	5	5
28	5	5	5	5	58	5	5	5	5
29	0	5	5	5	59	5	5	5	5

Layout sketch of source:



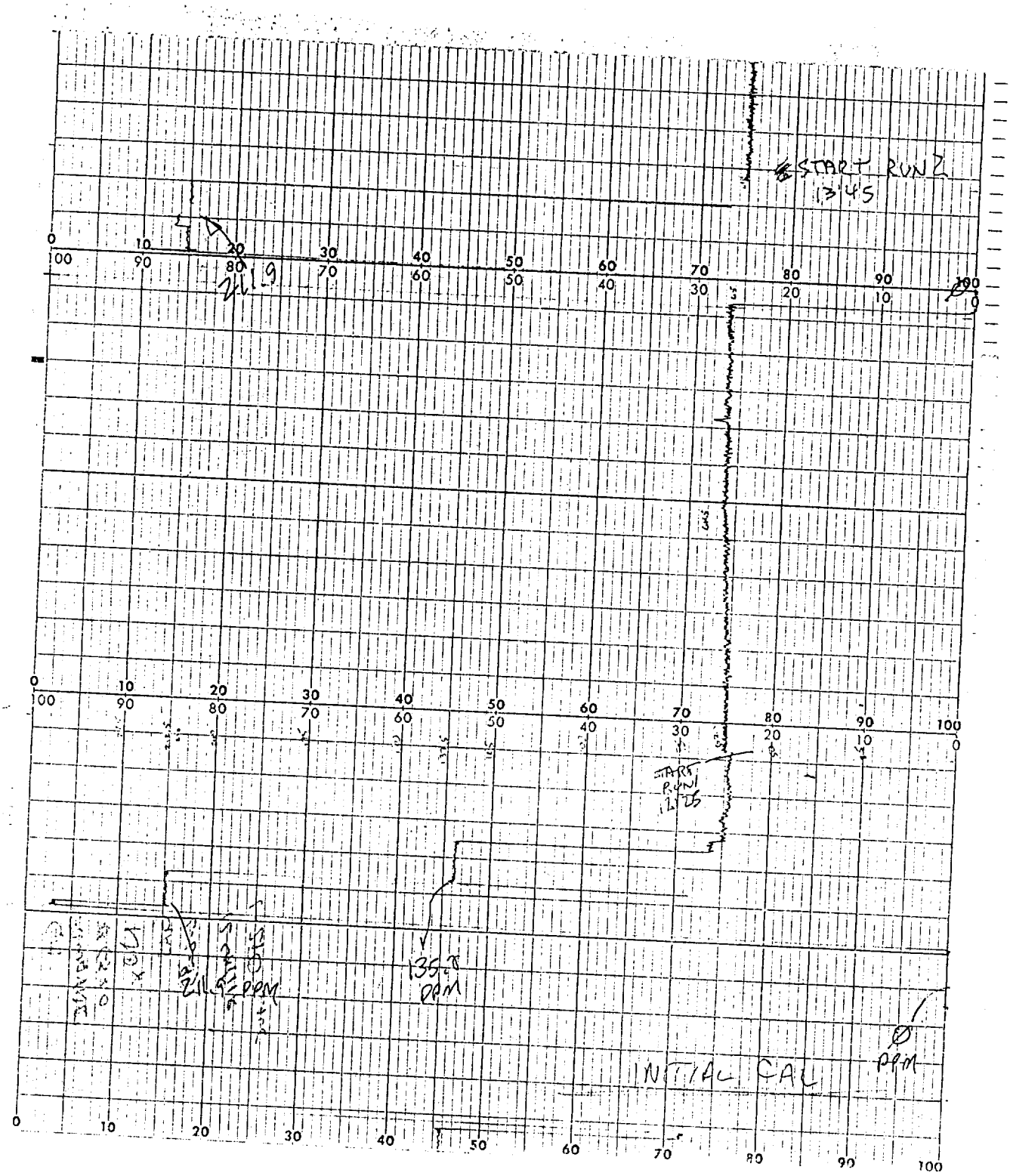
Range of opacity: 0 % to 5 %

Observer's Signature: David Wasralla

Date: Feb 3 1993

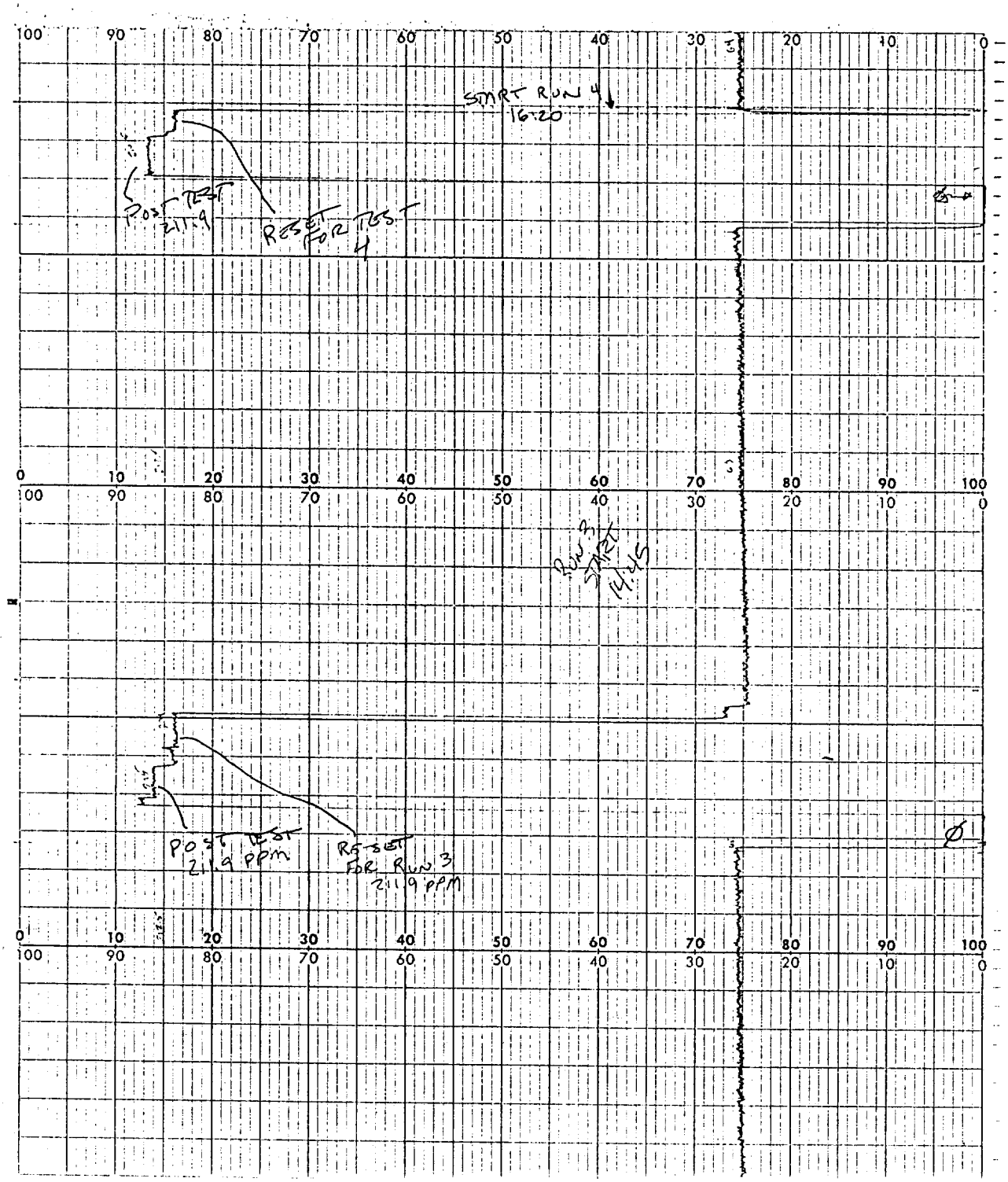
GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas
February 2, 1993

NITROGEN OXIDES (PPM)



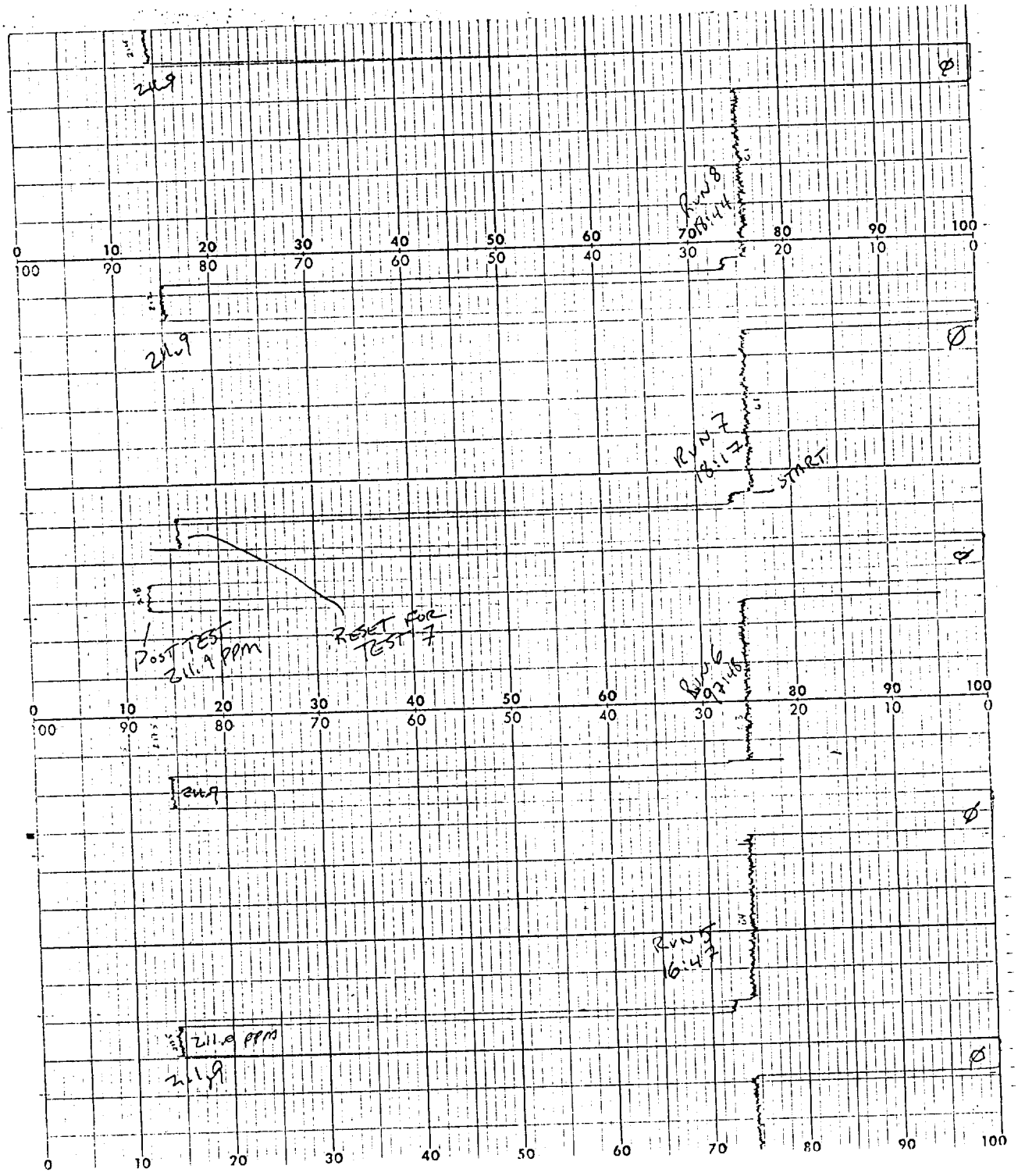
GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas
February 2, 1993

NITROGEN OXIDES (PPM)



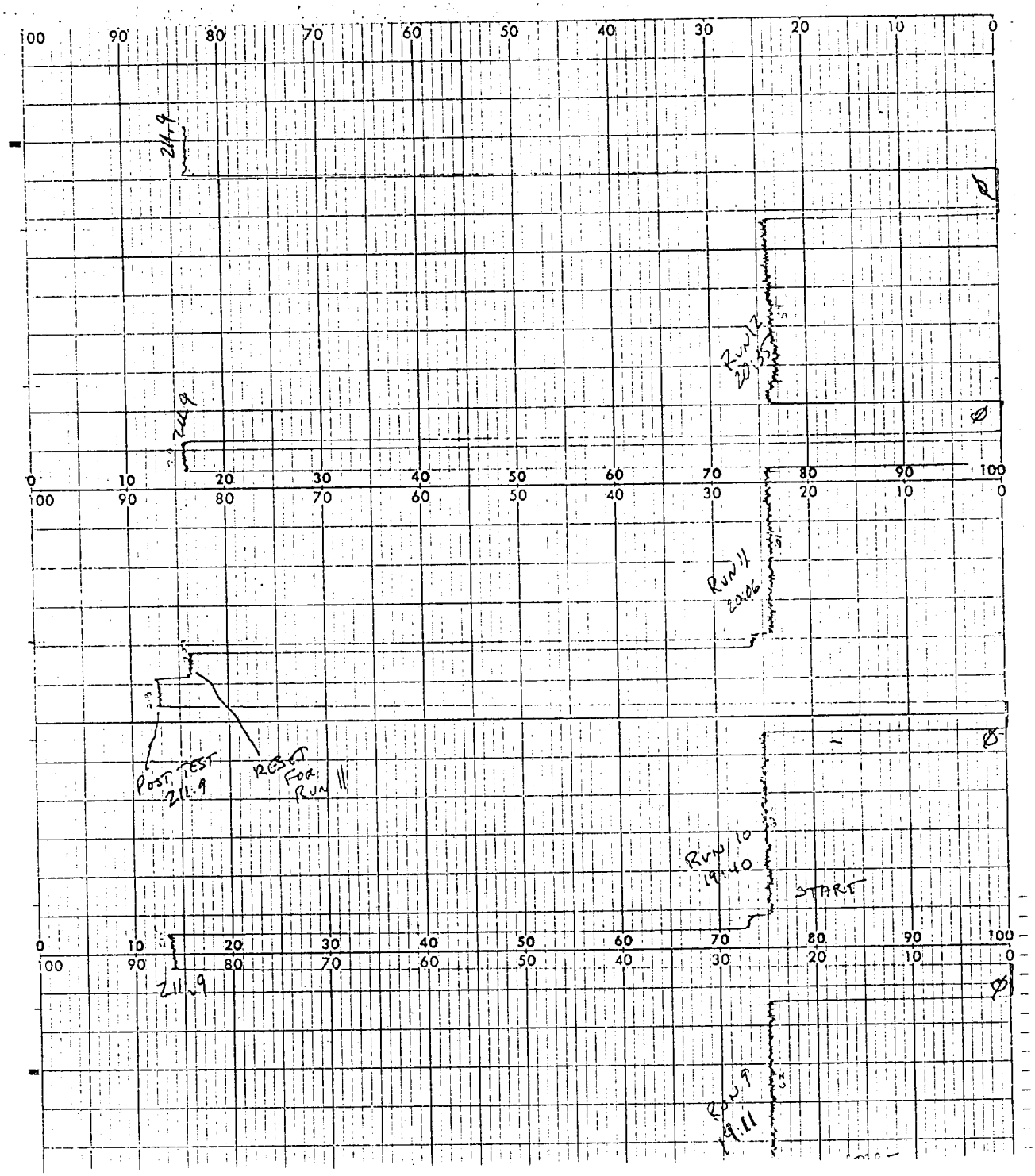
GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas
February 2, 1993

NITROGEN OXIDES (PPM)



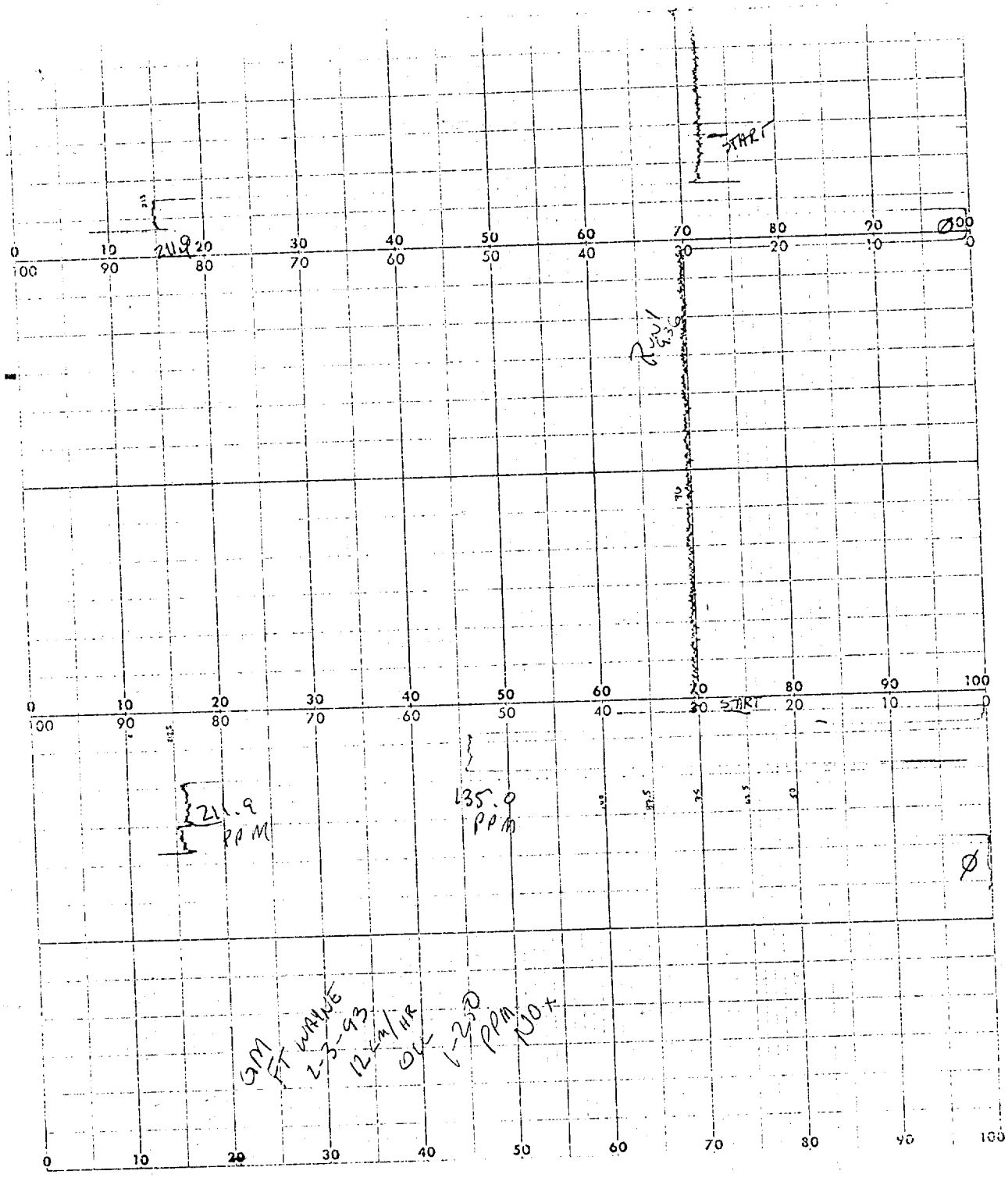
GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Natural Gas
February 2, 1993

NITROGEN OXIDES (PPM)



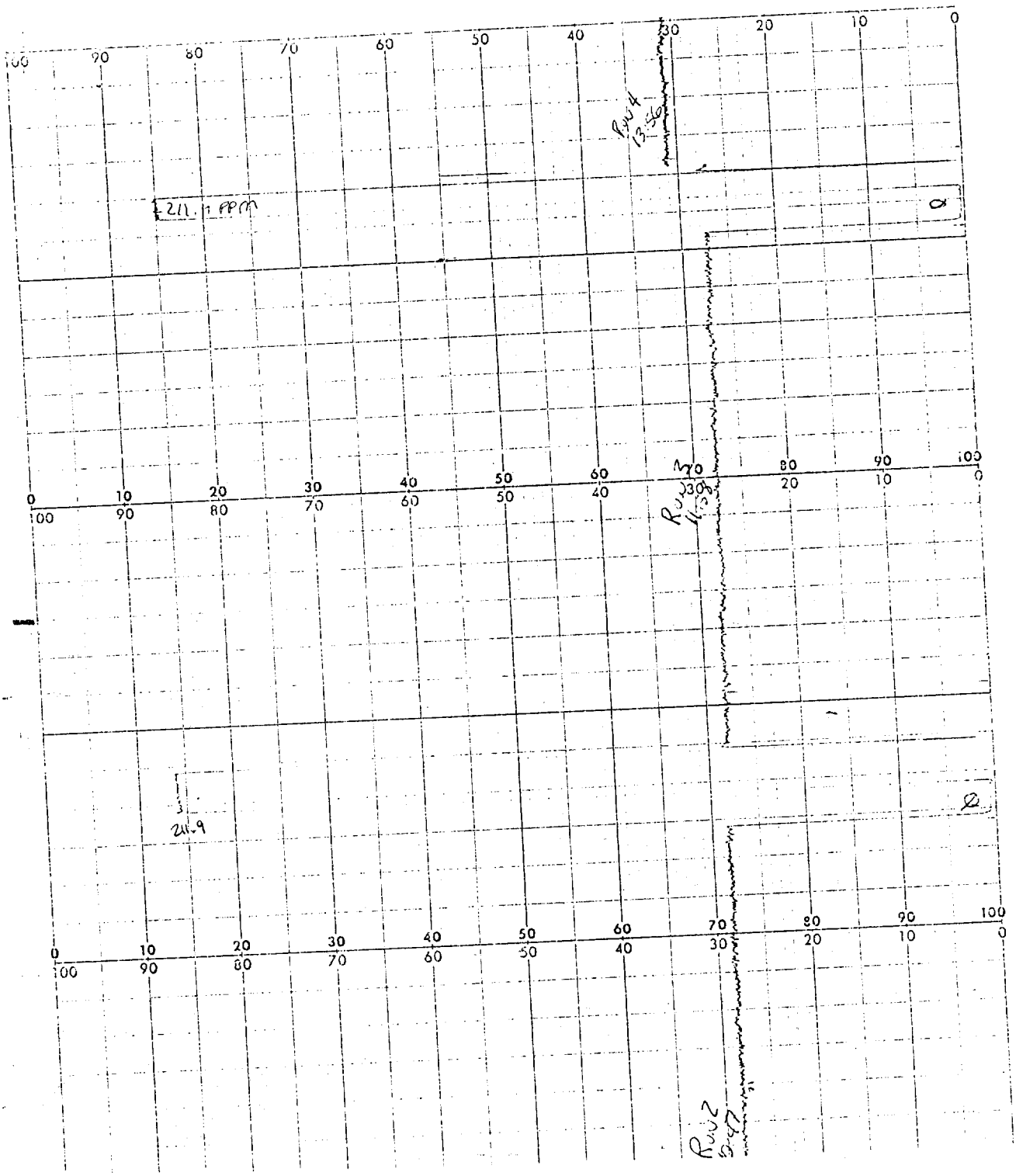
GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Oil
February 3, 1993

NITROGEN OXIDES (PPM)



GENERAL MOTORS CORPORATION
CAE Project No: 6520
Boiler #4 Stack, Oil
February 3, 1993

NITROGEN OXIDES (PPM)



MONITOR DATA

Run 1 - 1 Hour TEST.

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 12:14:40 1993 End Time: Tue Feb 2 13:14:50 1993

12:25 START 13:25 END

Unit #4 Opacity	1.900	%
Unit #4 O2	0.000	%
Unit #4 CO2	8.495	%
Unit #4 CO ppm	217.583	ppm
Unit #4 SO2 ppm	3.650	ppm
Unit #4 NO ppm	50.083	ppm
Unit #4 Fuel Input	218.123	MMBtu/Hr
Unit #4 SO2 Emission Rate	0.007	Lbs/mmBTU
Unit #4 CO Emission Rate	0.193	Lbs/mmBTU
Unit #4 NOx Emission Rate	0.073	Lbs/mmBTU
Unit #4 SO2 Mass Emission	1.616	Lbs/Hr
Unit #4 CO Mass Emission	42.152	Lbs/Hr
Unit #4 NOx Mass Emission	15.938	Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
ZDF1DDDDDDDDDDD?ZDF2DDDDDDDDDDD?ZDF3DDDDDDDDDDD?ZDF4DDDDDDDDDDD? More Below MM<
3 Help 33 Main Menu 33 Print 33 Previous 3
DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

Run 2 - 1 Hour

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 ~~13:25~~:00 1993 13:35 End Time: Tue Feb 2 ~~14:25~~:20 1993 14:35

Unit #4 Opacity	1.900 %
Unit #4 O2	0.000 %
Unit #4 CO2	8.359 %
Unit #4 CO ppm	213.721 ppm
Unit #4 SO2 ppm	3.459 ppm
Unit #4 NO ppm	50.197 ppm
Unit #4 Fuel Input	218.189 MMBtu/Hr
Unit #4 SO2 Emission Rate	0.007 Lbs/mmBTU
Unit #4 CO Emission Rate	0.193 Lbs/mmBTU
Unit #4 NOx Emission Rate	0.074 Lbs/mmBTU
Unit #4 SO2 Mass Emission	1.556 Lbs/Hr
Unit #4 CO Mass Emission	42.099 Lbs/Hr
Unit #4 NOx Mass Emission	16.240 Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Below MM<

ZDF1 DDDDDDDDDDD?ZDF2 DDDDDDDDDDD?ZDF3 DDDDDDDDDDD?ZDF4 DDDDDDDDDDD?

3 Help 33 Main Menu 33 Print 33 Previous 3

DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

RUN-3 - 1 Hour TEST

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

Specified Average Report More Above

Start Time: Tue Feb 2 14:45:00 1993 End Time: Tue Feb 2 15:35:50 1993 15:45:00

Unit #4 Opacity	1.900	%
Unit #4 O2	0.000	%
Unit #4 CO2	8.293	%
Unit #4 CO ppm	158.683	ppm
Unit #4 SO2 ppm	3.583	ppm
Unit #4 NO ppm	50.700	ppm
Unit #4 Fuel Input	218.208	MMBtu/Hr
Unit #4 SO2 Emission Rate	0.007	Lbs/mmBTU
Unit #4 CO Emission Rate	0.144	Lbs/mmBTU
Unit #4 NOx Emission Rate	0.076	Lbs/mmBTU
Unit #4 SO2 Mass Emission	1.626	Lbs/Hr
Unit #4 CO Mass Emission	31.501	Lbs/Hr
Unit #4 NOx Mass Emission	16.532	Lbs/Hr

More Below

F1 Help F2 Main Menu F3 Print F4 Previous

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 1~~6:10~~:30 1993 16:20 End Time: Tue Feb 2 1~~6:30~~:40 1993 16:41

Unit #4 Opacity	1.900	%
Unit #4 O2	0.000	%
Unit #4 CO2	8.285	%
Unit #4 CO ppm	157.600	ppm
Unit #4 SO2 ppm	3.050	ppm
Unit #4 NO ppm	51.550	ppm
Unit #4 Fuel Input	218.205	MMBtu/Hr
Unit #4 SO2 Emission Rate	0.006	Lbs/mmBTU
Unit #4 CO Emission Rate	0.144	Lbs/mmBTU
Unit #4 NOx Emission Rate	0.077	Lbs/mmBTU
Unit #4 SO2 Mass Emission	1.385	Lbs/Hr
Unit #4 CO Mass Emission	31.319	Lbs/Hr
Unit #4 NOx Mass Emission	16.827	Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Below MM<

ZDF1DDDDDDDDDDD?ZDF2DDDDDDDDDDD?ZDF3DDDDDDDDDDD?ZDF4DDDDDDDDDDD?

3 Help 33 Main Menu 33 Print 33 Previous 3

DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

RA - Run #1 - 21-min.

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 [illegible]:30 1993 End Time: Tue Feb 2 [illegible]:50 1993 :

16:47 17:08

Unit #4 Opacity	1.900 %
Unit #4 O2	0.000 %
Unit #4 CO2	8.229 %
Unit #4 CO ppm	164.619 ppm
Unit #4 SO2 ppm	3.429 ppm
Unit #4 NO ppm	51.714 ppm
Unit #4 Fuel Input	218.224 MMBtu/Hr
Unit #4 SO2 Emission Rate	0.007 Lbs/mmBTU
Unit #4 CO Emission Rate	0.151 Lbs/mmBTU
Unit #4 NOx Emission Rate	0.078 Lbs/mmBTU
Unit #4 SO2 Mass Emission	1.568 Lbs/Hr
Unit #4 CO Mass Emission	32.937 Lbs/Hr
Unit #4 NOx Mass Emission	16.998 Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Below MM<

ZDF1 DDDDDDDDDDD?ZDF2 DDDDDDDDDDD?ZDF3 DDDDDDDDDDD?ZDF4 DDDDDDDDDDD?

3 Help 33 Main Menu 33 Print 33 Previous 3

DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

Run #2 - 21 MIN

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;
Start Time: Tue Feb 2 17:48:40 1993 End Time: Tue Feb 2 18:09:10 1993

Unit #4 Opacity	1.795 %
Unit #4 O2	0.000 %
Unit #4 CO2	7.814 %
Unit #4 CO ppm	204.818 ppm
Unit #4 SO2 ppm	2.045 ppm
Unit #4 NO ppm	49.636 ppm
Unit #4 Fuel Input	159.086 MMBtu/Hr
Unit #4 SO2 Emission Rate	0.005 Lbs/mmBTU
Unit #4 CO Emission Rate	0.198 Lbs/mmBTU
Unit #4 NOx Emission Rate	0.079 Lbs/mmBTU
Unit #4 SO2 Mass Emission	0.718 Lbs/Hr
Unit #4 CO Mass Emission	31.440 Lbs/Hr
Unit #4 NOx Mass Emission	12.526 Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Below MM<

F1 Help | F2 Main Menu | F3 Print | F4 Previous

Run #3 21 MIN

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 ~~[illegible]~~:40 1993 End Time: Tue Feb 2 ~~[illegible]~~:00 1993

18:17 18:38

Unit #4 Opacity	1.778	%
Unit #4 O2	0.000	%
Unit #4 CO2	7.794	%
Unit #4 CO ppm	200.778	ppm
Unit #4 SO2 ppm	3.000	ppm
Unit #4 NO ppm	51.111	ppm
Unit #4 Fuel Input	159.050	MMBtu/Hr
Unit #4 SO2 Emission Rate	0.007	Lbs/mmBTU
Unit #4 CO Emission Rate	0.194	Lbs/mmBTU
Unit #4 NOx Emission Rate	0.081	Lbs/mmBTU
Unit #4 SO2 Mass Emission	1.055	Lbs/Hr
Unit #4 CO Mass Emission	30.806	Lbs/Hr
Unit #4 NOx Mass Emission	12.927	Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Below MM<

F1 DDDDDDDDDDD?ZDF2 DDDDDDDDDDD?ZDF3 DDDDDDDDDDD?ZDF4 DDDDDDDDDDD?

3 Help 33 Main Menu 33 Print 33 Previous 3

DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

Run #4 - 21 min

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 [illegible]:40 1993 End Time: Tue Feb 2 [illegible] 1993

18:44 19:05

Unit #4 Opacity	1.778	%
Unit #4 O2	0.000	%
Unit #4 CO2	7.794	%
Unit #4 CO ppm	200.778	ppm
Unit #4 SO2 ppm	3.000	ppm
Unit #4 NO ppm	51.111	ppm
Unit #4 Fuel Input	159.050	MMBtu/Hr
Unit #4 SO2 Emission Rate	0.007	Lbs/mmBTU
Unit #4 CO Emission Rate	0.194	Lbs/mmBTU
Unit #4 NOx Emission Rate	0.081	Lbs/mmBTU
Unit #4 SO2 Mass Emission	1.055	Lbs/Hr
Unit #4 CO Mass Emission	30.806	Lbs/Hr
Unit #4 NOx Mass Emission	12.927	Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM

ZDF1DDDDDDDDDDD?ZDF2DDDDDDDDDDD?ZDF3DDDDDDDDDDD?ZDF4DDDDDDDDDDD? More Below MM<

3 Help 33 Main Menu 33 Print 33 Previous 3

@DDDDDDDDDDDDDY@DDDDDDDDDDDDDY@DDDDDDDDDDDDDY@DDDDDDDDDDDDDY

Run 5 - 21 min

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 [redacted]:40 1993 End Time: Tue Feb 2 19:[redacted] 1993

19:11 19:32

Unit #4 Opacity	1.790 %
Unit #4 O2	0.000 %
Unit #4 CO2	7.795 %
Unit #4 CO ppm	197.800 ppm
Unit #4 SO2 ppm	2.350 ppm
Unit #4 NO ppm	49.650 ppm
Unit #4 Fuel Input	159.050 MMBtu/Hr
Unit #4 SO2 Emission Rate	0.005 Lbs/mmBTU
Unit #4 CO Emission Rate	0.191 Lbs/mmBTU
Unit #4 NOx Emission Rate	0.079 Lbs/mmBTU
Unit #4 SO2 Mass Emission	0.827 Lbs/Hr
Unit #4 CO Mass Emission	30.383 Lbs/Hr
Unit #4 NOx Mass Emission	12.557 Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
ZDF1DDDDDDDDDDD?ZDF2DDDDDDDDDDD?ZDF3DDDDDDDDDDD?ZDF4DDDDDDDDDDD?MMMMMMMMMMMMM More Below MM<
3 Help 33 Main Menu 33 Print 33 Previous 3
DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

Run 6 - 21 min

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 ~~[illegible]~~:20 1993 End Time: Tue Feb 2 ~~[illegible]~~:30 1993

19:40 20:01

Unit #4 Opacity	
Unit #4 O2	1.795 %
Unit #4 CO2	0.000 %
Unit #4 CO ppm	7.819 %
Unit #4 SO2 ppm	201.952 ppm
Unit #4 NO ppm	3.000 ppm
	49.952 ppm
Unit #4 Fuel Input	
Unit #4 SO2 Emission Rate	159.062 MMBtu/Hr
Unit #4 CO Emission Rate	0.007 Lbs/mmBTU
Unit #4 NOx Emission Rate	0.195 Lbs/mmBTU
Unit #4 SO2 Mass Emission	0.079 Lbs/mmBTU
Unit #4 CO Mass Emission	1.052 Lbs/Hr
Unit #4 NOx Mass Emission	30.961 Lbs/Hr
	12.594 Lbs/Hr

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ZDF1 DDDDDDDDDDD?ZDF2 DDDDDDDDDDD?ZDF3 DDDDDDDDDDD?ZDF4 DDDDDDDDDDD?

3 Help 33 Main Menu 33 Print 33 Previous 3

DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

RUN 7 - 21 MIN

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

Start Time: Tue Feb 2 [illegible]:10 1993 (20:06) End Time: Tue Feb 2 [illegible]:40 1993 (20:27) :

Unit #4 Opacity	1.765	%
Unit #4 O2	0.000	%
Unit #4 CO2	7.755	%
Unit #4 CO ppm	203.350	ppm
Unit #4 SO2 ppm	2.950	ppm
Unit #4 NO ppm	50.050	ppm
Unit #4 Fuel Input	159.060	MMBtu/Hr
Unit #4 SO2 Emission Rate	0.007	Lbs/mmBTU
Unit #4 CO Emission Rate	0.197	Lbs/mmBTU
Unit #4 NOx Emission Rate	0.080	Lbs/mmBTU
Unit #4 SO2 Mass Emission	1.042	Lbs/Hr
Unit #4 CO Mass Emission	31.391	Lbs/Hr
Unit #4 NOx Mass Emission	12.723	Lbs/Hr

MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Below MM<

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3 Help 33 Main Menu 33 Print 33 Previous 3

DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

Run #8 - 21 min

Use PgUp and PgDn keys to display other parameters.
Press the ENTER key to update the screen.

IM Specified Average Report MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Above MM;

: Start Time: Tue Feb 2 [illegible]:50 1993 End Time: Tue Feb 2 [illegible]:20 1993 :

20:35 20:56

Unit #4 Opacity	1.782 %
Unit #4 O2	0.000 %
Unit #4 CO2	7.714 %
Unit #4 CO ppm	209.818 ppm
Unit #4 SO2 ppm	2.545 ppm
Unit #4 NO ppm	50.136 ppm
Unit #4 Fuel Input	159.055 MMBtu/Hr
Unit #4 SO2 Emission Rate	0.006 Lbs/mmBTU
Unit #4 CO Emission Rate	0.205 Lbs/mmBTU
Unit #4 NOx Emission Rate	0.081 Lbs/mmBTU
Unit #4 SO2 Mass Emission	0.905 Lbs/Hr
Unit #4 CO Mass Emission	32.563 Lbs/Hr
Unit #4 NOx Mass Emission	12.813 Lbs/Hr

HMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM More Below MM<

ZDF1 DDDDDDDDDDD?ZDF2 DDDDDDDDDDD?ZDF3 DDDDDDDDDDD?ZDF4 DDDDDDDDDDD?

3 Help 33 Main Menu 33 Print 33 Previous 3

@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY@DDDDDDDDDDDDDDY

Run #9 - 21 min

PERTINENT CERTIFICATIONS

VISIBLE EMISSIONS EVALUATION

This is to certify that

David Nasralla

did complete a course in the opacity method of determining visible emissions from sources as specified by Federal Reference Method "9" conducted by Carl Koontz & Associates of Nashville, Tennessee.

Carl Koontz
Course Moderator

Valparaiso, IN
Location

CARL KOONTZ & ASSOCIATES
of Nashville, Tennessee

This is to acknowledge that
DAVID NASRALLA
successfully participated in Visible Emissions training on October 7, 1992 and is qualified to evaluate Visible Emissions for a period of six (6) months from the date of certification.

Carl Koontz
Instructor

CONTINUOUS EMISSIONS MONITOR CERTIFICATION

SM 8100 NO MONITOR
EX 4700 CO2 MONITOR
ZERO & CALIBRATION DRIFT REPORT

MAR 9 1993

FORT WAYNE ASSEMBLY
ROANOKE, INDIANA

UNIT 4 STACK

SM 8100 S/N 0361063
EX 4700 S/N 0360057

PREPARED FOR:

FORT WAYNE ASSEMBLY
12200 LAFAYETTE CENTER ROAD
ROANOKE, INDIANA 46783

MARCH 3, 1993

APPROVED BY: Sullivan C. Bailey

TABLE OF CONTENTS

I. INTRODUCTION

pH Environmental, Inc. was contracted by Fort Wayne Assembly to prepare a performance evaluation on a Lear Siegler SM8100 S/N 0361063 and Lear Siegler EX4700A S/N 0360057 with the Unicon 700 control unit S/N 0360064. The installations were made on Unit 4 Stack located at the Fort Wayne Assembly facility located in Roanoke, Indiana. The Calibration Drift test was performed in accordance with the emission monitoring requirements as promulgated on May 25, 1983, by the Environmental Protection Agency.* The Calibration Drift tests were conducted on February 19, 1993 throughout February 25, 1993. The instruments operated continuously throughout the calibration drift test period without maintenance or service.

II. INSTALLATION DESCRIPTION

The instruments were installed at the Fort Wayne Assembly plant on the Unit 4 Stack located at the Roanoke, Indiana facility. Further installation information can be obtained from the affected facility. The initial startup of the instruments was on December 16, 1992.

III. SUMMARY

Test results of the performance evaluation are presented on the following page. The test results clearly show that the Lear Siegler SM8100 Stack Gas Monitor and the Lear Siegler EX4700A are in conformance with Nitric Oxide and Carbon Dioxide requirements of the Performance Specifications 2 and 3- Performance Specifications and Specifications Test Procedures for Monitors of NO and CO2 from Stationary Sources.

IV. RESULTS

CALIBRATION DRIFT TEST PERIOD

The instruments operated continuously from February 19, 1993 through February 25, 1993 for a period of 168 hours. Federal Register specifications require a minimum operational period of 168 hours. Please see follow page titled " Log of Operations."

ZERO DRIFT and CALIBRATION DRIFT

Zero drift and calibration drift were tested in accordance with Paragraph 6 of Performance Specification 2 & 3. The SM8100 and EX4700A are designed to provide automatically timed zero and span calibration checked at selectable intervals throughout the calibration drift test period.

*Federal Register, Vol.48, No.102, May 25, 1983, 40 CFR 60 Appendix B.

ZERO DRIFT and CALIBRATION DRIFT cont'

Data for the zero and calibration drift tests were taken form the computer printout data of the instrument output during the period from February 19, 1993 throughout February 25, 1993. No adjustments were made during the 168 hour period calibration drift period since the drift limits were not exceeded. The CEMS calibration did not drift or deviate from any reference value by more than 2.5 percent of the span value for NO or by 0.5 percent of the CO2 reference. Please refer to the following pages for the results.

ZERO DRIFT & CALIBRATION DRIFT PERFORMANCE TEST RESULTS

	EPA SPECIFICATIONS	RESULTS
I. SM8100		NOX
Calibration Drift Test	ALL CD'S <2.5% OF SPAN VALUE	
ZERO DRIFT		.000%
SPAN DRIFT		.975%
II. EX4700A		CO2
Calibration Drift Test	ALL CD'S <0.5% OF SPAN VALUE	
ZERO DRIFT		.431%
SPAN DRIFT		.215%

LOG OF OPERATIONS

I. SM8100 (NO)

Date of Manufacture	March 21, 1986	
Initial Start-up	December 16, 1992	
	DATE	TIME
Start of CDTP	February 19, 1993	0705
End of CDTP	February 25, 1993	0705

II. EX4700A (CO2)

Date of Manufacture	March 18, 1986	
Initial Start-up	December 16, 1992	
	DATE	TIME
Start of CDTP	February 19, 1993	0705
End of CDTP	February 25, 1993	0705

T A B L E 2

ZERO AND SPAN CALIBRATION DRIFT TEST

CUSTOMER: FORT WAYNE ASSEMBLY
12200 LAFAYETTE CENTER ROAD
ROANOKE, IN.

DATE: 3-3-93

INST S/N: 0361063

INST. LOCATION: UNIT 4 STACK

MODEL: LEAR SIEGLER SM8100

ANALYZER RANGE: 0 - 375 PPM

OPERATOR: SULLIVAN C. BAILEY

TEST PARAMETER: NO

INST. RANGE: 0 - 375 PPM
ZERO SETTING: 0

READING NUMBER	DATE	TIME	ZERO READING INITIAL A	ZERO READING FINAL B	ZERO DRIFT C=B-A	
DAY 1	02-19-93	0705	0	0	0	0
DAY 2	02-20-93	0705	0	0	0	0
DAY 3	02-21-93	0705	0	0	0	0
DAY 4	02-22-93	0705	0	0	0	0
DAY 5	02-23-93	0705	0	0	0	0
DAY 6	02-24-93	0705	0	0	0	0
DAY 7	02-25-93	0705	0	0	0	0
			ARITHMETIC MEAN:		.000	0
			CONFIDENCE COEF.		.000	
			ZERO DRIFT:		.000	

UPSCALE VALUE 120 PPM

READING NUMBER	DATE	TIME	UPSCALE CAL READING INITIAL D	UPSCALE CAL READING FINAL E	UPSCALE DRIFT F=E-D	CAL DRIFT G=F-C	
DAY 1	02-19-93	0705	120	121	1	1	1
DAY 2	02-20-93	0705	120	120	0	0	0
DAY 3	02-21-93	0705	120	121	1	1	1
DAY 4	02-22-93	0705	120	120	0	0	0
DAY 5	02-23-93	0705	120	119	-1	-1	1
DAY 6	02-24-93	0705	120	119	-1	-1	1
DAY 7	02-25-93	0705	120	119	-1	-1	1
				ARITHMETIC MEAN:		-.143	5
				CONFIDENCE COEF:		.832	
				CAL DRIFT:		.975	

T A B L E 3

ZERO AND SPAN CALIBRATION DRIFT TEST

CUSTOMER: FORT WAYNE ASSEMBLY
12200 LAFAYETTE CENTER ROAD
ROANOKE, IN.

DATE: 3-3-93

INST S/N: 0360057

INST. LOCATION: UNIT 4 STACK

MODEL: LEAR SIEGLER EX4700A

ANALYZER RANGE: 0-20%

OPERATOR: SULLIVAN C. BAILEY

TEST PARAMETER: CO2

INST. RANGE: 0 - 20%
ZERO SETTING: 0

READING NUMBER	DATE	TIME	ZERO READING INITIAL A	ZERO READING FINAL B	ZERO DRIFT C=B-A	
DAY 1	02-19-93	0705	0	0	0	0
DAY 2	02-20-93	0705	0	0	0	0
DAY 3	02-21-93	0705	0	0	0	0
DAY 4	02-22-93	0705	0	.4	.4	.16
DAY 5	02-23-93	0705	0	.6	.6	.36
DAY 6	02-24-93	0705	0	.3	.3	.09
DAY 7	02-25-93	0705	0	.2	.2	.04
			ARITHMETIC MEAN:		.214	.65
			CONFIDENCE COEF.		.216	
			ZERO DRIFT:		.431	

UPSCALE VALUE 16.8 %

READING NUMBER	DATE	TIME	UPSCALE CAL READING INITIAL D	UPSCALE CAL READING FINAL E	UPSCALE DRIFT F=E-D	CAL DRIFT G=F-C	
DAY 1	02-19-93	0705	16.8	16.7	0	0	0
DAY 2	02-20-93	0705	16.8	16.8	0	0	0
DAY 3	02-21-93	0705	16.8	16.8	0	0	0
DAY 4	02-22-93	0705	16.8	16.8	0	-.16	.0256
DAY 5	02-23-93	0705	16.8	16.8	0	-.36	.1296
DAY 6	02-24-93	0705	16.8	16.8	0	-.09	.0081
DAY 7	02-25-93	0705	16.8	16.8	0	-.04	.0016
				ARITHMETIC MEAN:		-.093	.1649
				CONFIDENCE COEF:		.122	
				CAL DRIFT:		.215	

10. FIELD DATA

--- CEMS Calibration Report ---
General Motors

From 00:00 2/19/93 Through 23:59 2/19/93

Parameter	End Time	Zero Calibration Value	Zero Calibration Std.	Zero Calibration drift (abs)	Zero Calibration drift (%FS)	Span Calibration Value	Span Calibration Std.	Span Calibration drift (abs)	Span Calibration drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:05	0.0	0.0	0.0	0.0	121.0	120.0	1.0	0.3
CO2 Unit #4	07:05	0.0	0.0	0.0	0.0	16.7	16.8	-0.1	-0.5
CO Unit #4	07:05	10.0	0.0	10.0	1.0	640.0	665.0	-25.0	-2.5
SO2 Unit #4	07:05	1.0	0.0	1.0	0.3	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/20/93 Through 23:59 2/20/93

Parameter	End Time	---Zero Calibration--- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:05	0.0	0.0	0.0	0.0	120.0	120.0	0.0	0.0
CO2 Unit #4	07:05	0.0	0.0	0.0	0.0	16.8	16.8	0.0	0.0
CO Unit #4	07:05	0.0	0.0	0.0	0.0	655.0	665.0	-10.0	-1.0
SO2 Unit #4	07:05	1.0	0.0	1.0	0.3	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/21/93 Through 23:59 2/21/93

Parameter	End Time	---Zero Calibration --- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:05	0.0	0.0	0.0	0.0	121.0	120.0	1.0	0.3
CO2 Unit #4	07:05	0.0	0.0	0.0	0.0	16.8	16.8	0.0	0.0
CO Unit #4	07:05	0.0	0.0	0.0	0.0	669.0	665.0	4.0	0.4
SO2 Unit #4	07:05	0.0	0.0	0.0	0.0	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/23/93 Through 23:59 2/23/93

Parameter	End Time	---Zero Calibration--- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:04	0.0	0.0	0.0	0.0	119.0	120.0	-1.0	-0.3
CO2 Unit #4	07:04	0.6	0.0	0.6	3.0	16.8	16.8	0.0	0.0
CO Unit #4	07:04	35.0	0.0	35.0	3.5	651.0	665.0	-14.0	-1.4
SO2 Unit #4	07:04	1.0	0.0	1.0	0.3	100.0	100.0	0.0	0.0
Opac #4	07:05	0.0	0.0	0.0	0.0	35.0	34.6	0.4	0.4
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/24/93 Through 23:59 2/24/93

Parameter	End Time	Zero Calibration Value	Zero Calibration Std.	Zero Calibration drift (abs)	Zero Calibration drift (%FS)	Span Calibration Value	Span Calibration Std.	Span Calibration drift (abs)	Span Calibration drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:04	0.0	0.0	0.0	0.0	119.0	120.0	-1.0	-0.3
CO2 Unit #4	07:04	0.3	0.0	0.3	1.5	16.8	16.8	0.0	0.0
CO Unit #4	07:04	34.0	0.0	34.0	3.4	640.0	665.0	-25.0	-2.5
SO2 Unit #4	07:04	1.0	0.0	1.0	0.3	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/25/93 Through 23:59 2/25/93

Parameter	End Time	---Zero Calibration--- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:04	0.0	0.0	0.0	0.0	119.0	120.0	-1.0	-0.3
CO2 Unit #4	07:04	0.2	0.0	0.2	1.0	16.8	16.8	0.0	0.0
CO Unit #4	07:04	0.0	0.0	0.0	0.0	646.0	665.0	-19.0	-1.9
SO2 Unit #4	07:04	1.0	0.0	1.0	0.3	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

CONTINUOUS OPACITY MONITOR CERTIFICATION

RM 4200 OPACITY

CERTIFICATION REPORT

FORT WAYNE ASSEMBLY
ROANOKE, INDIANA

UNIT 4 STACK MONITOR

RM 4200 S/N 15603804

PREPARED FOR:

FORT WAYNE ASSEMBLY
12200 LAFAYETTE CENTER ROAD
ROANOKE, INDIANA 46783

MARCH 3, 1993

APPROVED BY: Sullivan C Bailey

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1. INTRODUCTION:

pH Environmental Service was contracted by Fort Wayne Assembly to prepare a performance evaluation on a Lear Siegler RM 4200 Opacity Monitor S/N 15603804 . The installation was on the Unit 4 stack. Zero and Calibration drift, calibration error, and response time were quantified. The certification was performed in accordance with the emission monitoring requirements as promulgated on March 30, 1983, by the Environmental Protection Agency.* Field test were performed continuously throughout the conditioning period and the operational test period without maintenance or service.

2. INSTALLATION DESCRIPTION AND START-UP:

The instrument is installed on the Unit 4 Stack located at the Roanoke, In. facility. The instrument is designed so an operator can swing open the transceiver and retroreflector to gain access to the external optics for cleaning. Further installation information can be obtained from the affected facility.

3. ALIGNMENT:

The RM 4200 is equipped with an optical window on the case side. Viewing through an optical bull's eye through the window, it is possible to verify and, if necessary, adjust the instrument alignment at any time during operation. Using the alignment window, an operator sights across the stack to the reflector. By turning the alignment bolts located on the flange as mounting hardware, an operator can center the reflector in the light beam using the bull's eye target as a guide. When using the alignment target, the operator must position the mode switch to "align." When the light spot is within the outer bull's eye ring the instrument is aligned for optimum accuracy.

4. SUMMARY:

Test results of the Performance Evaluation are presented on Page 5. These results are based on data obtained at Lear Siegler's production facility located at Englewood, CO and during normal operation following installation at the affected facility. Documentation and test data are found in the Appendix.

These results indicate that Lear Siegler RM 4200 Opacity Monitors are in conformance with all requirements of "Performance Specifications 1 - Performance Specifications Test Procedures for Monitors of Opacity from Stationary Sources."

* Federal Register, Vol.48, No 62, Part II, March 30, 1983, 40 CFR 60, Appendix B.

5. DISCUSSION OF RESULTS:

A. Optical Design Parameters. Paragraph 6.5 of performance Specification 1 pertaining to transmissometer systems specifies that one analyzer from each month's production must be tested by the manufacturer and shown to meet certain design specifications projections, and optical alignment sight. The serial number and production date (final testing) of the instrument used for this purpose is provided on the " Notice of Factory Certification" in the Appendix.

The detector, lamp, and filter used in the RM 4200 Transmissiometer are manufactured by a single supplier. In order to provide more accurate and meaningful data, the spectral response parameters have been determined from a composite spectral response curve of three components determined at the instrument manufacture facility, rather than separate curves for each component. The peak and mean spectral response values are given:

Peak Spectral Response 580.0 nm

Mean Spectral Response 584.16 nm

Percent Response Below 4.00%
400nm/above 700nm

Federal Register specifications require that the peak and mean spectral response fall between 500nm and 600nm, with response at any wavelength below 400nm or above 700nm less than 10 percent of the peak response.

To measure the angle of view for the RM 4200 transceiver was set up, calibrated, and placed on a gimballed test fixture facing a small light source at the other end of the monitor path length. The detector output of the subject transceiver was measured and recorded at the gimbal zero at 1/2 degree increments up, to the right, and to the left.

The angle of view and the angle of projection test results are given below:

Angle of View 4.0 degrees

Angle of Projection 3.0 degrees

Federal Register specifications require that both the angle of view and the angle of projection be no greater than 5 degrees. Additional test data are to be found in the Appendix.

Optical alignment was checked and found to be accordance with Paragraph 6.4 of Performance Specification 1.

B. Calibration Error. The Calibration Error Test was performed in accordance with Paragraph 7.1.4 of the referenced specifications at lear Siegler facility prior to shipment. Low,Mid and High range calibration filter were used. Fifteen nonconsecutive tests were made with the calibration filters using the three calibration filters (Five readings with each filter). The calibration error is represented by the sum of the mean differences plus 95% confidence interval expressed as a percentage of the known filter value. The initial certification of the neutral density filter was performed by National Bureau of standards. The results are shown on page 5. The test results are a 0.80% error at the low range, 0.80% at the mid range, and 1.417% at the high range. Federal Register specifications limit the allowable error to 3%.

C. Zero Drift and Calibration Drift. Zero Drift and Calibration Drift were tested in accordance with Paragraph 7.4 of Performance Specification 1. The RM 4200 Opacity Monitor is designed to provide automatically timed zero and span calibration checks every twenty-four hours throughout both the conditioning test period and operational test period. The zero value is determined by mechanically simulating a clear stack condition, thereby producing a zero condition that checks the analyzer, internal mirrors, and all electronic circuitry including the radiation source and detector assembly. The span of the system is checked with a calibration filter equivalent to an upscale opacity condition.

Data for the zero and calibration drift were taken from the field data of the instrument output during the period from February 19 through February 25, 1993. Adjustments were not made during the drift test. Twenty-four (24) hour results were calculated by taken the difference between consecutive calibration readings. Results of the zero and calibration drift test are:

T e s t	DRIFT IN % SPAN
Zero Drift (24 hours)	.000%
Calibration Drift (24 hours)	.349%

The drift is represented as an error term of the mean drift plus 95% confidence interval of the drift terms, expressed as percentage of opacity. Refer to Table II (page 7) for test results.

Federal Register specifications direct the twenty-four (24) calibration drift to be less than or equal to 2% opacity.

D. Response Time. Instrument response time was tested on March 13, 1986 in accordance with Paragraph 7.1.5 Performance Specification 1. Five upscale and five down scale readings were recorded. The average response time was 5.00 seconds. Federal Register specifications limit the response time to 10 seconds or less.

E. Conditioning Period. The RM 4200 transmissometer system was operated in accordance with Paragraph 7.3 for an initial 168 hour conditioning period from February 12 through February 18, 1993.

F. Operational Period. The operational period is defined as a "minimum period of time over which the continuous monitoring system is expected to operate within certain performance specifications without unscheduled maintenance, repair, or adjustment."

The instrument operated continuously in accordance with Paragraph 7.4 from February 19 through February 25, 1993 for a total of 168 hours. Federal Register specification requires a minimum operational period of 168 hours.

T A B L E 1

PERFORMANCE TEST RESULTS

RM 4200 S/N 15603804

	RESULTS	EPA SPECIFICATIONS
PEAK SPECTRAL RESPONSE	580.0 nm	>500 - <600 nm
MEAN SPECTRAL REAPONSE	584.16 nm	>500 - <600 nm
PERCENT RESPONSE BELOW 400 nm - ABOVE 700 nm	4.0 %	< 10 %
ANGLE OF VIEW, DEGREES	4.0	< 5.0
ANGLE OF PROJECTION, DEGREES	3.0	< 5.0
CALIBRATION ERROR: LOW	0.80 %	< 3 %
MID	0.80 %	< 3 %
HIGH	1.417 %	< 3 %
CONDITIONING PERIOD	168 HOURS	168 HOURS
OPERATIONAL TEST PERIOD	168 HOURS	168 HOURS
ZERO DRIFT (24 HOUR)	0.000 %	< 2 %
SPAN DRIFT (24 HOUR)	0.349 %	< 2 %
RESPONSE TIME	5.00 seconds	< 10 seconds

NOTICE OF FIELD CERTIFICATION

RM 4200

Certification is hereby given that the Lear Siegler visible emission monitoring system described below has been tested and satisfactorily evaluated in accordance with EPA on-site testing requirements, CFR, Title 40; Part 60, Appendix B, Specification 1, as promulgated in the March 1983 Federal Register, No.62,Vol.48, Part II. The instrument drift and calibration drift (24 hour) have been evaluated in accordance with Paragraph 7.4 and have been shown to meet specification. Copies of the attached certified test data can be submitted to the appropriate regulatory agency in compliance with Source Performance Monitoring requirements. Additional copies are available, by request, from pH Environmental Service.

In addition to the above field performance test data, several factory performance tests must be performed to verify design specifications, calibration error, and response time as defined in the reference specification (Paragraph 7). The factory performance test data should be reviewed before commencing with Field Performance Tests.

CUSTOMER: FORT WAYNE ASSEMBLY LOCATION: ROANOKE, IN.

TRANSMISSOMETER MODEL: RM 4200 S/N: 15603804

REFLECTOR MODEL: RM 4200 S/N: 15603804

OPACITY MEASUREMENT RANGE (Stack Exit): 0-100%

OPACITY RECORDER OUTPUT LEVEL: TO UNICON 700, RECORDED AT D.A.S.

CERTIFICATIONS	RESULTS	STANDARDS
ZERO DRIFT (24 HOUR)	.000 OPACITY	<2.0% OPACITY
CALIBRATION DRIFT (24 HOUR)	.349 OPACITY	<2.0% OPACITY
CONDITIONING PERIOD	168 HOUR	168 HOUR
OPERATIONAL TEST PERIOD	168 HOUR	168 HOUR

TEST PERFORMED BY: Sullivan C Bibley DATE: 2-27-93

TEST REVIEWED BY: Sullivan C Bibley DATE: 3-3-93

T A B L E 2

ZERO AND SPAN CALIBRATION DRIFT TEST

CUSTOMER: FORT WAYNE ASSEMBLY
12200 LAFAYETTE CENTER ROAD
ROANOKE, IN.

DATE: 3-3-93

INST S/N:15603804

INST. LOCATION: UNIT 4 STACK

MODEL: LEAR SIEGLER RM4200

ANALYZER RANGE: 0 - 100 %
TEST PARAMETER: OPACITY

OPERATOR: SULLIVAN C. BAILEY

INST. RANGE: 0 - 100%
ZERO SETTING: 0

READING NUMBER	DATE	TIME	ZERO READING INITIAL A	ZERO READING FINAL B	ZERO DRIFT C=B-A	
DAY 1	02-19-93	0705	0	0	0	0
DAY 2	02-20-93	0705	0	0	0	0
DAY 3	02-21-93	0705	0	0	0	0
DAY 4	02-22-93	0705	0	0	0	0
DAY 5	02-23-93	0705	0	0	0	0
DAY 6	02-24-93	0705	0	0	0	0
DAY 7	02-25-93	0705	0	0	0	0
			ARITHMETIC MEAN:		.000	0
			CONFIDENCE COEF.		.000	
			ZERO DRIFT:		.000	

UPSCALE VALUE 34.6%

READING NUMBER	DATE	TIME	UPSCALE CAL READING INITIAL D	UPSCALE CAL READING FINAL E	UPSCALE DRIFT F=E-D	CAL DRIFT G=F-C	
DAY 1	02-19-93	0705	34.6	34.9	.3	.3	.09
DAY 2	02-20-93	0705	34.6	34.9	.3	.3	.09
DAY 3	02-21-93	0705	34.6	34.9	.3	.3	.09
DAY 4	02-22-93	0705	34.6	34.9	.3	.3	.09
DAY 5	02-23-93	0705	34.6	35	.4	.4	.16
DAY 6	02-24-93	0705	34.6	34.9	.3	.3	.09
DAY 7	02-25-93	0705	34.6	34.9	.3	.3	.09
				ARITHMETIC MEAN:		.314	.7
				CONFIDENCE COEF:		.035	
				CAL DRIFT:		.349	

A. FIELD DATA

--- CEMS Calibration Report ---
General Motors

From 00:00 2/19/93 Through 23:59 2/19/93

Parameter	End Time	---Zero Calibration --- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:05	0.0	0.0	0.0	0.0	121.0	120.0	1.0	0.3
CO2 Unit #4	07:05	0.0	0.0	0.0	0.0	16.7	16.8	-0.1	-0.5
CO Unit #4	07:05	10.0	0.0	10.0	1.0	640.0	665.0	-25.0	-2.5
SO2 Unit #4	07:05	1.0	0.0	1.0	0.3	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/20/93 Through 23:59 2/20/93

Parameter	End Time	---Zero Calibration--- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:05	0.0	0.0	0.0	0.0	120.0	120.0	0.0	0.0
O2 Unit #4	07:05	0.0	0.0	0.0	0.0	16.8	16.8	0.0	0.0
CO Unit #4	07:05	0.0	0.0	0.0	0.0	655.0	665.0	-10.0	-1.0
SO2 Unit #4	07:05	1.0	0.0	1.0	0.3	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/21/93 Through 23:59 2/21/93

Parameter	End Time	---Zero Calibration --- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:05	0.0	0.0	0.0	0.0	121.0	120.0	1.0	0.3
CO2 Unit #4	07:05	0.0	0.0	0.0	0.0	16.8	16.8	0.0	0.0
CO Unit #4	07:05	0.0	0.0	0.0	0.0	669.0	665.0	4.0	0.4
SO2 Unit #4	07:05	0.0	0.0	0.0	0.0	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/22/93 Through 23:59 2/22/93

Parameter	End Time	---Zero Calibration --- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:05	0.0	0.0	0.0	0.0	120.0	120.0	0.0	0.0
CO2 Unit #4	07:05	0.4	0.0	0.4	2.0	16.8	16.8	0.0	0.0
CO Unit #4	07:05	30.0	0.0	30.0	3.0	663.0	665.0	-2.0	-0.2
SO2 Unit #4	07:05	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/23/93 Through 23:59 2/23/93

Parameter	End Time	Zero Calibration Value	Zero Calibration Std.	Zero drift (abs)	Zero drift (%FS)	Span Calibration Value	Span Calibration Std.	Span drift (abs)	Span drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:04	0.0	0.0	0.0	0.0	119.0	120.0	-1.0	-0.3
CO2 Unit #4	07:04	0.6	0.0	0.6	3.0	16.8	16.8	0.0	0.0
CO Unit #4	07:04	35.0	0.0	35.0	3.5	651.0	665.0	-14.0	-1.4
SO2 Unit #4	07:04	1.0	0.0	1.0	0.3	100.0	100.0	0.0	0.0
Opac #4	07:05	0.0	0.0	0.0	0.0	35.0	34.6	0.4	0.4
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/24/93 Through 23:59 2/24/93

Parameter	End Time	---Zero Calibration--- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:04	0.0	0.0	0.0	0.0	119.0	120.0	-1.0	-0.3
CO2 Unit #4	07:04	0.3	0.0	0.3	1.5	16.8	16.8	0.0	0.0
CO Unit #4	07:04	34.0	0.0	34.0	3.4	640.0	665.0	-25.0	-2.5
SO2 Unit #4	07:04	1.0	0.0	1.0	0.3	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

--- CEMS Calibration Report ---
General Motors

From 00:00 2/25/93 Through 23:59 2/25/93

Parameter	End Time	---Zero Calibration--- Value	Std.	drift (abs)	drift (%FS)	--- Span Calibration --- Value	Std.	drift (abs)	drift (%FS)
NO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #3	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #3	00:00	No Zero Cal Today				No Span Cal Today			
NO Unit #4	07:04	0.0	0.0	0.0	0.0	119.0	120.0	-1.0	-0.3
CO2 Unit #4	07:04	0.2	0.0	0.2	1.0	16.8	16.8	0.0	0.0
CO Unit #4	07:04	0.0	0.0	0.0	0.0	646.0	665.0	-19.0	-1.9
SO2 Unit #4	07:04	1.0	0.0	1.0	0.3	101.0	100.0	1.0	0.3
Opac #4	07:05	0.0	0.0	0.0	0.0	34.9	34.6	0.3	0.3
NO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO2 Unit #5	00:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opac #5	00:00	No Zero Cal Today				No Span Cal Today			

9. NOTICE OF FACTORY CERTIFICATION

NOTICE OF FACTORY CERTIFICATION - RM41/RM4100

Certification is hereby given that the Lear Siegler Visible Emission Monitoring System described below has been tested and satisfactorily evaluated in accordance with EPA requirements, CFR, Title 40, Part 60, Appendix B, Specification 1, as promulgated in the March 30, 1983 Federal Register, Vol. 48, No. 62. Calibration error and response time has been evaluated according to procedures defined in paragraph seven and have been shown to meet specification. Design specifications, which include peak spectral response, mean spectral response, angle of view, angle of projection and optical alignment sight, meet stated requirements. Copies of the attached certified data can be submitted to the appropriate regulatory agency in compliance with source performance monitoring requirements. Additional copies are available, by request, from LSI.

In addition to the above factory test data, additional on-site operational performance tests must be performed as defined in the referenced specification (Para. 8.2) to complete specified EPA source performance monitoring requirements.

Customer HONEYWELL/GM Location: ROANOAKE, IND.

Transmissometer Model RM 4200 S/N 15603804

Reflector Model RM 4200 S/N 15603804

Converter Model UNICON 7 S/N 0360064 Output 4-20 mA

Separation Distance, Transceiver Flange to Reflector Flange 6 ft. 6 in.

* Recorder Model N/A S/N

* If recorder is supplied with opacity monitoring system, transmissometer and recorder are to be kept together as a system.

CERTIFICATION TEST	EPA SPECIFICATION	RESULTS
Performance Specifications		
Calibration error % opacity	≤3 % Low	.8 % Low
Calibration error % opacity	≤3 % Mid	.8 % Mid
Calibration error % opacity	≤3 % High	1.417 % High
Response Time	<10 Seconds	5.0 Seconds

FACTORY CERTIFICATION

RM41

SPECTRAL RESPONSE

For the purposes of demonstrating conformance with the spectral response requirements, a composite spectral response curve (Data Sheet 1.1) of the Tungsten light source shaping filter and photodetector was obtained from Lear Siegler's facility. This curve shows the peak spectral response of the tested unit. The curve also shows a relative response less than 10 percent of peak response above 700nm and below 400nm. Data Sheet 1.2 shows calculation of the mean spectral response of the tested unit. All of the above parameters are well within the referenced specification (Paragraph 6.1). These parameters are primarily a function of basic optical component design and are not subject to any significant variation within the basic RM41/4100 design.

ANGLE-OF-VIEW AND ANGLE-OF-PROJECTION

Procedure: Place the transceiver on the Gimballed test fixture and set both vertical and horizontal readings at zero. With the transceiver mounted on the Gimballed head, set up and calibrate the RM41 measurement system for 3 meter pathlength and span (range) to be used in the installation. Replace the reflector unit with a second transceiver unit.

Angle-of-View Record the detector output of the subject transceiver at the Gimbal zero setting and at every 1/2 degree increment up to 2.5 degrees up, down, to the left and to the right of zero. Record the results on Data Sheet 1.3. Record the lowest angle in each direction which results in a detector output of zero. Add the two vertical readings, add the two horizontal readings and record the greater of the two sums as the system angle-of-view on Data Sheet 1.3 and on the Notice of Certification.

Angle-of-Projection Record the output of the secondary transceiver (at reflector location) with the subject transceiver at the Gimbal zero setting and at every 1/2 degree increments up to 2.5 degrees up, down, to the right and to the left of zero. Record the results on Data Sheet 1.3. Record the lowest angle in each direction which results in a detector output of zero. Add the two vertical readings, add the two horizontal readings, and record the greater of the two sums and the system angle of projection on Data Sheet 1.3 and on the Notice of Certification. Also record the date of testing.

CALIBRATION ERROR AND RESPONSE TIME TESTS

The calibration error test and the response time test must be performed prior to installation of the opacity monitoring system on the stack. The results of these tests reflect the stack installation parameters and the entire continuous monitoring system (transceiver, control unit, and data recorder). It is, therefore, required that the instrument system be set up for the monitor pathlength and full scale span to be used in the installation.

CALIBRATION ERROR TEST

Procedure: Set up and calibrate the RM41 measurement system for the monitor pathlength and span (range) to be used in the installation. Place the calibration filter assembly into the transmissometer path midway between the transceiver and the reflector. Position the filter assembly so that the projected beam passes unobstructed through the frame at an angle of 3 degrees to the normal of the filter surfaces. The 3 degree angle is important since a lesser angle may result in unwanted surface reflections and a greater angle can result in a significant neutral density error. Alternately insert the low, mid, and high range neutral density filters (the values of which must be determined from Table 1.A) into the light path according the the following sequence: low, high, mid, high, low, mid, high, mid, low, high, mid, low, mid, high and low. This sequence yields five non-consecutive readings of each filter (a total of 15 readings). Record the measurement system output readings in percent opacity on Data Sheet 1.4. Subtract the known filter opacity value from the value shown by the measurement system for each of the 15 readings and record the differences. Use the arithmetic sum of these difference values to calculate the mean difference and the 95 percent confidence interval of the five readings at each test filter value using the equations on Data Sheet 1.5. Record the sum (in percent opacity) of the mean difference and the 95 percent confidence interval for each of the three test filters on the Data Sheet and on the Notice of Certification. Also record the date of testing.

RESPONSE TIME TEST

Using the apparatus and configuration described in the calibration error test, insert the high range filter into the transmissometer path five times. Record the upscale and downscale time intervals required for the system to respond to 95 percent of the final (stable) high range filter and zero values on Data Sheet 1.5. Calculate the mean of the ten response time values and record it on the Data Sheet and on the Notice of Certification. Also record the date of testing.

OPTICAL ALIGNMENT SIGHT TEST

Procedures: Place the transceiver on the Gimballed test fixture and set both horizontal and vertical readings at zero. With the transceiver mounted on the Gimballed head, set up and calibrate the RM41/4100 measurement system for an 8 meter pathlength (26'-3"). Establish zero current and record as reference value before starting misalignment procedure.

Rotational Misalignment: Place a neutral density filter close to 10% opacity in light path and record transceiver output. Using the horizontal adjustment, slowly rotate transceiver until the transceiver output changes 2% opacity. Check the alignment bulls-eye and verify it indicates misalignment. Return horizontal reading to zero; alignment zero should result in same zero current as initially determined.

Lateral Misalignment: Place a neutral density filter close to 10% opacity light path and record transceiver output. Slowly move reflector stand laterally until the transciever output changes 2% opacity. Check the transceiver alignment bulls-eye and verify it indicates misalignment.

FACTORY CERTIFICATION

DOCUMENTATION

RM41/4100 Effective Date: September 1983

NOTICE OF CERTIFICATION AND TABULATED RESULTS

NOTES ON:

CALIBRATION FILTER SELECTION

SPECTRAL RESPONSE

ANGLE OF VIEW

ANGLE OF PROJECTION

CALIBRATION ERROR TEST

RESPONSE TIME TEST

OPTICAL ALIGNMENT SIGHT TEST

CERTIFICATION DATA:

DATA SHEET 1.1 RM41/4100 COMPOSITE SPECTRAL RESPONSE CURVE

DATA SHEET 1.2 MEAN SPECTRAL RESPONSE CALCULATIONS

DATA SHEET 1.3 ANGLE OF PROJECTION, ANGLE OF VIEW & OPTICAL ALIGNMENT

DATA SHEET 1.4 CALCULATION FORM

DATA SHEET 1.5 RESPONSE TIME TEST

RECORDER TRACES OF CALIBRATION ERROR TEST AND RESPONSE TIME TESTS

Design Specifications

In accordance with Paragraph 6.5 of the referenced specifications, one analyzer from each month's production was tested per Sections 6.1 through 6.4 and satisfactorily met all Design Specifications of Section 5. Listed below are the results of the monthly unit tested for Design Specifications:

TEST UNIT S/N 1530600C Date of Test 3/13/96

	EPA SPECIFICATION	RESULTS
Peak Spectral Response	500-600 nm	580 nm
Mean Spectral Response	500-600 nm	584.16 nm
Angle of View	≤5 degrees	4.0 degrees
Angle of Projection	≤5 degrees	3.0 degrees
Optical Alignment	☒ Pass	☐ Fail

Test Performed By: Mark Rhyne Date 3/13/96

Test Reviewed By: [signature] Date 3/13/96

RM 41/4200 SPECTRAL RESPONSE DATA SHEET

SERIAL # 15506006 OPERATOR MARK HIGGINS

DATE MARCH 3,1906

A	B	C	D	E	F	G	H
400 nm	0.00	0.00	0.00	1.69	0.00	0.00	0.00
420 nm	0.00	0.00	0.00	1.49	0.00	0.00	0.00
440 nm	0.00	0.00	0.00	1.25	0.00	0.00	0.00
460 nm	0.16	0.00	0.16	1.13	0.18	0.04	18.40
480 nm	0.47	0.00	0.47	1.06	0.50	0.12	60.00
500 nm	1.00	0.00	1.00	1.00	1.00	0.20	100.00
520 nm	1.97	0.00	1.97	1.00	1.97	0.40	208.40
540 nm	3.17	0.00	3.17	1.02	3.23	0.65	350.69
560 nm	4.22	0.00	4.22	1.06	4.47	0.90	502.13
580 nm	4.61	0.00	4.61	1.08	4.98	1.00	580.20
600 nm	4.17	0.00	4.17	1.12	4.67	0.94	562.83
620 nm	3.25	0.00	3.25	1.14	3.71	0.74	461.30
640 nm	2.14	0.00	2.14	1.19	2.55	0.51	327.35
660 nm	1.20	0.01	1.19	1.23	1.46	0.29	194.03
680 nm	0.66	0.09	0.57	1.23	0.70	0.14	95.76
700 nm	0.42	0.20	0.22	1.25	0.28	0.06	38.66

TOTALS 5.97 3486.63

MEAN RESPONSE = 504.14

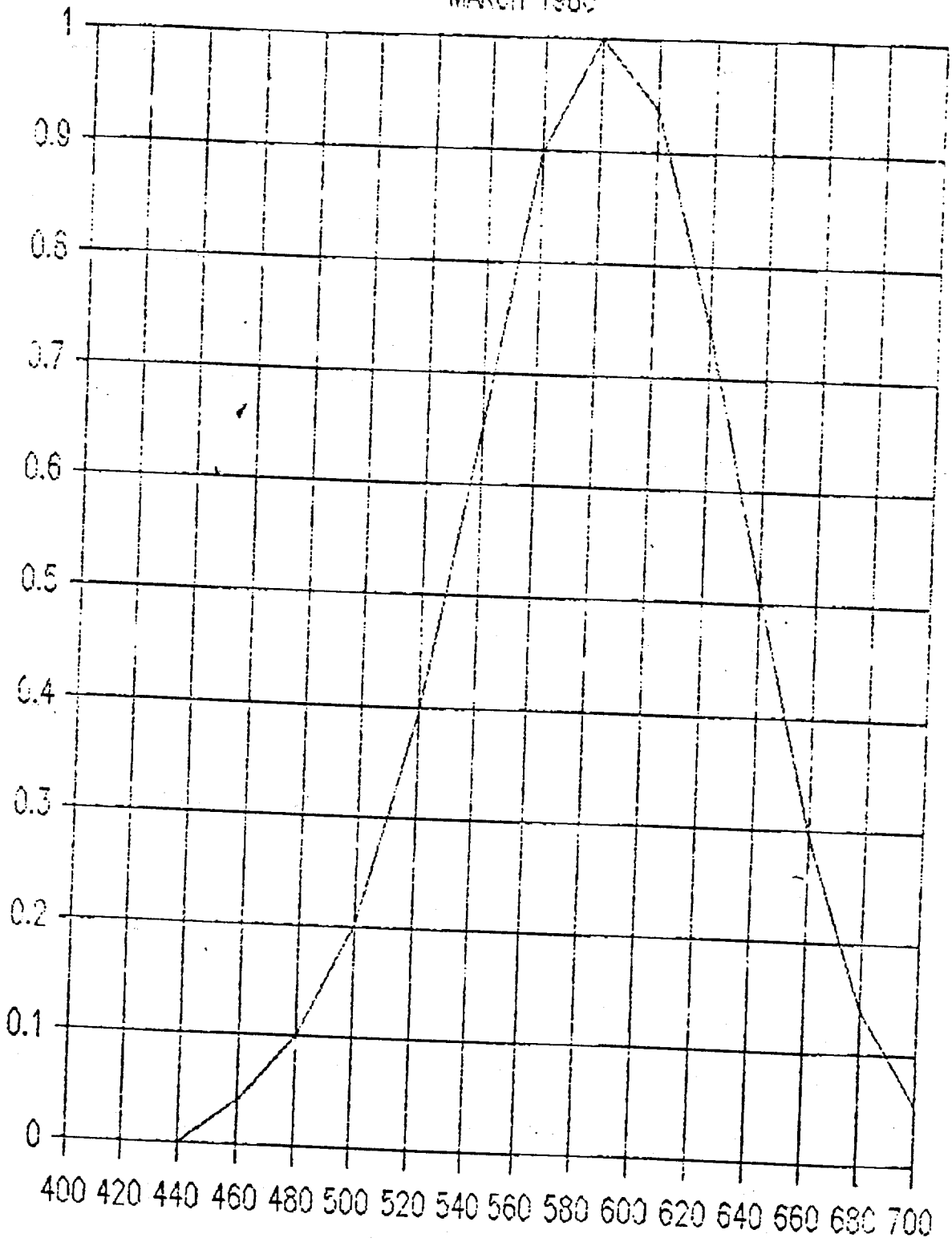
PEAK RESPONSE = 580

SYMBOLS:

A = Monochrometer setting
B = Test Output of the subject unit
C = Dark Output of the subject unit
D = Difference
E = Multiplier
F = Largest product from equation D x E
G = Relative transmission (D x E / F)
H = Product of G x A
Peak Response = Monochrometer setting where G = 1

SPECTRAL RESPONSE

MARCH 1986



— S/N 15506006

DATA SHEET 1.3

INSTRUMENT S/N 15306006 DATE: 3 13 82 OPERATOR: MARK HIGGINS

ANGLE-OF-PROJECTION TEST

DIRECTION	ANGLE 0.0	0.5	1.0	1.5	2.0	2.5	LOWEST WITH ZERO READING
UP	20.00	15.43	4.35	0.00	0.00	0.00	A 1.5
DOWN	20.00	9.05	0.10	0.00	0.00	0.00	B 1.5
LEFT	20.00	9.01	0.41	0.00	0.00	0.00	C 1.5
RIGHT	20.00	14.15	2.47	0.00	0.00	0.00	D 1.5

VERTICAL ANGLE-OF-PROJECTION (A+B) = 3.0

HORIZONTAL ANGLE-OF-PROJECTION (C+D) = 3.0

SYSTEM ANGLE-OF-PROJECTION (GREATER OF THE TWO) = 3.0

ANGLE-OF-VIEW TEST

DIRECTION	ANGLE 0.0	0.5	1.0	1.5	2.0	2.5	LOWEST WITH ZERO READING
UP	20.00	19.41	11.68	0.43	0.00	0.00	A 2.0
DOWN	20.00	19.05	11.44	0.57	0.00	0.00	B 2.0
LEFT	20.00	19.58	17.77	7.27	0.00	0.00	C 2.0
RIGHT	20.00	19.39	15.48	2.92	0.00	0.00	D 2.0

VERTICAL ANGLE-OF-VIEW (A+B) = 4.0

HORIZONTAL ANGLE-OF-VIEW (C+D) = 4.0

SYSTEM ANGLE-OF-VIEW (GREATER OF THE TWO) = 4.0

OPTICAL ALIGNMENT SIGHT TEST

ROTATIONAL ALIGNMENT	☒ Pass	☐ Fail
LATERAL ALIGNMENT	☒ Pass	☐ Fail

CALIBRATION FILTER SELECTION

To calculate which neutral density filters to use, multiply the full scale value (in percent opacity) by 0.2, 0.6, and 0.9 for the low, mid, and high filter values respectively, to obtain the simulated stack-exit opacity ($OP_{stack\ exit}$). Then calculate the filter values in optical density using the following equation:

$$\text{O.D. filter} = \left(\frac{0.5}{\text{OPLR}}\right)\left(\text{LOG}_{10}\ 1 - \frac{OP_{\text{stack exit}}}{100}\right)$$

Where:

$$\text{OPLR} = \frac{\text{Stack exit ID}}{2\ (\text{Installation ID})} = \frac{.5}{}$$

Stack exit ID = 5'6"

Installation ID = 5'6"

Record the three calculated filter values in optical density in Table 1A.

TABLE 1A

Low Filter .097 O.D.

Mid Filter .398 O.D.

High Filter 1.000 O.D.

Select the filter values which most closely match the calculated values and record their optical density values in Table 1B.

Then calculate the corresponding stack exit opacity ($OP_{stack\ exit}$) for each filter using the following equation and record the resultant stack exit opacity values in the last column below.

$$OP_{\text{stack exit}} = 100\left[1 - 10^{(-2\ \text{O.D.})(\text{OPLR})}\right]$$

Where O.D. is the optical density of the calibration filter.

Table 1B shows the actual filters used.

TABLE 1B

Low Filter .132	O.D.	26.2	% Opacity	S/N
Mid Filter .402	O.D.	60.4	% Opacity	S/N
High Filter .99	O.D.	89.5	% Opacity	S/N

DATA SHEET 1.4

CALIBRATION ERROR TEST

Instrument S/N 1-203804 Date: 3/13/86 Operator: Mark Higgins

Analyser Range 0-100 % Opacity OPLR Value -5

Filter		Reading
1	Zero	0
2	Low	27.0
3	High	90.6
4	Mid	61.2
5	High	91.0
6	Low	27.0
7	Mid	61.2
8	High	91.1
9	Mid	61.2
10	Low	27.0
11	High	91.1
12	Mid	61.2
13	Low	27.0
14	Mid	61.2
15	High	91.0
16	Low	27.0
17	Zero	0

Mean Diff = [ΣX_i] /5

C.I. = $0.2776 \sqrt{5(\Sigma X_i^2)-(\Sigma X_i)^2}$

Cal Error = Mean Diff + C.I.

C.I. = Confidence Interval

LOW FILTER 26.2 % Opacity

Inst. Reading	Diff (Xi)	$(X_i)^2$
27.0	.8	.64
27.0	.8	.64
27.0	.8	.64
27.0	.8	.64
27.0	.8	.64
	ΣX_i = 4.0	ΣX_i^2 3.2

Mean Diff = .8
C.I. = 0
Cal Error = .8

MID FILTER 60.4 % Opacity

Inst. Reading	Diff Σ(Xi)	$(X_i)^2$
61.2	.8	.64
61.2	.8	.64
61.2	.8	.64
61.2	.8	.64
61.2	.8	.64
	ΣX_i = 4.0	ΣX_i^2 3.2

Mean Diff = .8
C.I. = 0
Cal Error = .8

HIGH FILTER 89.8 % Opacity

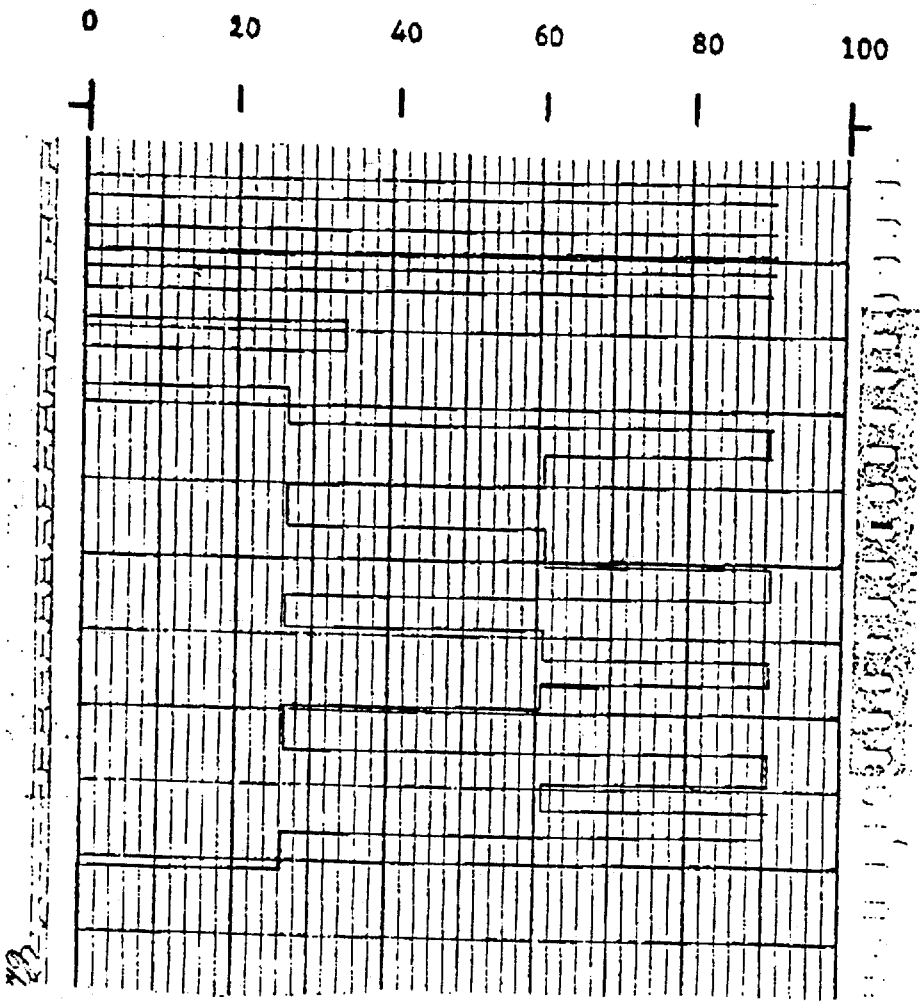
Inst. Reading	Diff Σ(Xi)	$\Sigma(X_i)^2$
90.6	.8	.64
91.0	1.2	1.44
91.1	1.3	1.69
91.1	1.3	1.69
91.0	1.2	1.44
	ΣX_i = 5.8	ΣX_i^2 6.9

Mean Diff = 1.16
C.I. = .257
Cal Error = 1.417

RM 41 / 4200 CERTIFICATION

RECORDER TRACES

S/N: 1562034 DATE: 3/13/86



RESPONSE TIME TEST

Date of Test 3/13/86 Operator MARK HIGGINS

Span Filter .45 % Opacity Instrument S/N 15603804

Analyzer Range 0-100 % Opacity

Upscale	1	5.0	seconds
	2	5.0	seconds
	3	5.0	seconds
	4	5.0	seconds
	5	5.0	seconds
Downscale	1	5.0	seconds
	2	5.0	seconds
	3	5.0	seconds
	4	5.0	seconds
	5	5.0	seconds

Average Response 5.0 seconds