APPLICATION NUMBER 1431370699 B005

Siemens Energy and Automation, Inc.

SOURCE DESCRIPTION (OR SCC CODE) Natural Gas Boiler #2

CONTROL EQUIPMENT Low NO_x Burners

DATE(S) OF TEST August 8, 1994

FINAL TEST REPORT RECEIVED ON August 25, 1994

POLLUTANT(S) TESTED NO_x

TEST METHOD U.S. EPA Reference Methods 1-4 and 7e

TEST FIRM K & B Design, Inc.

EMISSION RATES*:

ALLOWABLE** 0.13 lb./mmbtu

ACTUAL

NO_x 0.10 lb./mmbtu or 2.01 lbs./hr.

OPERATING RATES*:

DURING TEST** 20.5 mmbtu/hr. MAXIMUM** 24.5 mmbtu/hr.

EMISSION FACTOR***

COMMENTS:

I HEREBY VERIFY THAT THE INFORMATION CONTAINED WITHIN THE STACK TEST REPORT HAS BEEN REVIEWED AND IT HAS BEEN DETERMINED THAT THE TEST PROCEDURES, ANALYSES AND CALCULATIONS ARE:

[x] AN ACCEPTABLE DEMONSTRATION OF CONFORMANCE WITH THE APPROVED TESTING METHODOLOGY.

[ ] AN UNACCEPTABLE DEMONSTRATION OF CONFORMANCE WITH THE APPROVED TESTING METHODOLOGY.

~~March~~ 9 14, 1994

DATE OF REVIEW

PREPARED BY

REVIEWED BY

* BASED ON- RUN AVERAGE

** SPECIFY APPLICABLE UNITS

*** SPECIFY IN UNITS OF MASS/INPUT

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(Filename: a:\appendk.frm - SAL's Diskette #9)

Observer's Report

Compliance Test For
NO_x

Conducted on:	Siemens Energy and Automation
Source:	Natural Gas Fired Boiler #2
Premise Number:	1431370699 B005
Test Firm:	K & B Design, Inc.
Prepared by:	Denise L. Bien, ETII
Date Prepared:	August 26, 1994

Department of Environmental Services - Air Quality Management
(D.O.E.S. - A.Q.M.)

Siemans Energy & Automation
1431370699 B005 and B004

Testing for NO_x emissions was conducted on boiler #2 at Siemens Energy & Automation (1431370699 B005) on, August 8, 1994. The boiler is a natural gas/#2 fuel oil fired boiler, B004 is an identical unit. The boiler is rated at 24.5 mmbtu/hr. heat input. The Ohio Administrative Code (OAC) Rules 3745-31-05, 3745-15-07, 3745-17-07, 3745-17-10, 3745-18-06 apply to the source and 40 CFR Part 60 Subpart Dc. These rules limit the source to emission rates of 0.13 lbs. NO_x/ mmbtu for natural gas, and 0.17 lbs. NO_x/mmbtu for #2 fuel oil. The source was tested to determine if it meets PTI requirements.

U.S. EPA Reference Methods 1-4 and 7e were utilized to sample the stack. Port location was in accord with Federal Register specifications.

The NO_x emission rates (by f factor method) during testing were as follows:

Run #1	Run 2#	Run #3	**Average**
0.10 lbNO_x/mmbtu	0.10 lbNO_x/mmbtu	0.10 lbNO_x/mmbtu	0.10 lb NO_x/mmbtu

The NO_x emissions averaged 0.11 lbs/mmbtu derived from natural gas usage calculations. These results are below the 0.13 lbs./mmbtu listed in the PTI. This also represents an average value of 39.8 ppm NO_x and 2.0 lbs./hr. NO_x.

Results from previous testing run on 3/17/94 were as follows:

Run # 1	Run # 2	Run # 3	**Average**
0.15 lb NOx/mmbtu	0.15 lb NO_x/mmbtu	0.15 lb.NO_x/mmbtu	**0.15 lb.NO_x/mmbtu**

Stack parameters during this test were as follows:

Siemans Energy & Automation
1431370699 B005 and B004

Run Number	Velocity (fps)	Stack Temp - °F	Flow Rate (dscfm)	Moisture %	% CO_2	% O_2
1	13.2	230	6,712	10.6	4.2	12.0
2	13.9	231	7.001	11.3	4.2	11.3
3	13.9	233	7,009	10.9	4.3	11.9
Average	13.7	231	6,907	10.9	4.2	11.7

Stack parameters from previous testing on 3/15/94 were as follows:

Run Number	Velocity (fps)	Stack Temp. - °F	Flow Rate (dscfm)	Moisture %	% CO_2	% O_2
1	7.3	159	4,126	9.8	4.4	11.9
2	7.9	171	4,421	9.0	4.3	12.0
3	7.5	160	4,391	6.8	4.2	12.0
Average	7.6	163	4,313	8.5	4.3	12.0

The boiler was run in automatic mode. The load averaged 20.5 mmbtu/hr. by f factor and heat input by fuel meter was 17.6 mmbtu/hr. This is 83.7 % and 71.8 % respectively, of the 24.5 mmbtu/hr. rated capacity. There was not enough real load for the source to operate at maximum steam output.

Natural gas heat content was 1,025 btu/ft^3.

Stack volumetric flow averaged 6,907 dscfm at 231 °F and 10.9 % moisture. Stack O_2 averaged 11.7 % and CO_2 averaged 4.2 %. The f_o-factor was 2.19, which is 22% above the standard for natural gas of 1.79.

Quality assurance measures to assure precision and accuracy included calibration of all equipment used, leak checks before and after each test run, sample blanks and full documentation of all results, process data and calibrations. All calculations were checked and found to be accurate. Observer notes agreed with the data in the test report.

Siemans Energy & Automation
1431370699 B005 and B004

In conclusion, based upon D.O.E.S.-A.Q.M. analysis of the test procedures and the final test report submitted by Siemens Energy & Automation and K & B Design, Inc., this boiler has a mass emission rate of 0.10 lb./mmbtu and visible emissions of near 0% while operating at 83.7 % of maximum load.

Siemans Energy & Automation
1431370699 B005 and B004

In conclusion, based upon D.O.E.S.-A.Q.M. analysis of the test procedures and the final test report submitted by Siemens Energy & Automation and K & B Design, Inc., this boiler has a mass emission rate of 0.10 lb./mmbtu and visible emissions of near 0% while operating at 83.7 % of maximum load. Testing at permit renewal is indicated by Ohio EPA Engineering Guidance.

DETERMINATION OF
NO_x EMISSION RATES
BOILER 2
SIEMENS ENERGY & AUTOMATION, INC.
MOTORS & DRIVES DIVISION
NORWOOD PLANT
AUGUST 8, 1994

Mailing Address:
4620 Forest Avenue
Norwood, Ohio 45212-3396

Telephone #:
513/841-3450

Performed by:
K&B Design, Inc.

Thomas E. Bayer
Project Manager

Job # F-810
August 16, 1994

K&B Design, Inc.
3131 Disney Street
Cincinnati, OH 45209
(513) 351-6200

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1.0 EXECUTIVE SUMMARY

K&B Design, Inc. was retained by Siemens Energy & Automation, Inc. to determine NO_x emission rates from Boiler 2 (Source No. B005) at the Norwood Plant. Continuous gas samples were analyzed from the outlet stack of the furnace using USEPA Reference Methods 1-4 and 7E for stationary source sampling.

The results of the tests are summarized below:

RUN #/ FURNACE	NOx EMISSION RATE[1] (lb/MM Btu)[2]	(lb/MM Btu)[3]
1	0.11	0.10
2	0.11	0.10
3	0.11	0.10
Average	0.11	0.10

[1]As nitrogen dioxide.
[2]Based on fuel integrator and fuel analysis.
[3]Based on published F-factor of 8,710 dscf/MM Btu.

2.0 *INTRODUCTION*

K&B Design, Inc. was retained by Siemens Energy & Automation, Inc. to determine NO_x emission rates from Boiler 2 at the Norwood Plant. Three test runs were conducted on Boiler 2 over a one day period. The tests were conducted on August 8, 1994. In addition to the NO_x concentration, measurements were also made of the stack gas temperature, moisture content, velocity and volumetric flow rate, oxygen and carbon dioxide content.

Ms. Karen Notestine of Siemens provided process data and coordinated the sampling with production personnel. Mr. Tom Bayer, Mr. Brian Finn, and Mr. Rick Feller of K&B Design conducted the stack tests.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

The sampling and analytical procedures used in this survey conform with the USEPA Reference Methods for stationary source sampling. The following procedures were employed:

° ***Measurement Sites***
Location of measurement sites and the number of traverse points to be sampled were determined as specified in USEPA Reference Method 1, *"Sample and Velocity Traverses for Stationary Sources"*. A drawing of the sampling site is included in Figure 3.1.

° ***Velocity, Flow Rate, and Temperature***
The stack gas velocity and temperature were determined using USEPA Reference Method 2, *"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type "S" Pitot Tube)"*. The velocity pressure was measured with a Type "S" pitot tube and oil manometer. The stack temperature was measured with a calibrated Type "K" thermocouple.

° ***Analysis for Carbon Dioxide and Oxygen***
Carbon dioxide and oxygen were determined using USEPA Reference Method 3, *"Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight"*. An intergrated sample was collected during each sample run. Analysis was performed with an Orsat analyzer.

° ***Stack Gas Moisture***
Stack gas moisture content was determined using USEPA Reference Method 4, *"Determination of Moisture Content in Stack Gases"*. The impingers were weighed to the nearest 0.5 g with a digital electronic balance before and after each test. A drawing of the sampling train is included in Figure 3.2.

° ***Nitrogen Oxide***
Nitrogen oxide emissions were determined using USEPA Reference Method 7E, *"Determination of Nitrogen Oxide Emissions From Stationary Sources - Instrumental Analyzer Procedure"*. A continuous sample of the stack gas was extracted and analyzed on a wet basis with a chemiluminescent analyzer. The instrument output was recorded on a chart recorder and instantaneously logged on a Macintosh computer equipped with a 12 bit A/D high resolution data acquisition board.

The analyzer was calibrated as specified in the Reference Method with zero, mid-level, and high-level mixtures of NO in nitrogen. The calibration standards were certified by USEPA Protocol 1 *"Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors"*.

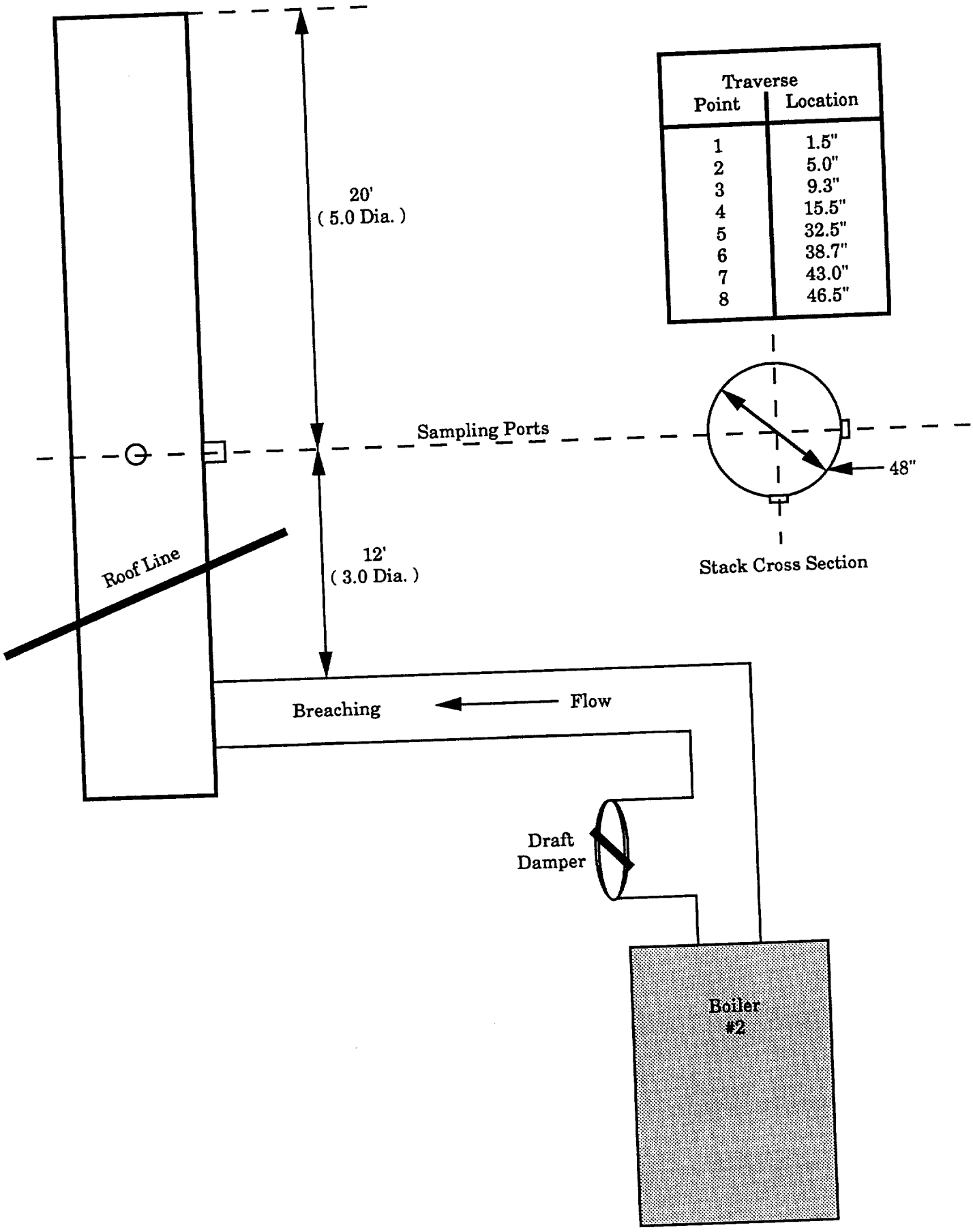


Figure 3.1 Sampling Site Detail

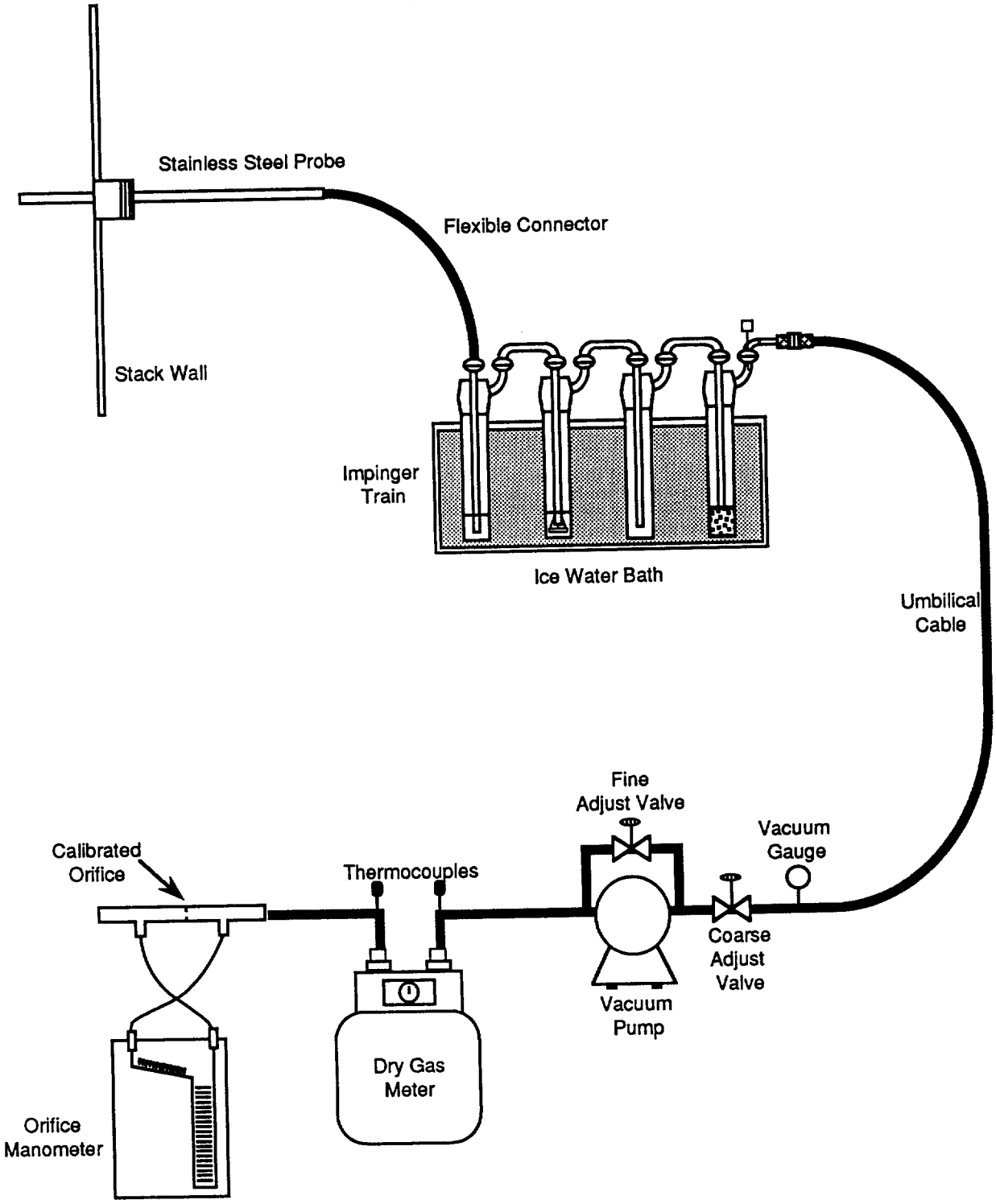


Figure 3.2 USEPA Reference Method 4 sampling train

Prior to the first test and each subsequent test, the analyzer calibration was established by introducing the high level span gas and zero gas upsteam of the instrument and making the necessary adjustments. The mid-level calibration gas was then introduced in the same manor to check the calibration error. A measurement system pre-test bias check was performed. The zero and mid-level span gas were introduced to the analyzer through a 3-way calibration valve and a solenoid valve located at the sample probe. The system bias was checked by comparing the instrument response to the results obtained from the analyzer calibration check. The up-scale and down-scale measurement system response time was also determined at this time. After each test, the analyzer system response to zero air and the mid-level span gas was checked to determine the post test system bias and analyzer drift.

The analyzer interference response was checked prior to its initial use in the field. The check consists of introducing several different gaseous components to the analyzer and recording there response. The sum of the interference responses of the test gases must be less than 2 % of the span value. The test results for this check are included in the QA/QC section of the report. The analyzer will be rechecked if any changes are made in the instrumentation that could alter the interference response.

The analyzer NO_2 to NO conversion efficiency was not required. Previous test data shows NO2 is less than 5% of the NOx concentration. A drawing of the sampling train is included in Figure 3.3.

° ***Emission Rates***

Since there was no isolated gas meter for this boiler, the heat input rate was determined from a published F-factor (USEPA Reference Method 19), the NOx emission rates as a function of the heat input, were calculated from the measured concentration, the oxygen content of the stack gas and the F-factor. The fuel usage from a common plant gas meter was recorded as a back-up method and second check of the heat input rate.

° ***Quality Assurance***

The Quality Assurance procedures used in this survey include equipment calibration by USEPA and manufacturer's guidelines, use of standard published procedures for sample collection and analysis, and attention to the QA procedures included in the Reference Methods. The calibration procedures and results for the equipment used in this survey are included Appendix A.

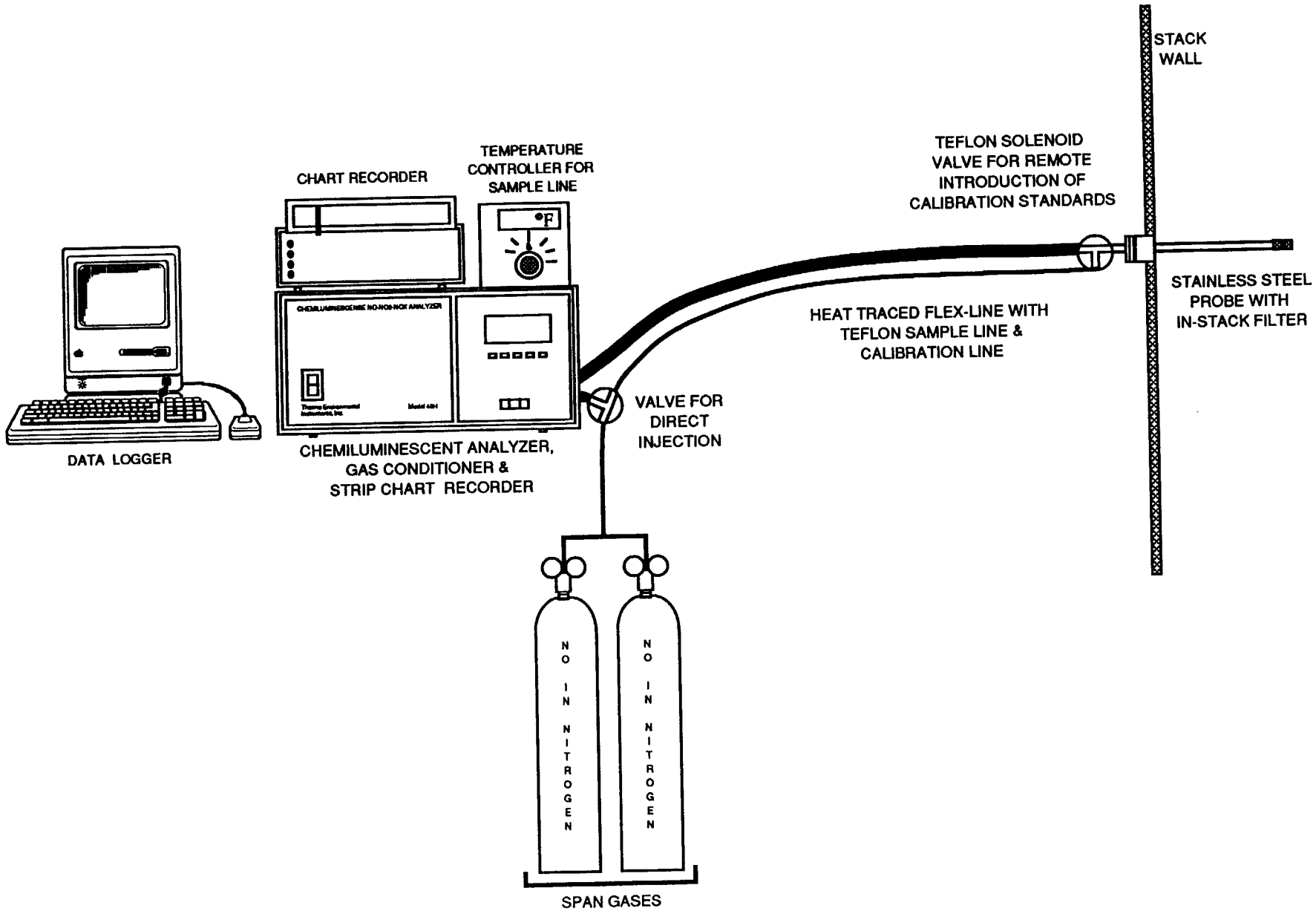


Figure 3.3 USEPA Reference Method 7E measurement system

4.0 DESCRIPTION OF OPERATIONS

Boiler B004 and B005 are identical units. They were manufactured by Clayton Industries and are rated at 24.5 MMBtu/hr. The boilers are fired with natural gas but may be fired with #2 fuel oil. Boiler #2 (B005) was tested firing natural gas. The boiler was operated at 90% of capacity for the three tests.

The emission samples were collected in the main exhaust stack. The test site meets the criteria of Reference Method 1. The test ports are 3 diameters downstream and 5 diameters upstream of the nearest flow disturbance. The diameter of the stack is 48".

5.0 TEST RESULTS

The stack gas flow rates, temperature, etc. are summarized in Table 5.1. The average flow rate was 10,312 acfm (6,915 dscfm) at 231°F and 10.9 % water vapor. The average O_2 concentration was 11.9 % and the average CO_2 concentration was 4.3 %.

Nitrogen oxide emissions are summarized in Table 5.2. A computer generated graphic representation of the NO_x instrument response recorded for each run is included as Figures 5.1 through 5.3. The average NO_x concentration for the three test runs was 39.8 ppm. The average NO_x emission rate was 2.0 lb/hr. The emission rate based on heat input was calculated both by fuel usage, 0.11 lb/MM Btu and published F-factor 0.10 lb/MM Btu.

The Appendices to this report contain the QA/QC data, process data, copies of the field data forms, data log files with recorder charts, and emissions calculations for each run.

Table 5.1 Summary of stack gas conditions-Boiler 2

RUN NO.	DATE 1994	VELOCITY (fps)[a]	FLOW RATE (acfm)[b]	FLOW RATE (dscfm)[c]	TEMP. (°F)	MOISTURE (%)	O2 (%)	CO2 (%)
1	8/11	13.3	10,005	6,744	230	10.6	12.0	4.2
2	8/11	13.9	10,465	6,992	231	11.3	11.8	4.3
3	8/11	13.9	10,465	7,010	232	10.9	11.9	4.3
Average		13.7	10,312	6,915	231	10.9	11.9	4.3

[a]Feet per second at stack conditions.
[b]Actual cubic feet per minute at stack conditions.
[c]Dry standard cubic feet per minute at 68°F and 29.92" Hg.

Table 5.2 Summary of NO_x emission rates-Boiler 2

RUN NO.	CONCENTRATION (ppm)	MASS EMISSION RATE[1] (lb/hr)	(lb/MM Btu)[2]	(lb/MM Btu)[3]
1	39.5	1.9	0.11	0.10
2	39.7	2.0	0.11	0.10
3	40.2	2.0	0.11	0.10
Average	39.8	2.0	0.11	0.10

[1] As nitrogen dioxide

[2] Based on fuel integrator and fuel analysis.

[3] Based on published F-factor of 8,710 dscf/MMBtu.

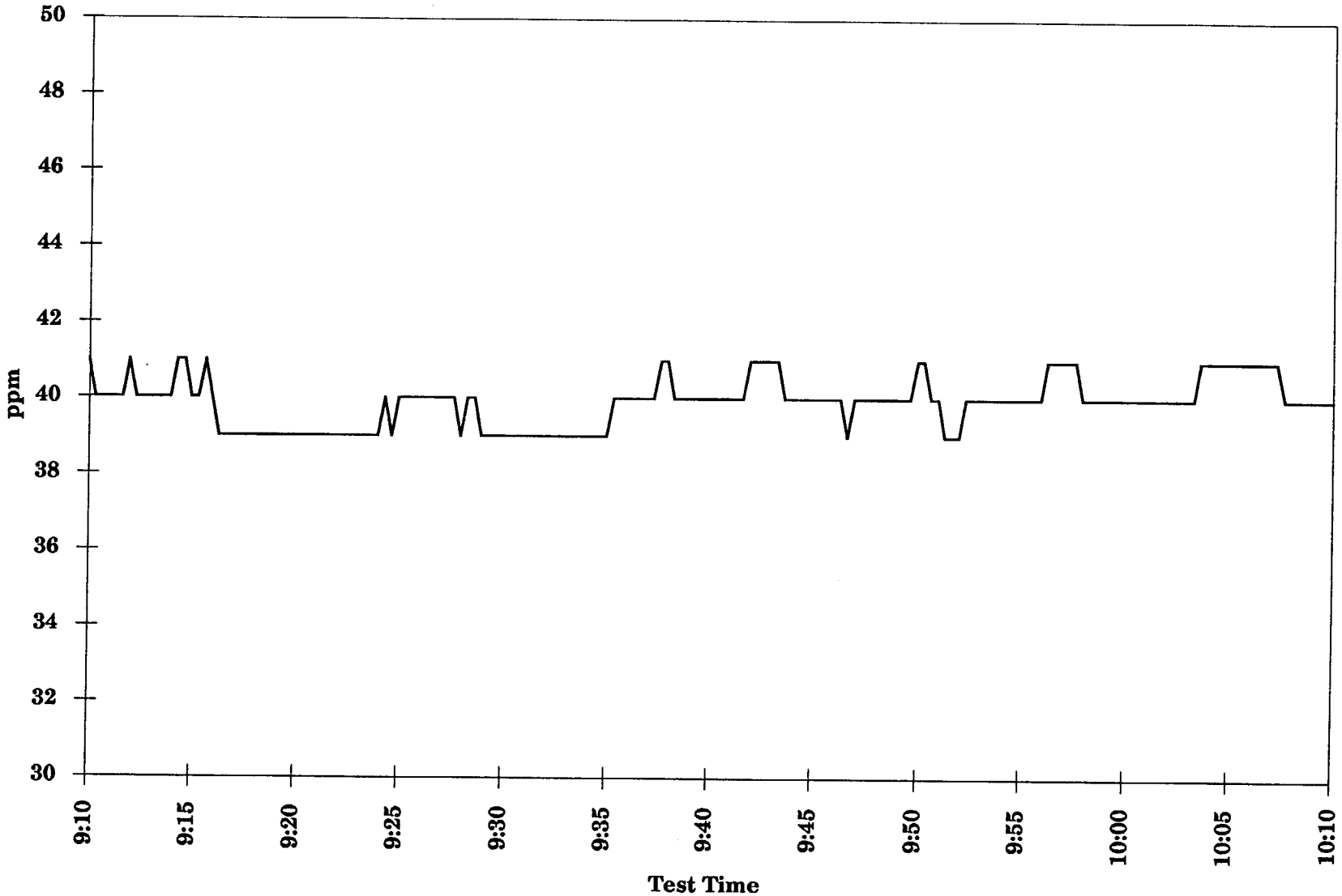


Figure 5.1 NOx Data Summary Run 1

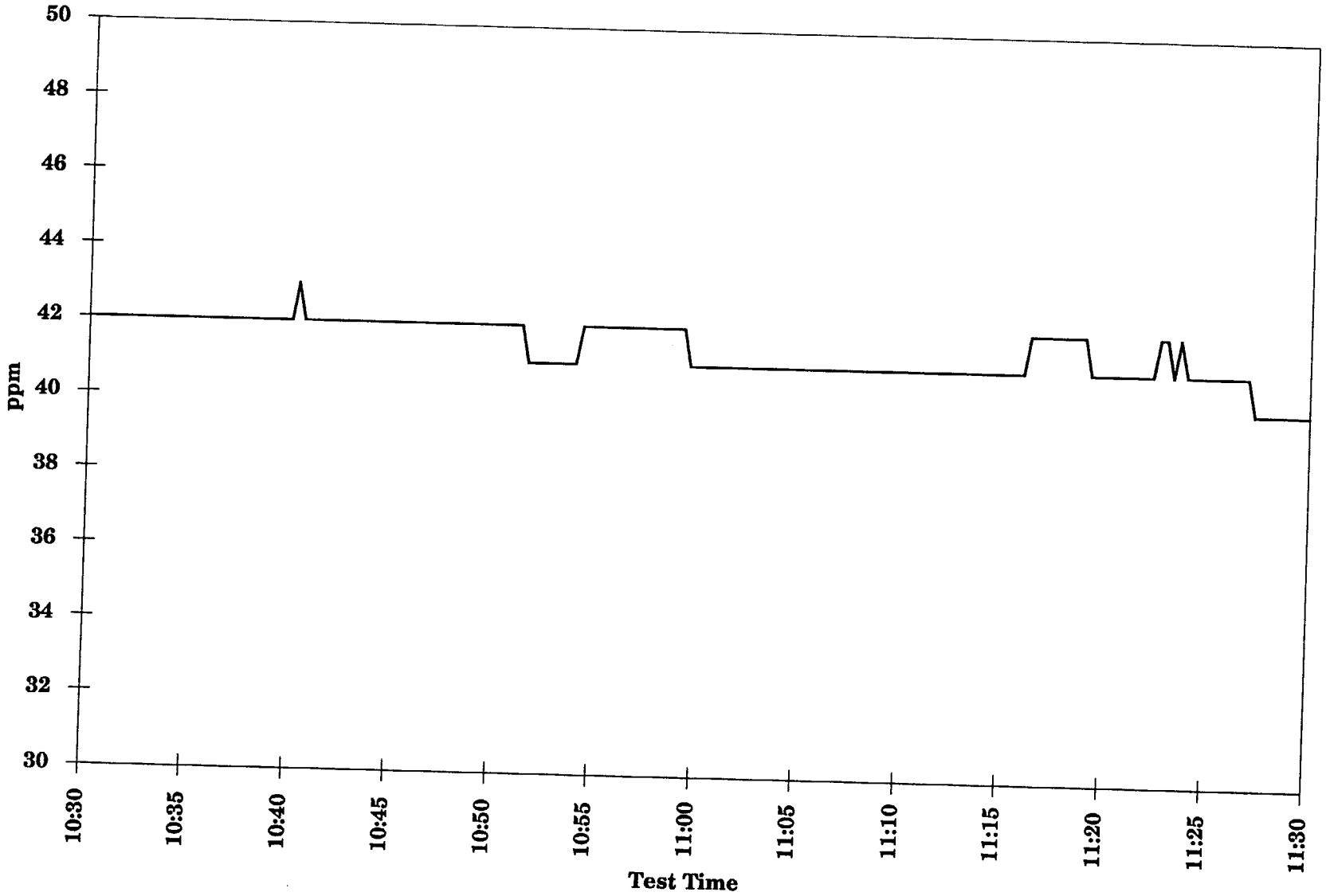


Figure 5.2 NOx Data Summary Run 2

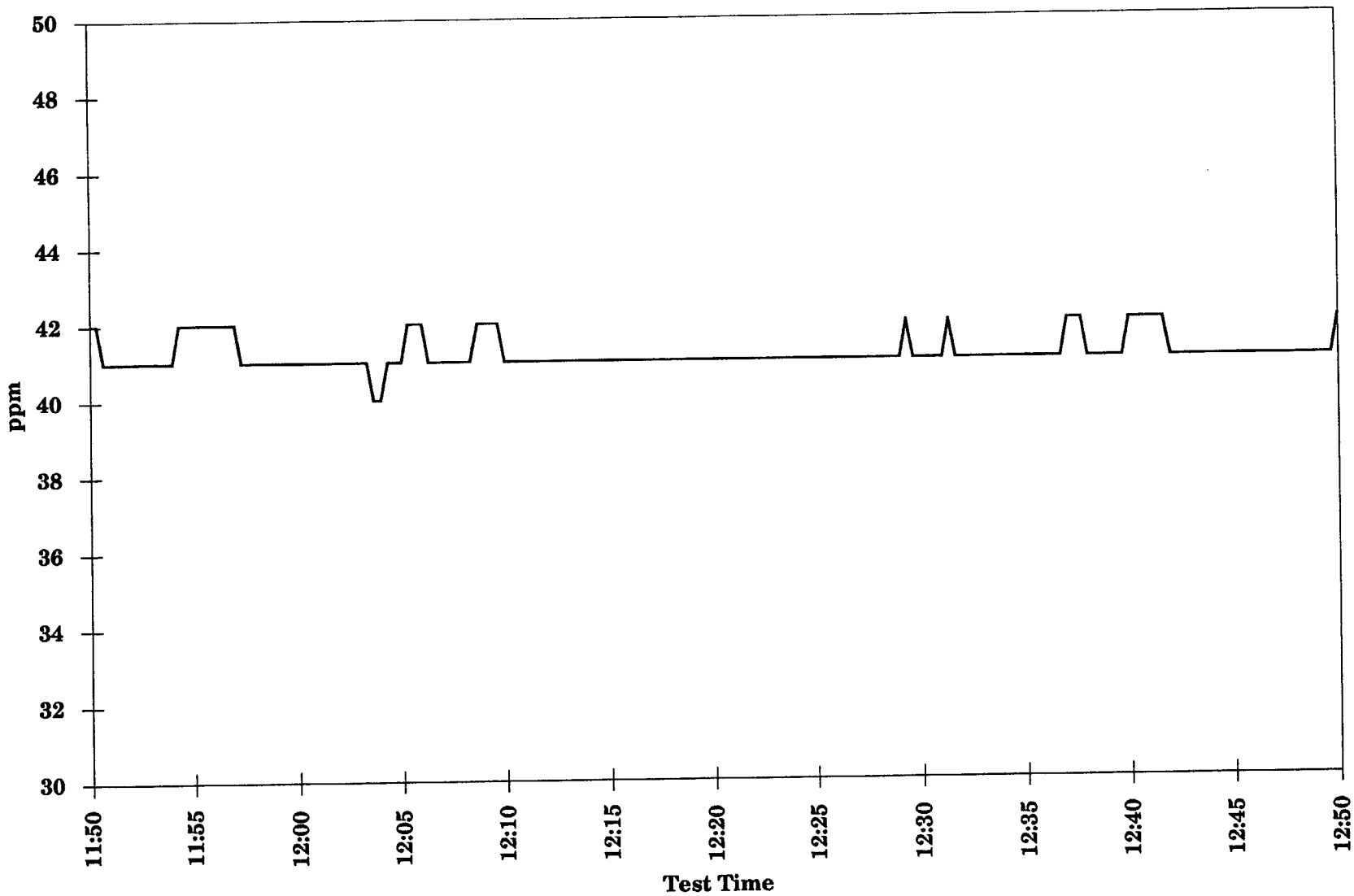


Figure 5.3 NOx Data Summary Run 3

QUALITY ASSURANCE PROCEDURES AND RESULTS

The sampling and analytical equipment used in this survey has been calibrated and maintained as recommended in USEPA Reference Methods for Stationary Source Sampling, the Quality Assurance Handbook for Air Pollution Measurement Systems, and in the manufacturers owners manuals. The paragraphs below summarize the calibration procedures that will be employed.

- **Analytical Balance**
  Gravimetric analysis is performed on a Sartorius Model B 120 S analytical balance that is readable to 0.1 mg. The analytical balance is permanently mounted in the laboratory. The balance is calibrated on each day of use with a series of standard weights. The results of the daily calibration are recorded in a logbook.

- **Nozzles**
  Nozzles are regularly inspected in the field for obvious signs of damage and irregularities. If the nozzle shows signs of damage, it is not used until the damage is repaired. The nozzle diameter is determined in the field by measuring three different diameters with a precision micrometer. The three measurements are averaged to establish the nozzle diameter. The nozzle is acceptable if the difference between the high and low measurements is less than 0.004 in.

- **Pitot Tubes**
  The 'S'-type pitot tubes are built to the design specifications cited in Reference Method 2 and are assigned a coefficient of 0.84. Standard pitot tubes have a coefficient of 0.99. The pitot tubes, connecting lines, and manometers are leak-checked in the field before and after each test run.

- **Thermocouples**
  Thermocouples are calibrated on an annual basis. The thermocouples are calibrated against an NBS traceable mercury in glass thermometer The thermocouples are calibrated at approximately 32°F, 70°F, 212°F, and 400°F.

- **Digital Readouts**
  The digital readouts that display temperature are calibrated with a Omega Engineering thermocouple simulator which generates millivolt signals corresponding to temperatures from 0°F to 1000° F in 100° increments.

- **Orsat Analyzer**
  The Orsat analyzer is calibrated in the field with a standard gas mixture of oxygen and carbon dioxide in nitrogen. The calibration standard is certified to ±1% by the supplier. Analyzer reagents are changed when analysis indicates slow adsorption, lack of agreement between runs, or when the calibration standards cannot be accurately measured.

- **Fyrite Analyzers**
  The Fyrite analyzers are routinely leak checked and reagents are changed as performance dictates.

° **Control Consoles**
The Method 5 control consoles are Nutech Model 2010 consoles with digital temperature controllers. The dry gas meter coefficient (Y-factor) and the orifice constant (ΔH@) are established by calibrating the control consoles at 5 flow rates. Five critical orifices serve as the reference standards. The Method 5 control consoles are calibrated after each test series to confirm the Y-factor has not changed more than plus or minus 5%.

The Method 6 and VOST control consoles are calibrated against a soap bubble meter at the flow rate used during the emission test. The consoles are calibrated before and after each test series.

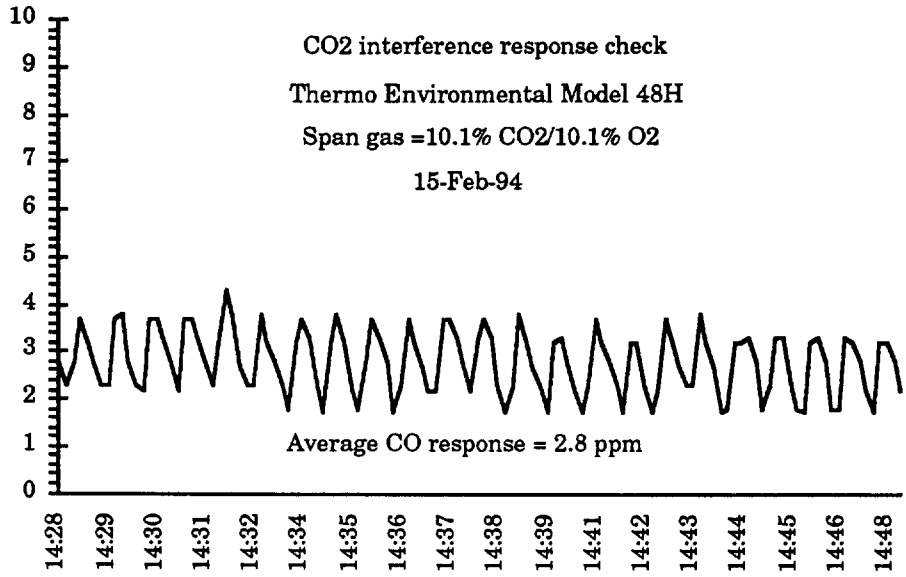
° **NOx Flasks**
The NOx flasks and stopcocks are calibrated by filling the flask and matching stopcock with deionized water. The flask and stopcock are then weighed on a digital balance to the nearest 0.1 gram. The water is drained, the glass ware is dried and the weight is recorded. The difference between the tare weight and the gross weight is the flask volume in milliliters.

° **Method 7E Calibration and Span Gas**
The NO-NO_2-NO_x chemiluminescent analyzer is calibrated as specified in the Reference Method with zero air, mid-level, and high-level mixtures of nitrogen oxide in nitrogen. The calibration standards are certified by USEPA Protocol 1 *"Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors"*.

The analyzer interference response was checked prior to its initial use in the field. The check consists of introducing CO, SO_2, CO_2, and O_2 to the analyzer and recording the response. The sum of the interference responses of the test gases must be less than 2% of the span value. The analyzer interference response is re-checked if any changes are made in the instrumentation that could alter the interference response.

The analyzer NO_2 to NO conversion efficiency is checked by introducing an NO_2 test gas to the analyzer. The NO_x response will be recorded for 30 minutes. If the response remains within 2.0% of the highest value, the conversion efficiency is considered to be 100%.

° **Method 10 Calibration and Span Gas**
The carbon monoxide gas filter correlation NDIR analyzer is calibrated as specified in the Reference Method with nitrogen, low-level, mid-level, and high-level mixtures of carbon monoxide in nitrogen. The calibration standards are certified by the supplier to ±2%. The analyzer was challenged with a 10.1% CO_2/10.1% O_2 mixture to determine the interference of CO2 in the detector. The results of this test indicated the response is negligible. The results of the test is summarized below:



° **Personal Sampling Pumps**
Personal sampling pumps are calibrated against a soap film bubble meter with representative sampling media in line to simulate actual sampling conditions. Triplicate calibration runs are made and the run values are averaged to arrive at the actual sampling rate.

° **Method 25 Trap and Tank Background Check**
Prior to field use, the condensate traps are baked at elevated temperature and then analyzed on the NMO analyzer to ensure there is <10 ppm-C_1 residual contamination. The tanks are also heated at elevated temperature, purged with zero air and then analyzed on the NMO analyzer to ensure there is <10 ppm-C_1 residual contamination

° **Method 25 Sample Tank Volume Determination**
The Method 25 sample tanks are calibrated prior to being placed into field service. The calibration procedure consists weighing the empty tank to nearest 1 gram on a calibrated digital balance. The tank is then filled with water and weighed again. The difference in the tare weight and the gross weight is the tank volume in milliliters.

° **Method 25 Sample Flow Controllers**
The Method 25 sample flow controllers are calibrated upon receipt from the manufacturer. They are calibrated with a soap bubble meter at two points to establish linearity.

° **Method 25 Sample Train Leak Checks**
The Method 25 sample train consists of a trap, a tank , a control console and a probe of varying length. The volume of the sample train must be known to leak check the probe, trap, and console in the field (The tank is leak checked separately in the lab or the field).

The trap body is constructed from 22" of 0.375" OD x 0.049" wall tubing and packed tightly with quartz glass wool (estimated blockage of 50%). The trap probe is constructed from 22" of 0.125" OD x 0.035" wall tubing for a total trap volume of 10.32 cm^3.

The console has 82" of 0.250" OD x 0.035" wall tubing and 9" of 0.125" OD x 0.035" wall tubing for a tubing volume of 34.54 cm^3. The filter holder has a volume of 8 cm^3 for a total console volume of 42.54 cm^3. The total volume of the trap and console is therefore 52.86 cm^3. This value is a constant.

The probe volume is a function of the length of the probe. The probes are constructed of 0.250" OD x 0.035" wall tubing and vary in length. The most common probe length is 4'. This length of probe has a volume of 20.02 cm^3 which results in a total train volume of 72.88 cm^3.

The allowable leak rate is calculated using the following equation:

$$\Delta P = \frac{F\,Pb\,\emptyset}{V_t} \quad (0.01)$$

where:

ΔP = allowable pressure change, cm Hg

F = sampling flow rate, cc/min (80 cc/min)

Pb = barometric pressure, cm Hg

$\emptyset$ = leak check period, min (5 min)

V_t = volume of sample train, cm^3

For example, the allowable leak rate for a train with a 4' probe at a barometric pressure of 74.2 cm would be:

$$\Delta P = \frac{80 \times 74.2 \times 5}{72.88} \quad (0.01)$$

$$\Delta P = 4.07 \text{ cm (or 40.7 mm)}$$

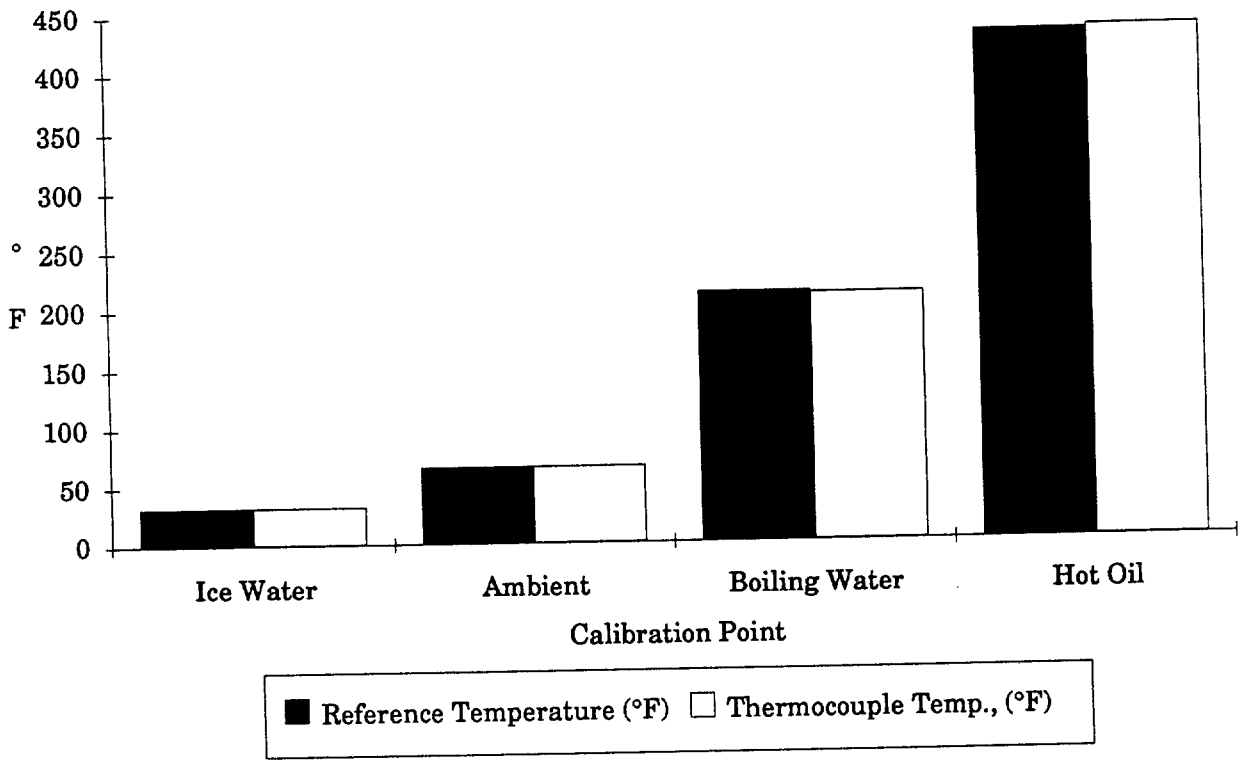
° **Method 25A Calibration and Span Gas**
The flame ionization analyzers are calibrated as specified in the Reference Method with ultra zero air (< 0.1 ppm THC), low-level, mid-level, and high-level mixtures of propane in air. The calibration standards are certified by USEPA Protocol 1 *"Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors"*.

° **Barometers**
The aneroid field barometers are calibrated with a stationary mercury column barometer prior to each field use. The reference barometer is permanently mounted in the laboratory.

° **Reagents**
All reagents used for the preparation of sample trains, collection and recovery of samples, and analysis meet the requirements of the Reference Methods.

THERMOCOUPLE CALIBRATION

Thermocouple ID 6B
ReferenceThermometer 9N911
Date 2/25/94
Calibrated by D. THOMPSON



Calibration Point	Ice Water	Ambient	Boiling Water	Hot Oil
Reference Temperature (°F)	32	66	212	430
Thermocouple Temp., (°F)	32	66	210	433
% Difference	0.00%	0.00%	0.30%	0.34%

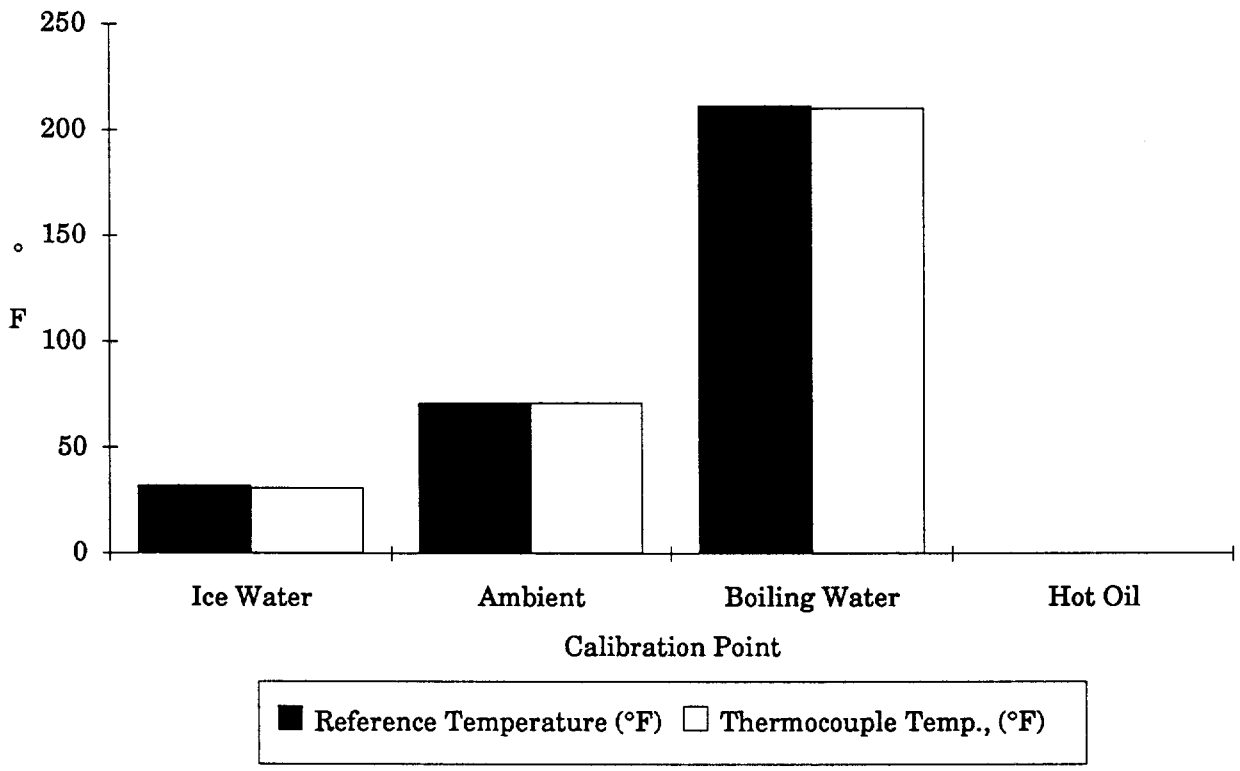
Note:

$$\% \text{ Difference} = \frac{(\text{Ref. temp., °F} + 460) - (\text{Thermocouple temp., °F} + 460)}{(\text{Ref. temp., °F} + 460)} \times 100$$

The absolute value of the % Difference must be ≤ 1.5 %

THERMOCOUPLE CALIBRATION

Thermocouple ID K-4 DGM INLET
ReferenceThermometer 9N911
Date 3/10/94
Calibrated by D. THOMPSON



Calibration Point	Ice Water	Ambient	Boiling Water	Hot Oil
Reference Temperature (°F)	32	71	211	NA
Thermocouple Temp., (°F)	31	71	210	NA
% Difference	0.20%	0.00%	0.15%	NA

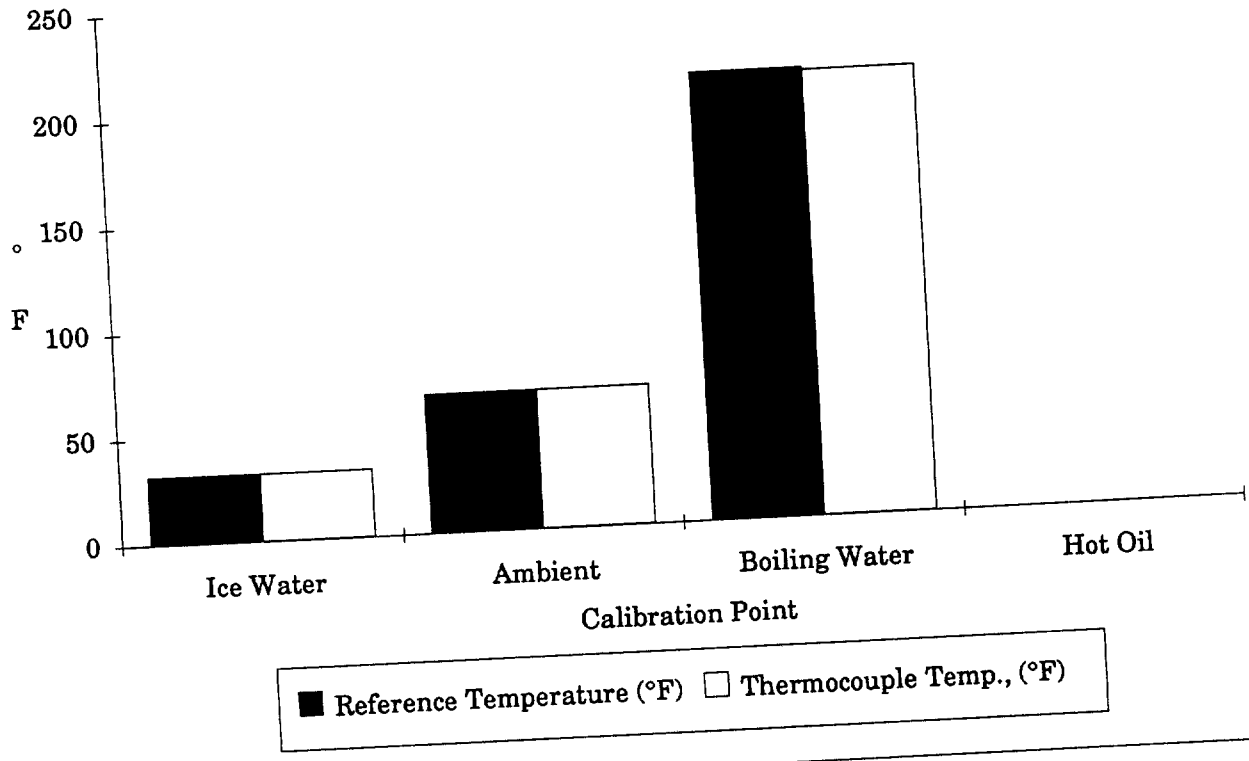
Note:

$$\% \text{ Difference} = \frac{(\text{Ref. temp., °F} + 460) - (\text{Thermocouple temp., °F} + 460)}{(\text{Ref. temp., °F} + 460)} \times 100$$

The absolute value of the % Difference must be ≤ 1.5 %

THERMOCOUPLE CALIBRATION

Thermocouple ID I-2
ReferenceThermometer 9N911
Date 2/25/94
Calibrated by D. THOMPSON



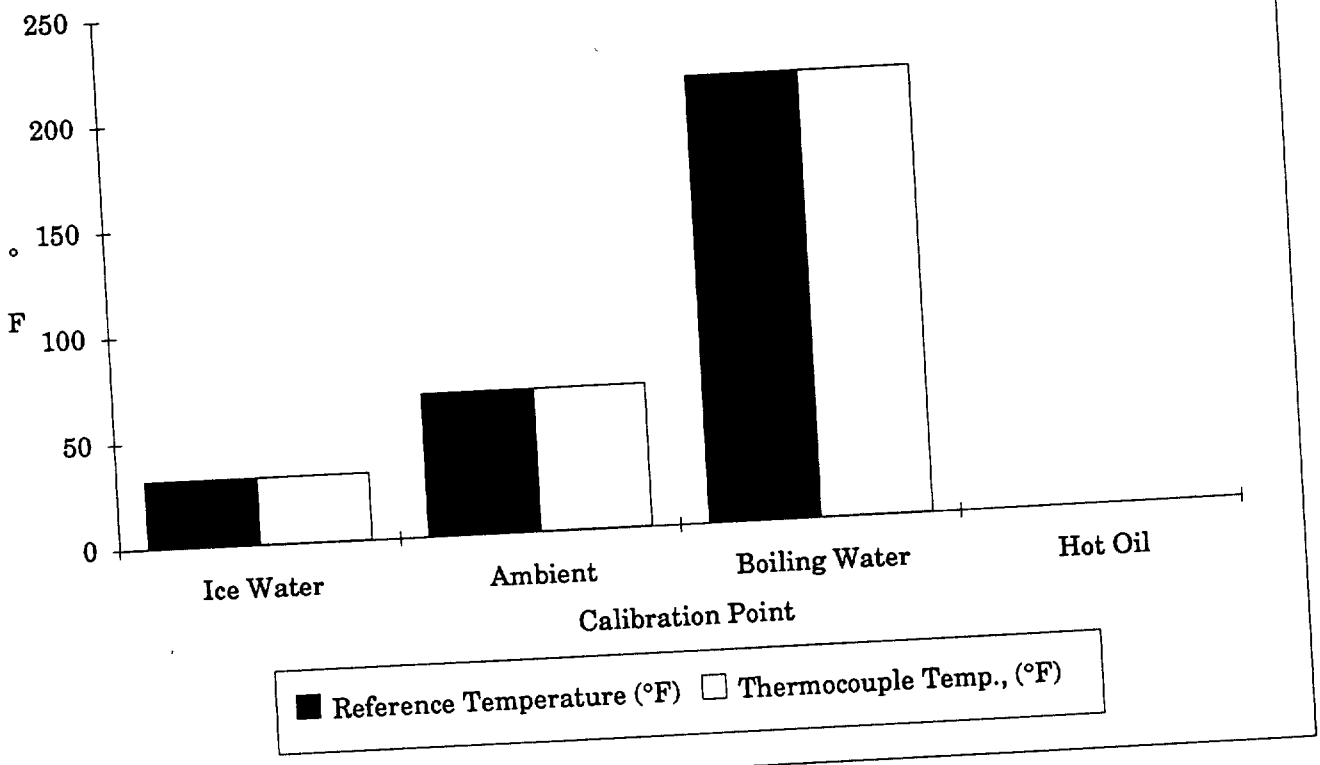
Calibration Point	Ice Water	Ambient	Boiling Water	Hot Oil
Reference Temperature (°F)	32	66	211	NA
Thermocouple Temp., (°F)	32	66	210	NA
Difference	0	0	1	NA

Note:

Thermocouple temperature must be ± 2 °F of reference temperature.

THERMOCOUPLE CALIBRATION

Thermocouple ID I-5
ReferenceThermometer 9N911
Date 2/25/94
Calibrated by D. THOMPSON



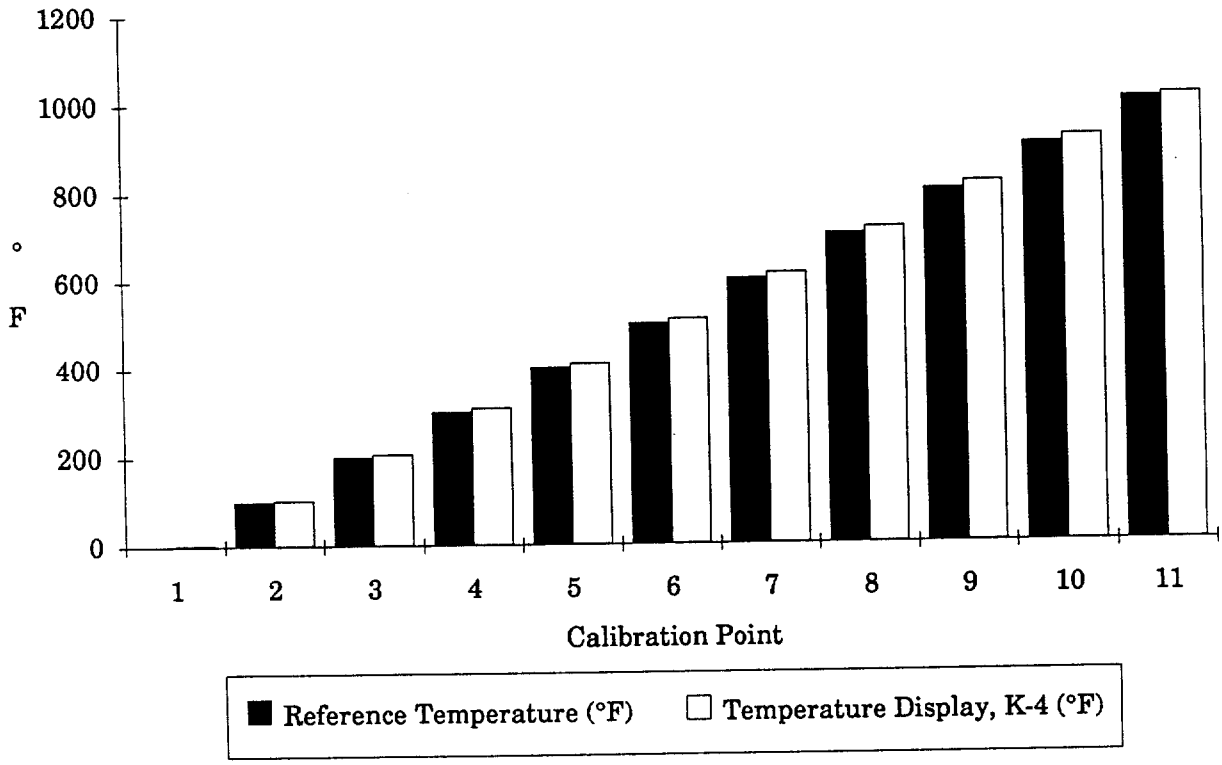
Calibration Point	Ice Water	Ambient	Boiling Water	Hot Oil
Reference Temperature (°F)	32	68	211	NA
Thermocouple Temp., (°F)	32	68	211	NA
Difference	0	0	0	NA

Note:

Thermocouple temperature must be ± 2 °F of reference temperature.

TEMPERATURE DISPLAY CALIBRATION

Temperature Display ID K-4
Reference Source Omega SN 102
Date 2-23-94
Calibrated by D. THOMPSON



Calibration Point	1	2	3	4	5	6	7	8	9	10	11
Reference Temperature (°F)	0	100	200	300	400	500	600	700	800	900	1000
Temperature Display, K-4 (°F)	4	103	206	309	409	510	613	714	815	916	1008
% Difference	0.87%	0.54%	0.91%	1.18%	1.05%	1.04%	1.23%	1.21%	1.19%	1.18%	0.55%

Note:

$$\% \text{ Difference} = \frac{(\text{Ref. temp., °F} + 460) - (\text{Thermocouple temp., °F} + 460)}{(\text{Ref. temp., °F} + 460)} \times 100$$

The absolute value of the % Difference must be ≤ 1.5 %

Pre-Test Calibration

Calibration date: 2/15/94
Console Identification: K-4
Calibrated By: Dan Thompson

Dry Gas Meter						
		1	2	3	4	5
Orifice number						
Orifice coefficient	K'	0.2425	0.3122	0.4535	0.5504	0.6785
Barometric pressure	in. Hg	29.22	29.22	29.21	29.22	29.22
Ambient temperature	°F	71	71	72	71	71
Vaccuum	in. Hg	19	19	19	19	19
Orifice ΔH	in. H2O	0.31	0.52	1.20	1.80	2.70
Time	minutes	10.0	10.0	10.0	10.0	10.0
Initail volume	cubic feet	228.400	232.100	299.200	236.500	244.200
Final volume	cubic feet	231.571	236.209	305.300	243.800	253.384
Volume metered	cubic feet	3.171	4.109	6.100	7.300	9.184
Inlet initial temperature	°F	76	76	76	77	80
Outlet initial temperature	°F	74	74	76	75	76
Inlet final temperature	°F	84	77	79	80	81
Outlet final temperature	°F	79	75	77	86	77
Average temperature	°F	78	76	77	80	79
Volume metered std.	dscf	3.039	3.960	5.871	7.006	8.850
Volume through orifice std.	dscf	3.075	3.959	5.743	6.979	8.604
DGM calibration factor	Y	1.012	1.000	0.978	0.996	0.972
AVERAGE Y						**0.992**
DGM ΔH@	in. H2O	1.769	1.802	1.976	2.005	1.991
AVERAGE ΔH@						**1.909**

DGM Calibration Factor's (Y) must be ± 2.0 % of the average Y.

Maximum	1.011
Minimum	0.972

DGM Orifice ΔH@'s must be ± 0.2 of the average ΔH@.

Maximum	2.109
Minimum	1.709

Post Test Calibration Form

Calibration date:	8/15/94			
Console Identification:	K-4			
Calibrated By:	T. Bayer			
Job Number:	F-810			
Client:	Siemens			
Dry Gas Meter				
Run number / Low Load		1	2	3
Orifice number		3	4	5
Orifice coefficient	K'	0.4535	0.5504	0.6785
Barometric pressure	in. Hg	29.62	29.62	29.62
Ambient temperature	°F	73	73	73
Vaccuum	in. Hg	19	19	19
Orifice ΔH	in. H2O	1.2	1.8	2.7
Time	minutes	10.0	10.0	10.0
Initail volume	cubic feet	139.787	150.075	130.686
Final volume	cubic feet	145.915	157.51	139.787
Volume metered	cubic feet	6.128	7.435	9.101
Inlet initial temperature	°F	77	80	76
Outlet initial temperature	°F	76	78	75
Inlet final temperature	°F	81	84	80
Outlet final temperature	°F	77	79	76
Average temperature	°F	78	80	77
Volume metered std.	dscf	5.972	7.223	8.919
Volume through orifice std.	dscf	5.818	7.062	8.705
DGM calibration factor	Y	0.974	0.978	0.976
AVERAGE Y				**0.976**
Dry Gas Meter Calibration Factor's (Y) must be ± 2.0 % of the average Y.				
			Maximum	0.996
			Minimum	0.956

Method 7E Instrument Interference Response Check

Date: June 6, 1993

Manufacturer: Thermo Environmental Instruments Inc.

Model: 42H NO-NO2-NOx Chemiluminescence Analyzer

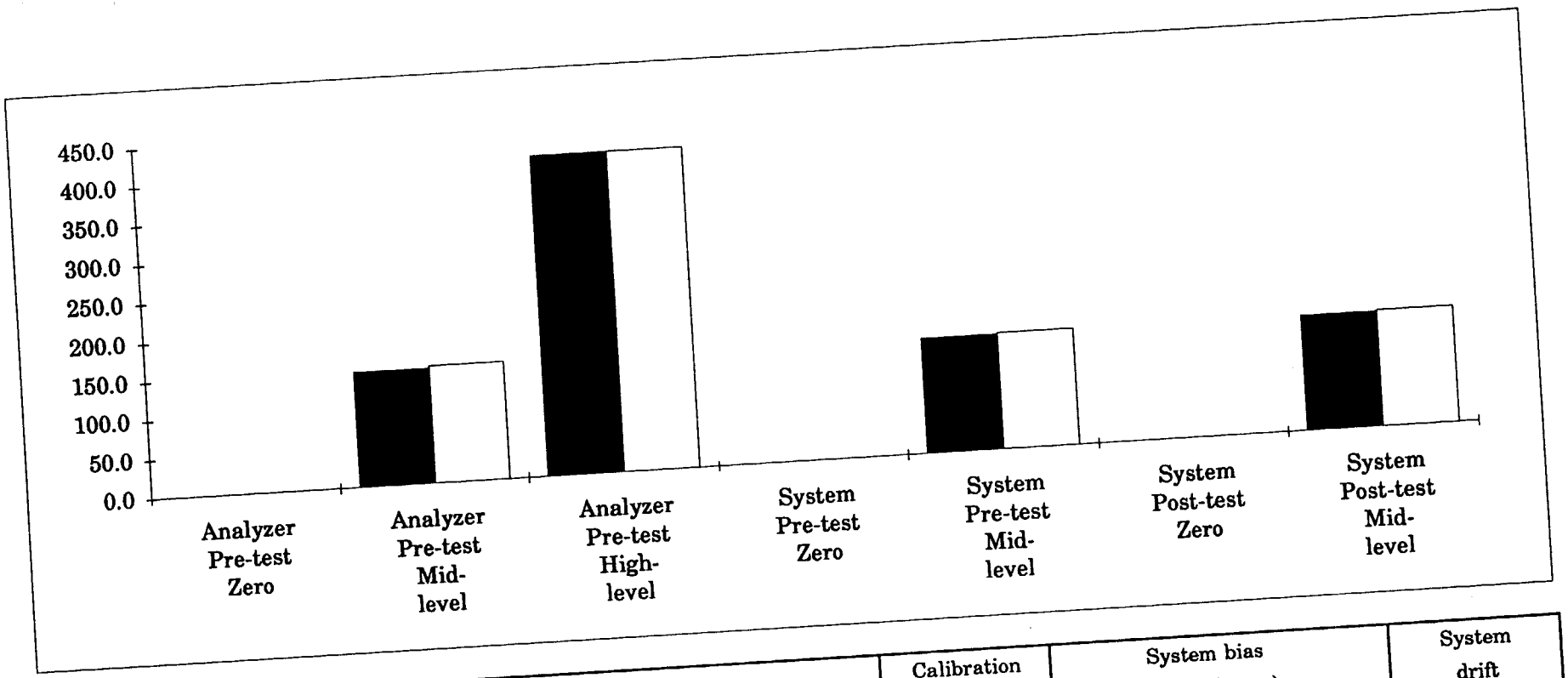
SN: 42H-41303-265

By: Tom Bayer

Test Gas	Concentration	Analyzer Output Response (ppm NOx)	% of Span
O2	20.9 %	0.0	0.0
SO2	221.1 ppm	2.0	0.2
CO2	10.1 %	0.0	0.0
CO	301.0 ppm	0.0	0.0

Total % = 0.2

$$\% \text{ of Span} = \frac{\text{Analyzer Output (ppm NOx)}}{\text{Analyzer Span (1000)}} \times 100$$ Total limit = 2%



Span gas concentration (ppm)	Calibration response, ppm				Calibration error (% of span)	System bias (% of span)		System drift (% of span)
	Analyzer	System injection				Pre-test	Post-test	
	Pre-test	Pre-test	Post-test	Average				
0	0	0	0	0		0.0	0.0	0.0
149	152	151	151	151	1.7	0.2	0.2	0.0
413	413							

NO2 to NO Conversion efficiency				
Time		Conversion response (ppm)		Efficiency
Start	Stop	Maximum	Minimum	%
				NA

Span value (ppm)
500

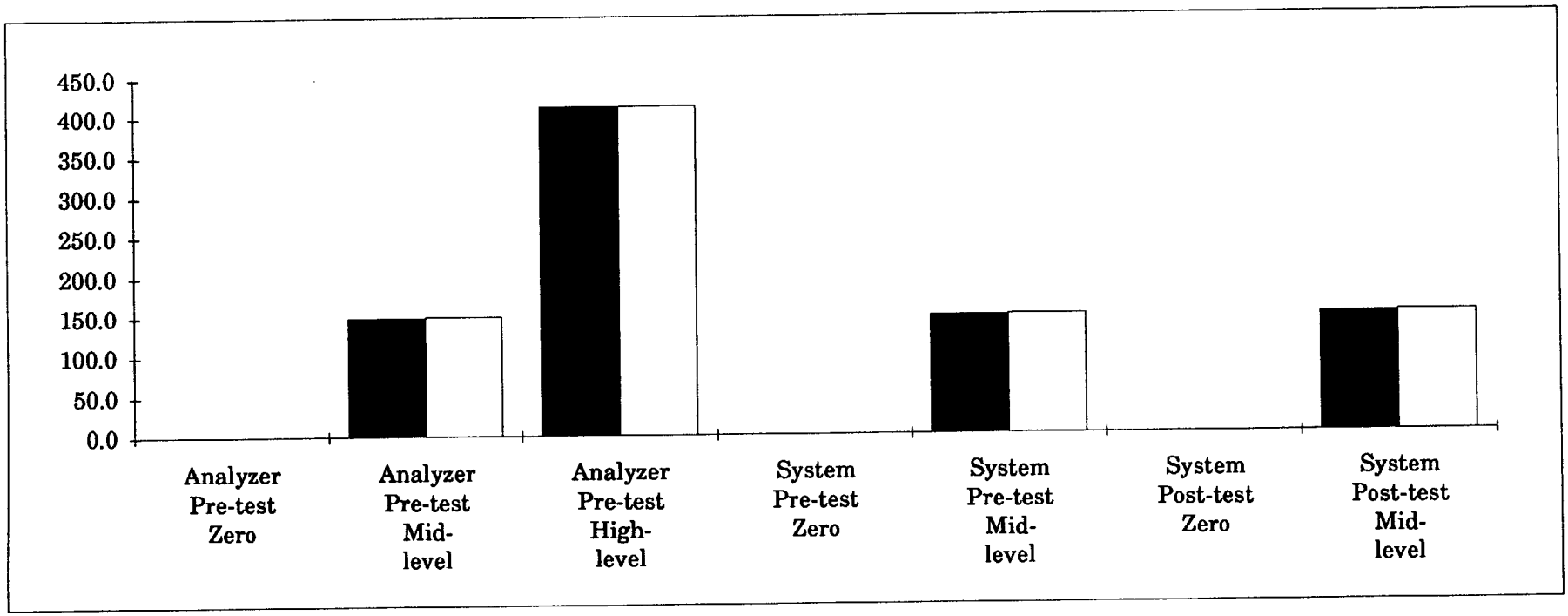
Analyzer Calibration error = $\frac{\text{Span gas concentration- Analyzer calibration response}}{\text{Span}}$ x 100 Limit = 2%

Drift = $\frac{\text{Post test system calibration response - Pretest system calibration response}}{\text{Span}}$ x 100 Limit = 5%

System bias = $\frac{\text{System calibration response - Analyzer calibration response}}{\text{Span}}$ x 100 Limit = 5%

Conversion efficiency = $\frac{\text{Max. conversion response- Min. conversion response}}{\text{Max. conversion response}}$ x 100 Limit = 2%

NOx Calibration Data-Run 1



Span gas concentration (ppm)	Calibration response, ppm				Calibration error (% of span)	System bias (% of span)		System drift (% of span)
	Analyzer	System injection						
	Pre-test	Pre-test	Post-test	Average		Pre-test	Post-test	
0	0	0	1	1		0.2	0.1	0.1
149	151	151	150	151	1.1	0.2	0.1	0.1
413	413							

NO2 to NO Conversion efficiency				
Time		Conversion response (ppm)		Efficiency
Start	Stop	Maximum	Minimum	%
				NA

Span value (ppm)
500

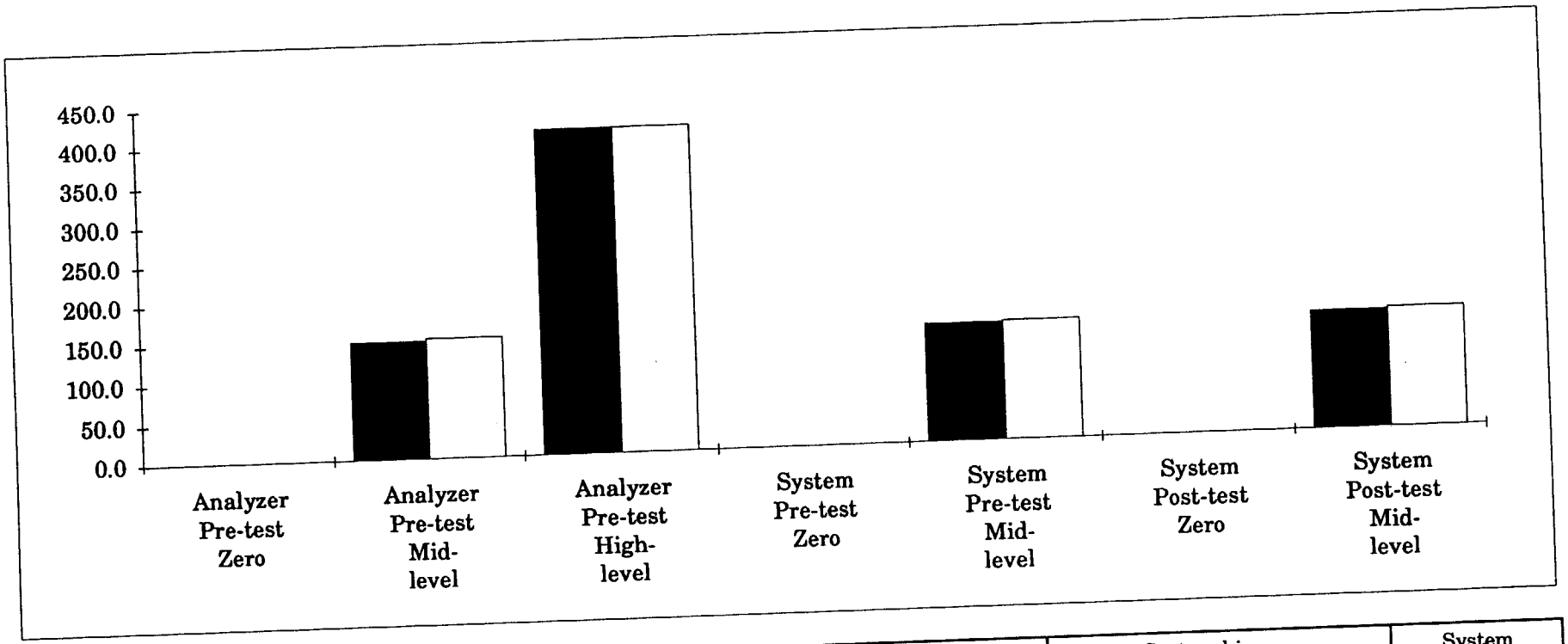
$$\text{Analyzer Calibration error} = \frac{\text{Span gas concentration- Analyzer calibration response}}{\text{Span}} \times 100 \quad \text{Limit} = 2\%$$

$$\text{Drift} = \frac{\text{Post test system calibration response - Pretest system calibration response}}{\text{Span}} \times 100 \quad \text{Limit} = 5\%$$

$$\text{System bias} = \frac{\text{System calibration response - Analyzer calibration response}}{\text{Span}} \times 100 \quad \text{Limit} = 5\%$$

$$\text{Conversion efficiency} = \frac{\text{Max. conversion response- Min. conversion response}}{\text{Max. conversion response}} \times 100 \quad \text{Limit} = 2\%$$

NOx Calibration Data-Run 2



Span gas concentration (ppm)	Calibration response, ppm				Calibration error (% of span)	System bias (% of span)		System drift (% of span)
	Analyzer	System injection				Pre-test	Post-test	
	Pre-test	Pre-test	Post-test	Average				
0	0	0	0	0		0.0	0.0	0.0
149	152	152	151	152	1.7	0.2	0.1	0.1
413	413							

NO2 to NO Conversion efficiency				
Time		Conversion response (ppm)		Efficiency
Start	Stop	Maximum	Minimum	%
				NA

Span value (ppm)
500

Analyzer Calibration error = $\frac{\text{Span gas concentration- Analyzer calibration response}}{\text{Span}}$ x 100 Limit = 2%

Drift = $\frac{\text{Post test system calibration response - Pretest system calibration response}}{\text{Span}}$ x 100 Limit = 5%

System bias = $\frac{\text{System calibration response - Analyzer calibration response}}{\text{Span}}$ x 100 Limit = 5%

Conversion efficiency = $\frac{\text{Max. conversion response- Min. conversion response}}{\text{Max. conversion response}}$ x 100 Limit = 2%

NOx Calibration Data-Run 3

215-691-2474
FAX# 215-758-8384

LIQUID CARBONIC
CYLINDER GAS PRODUCTS
EAST COAST REGION
145 SHIMERSVILLE RD., BETHLEHEM, PA 18015

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

CUSTOMER *S/T CINCINNATI*

P.O NUMBER

REFERENCE STANDARD

COMPONENT	NIST SRM NO.	CYLINDER NO.	CONCENTRATION
NITRIC OXIDE	*GMIS VS. 1685B*	*CLM-004735*	*265.6 PPM*

ANALYZER READINGS

R=REFERENCE STANDARD *Z=ZERO GAS* *C=GAS CANDIDATE*

1. COMPONENT *NITRIC OXIDE* ANALYZER MAKE-MODEL-S/N *THERMO ENVIRON. 14A 14A-35387-250*

ANALYTICAL PRINCIPLE *CHEMILUMINESCENCE* LAST CALIBRATION DATE *11/30/93*

FIRST ANALYSIS DATE *02/07/94* SECOND ANALYSIS DATE *02/14/94*

Z	0.00	R	2.30	C	1.30	CONC.	150.1	Z	0.00	R	2.27	C	1.27	CONC.	148.6
R	2.30	Z	0.00	C	1.30	CONC.	150.1	R	2.27	Z	0.00	C	1.27	CONC.	148.6
Z	0.00	C	1.30	R	2.30	CONC.	150.1	Z	0.00	C	1.27	R	2.27	CONC.	148.6
U/M	*VOLTS*			MEAN TEST ASSAY			150.1	U/M	*VOLTS*			MEAN TEST ASSAY			148.6

Received 3/3/94

THIS CYLINDER NO. *SA 8079*
HAS BEEN CERTIFIED ACCORDING TO SECTION 3.0.4
OF TRACEABILITY PROTOCOL NO. *1*
PROCEDURE *G1*
CERTIFIED ACCURACY ± *1.0* % NIST TRACEABLE
CYLINDER PRESSURE *2000* PSIG
CERTIFICATION DATE *02/14/94*
EXPIRATION DATE *02/14/96*

CERTIFIED CONCENTRATION
NITRIC OXIDE *149.4 PPM*
NITROGEN *BALANCE*

ANALYZED BY *KEVIN BRADY*

CERTIFIED BY *BOB HILLARD*

215-691-2474
FAX# 215-758-8384

LIQUID CARBONIC

CYLINDER GAS PRODUCTS

EAST COAST REGION
145 SHIMERSVILLE RD., BETHLEHEM, PA 18015

CERTIFICATE OF ANALYSIS / EPA PROTOCOL GAS

CUSTOMER *S/T CINCINNATI*

P.O NUMBER

REFERENCE STANDARD

COMPONENT	NIST SRM NO.	CYLINDER NO.	CONCENTRATION
NITRIC OXIDE	*GMIS VS. 1687B*	*CLM-000650*	*770.1 PPM*

ANALYZER READINGS

R=REFERENCE STANDARD *Z=ZERO GAS* *C=GAS CANDIDATE*

1. COMPONENT *NITRIC OXIDE* ANALYZER MAKE-MODEL-S/N *THERMO ENVIRON. 14A 14A-35387-250*

ANALYTICAL PRINCIPLE *CHEMILUMINESCENCE* LAST CALIBRATION DATE *02/24/94*

FIRST ANALYSIS DATE *02/28/94* SECOND ANALYSIS DATE *03/07/94*

Z	0.00	R	7.43	C	4.00	CONC.	414.6	Z	0.00	R	7.33	C	3.92 CONC.	411.8
R	7.42	Z	0.00	C	4.00	CONC.	415.1	R	7.33	Z	0.00	C	3.92 CONC.	411.8
Z	0.00	C	4.00	R	7.43	CONC.	414.6	Z	0.00	C	3.93	R	7.35 CONC.	411.8
U/M	*VOLTS*			MEAN TEST ASSAY			414.8	U/M	*VOLTS*			MEAN TEST ASSAY		411.8

THIS CYLINDER NO. *SGAL 3426*
HAS BEEN CERTIFIED ACCORDING TO SECTION *3.0.4*
OF TRACEABILITY PROTOCOL NO. *1*
PROCEDURE *G1*
CERTIFIED ACCURACY *± 1.0 %* NIST TRACEABLE
CYLINDER PRESSURE *2000* PSIG
CERTIFICATION DATE *03/07/94*
EXPIRATION DATE *03/07/96*

CERTIFIED CONCENTRATION

NITRIC OXIDE	*413.3 PPM*
NITROGEN	*BALANCE*

ANALYZED BY *K. Brady* KEVIN BRADY

CERTIFIED BY *Bob Hillard* BOB HILLARD

K & B Design, Inc.
Industrial Ventilation Engineering - Stack Testing
3131 Disney Street Cincinnati, OH 45209 (513) 351-6200
FAX (513) 351-4071
Dayton Regional Operations (513) 436-1811

Prepared By T. BAKER | Date 8-11-94

Client	Siemens	Sheet	1 of 1
Project	NOx Testing	Proj. No.	F-810
Task	Boiler		
Sheet Title	Natural Gas Usage		

Process DATA

Boiler operated at % CAPACITY
For ALL test RUNS.

Gas Meter DATA (reading x600 = ft³)

RUN 1	Time	9:10	Initial reading	677275
		10:10	Final reading	677303
			TOTAL	28.0
			Gas Used	16,800 ft³
RUN 2	Time	10:30	Initial Reading	677313
		11:30	Final reading	677342
			TOTAL	29.0
			Gas Used	17,400 ft³
RUN 3	Time	11:50	Initial Reading	677352
		12:50	Final Reading	677381
			TOTAL	29.0
			Gas Used	17,400 ft³

Linda Kottenghaus
287-3925
CG&E

Requested Loc ID / Meter : 0058
Requested Class : BTU
Requested Effective Date : 02/01/94
Requested Released Date : 03/01/94
Requested Released Time : 14:59:13:03

TEXAS GAS TRANSMISSION CORPORATION
GAS ANALYSIS SYSTEM
RELEASED SAMPLES REPORT

Printed By : [illegible]
Printed Date : 03/01/94
Printed Time : 14:59:13:03
Page : 1

Sample Loc ID : 0058 LEBANON
Source : WLD Type : CHRM Freq : D Sample Group : ANALYSIS Measure Point : 1367 Effective Date : 02/28/94
Calc Flag : A Comments : Sample Date : 02/27/94 Sample Origin : ACT

COMPONENTS

Comp Code	Component Name	Press Base	Mole Percent	BTU Factor	BTU Value	SPG Factor	SPG Value	Non-Hydro	Norm
N2	NITROGEN		0.416738			0.96723	0.00403	N	Y
CO2	CARBON DIOXIDE		1.048223			1.51965	0.01593	N	Y
C1	METHANE		95.832290	1012.00	969.82	0.55382	0.53083	N	Y
C2S	ETHANE		2.219690	1773.70	39.37	1.03824	0.02305	N	Y
C3S	PROPANE		0.291120	2522.10	7.09	1.52256	0.00420	N	Y
IC4H10	ISO-BUTANE		0.055782	3260.30	1.82	2.00604	0.00112	N	Y
NC4H10	NORMAL-BUTANE		0.057895	3270.10	1.89	2.00604	0.00116	N	Y
IC5H12	ISO-PENTANE		0.026804	4011.10	1.06	2.49115	0.00066	N	Y
NC5H12	NORMAL-PENTANE		0.017116	4018.20	0.69	2.49115	0.00043	N	Y
C6H14+	HEXANE PLUS		0.044712	5141.10	2.30	3.22762	0.00144	N	Y
H2O	WATER VAPOR		0.000000					N	N
SPG	SPEC GRAV ACT VALUE	14.730	0.583940					N	N
Z	COMP FACT ACT VALUE	14.730	0.997895					N	N
BTU-IDL	IDEAL BTU	14.730	1024.042928					N	N

BTU

Comp Code	Press Base	BTU/cf Dry	BTU/cf Sat	BTU/cf Am Dal
BTU	14.730	1025.200000	1009.300000	
BTU	15.025	1046.000000	1029.900000	
BTU	14.650	1020.700000	1005.700000	

EXCLUSIVE DATES
02/28/94 - 03/01/94

$\overline{X}$=1025 BTU/ft^3

Release Date : 02/28/94 Release Time : 11:45:32:97

METHOD 1-TRAVERSE POINT LOCATION FOR RECTANGULAR DUCTS

Client Siemens Job # E-810 Date 8-11-94

Source Boiler 2 Site Outlet STACK By TB

INSIDE DUCT DIMENSIONS 51.0"

NIPPLE DEPTH 3.0"

EQUIVALENT STACK DIAMETER 48

DISTANCE (A) UPSTREAM OF DISTURBANCE ~20'

STACK DIAMETERS >2.0

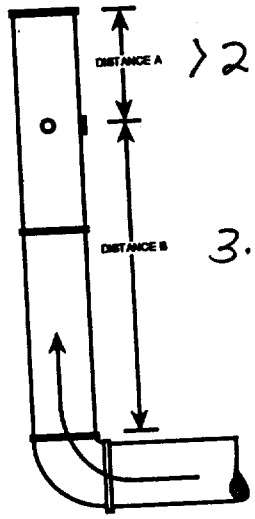
DISTANCE (B) DOWNSTREAM OF DISTURBANCE ~12.0'

STACK DIAMETERS 3

NUMBER OF TRAVERSE POINTS 16

MATRIX (8X8)

SKETCH OF MEASUREMENT SITE



TRAVERSE POINT NUMBER	INSIDE OF NEAR WALL TO TRAVERSE PT.	NIPPLE DEPTH	TRAVERSE POINT LOCATION	PORT NO.	DISTANCE FROM EDGE OF STACK
1	0.032	48"	1.5	3.0"	4.5
2	0.105		5.0		8.0
3	0.194		9.3		12.3
4	0.323		15.5		18.5
5	0.677		32.5		35.5
6	0.806		38.7		41.7
7	0.895		43.0		46.0
8	0.968		46.5		49.5

METHOD 2-VELOCITY DATA

Client Siemens
Job # F-810
Date 8-11-94
Source Boiler
Site Outlet STACK
Run 1
Barometric Pressure (Pb) 29.50 in Hg
Static Pressure (Pg) — 0.11 in H_2O

Pitot Tube # 6B Cp 0.84
Pre-Test leak check ✓ Post-test leak check ✓
Thermocouple # 6B Duct Dimensions 48.0" Ø

MOISTURE DATA

Wet Bulb TC# — Dry Bulb TC # —
Temperature : Wet — Dry —

FYRITE DATA

Oxygen (%) — Carbon Dioxide (%) —

TRAVERSE POINT NUMBER	ΔP (" H20)	STACK TEMPERATURE (°F)	TRAVERSE POINT NUMBER	ΔP (" H20)	STACK TEMPERATURE (°F)
1	0.035	226	1	0.035	228
2	0.040	227	2	0.040	229
3	0.040	228	3	0.040	230
4	0.040	228	4	0.040	230
5	0.045	229	5	0.045	231
6	0.045	230	6	0.050	233
7	0.045	230	7	0.050	234
8	0.035	230	8	0.030	234

PRELIMINARY DATA

Bws: —
ΔP: —
√ΔP: 0.202
Ts: 230
Vs: 73.6 fps
Qa: 10,239 acfm
Qsd: 7,063 dscfm
Qs: — scfm

EMISSION TESTING DATA SHEET

Client Siemens
Job # E-810 Date 8-11-94
Source Boiler
Site Outlet STACK
Run # 1
Sample type M-4
Barometric pressure (Pb), in Hg —
Static pressure (Pg), in H_2O —

Meter box # K-4 Sample box # S/Scr #1
Meter ΔH@ 1.909 Meter Y factor 0.992
Filter # — Pitot # / Cp —
Probe length/type 2' SS
Stack TC # — Oven TC # —
Impinger TC # I-5
Duct dimensions 48.0" Ø
Operators TB, BF, RF

C factor — Reference ΔP —
Nozzle I.D. — — — Avg. —
Pretest leak rate 0.002 cfm@ 10 "Hg
Post-test leak rate 0.002 cfm@ 4 "Hg
Pitot tube leak check: Pre — Post —
Orsat train leak check: Pre ✓ Post ✓
Record data every 10.0 Minutes
Page 1 of 1

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	CLOCK TIME (hr)	METER READING (cu ft)	VELOCITY PRESSURE ΔP ("H_2O)	ORIFICE PRESSURE ΔH@ ("H_2O) DESIRED	ORIFICE PRESSURE ΔH@ ("H_2O) ACTUAL	TRAIN VACUUM ("Hg)	TEMPERATURES (°F) STACK	PROBE	FILTER	IMP	METER IN	METER OUT	% O2
	0	9:10	188.926	—	2.0	2.0	3.5	—	—	—	61	80	80	
C	10		196.680	—			3.5	—	—	—	50	82	80	12.2
E	20		204.500	—			3.5	—	—	—	61	88	82	
N	30		212.250	—			3.5	—	—	—	65	93	85	13.0
T	40		220.050	—			4.0	—	—	—	65	94	85	
E	50		227.900	—			4.0	—	—	—	67	95	87	11.8
R	60	10:10	235.774	—										
														12.0
	60	1.0	46.848	—	2.0	2.0	4.0	—	—	—	—	86		

L

METHOD 3-ORSAT DATA

Client Siemens Job # F-810 Date 8-11-94

Source Boiler Site Outlet STACK Run 1

		CO_2	O_2 (1)	CO (2)	N_2 (3)
Run 1	Actual %	4.2	16.2		100.0
	Net %	4.2	12.0	—	83.8
Run 2	Actual %	4.2	16.2		100.0
	Net %	4.2	12.0	—	83.8
Run 3	Actual %	4.2	16.2		100.0
	Net %	4.2	12.0	—	83.8
Average		4.2	12.0	ND	83.8

(1) Net is actual O_2 reading minus the actual CO_2 reading.

(2) Net is actual CO reading minus the actual O_2 reading.

(3) Net is 100 minus the actual CO reading.

ACTUAL Fo:

Orsat data

$$Fo = \frac{20.9\% - \%O2}{\%CO2}$$

$$Fo = \frac{20.9\% - (12.0)}{(4.2)}$$

Fo = 2.119

Expected Fo Value = 1.600-1.836

EXPECTED Fo:

Fuel type	Fo range
Coal:	
Anthracite and lignite	1.016-1.130
Bituminous	1.083-1.230
Oil:	
Distillate	1.260-1.413
Residual	1.210-1.370
Gas:	
Natural	1.600-1.836
Propane	1.434-1.586
Butane	1.405-1.553
Wood	1.000-1.120
Wood bark	1.003-1.130

SAMPLE RECOVERY DATA

Client Siemens Job # F-810 Date 8-11-94

Source Boiler Site Outlet Run 1

Filter # — Glassware set # 1 Sample box # 25

Impinger # / Wt.	#1	#2	#3	#4	#5	TOTAL
Final (g)	685.7	722.1	582.6	745.2		
Initial (g)	598.8	710.9	579.6	734.2		
Net (g)	86.9	11.2	3.0	11.0		112.1

RECOVERED SAMPLE

DESCRIPTION OF PARTICULATE ON FILTER —

COLOR OF SILICA GEL 20% spent

COMMENTS none

BALANCE CHECK
EX 1200A S/N C0235207

TEST WEIGHT 500 GM #840500.4	INITIAL WEIGHT 500.0
	FINAL WEIGHT 500.0

RECOVERED BY R. Fell

METHOD 2-VELOCITY DATA

Client Siemens
Job # E-810
Date 8-11-94
Source Boiler
Site Outlet STACK
Run 2
Barometric Pressure (Pb) 29.50 in Hg
Static Pressure (Pg) -0.11 in H_2O

Pitot Tube # 6B Cp 0.84 ✓
Pre-Test leak check ✓ Post-test leak check ✓
Thermocouple # 6B Duct Dimensions 48.0" Ø

MOISTURE DATA

Wet Bulb TC# — Dry Bulb TC # —
Temperature : Wet — Dry —

FYRITE DATA

Oxygen (%) — Carbon Dioxide (%) —

TRAVERSE POINT NUMBER	ΔP (" H20)	STACK TEMPERATURE (°F)	TRAVERSE POINT NUMBER	ΔP (" H20)	STACK TEMPERATURE (°F)
1	0.045	226	1	0.040	224
2	0.045	230	2	0.040	228
3	0.045	231	3	0.040	230
4	0.045	234	4	0.045	233
5	0.050	235	5	0.050	235
6	0.050	236	6	0.050	236
7	0.045	235	7	0.045	235
8	0.040	220	8	0.040	227

PRELIMINARY DATA

Bws: _____
ΔP: _____
√ΔP: 0.211
Ts: 231
Vs: _____ fps
Qa: _____ acfm
Qsd: _____ dscfm
Qs: _____ scfm

EMISSION TESTING DATA SHEET

Client Siemens | Meter box # K-4 | Sample box # 3/Set #2 | C factor — | Reference ΔP —

Job # F-810 | Date 8-11-94 | Meter ΔH@ 1.909 | Meter Y factor 0.992 | Nozzle I.D. — — — Avg. —

Source Boiler | Filter # — | Pitot # / Cp — | Pretest leak rate 0.002 cfm@ 10 "Hg

Site Outlet STACK | Probe length/type 2' SS | Post-test leak rate 0.002 cfm@ 4 "Hg

Run # 2 | Stack TC # — | Oven TC # — | Pitot tube leak check: Pre — Post —

Sample type M-4 | Impinger TC # I-2 | Orsat train leak check: Pre ✓ Post ✓

Barometric pressure (Pb), in Hg — | Duct dimensions 48" Ø | Record data every 10.0 Minutes

Static pressure (Pg), in H_2O — | Operators TB, RF, BF | Page 1 of 1

*235.936

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	CLOCK TIME (hr)	METER READING (cu ft)	VELOCITY PRESSURE ΔP BF ("H_2O)	ORIFICE PRESSURE ΔH@ ("H_2O) DESIRED	ORIFICE PRESSURE ΔH@ ("H_2O) ACTUAL	TRAIN VACUUM ("Hg)	TEMPERATURES (°F) STACK	PROBE	FILTER	IMP	METER IN	METER OUT	%O_2
	0	10:30	~~235.877~~											
C	10		243.880	—	2.0	2.0	3.5	—	—	—	67	90	88	
E	20		251.735	—			3.5	—	—	—	63	94	89	11.9
N	30		259.575	—			3.5	—	—	—	63	98	90	
T	40		—	—			3.5	—	—	—	63	99	92	11.7
E	50		275.420	—			3.5	—	—	—	63	100	93	
R	60	11:30	283.297	—	↓	↓	3.5	—	—	—	61	100	93	11.9
	60	1.0	47.361	—	2.0	2.0	4	—	—	—	—	93		11.8

METHOD 3-ORSAT DATA

Client Siemens Job # F-810 Date 8-11-94

Source Boiler Site Outlet STACK Run 2

		CO_2	O_2 (1)	CO (2)	N_2 (3)
Run 1	Actual %	4.3	16.1		100.0
	Net %	4.3	11.8	—	83.9
Run 2	Actual %	4.3	16.1		100.0
	Net %	4.3	11.8	—	83.9
Run 3	Actual %	4.3	16.1		100.0
	Net %	4.3	11.8	—	83.9
Average		4.3	11.8	ND	83.9

(1) Net is actual O_2 reading minus the actual CO_2 reading.

(2) Net is actual CO reading minus the actual O_2 reading.

(3) Net is 100 minus the actual CO reading.

ACTUAL Fo:

Orsat data

$$Fo = \frac{20.9\% - \%O2}{\%CO2}$$

$$Fo = \frac{20.9\% - (11.8)}{(4.3)}$$

Fo = 2.116

Expected Fo Value = 1.600-1.836

EXPECTED Fo:

Fuel type	Fo range
Coal:	
Anthracite and lignite	1.016-1.130
Bituminous	1.083-1.230
Oil:	
Distillate	1.260-1.413
Residual	1.210-1.370
Gas:	
Natural	1.600-1.836
Propane	1.434-1.586
Butane	1.405-1.553
Wood	1.000-1.120
Wood bark	1.003-1.130

SAMPLE RECOVERY DATA

Client Siemens Job # F-810 Date 8-11-94

Source Boiler Site Outlet Run 2

Filter # — Glassware set # 2 Sample box # 2

Impinger # / Wt.	#1	#2	#3	#4	#5	TOTAL
Final (g)	702.2	749.4	564.2	652.6		
Initial (g)	608.4	736.6	561.3	642.5		
Net (g)	93.8	12.8	2.9	10.1		119.6

RECOVERED SAMPLE

DESCRIPTION OF PARTICULATE ON FILTER —

COLOR OF SILICA GEL 50% Spent

COMMENTS None

BALANCE CHECK
EX 1200A S/N C0235207

TEST WEIGHT 500 GM #840500.4	INITIAL WEIGHT 500.0
	FINAL WEIGHT 500.0

RECOVERED BY T. Bayer

METHOD 2-VELOCITY DATA

Client Siemens
Job # F-810
Date 8-11-94
Source Boiler
Site Outlet STACK
Run 3
Barometric Pressure (Pb) 29.50 in Hg
Static Pressure (Pg) −0.11 in H_2O

Pitot Tube # 6B Cp 0.84
Pre-Test leak check ✓ Post-test leak check ✓
Thermocouple # 6B Duct Dimensions 48.0" Ø

MOISTURE DATA

Wet Bulb TC# — Dry Bulb TC # —
Temperature : Wet — Dry —

FYRITE DATA

Oxygen (%) — Carbon Dioxide (%) —

TRAVERSE POINT NUMBER	ΔP (" H20)	STACK TEMPERATURE (°F)	TRAVERSE POINT NUMBER	ΔP (" H20)	STACK TEMPERATURE (°F)
1	0.040	234	1	0.045	225
2	0.040	234	2	0.045	226
3	0.045	234	3	0.045	227
4	0.045	235	4	0.045	229
5	0.050	239	5	0.050	231
6	0.050	236	6	0.050	234
7	0.045	236	7	0.045	235
8	0.040	236	8	0.035	235

PRELIMINARY DATA

Bws: —
ΔP: —
√ΔP: 0.211
Ts: 232
Vs: — fps
Qa: — acfm
Qsd: — dscfm
Qs: — scfm

EMISSION TESTING DATA SHEET

Client Siemens | Meter box # K-4 | Sample box # S/SET #3 | C factor — | Reference ΔP —

Job # F-810 | Date 8-11-94 | Meter ΔH@ 1.909 | Meter Y factor 0.992 | Nozzle I.D. — — — Avg. —

Source Boiler | Filter # — | Pitot # / Cp — | Pretest leak rate 0.001 cfm@ 10 "Hg

Site Outlet STACK | Probe length/type 2' SS | Post-test leak rate 0.002 cfm@ 4 "Hg

Run # 3 | Stack TC # — | Oven TC # — | Pitot tube leak check: Pre — Post —

Sample type M-4 | Impinger TC # I-5 | Orsat train leak check: Pre ✓ Post ✓

Barometric pressure (Pb), in Hg — | Duct dimensions 48" Ø | Record data every 10.0 Minutes

Static pressure (Pg), in H_2O — | Operators TB, RE, BF | Page 1 of 1

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	CLOCK TIME (hr)	METER READING (cu ft)	VELOCITY PRESSURE ΔP ("H_2O)	ORIFICE PRESSURE ΔH@ ("H_2O)		TRAIN VACUUM ("Hg)	TEMPERATURES (°F)					
					DESIRED	ACTUAL		STACK	PROBE	FILTER	IMP	METER IN	METER OUT
	0	11:50	283.513	—									
C	10		293.355	—	2.0	2.0	4.0	—	—	—	67	93	92
E	20		299.230	—	2.0	2.0	4.0	—	—	—	50	96	92
N	30		307.100	—	2.0	2.0	4.0	—	—	—	55	98	93
T	40		314.915	—	2.0	2.0	4.0	—	—	—	56	99	93
E	50		322.740	—	2.0	2.0	4.0	—	—	—	62	102	95
R	60	12:50	330.508	—	2.0	2.0	4.0	—	—	—	61	100	94
	60	1.0	46.995	—	2.0	2.0	4	—	—	—	—	96	

%O

11.8

11.7

11.9

11.8

METHOD 3-ORSAT DATA

Client Siemens Job # E-810 Date 8-11-94

Source Boiler Site Outlet STACK Run 3

		CO_2	O_2 (1)	CO (2)	N_2 (3)
Run 1	Actual %	4.3	16.2		100.0
	Net %	4.3	11.9	—	83.8
Run 2	Actual %	4.3	16.2		100.0
	Net %	4.3	11.9	—	83.8
Run 3	Actual %	4.3	16.2		100.0
	Net %	4.3	11.9	—	83.8
Average		4.3	11.9	ND	83.8

(1) Net is actual O_2 reading minus the actual CO_2 reading.

(2) Net is actual CO reading minus the actual O_2 reading.

(3) Net is 100 minus the actual CO reading.

ACTUAL Fo:

Orsat data

$$Fo = \frac{20.9\% - \%O2}{\%CO2}$$

$$Fo = \frac{20.9\% - (11.9)}{(4.3)}$$

Fo = 2.093

Expected Fo Value = 1.600-1.836

EXPECTED Fo:

Fuel type	Fo range
Coal:	
Anthracite and lignite	1.016-1.130
Bituminous	1.083-1.230
Oil:	
Distillate	1.260-1.413
Residual	1.210-1.370
Gas:	
Natural	1.600-1.836
Propane	1.434-1.586
Butane	1.405-1.553
Wood	1.000-1.120
Wood bark	1.003-1.130

SAMPLE RECOVERY DATA

Client Siemens Job # F-810 Date 8-11-94
Source Boiler Site Outlet Run 3

Filter # — Glassware set # 3 Sample box # 5

Impinger # / Wt.	#1	#2	#3	#4	#5	TOTAL
Final (g)	777.6	732.1	585.3	754.6		
Initial (g)	685.7	722.1	582.6	745.2		
Net (g)	91.9	10.0	2.7	9.4		114.0

RECOVERED SAMPLE

DESCRIPTION OF PARTICULATE ON FILTER —
COLOR OF SILICA GEL 50% Spent
COMMENTS None

BALANCE CHECK
EX 1200A S/N C0235207

TEST WEIGHT 500 GM #840500.4	INITIAL WEIGHT 500.0
	FINAL WEIGHT 500.0

RECOVERED BY T Bayless

METHOD 7E CALIBRATION DATA

Client Siemens Job # F-810 Date 8-11-94 Calibration Console #2

Source Boiler #2 Site Outlet STACK Analyzer NOX #1 Operator TB, BF, RF

Run# 1 Start time 9:10 AM Stop time 10:10 AM Span 0-500 ppm

Span gas concentration (ppm)	Calibration response, ppm: Analyzer Pre-test	System Pre-test	System Post-test	Analyzer calibration error (% of span)	System bias (% of span) Pre-test	System bias (% of span) Post-test	Drift (% of span)
0	0	0	0				
149.4	152	151	151				
413.3	413						

Run# 2 Start time 10:30 Stop time 11:30 Span 0-500 ppm

Span gas concentration (ppm)	Calibration response, ppm: Analyzer Pre-test	System Pre-test	System Post-test	Analyzer calibration error (% of span)	System bias (% of span) Pre-test	System bias (% of span) Post-test	Drift (% of span)
0	0	0	1.0				
149	151	151	150				
413	413						

Run# 3 Start time 11:50 Stop time 12:50 Span 0-500 ppm

Span gas concentration (ppm)	Calibration response, ppm: Analyzer Pre-test	System Pre-test	System Post-test	Analyzer calibration error (% of span)	System bias (% of span) Pre-test	System bias (% of span) Post-test	Drift (% of span)
0	0	0	0				
149	152	152	151				
413	413						

NO2 to NO Conversion efficiency				
Time		Conversion response (ppm)		Efficiency
Start	Stop	Maximum	Minimum	%
—	—	—	—	N.A.

☒ NO2 to NO conversion efficiency not required. Previous test data shows NO2 is less than 5% of the NOx concentration.

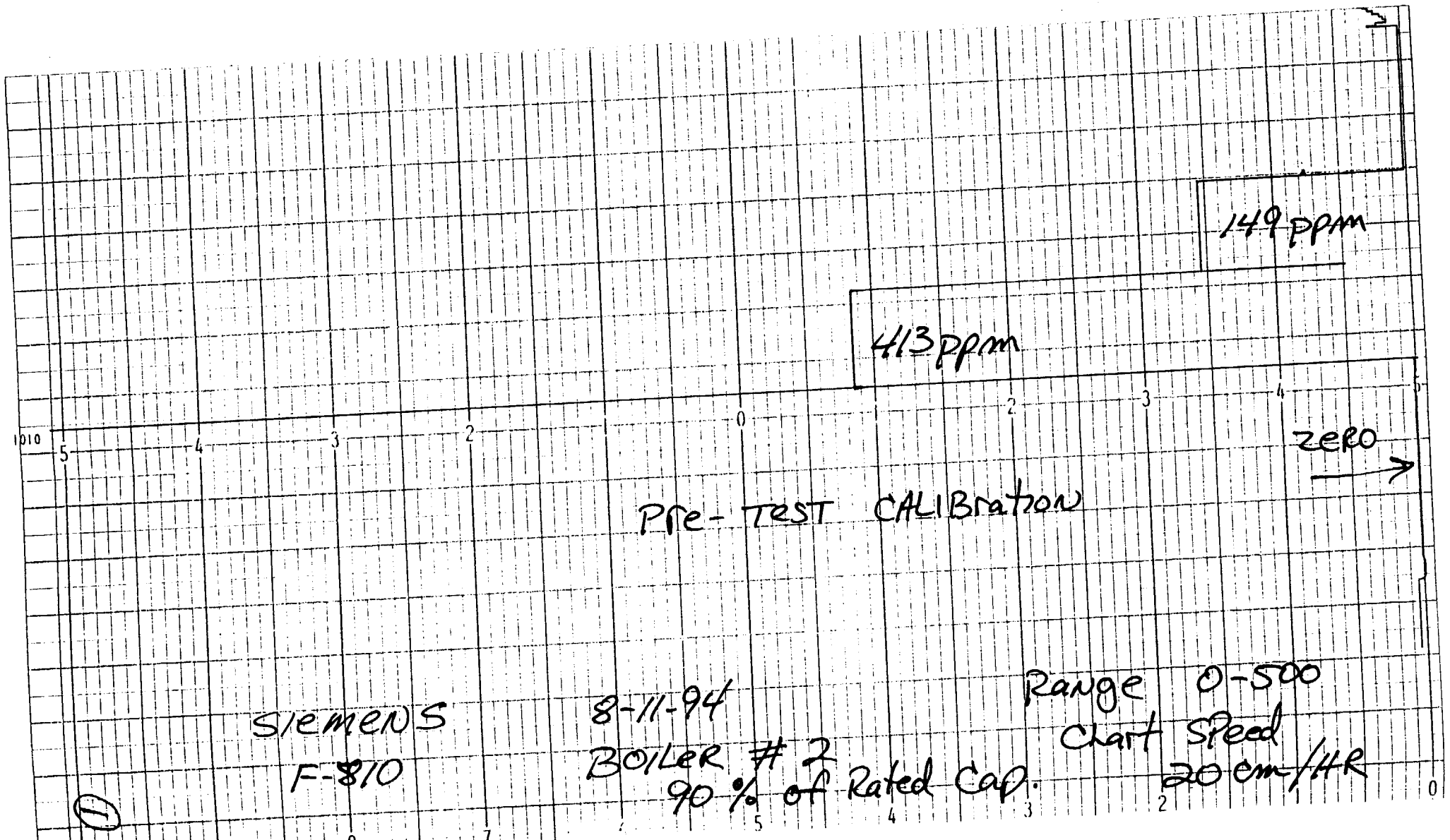
Response Time Up-scale 180 sec. Down-scale 150 sec.

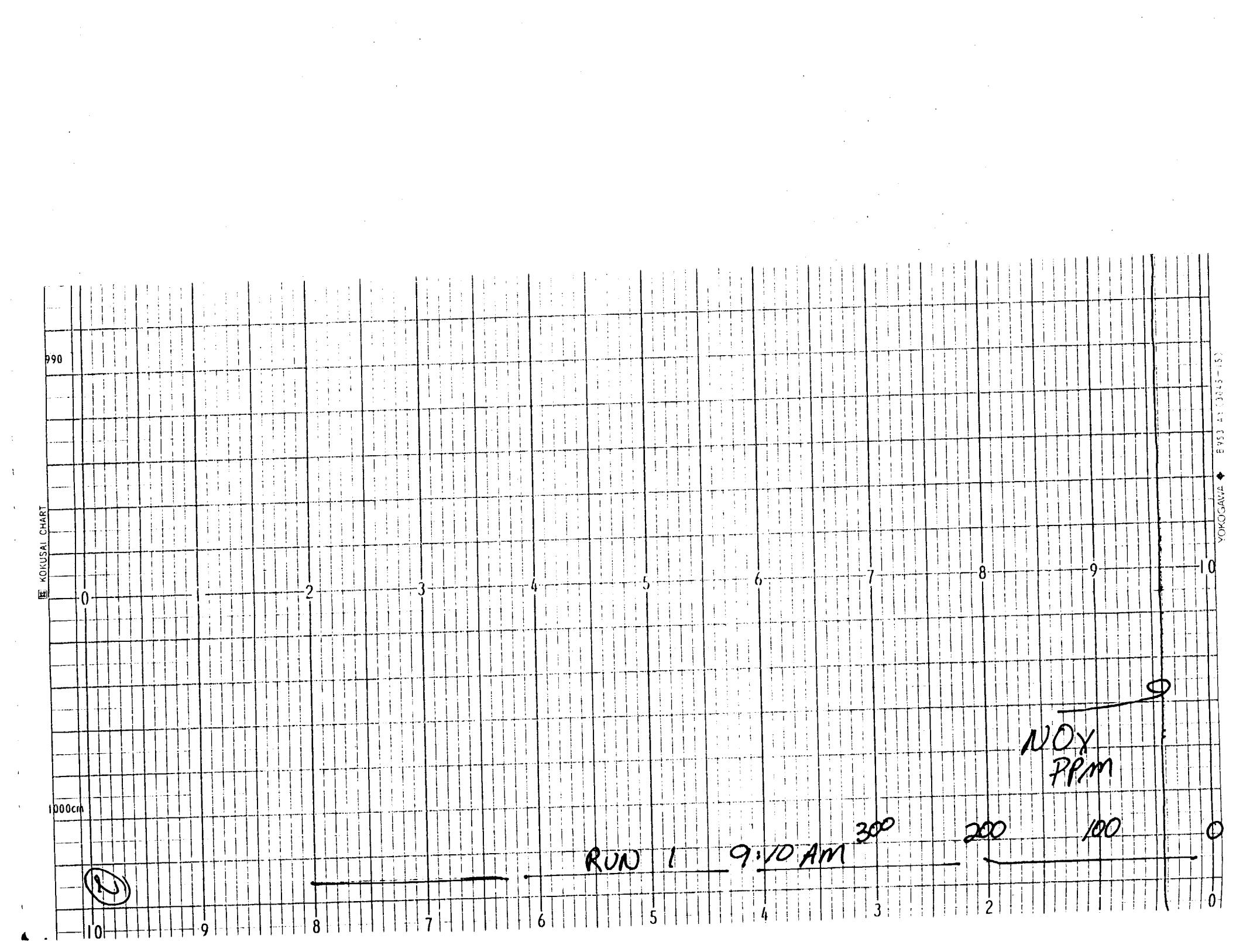
Analyzer Calibration error = $\frac{\text{Span gas concentration - Analyzer calibration response}}{\text{Span}} \times 100$ Limit = 2%

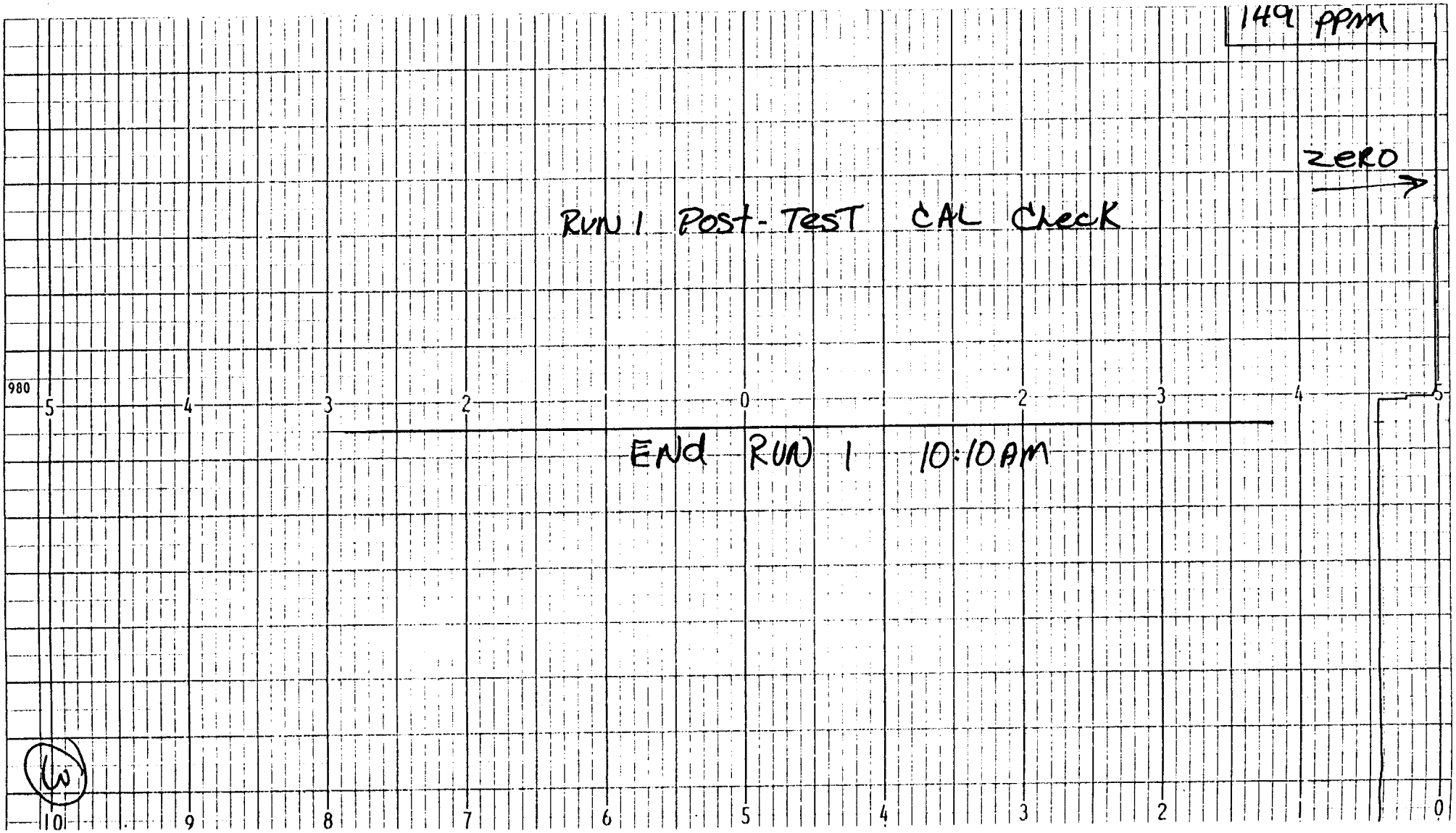
System bias = $\frac{\text{System calibration response - Analyzer calibration response}}{\text{Span}} \times 100$ Limit = 5%

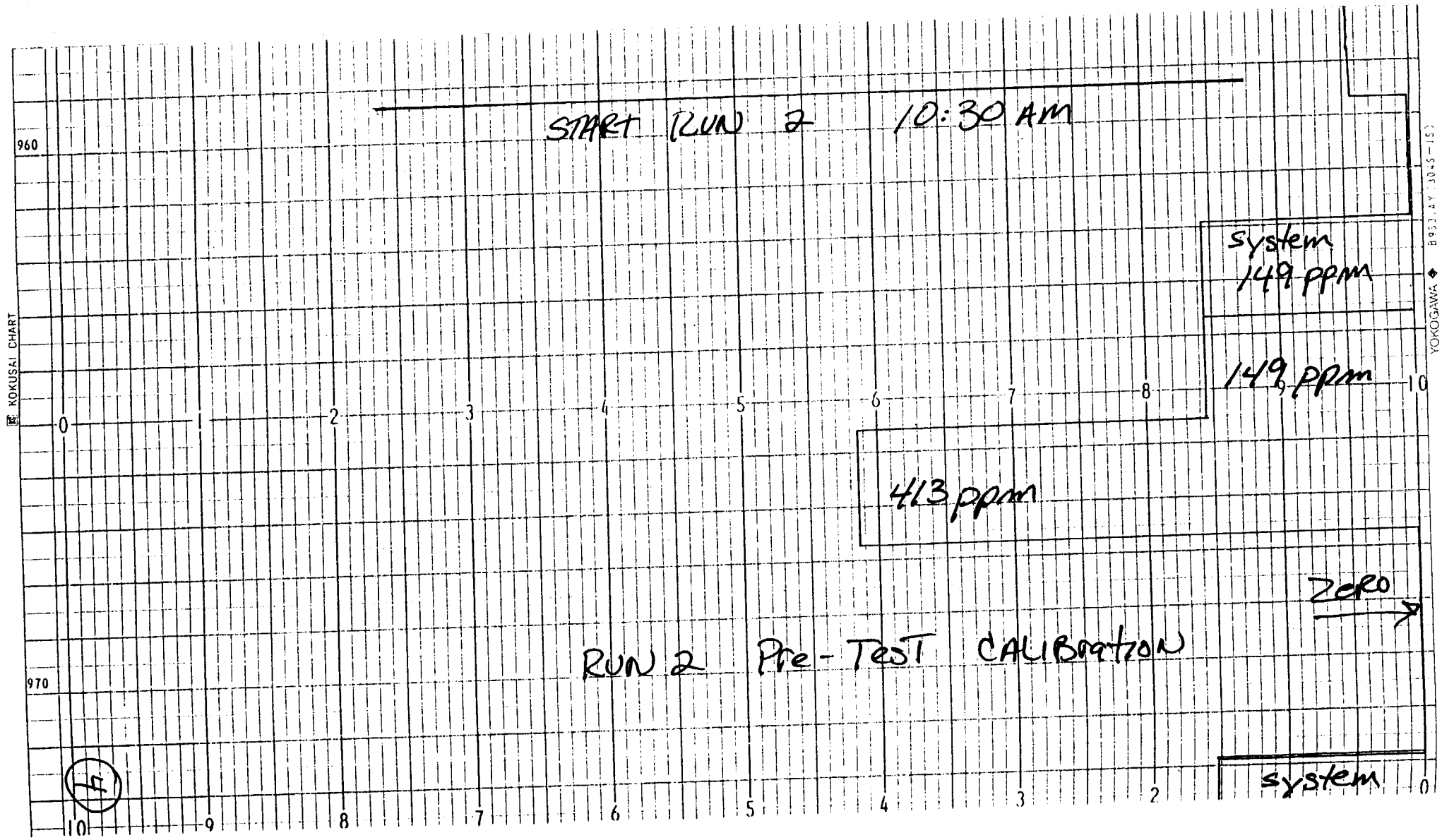
Drift = $\frac{\text{Post test system calibration response - Pretest system calibration response}}{\text{Span}} \times 100$ Limit = 5%

Conversion efficiency = $\frac{\text{Max. conversion response - Min. conversion response}}{\text{Max. conversion response}} \times 100$ Limit = 2%


149 ppm
413 ppm
ZERO
Pre-TEST CALIBration
SIEMENS
F-810
8-11-94
BOILER # 2
90 % of Rated Cap.
Range 0-500
Chart Speed
20 cm/HR


KOKUSAI CHART
990
1000cm
0
1
2
3
4
5
6
7
8
9
10
NOX
PPM
300
200
100
0
RUN 1 9:10 AM
2
YOKOGAWA


149 ppm
ZERO
RUN 1 POST-TEST CAL CHECK
980
END RUN 1 10:10AM
(3)


START RUN 2 10:30 AM
system
149 ppm
149 ppm
413 ppm
Zero
RUN 2 Pre-Test CALIBRATION
system
KOKUSAI CHART
YOKOGAWA

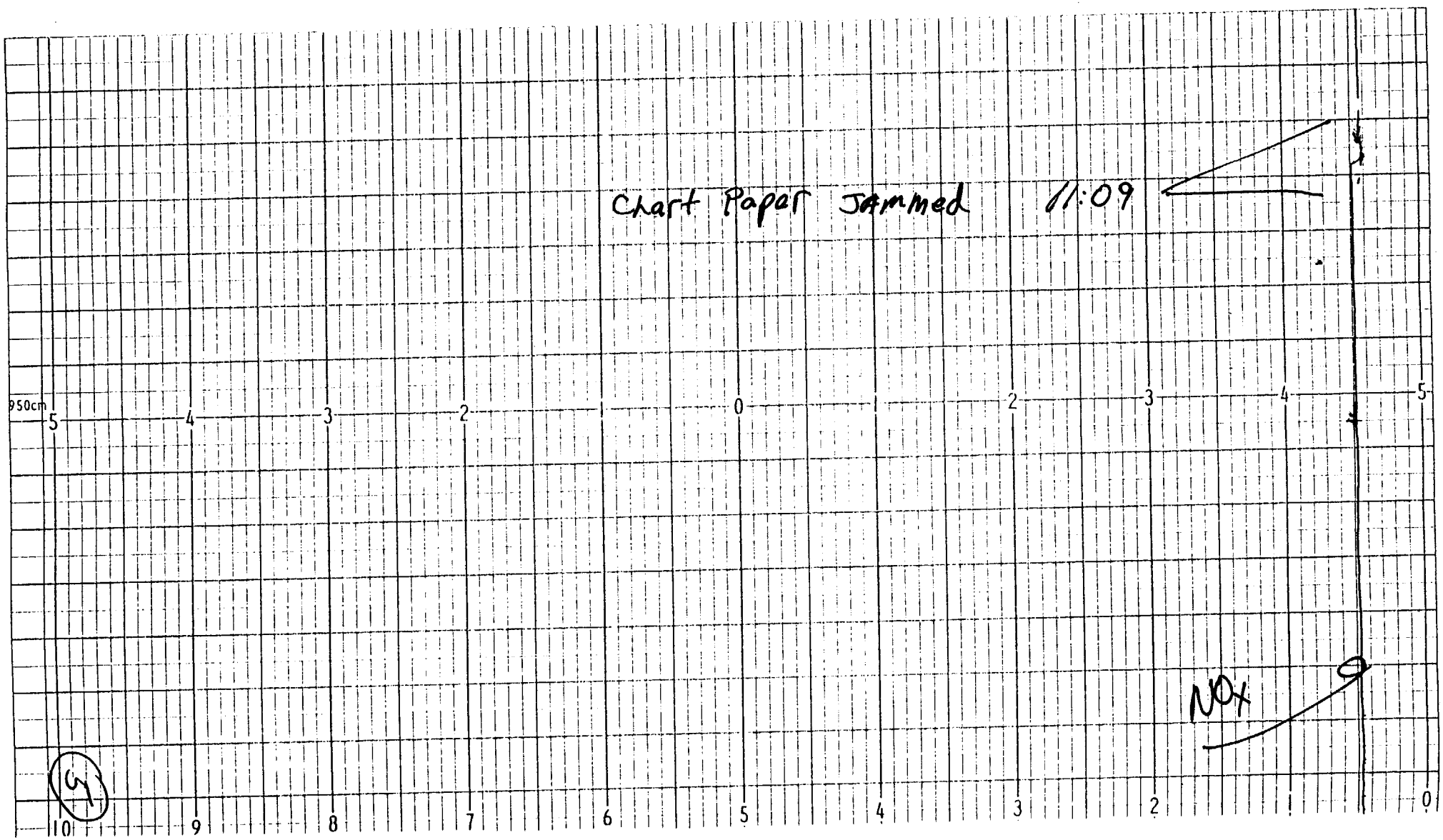
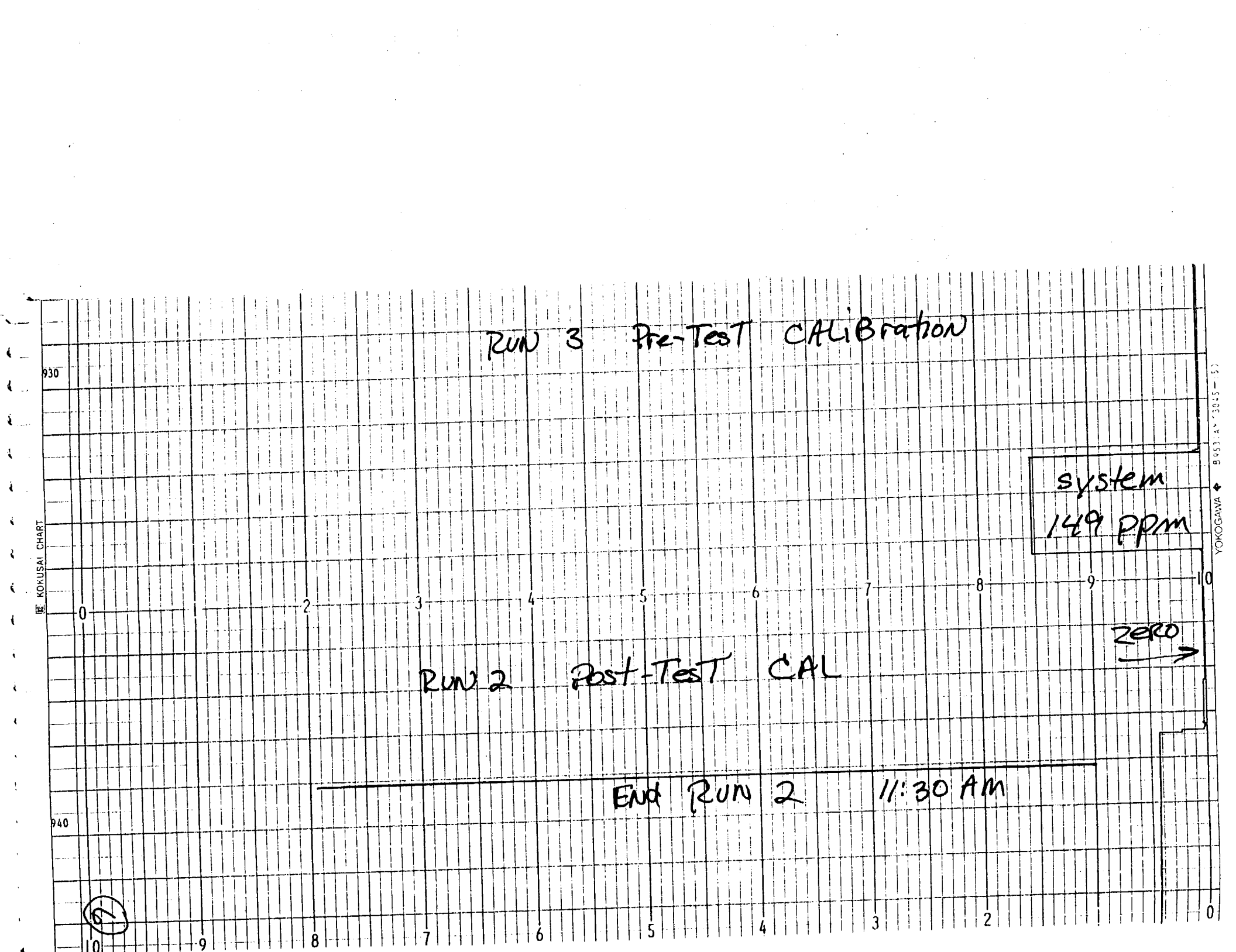
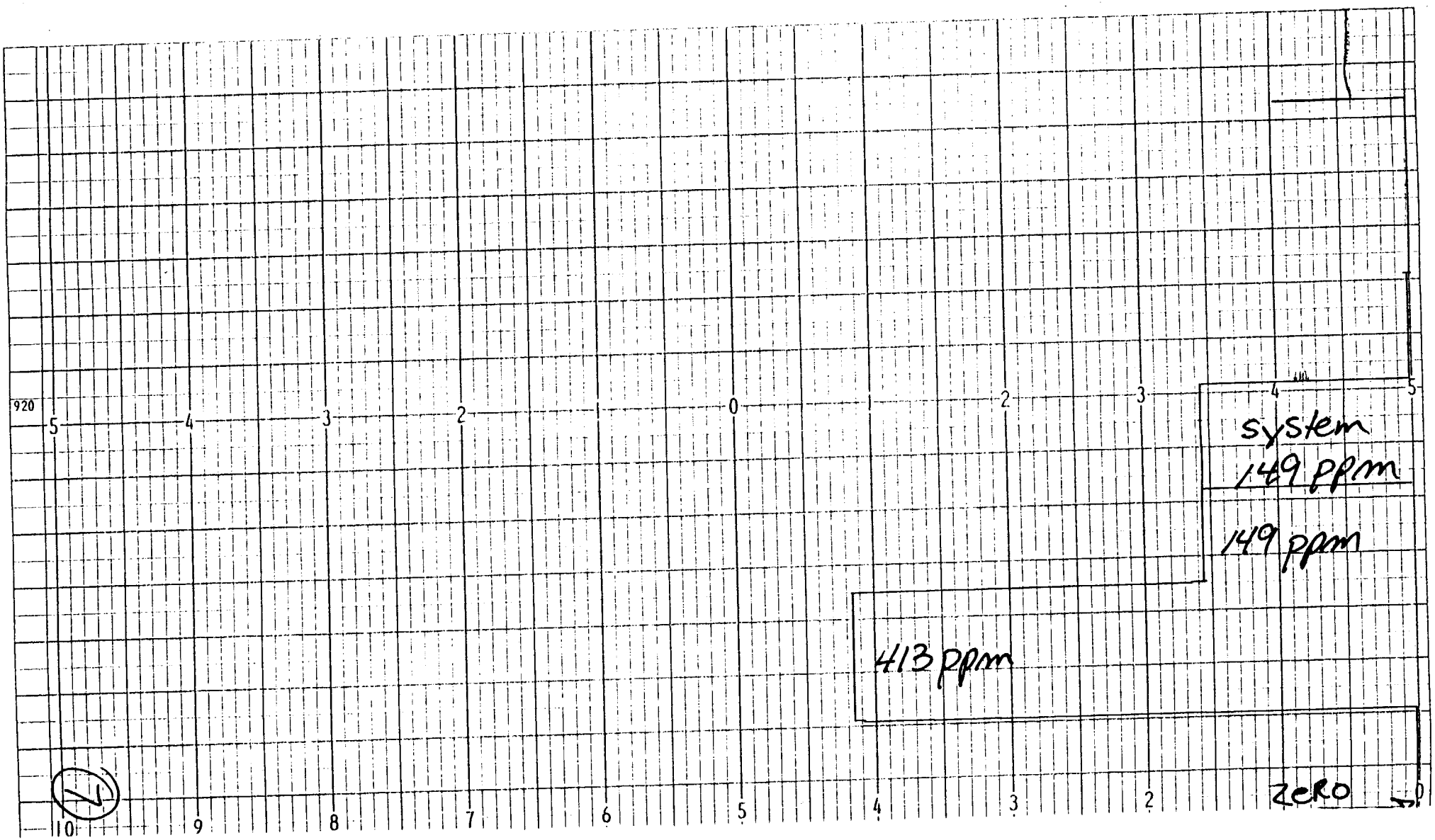
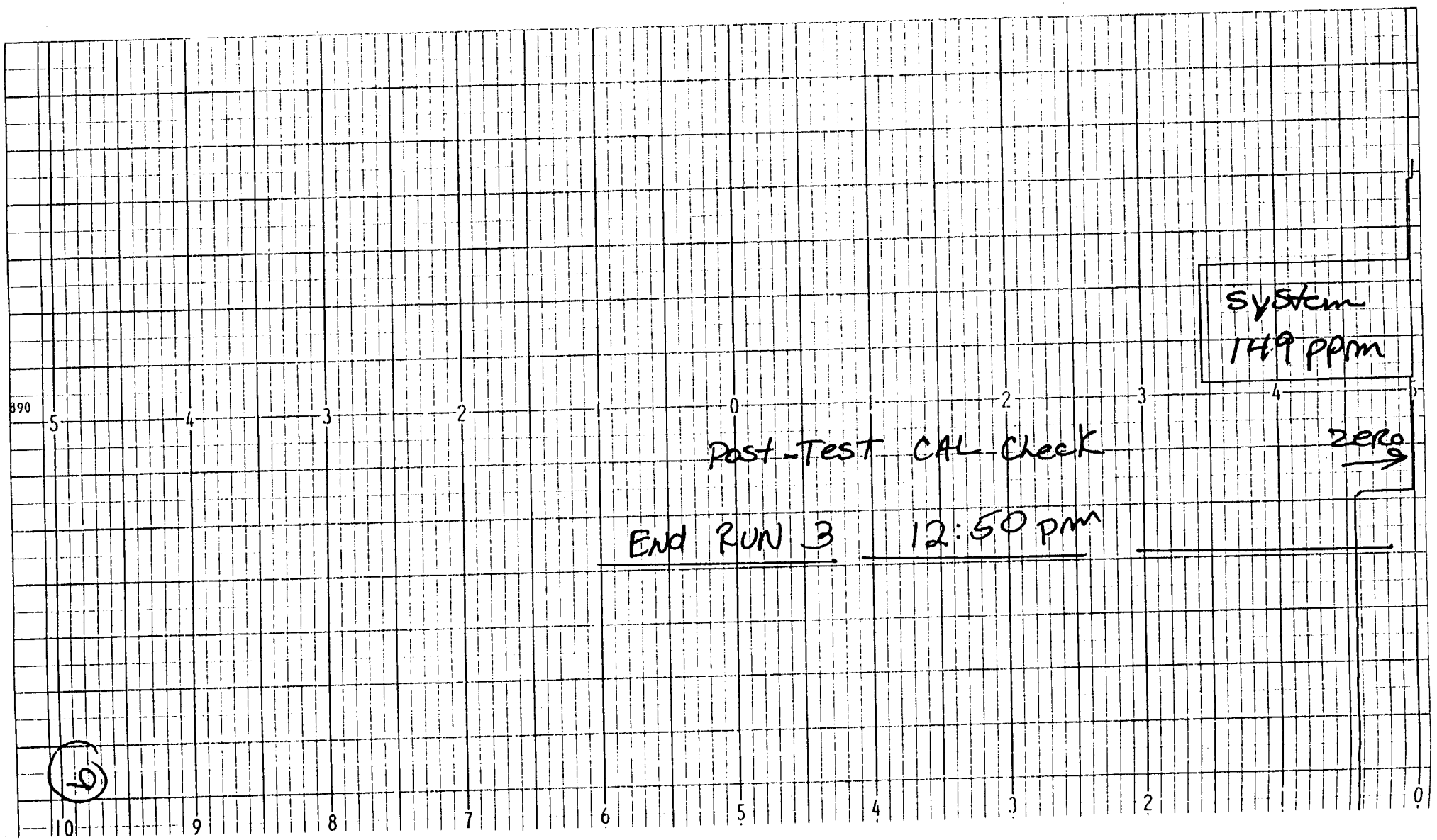


Chart Paper Jammed 11:09
950cm
NOx
5
4
3
2
0
2
3
4
5
10
9
8
7
6
5
4
3
2
0


RUN 3 Pre-Test CALIBration
930
KOKUSAI CHART
YOKOGAWA
system
149 PPm
0
2
3
4
5
6
7
8
9
10
ZERO
RUN 2 Post-Test CAL
END RUN 2 11:30 AM
940
6
10
9
8
7
6
5
4
3
2
0


920
system
149 ppm
149 ppm
413 ppm
zero
(2)


900cm
910
NOx
START RUN 3 11:50
KOKUSAI CHART
YOKOGAWA


System
149 ppm
Post-Test CAL Check
Zero
End Run 3 12:50 pm
6

Run 1 Boiler 2 NOx Log

Run 1 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	9:10:12	41	0	40
11-Aug-94	9:10:32	40	0	40
11-Aug-94	9:10:52	40	0	40
11-Aug-94	9:11:12	40	0	40
11-Aug-94	9:11:32	40	0	40
11-Aug-94	9:11:52	40	0	40
11-Aug-94	9:12:12	41	0	40
11-Aug-94	9:12:32	40	0	40
11-Aug-94	9:12:52	40	0	40
11-Aug-94	9:13:12	40	0	40
11-Aug-94	9:13:32	40	0	40
11-Aug-94	9:13:52	40	0	40
11-Aug-94	9:14:12	40	0	40
11-Aug-94	9:14:32	41	0	41
11-Aug-94	9:14:52	41	0	41
11-Aug-94	9:15:12	40	0	40
11-Aug-94	9:15:32	40	0	40
11-Aug-94	9:15:52	41	0	40
11-Aug-94	9:16:12	40	0	40
11-Aug-94	9:16:32	39	0	40
11-Aug-94	9:16:52	39	0	39
11-Aug-94	9:17:12	39	0	39
11-Aug-94	9:17:32	39	0	39
11-Aug-94	9:17:52	39	0	39
11-Aug-94	9:18:12	39	0	39
11-Aug-94	9:18:32	39	0	39
11-Aug-94	9:18:52	39	0	39
11-Aug-94	9:19:12	39	0	39
11-Aug-94	9:19:32	39	0	39
11-Aug-94	9:19:52	39	0	39
11-Aug-94	9:20:12	39	0	39
11-Aug-94	9:20:32	39	0	39
11-Aug-94	9:20:52	39	0	39
11-Aug-94	9:21:12	39	0	39
11-Aug-94	9:21:32	39	0	39
11-Aug-94	9:21:52	39	0	39
11-Aug-94	9:22:12	39	0	39
11-Aug-94	9:22:32	39	0	39
11-Aug-94	9:22:52	39	0	39
11-Aug-94	9:23:12	39	0	39
11-Aug-94	9:23:32	39	0	39
11-Aug-94	9:23:52	39	0	40
11-Aug-94	9:24:12	40	0	40
11-Aug-94	9:24:32			

Run 1 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	9:24:52	39	0	40
11-Aug-94	9:25:12	40	0	40
11-Aug-94	9:25:32	40	0	40
11-Aug-94	9:25:52	40	0	40
11-Aug-94	9:26:12	40	0	40
11-Aug-94	9:26:32	40	0	40
11-Aug-94	9:26:52	40	0	40
11-Aug-94	9:27:12	40	0	40
11-Aug-94	9:27:32	40	0	40
11-Aug-94	9:27:52	40	0	40
11-Aug-94	9:28:12	39	0	40
11-Aug-94	9:28:32	40	0	39
11-Aug-94	9:28:52	40	0	40
11-Aug-94	9:29:12	39	0	39
11-Aug-94	9:29:32	39	0	39
11-Aug-94	9:29:52	39	0	39
11-Aug-94	9:30:12	39	0	39
11-Aug-94	9:30:32	39	0	39
11-Aug-94	9:30:52	39	0	39
11-Aug-94	9:31:12	39	0	39
11-Aug-94	9:31:32	39	0	39
11-Aug-94	9:31:52	39	0	39
11-Aug-94	9:32:12	39	0	39
11-Aug-94	9:32:32	39	0	39
11-Aug-94	9:32:52	39	0	39
11-Aug-94	9:33:12	39	0	39
11-Aug-94	9:33:32	39	0	39
11-Aug-94	9:33:52	39	0	39
11-Aug-94	9:34:12	39	0	39
11-Aug-94	9:34:32	39	0	39
11-Aug-94	9:35:08	39	0	39
11-Aug-94	9:35:12	39	0	39
11-Aug-94	9:35:32	40	0	40
11-Aug-94	9:35:52	40	0	40
11-Aug-94	9:36:12	40	0	40
11-Aug-94	9:36:32	40	0	40
11-Aug-94	9:36:52	40	0	40
11-Aug-94	9:37:12	40	0	40
11-Aug-94	9:37:32	40	0	40
11-Aug-94	9:37:52	41	0	40
11-Aug-94	9:38:12	41	0	40
11-Aug-94	9:38:32	40	0	40
11-Aug-94	9:38:52	40	0	40
11-Aug-94	9:39:12	40	0	40

Run 1 Boiler 2 NOx Log

Run 1 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	9:39:32	40	0	40
11-Aug-94	9:39:52	40	0	40
11-Aug-94	9:40:12	40	0	40
11-Aug-94	9:40:32	40	0	40
11-Aug-94	9:40:52	40	0	40
11-Aug-94	9:41:12	40	0	40
11-Aug-94	9:41:32	40	0	40
11-Aug-94	9:41:52	40	0	40
11-Aug-94	9:42:12	41	0	41
11-Aug-94	9:42:32	41	0	41
11-Aug-94	9:42:52	41	0	41
11-Aug-94	9:43:12	41	0	41
11-Aug-94	9:43:32	41	0	40
11-Aug-94	9:43:52	40	0	40
11-Aug-94	9:44:12	40	0	40
11-Aug-94	9:44:32	40	0	40
11-Aug-94	9:44:52	40	0	40
11-Aug-94	9:45:12	40	0	40
11-Aug-94	9:45:32	40	0	40
11-Aug-94	9:45:52	40	0	40
11-Aug-94	9:46:12	40	0	40
11-Aug-94	9:46:32	40	0	39
11-Aug-94	9:46:52	39	0	40
11-Aug-94	9:47:12	40	0	40
11-Aug-94	9:47:32	40	0	40
11-Aug-94	9:47:52	40	0	40
11-Aug-94	9:48:12	40	0	40
11-Aug-94	9:48:32	40	0	40
11-Aug-94	9:48:52	40	0	40
11-Aug-94	9:49:12	40	0	40
11-Aug-94	9:49:32	40	0	40
11-Aug-94	9:49:52	41	0	41
11-Aug-94	9:50:12	41	0	41
11-Aug-94	9:50:32	40	0	40
11-Aug-94	9:50:52	40	0	40
11-Aug-94	9:51:12	39	0	39
11-Aug-94	9:51:32	39	0	39
11-Aug-94	9:51:52	39	0	40
11-Aug-94	9:52:12	40	0	40
11-Aug-94	9:52:32	40	0	40
11-Aug-94	9:52:52	40	0	40
11-Aug-94	9:53:12	40	0	40
11-Aug-94	9:53:32	40	0	40
11-Aug-94	9:53:52			

Run 1 Boiler 2 NOx Log

Run 1 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	9:54:12	40	0	40
11-Aug-94	9:54:32	40	0	40
11-Aug-94	9:54:52	40	0	40
11-Aug-94	9:55:12	40	0	40
11-Aug-94	9:55:32	40	0	40
11-Aug-94	9:55:52	40	0	40
11-Aug-94	9:56:12	40	0	40
11-Aug-94	9:56:32	41	0	41
11-Aug-94	9:56:52	41	0	41
11-Aug-94	9:57:12	41	0	41
11-Aug-94	9:57:32	41	0	41
11-Aug-94	9:57:52	41	0	41
11-Aug-94	9:58:12	40	0	40
11-Aug-94	9:58:32	40	0	40
11-Aug-94	9:58:52	40	0	40
11-Aug-94	9:59:12	40	0	40
11-Aug-94	9:59:32	40	0	40
11-Aug-94	9:59:52	40	0	40
11-Aug-94	10:00:12	40	0	40
11-Aug-94	10:00:32	40	0	40
11-Aug-94	10:00:52	40	0	40
11-Aug-94	10:01:12	40	0	40
11-Aug-94	10:01:32	40	0	40
11-Aug-94	10:01:52	40	0	40
11-Aug-94	10:02:12	40	0	40
11-Aug-94	10:02:32	40	0	40
11-Aug-94	10:02:52	40	0	40
11-Aug-94	10:03:12	40	0	40
11-Aug-94	10:03:32	41	0	41
11-Aug-94	10:03:52	41	0	41
11-Aug-94	10:04:12	41	0	41
11-Aug-94	10:04:32	41	0	41
11-Aug-94	10:04:52	41	0	41
11-Aug-94	10:05:12	41	0	41
11-Aug-94	10:05:32	41	0	41
11-Aug-94	10:05:52	41	0	41
11-Aug-94	10:06:12	41	0	41
11-Aug-94	10:06:32	41	0	41
11-Aug-94	10:06:52	41	0	41
11-Aug-94	10:07:12	41	0	40
11-Aug-94	10:07:32	40	0	40
11-Aug-94	10:07:52	40	0	40
11-Aug-94	10:08:12	40	0	40
11-Aug-94	10:08:32			

Run 1 Boiler 2 NOx Log

Run 1 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	10:08:52	40	0	40
11-Aug-94	10:09:12	40	0	40
11-Aug-94	10:09:32	40	0	40
11-Aug-94	10:09:52	40	0	40
11-Aug-94	10:10:12	40	0	40

Run 1	**Average**	**40**

Run 2 Boiler 2 NOx Log

Run 2 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	10:30:15	42	0	42
11-Aug-94	10:30:35	42	0	42
11-Aug-94	10:30:55	42	0	42
11-Aug-94	10:31:16	42	0	42
11-Aug-94	10:31:35	42	0	42
11-Aug-94	10:31:55	42	0	42
11-Aug-94	10:32:15	42	0	41
11-Aug-94	10:32:35	42	0	41
11-Aug-94	10:32:55	42	0	41
11-Aug-94	10:33:15	42	0	41
11-Aug-94	10:33:35	42	0	41
11-Aug-94	10:33:55	42	0	41
11-Aug-94	10:34:15	42	0	42
11-Aug-94	10:34:35	42	0	42
11-Aug-94	10:34:55	42	0	42
11-Aug-94	10:35:15	42	0	42
11-Aug-94	10:35:35	42	0	42
11-Aug-94	10:35:55	42	0	42
11-Aug-94	10:36:15	42	0	42
11-Aug-94	10:36:35	42	0	42
11-Aug-94	10:36:55	42	0	42
11-Aug-94	10:37:15	42	0	42
11-Aug-94	10:37:35	42	0	42
11-Aug-94	10:37:55	42	0	41
11-Aug-94	10:38:15	42	0	42
11-Aug-94	10:38:35	42	0	42
11-Aug-94	10:38:55	42	0	42
11-Aug-94	10:39:15	42	0	42
11-Aug-94	10:39:35	42	0	42
11-Aug-94	10:39:55	42	0	42
11-Aug-94	10:40:15	42	0	42
11-Aug-94	10:40:35	43	0	42
11-Aug-94	10:40:55	42	0	42
11-Aug-94	10:41:15	42	0	42
11-Aug-94	10:41:35	42	0	42
11-Aug-94	10:41:55	42	0	42
11-Aug-94	10:42:15	42	0	41
11-Aug-94	10:42:35	42	0	41
11-Aug-94	10:42:55	42	0	41
11-Aug-94	10:43:15	42	0	41
11-Aug-94	10:43:35	42	0	41
11-Aug-94	10:43:55	42	0	41
11-Aug-94	10:44:15	42	0	41
11-Aug-94	10:44:35	42	0	42

Run 2 Boiler 2 NOx Log

Run 2 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	10:44:55	42	0	42
11-Aug-94	10:45:15	42	0	42
11-Aug-94	10:45:35	42	0	42
11-Aug-94	10:45:55	42	0	42
11-Aug-94	10:46:15	42	0	42
11-Aug-94	10:46:35	42	0	42
11-Aug-94	10:46:55	42	0	42
11-Aug-94	10:47:15	42	0	42
11-Aug-94	10:47:35	42	0	42
11-Aug-94	10:47:55	42	0	42
11-Aug-94	10:48:15	42	0	42
11-Aug-94	10:48:35	42	0	42
11-Aug-94	10:48:55	42	0	42
11-Aug-94	10:49:15	42	0	42
11-Aug-94	10:49:35	42	0	42
11-Aug-94	10:49:55	42	0	42
11-Aug-94	10:50:15	42	0	41
11-Aug-94	10:50:35	42	0	41
11-Aug-94	10:50:55	42	0	41
11-Aug-94	10:51:15	42	0	41
11-Aug-94	10:51:35	42	0	41
11-Aug-94	10:51:55	41	0	41
11-Aug-94	10:52:15	41	0	41
11-Aug-94	10:52:35	41	0	41
11-Aug-94	10:52:55	41	0	41
11-Aug-94	10:53:15	41	0	41
11-Aug-94	10:53:35	41	0	41
11-Aug-94	10:53:55	41	0	41
11-Aug-94	10:54:15	41	0	41
11-Aug-94	10:54:35	42	0	41
11-Aug-94	10:54:55	42	0	41
11-Aug-94	10:55:15	42	0	41
11-Aug-94	10:55:35	42	0	41
11-Aug-94	10:55:55	42	0	41
11-Aug-94	10:56:15	42	0	41
11-Aug-94	10:56:35	42	0	41
11-Aug-94	10:56:55	42	0	41
11-Aug-94	10:57:15	42	0	41
11-Aug-94	10:57:35	42	0	41
11-Aug-94	10:57:55	42	0	41
11-Aug-94	10:58:15	42	0	41
11-Aug-94	10:58:35	42	0	41
11-Aug-94	10:58:55	42	0	41
11-Aug-94	10:59:15	42	0	41

Run 2 Boiler 2 NOx Log

Run 2 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	10:59:35	42	0	41
11-Aug-94	10:59:55	41	0	41
11-Aug-94	11:00:15	41	0	41
11-Aug-94	11:00:35	41	0	41
11-Aug-94	11:00:55	41	1	40
11-Aug-94	11:01:15	41	0	40
11-Aug-94	11:01:35	41	1	40
11-Aug-94	11:01:55	41	1	40
11-Aug-94	11:02:15	41	0	41
11-Aug-94	11:02:35	41	0	41
11-Aug-94	11:02:55	41	0	41
11-Aug-94	11:03:15	41	0	41
11-Aug-94	11:03:35	41	0	40
11-Aug-94	11:03:55	41	0	40
11-Aug-94	11:04:15	41	0	40
11-Aug-94	11:04:35	41	0	40
11-Aug-94	11:04:55	41	0	40
11-Aug-94	11:05:15	41	0	40
11-Aug-94	11:05:35	41	1	40
11-Aug-94	11:05:55	41	1	40
11-Aug-94	11:06:15	41	0	40
11-Aug-94	11:06:35	41	0	40
11-Aug-94	11:06:55	41	0	40
11-Aug-94	11:07:15	41	1	41
11-Aug-94	11:07:35	41	0	40
11-Aug-94	11:07:55	41	0	40
11-Aug-94	11:08:15	41	1	40
11-Aug-94	11:08:35	41	1	40
11-Aug-94	11:08:55	41	1	40
11-Aug-94	11:09:15	41	0	40
11-Aug-94	11:09:35	41	0	40
11-Aug-94	11:09:55	41	1	40
11-Aug-94	11:10:15	41	1	40
11-Aug-94	11:10:35	41	0	41
11-Aug-94	11:10:55	41	0	41
11-Aug-94	11:11:15	41	0	41
11-Aug-94	11:11:35	41	0	41
11-Aug-94	11:11:55	41	0	40
11-Aug-94	11:12:15	41	0	40
11-Aug-94	11:12:35	41	0	40
11-Aug-94	11:12:55	41	0	40
11-Aug-94	11:13:15	41	0	40
11-Aug-94	11:13:35	41	0	40
11-Aug-94	11:13:55	41	0	40

Run 2 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	11:14:15	41	0	40
11-Aug-94	11:14:35	41	0	40
11-Aug-94	11:14:55	41	0	40
11-Aug-94	11:15:15	41	1	40
11-Aug-94	11:15:35	41	0	40
11-Aug-94	11:15:55	41	0	41
11-Aug-94	11:16:15	41	0	41
11-Aug-94	11:16:35	42	1	41
11-Aug-94	11:16:55	42	1	41
11-Aug-94	11:17:15	42	0	41
11-Aug-94	11:17:35	42	1	41
11-Aug-94	11:17:55	42	1	41
11-Aug-94	11:18:15	42	0	41
11-Aug-94	11:18:35	42	1	41
11-Aug-94	11:18:55	42	1	41
11-Aug-94	11:19:15	42	1	41
11-Aug-94	11:19:35	41	1	40
11-Aug-94	11:19:55	41	1	40
11-Aug-94	11:20:15	41	1	41
11-Aug-94	11:20:35	41	1	40
11-Aug-94	11:20:55	41	1	40
11-Aug-94	11:21:15	41	1	40
11-Aug-94	11:21:35	41	1	40
11-Aug-94	11:21:55	41	0	40
11-Aug-94	11:22:15	41	1	40
11-Aug-94	11:22:35	41	1	40
11-Aug-94	11:22:55	42	1	41
11-Aug-94	11:23:15	42	1	41
11-Aug-94	11:23:35	41	1	40
11-Aug-94	11:23:55	42	2	40
11-Aug-94	11:24:15	41	0	40
11-Aug-94	11:24:35	41	1	40
11-Aug-94	11:24:55	41	1	40
11-Aug-94	11:25:15	41	1	40
11-Aug-94	11:25:35	41	1	40
11-Aug-94	11:25:55	41	1	40
11-Aug-94	11:26:15	41	1	40
11-Aug-94	11:26:35	41	1	40
11-Aug-94	11:26:55	41	1	40
11-Aug-94	11:27:15	41	2	39
11-Aug-94	11:27:35	40	1	39
11-Aug-94	11:27:55	40	1	39
11-Aug-94	11:28:15	40	1	39
11-Aug-94	11:28:35	40	1	39

Run 2 Boiler 2 NOx Log

Run 2 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	11:28:55	40	1	39
11-Aug-94	11:29:15	40	0	39
11-Aug-94	11:29:35	40	1	39
11-Aug-94	11:29:55	40	1	39
11-Aug-94	11:30:15	40	1	39
Run 2	Average	41		

Run 3 Boiler 2 NOx Log

Run 3 Date	Time	NOx ppm	NO2 ppm	NO ppm
1-Aug-94	11:50:12	42	0	41
11-Aug-94	11:50:32	42	0	41
11-Aug-94	11:50:54	41	0	41
11-Aug-94	11:51:12	41	0	41
11-Aug-94	11:51:32	41	0	41
11-Aug-94	11:51:52	41	0	41
11-Aug-94	11:52:12	41	0	41
11-Aug-94	11:52:32	41	0	41
11-Aug-94	11:52:52	41	0	40
11-Aug-94	11:53:12	41	0	40
11-Aug-94	11:53:32	41	0	40
11-Aug-94	11:53:52	41	0	41
11-Aug-94	11:54:12	41	0	41
11-Aug-94	11:54:32	42	0	41
11-Aug-94	11:54:52	42	0	42
11-Aug-94	11:55:12	42	0	41
11-Aug-94	11:55:32	42	0	41
11-Aug-94	11:55:52	42	0	41
11-Aug-94	11:56:12	42	0	41
11-Aug-94	11:56:32	42	0	41
11-Aug-94	11:56:52	42	0	41
11-Aug-94	11:57:12	42	0	41
11-Aug-94	11:57:32	41	0	41
11-Aug-94	11:57:52	41	0	41
11-Aug-94	11:58:12	41	0	41
11-Aug-94	11:58:32	41	0	40
11-Aug-94	11:58:52	41	0	41
11-Aug-94	11:59:12	41	0	41
11-Aug-94	11:59:32	41	0	41
11-Aug-94	11:59:52	41	0	41
11-Aug-94	12:00:12	41	0	41
11-Aug-94	12:00:32	41	0	41
11-Aug-94	12:00:52	41	0	41
11-Aug-94	12:01:12	41	0	41
11-Aug-94	12:01:32	41	0	41
11-Aug-94	12:01:52	41	0	41
11-Aug-94	12:02:12	41	0	41
11-Aug-94	12:02:32	41	0	41
11-Aug-94	12:02:52	41	0	41
11-Aug-94	12:03:12	41	0	40
11-Aug-94	12:03:32	41	0	40
11-Aug-94	12:03:52	40	0	40
11-Aug-94	12:04:12	40	0	40
11-Aug-94	12:04:32	41	1	40

Run 3 Boiler 2 NOx Log

Run 3 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	12:04:52	41	0	40
11-Aug-94	12:05:12	41	0	41
11-Aug-94	12:05:32	42	0	41
11-Aug-94	12:05:52	42	0	41
11-Aug-94	12:06:12	42	1	41
11-Aug-94	12:06:32	41	0	41
11-Aug-94	12:06:52	41	0	41
11-Aug-94	12:07:12	41	0	41
11-Aug-94	12:07:32	41	0	41
11-Aug-94	12:07:52	41	1	40
11-Aug-94	12:08:12	41	0	41
11-Aug-94	12:08:32	41	0	41
11-Aug-94	12:08:52	42	1	41
11-Aug-94	12:09:12	42	0	41
11-Aug-94	12:09:32	42	1	41
11-Aug-94	12:09:52	42	1	41
11-Aug-94	12:10:12	41	0	41
11-Aug-94	12:10:32	41	1	40
11-Aug-94	12:10:52	41	0	41
11-Aug-94	12:11:12	41	0	41
11-Aug-94	12:11:32	41	0	41
11-Aug-94	12:11:52	41	0	41
11-Aug-94	12:12:12	41	0	41
11-Aug-94	12:12:32	41	0	41
11-Aug-94	12:12:52	41	0	41
11-Aug-94	12:13:12	41	0	41
11-Aug-94	12:13:32	41	0	41
11-Aug-94	12:13:52	41	1	40
11-Aug-94	12:14:12	41	1	40
11-Aug-94	12:14:32	41	0	40
11-Aug-94	12:14:52	41	1	40
11-Aug-94	12:15:12	41	0	40
11-Aug-94	12:15:32	41	0	40
11-Aug-94	12:15:52	41	0	40
11-Aug-94	12:16:12	41	0	40
11-Aug-94	12:16:32	41	0	40
11-Aug-94	12:16:52	41	0	40
11-Aug-94	12:17:12	41	1	40
11-Aug-94	12:17:32	41	1	40
11-Aug-94	12:17:52	41	1	40
11-Aug-94	12:18:12	41	0	40
11-Aug-94	12:18:32	41	1	40
11-Aug-94	12:18:52	41	1	40
11-Aug-94	12:19:12	41	0	40

Run 3 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	12:19:32	41	1	40
11-Aug-94	12:19:52	41	1	40
11-Aug-94	12:20:12	41	1	40
11-Aug-94	12:20:32	41	1	40
11-Aug-94	12:20:52	41	0	40
11-Aug-94	12:21:12	41	1	40
11-Aug-94	12:21:32	41	0	41
11-Aug-94	12:21:52	41	1	40
11-Aug-94	12:22:12	41	1	40
11-Aug-94	12:22:32	41	0	40
11-Aug-94	12:22:52	41	1	40
11-Aug-94	12:23:12	41	0	40
11-Aug-94	12:23:32	41	1	40
11-Aug-94	12:23:52	41	1	40
11-Aug-94	12:24:12	41	0	40
11-Aug-94	12:24:32	41	1	40
11-Aug-94	12:24:52	41	1	40
11-Aug-94	12:25:12	41	1	40
11-Aug-94	12:25:32	41	1	40
11-Aug-94	12:25:52	41	1	40
11-Aug-94	12:26:12	41	1	40
11-Aug-94	12:26:32	41	0	40
11-Aug-94	12:26:52	41	1	40
11-Aug-94	12:27:12	41	0	40
11-Aug-94	12:27:32	41	1	40
11-Aug-94	12:27:52	41	0	40
11-Aug-94	12:28:12	41	1	40
11-Aug-94	12:28:32	41	1	40
11-Aug-94	12:28:52	41	0	40
11-Aug-94	12:29:12	41	0	41
11-Aug-94	12:29:32	42	1	41
11-Aug-94	12:29:52	41	0	40
11-Aug-94	12:30:12	41	1	40
11-Aug-94	12:30:32	41	1	40
11-Aug-94	12:30:52	41	1	40
11-Aug-94	12:31:12	41	1	40
11-Aug-94	12:31:32	42	2	40
11-Aug-94	12:31:52	41	1	40
11-Aug-94	12:32:12	41	0	40
11-Aug-94	12:32:32	41	1	40
11-Aug-94	12:32:52	41	1	40
11-Aug-94	12:33:12	41	1	40
11-Aug-94	12:33:32	41	1	40
11-Aug-94	12:33:52	41	1	40

Run 3 Boiler 2 NOx Log

Run 3 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	12:34:12	41	1	40
11-Aug-94	12:34:32	41	1	40
11-Aug-94	12:34:52	41	1	40
11-Aug-94	12:35:12	41	1	40
11-Aug-94	12:35:32	41	1	40
11-Aug-94	12:35:52	41	1	40
11-Aug-94	12:36:12	41	0	40
11-Aug-94	12:36:32	41	1	40
11-Aug-94	12:36:52	42	1	40
11-Aug-94	12:37:12	42	1	40
11-Aug-94	12:37:32	42	2	40
11-Aug-94	12:37:52	41	1	40
11-Aug-94	12:38:12	41	1	40
11-Aug-94	12:38:32	41	1	40
11-Aug-94	12:38:52	41	1	40
11-Aug-94	12:39:12	41	1	40
11-Aug-94	12:39:32	41	0	40
11-Aug-94	12:39:52	42	1	41
11-Aug-94	12:40:12	42	0	41
11-Aug-94	12:40:32	42	1	41
11-Aug-94	12:40:52	42	0	41
11-Aug-94	12:41:12	42	1	40
11-Aug-94	12:41:32	42	1	40
11-Aug-94	12:41:52	41	0	40
11-Aug-94	12:42:12	41	1	40
11-Aug-94	12:42:32	41	1	40
11-Aug-94	12:42:52	41	1	40
11-Aug-94	12:43:12	41	1	40
11-Aug-94	12:43:32	41	0	40
11-Aug-94	12:43:52	41	1	40
11-Aug-94	12:44:12	41	2	40
11-Aug-94	12:44:32	41	1	40
11-Aug-94	12:44:52	41	2	39
11-Aug-94	12:45:12	41	1	40
11-Aug-94	12:45:32	41	2	40
11-Aug-94	12:45:52	41	1	40
11-Aug-94	12:46:12	41	1	40
11-Aug-94	12:46:32	41	1	40
11-Aug-94	12:46:52	41	1	40
11-Aug-94	12:47:12	41	2	40
11-Aug-94	12:47:32	41	1	40
11-Aug-94	12:47:52	41	2	40
11-Aug-94	12:48:12	41	0	40
11-Aug-94	12:48:32			

Run 3 Boiler 2 NOx Log

Run 3 Date	Time	NOx ppm	NO2 ppm	NO ppm
11-Aug-94	12:48:52	41	1	40
11-Aug-94	12:49:12	41	1	40
11-Aug-94	12:49:32	41	2	40
11-Aug-94	12:49:52	41	1	40
11-Aug-94	12:50:12	42	1	40
Run 3	**Average**	**41**		

APPENDIX E

Emission Rate Calculations

NOMENCLATURE

A_n = area of sampling nozzle, ft^2

B_{ws} = proportion by volume of water vapor in gas stream, dimensionless

C = average analyzer concentration, ppm

C_{ER1} = condensible particulate emission rate, lb/hr

C_{ER2} = condensible particulate emission rate, lb/MMBtu

C_{gas} = effluent gas concentration, ppm

C_m = average of initial and final system bias responses for upscale calibration gas, ppm

C_{ma} = actual concentration of the upscale calibration gas, ppm

C_{NOx} = gas concentration, lb/dscf

C_o = average of initial and final system bias responses for zero calibration gas, ppm

CC_s1 = concentration of condensible particulate in stack gas, grains/dscf

CC_s2 = concentration of condensible particulate in stack gas, lb/dscf

CO = percent carbon monoxide in stack gas by volume, dry basis, %

CO_2 = percent carbon dioxide in stack gas by volume, dry basis, %

$COER_1$ = CO emission rate, lb/hr

$COER_2$ = CO emission rate, lb/MMBtu

C_p = pitot tube coefficient, dimensionless

Cs_1 = concentration of filterable particulate in stack gas, grains/dscf

Cs_2 = concentration of filterable particulate in stack gas, lb/dscf

dia = diameter of stack at measurement site, inches

D = Density of fuel oil, lb/gal

ER_1 = filterable particulate emission rate, lb/hr

ER_2 = filterable particulate emission rate, lb/MMBtu

GCV = Gross calorific value of fuel, Btu/lb for coal and oil or Btu/scf for natural gas

ΔH = average pressure drop across orifice, inches H_2O

%I = percent isokinetic

NOMENCLATURE

L= length of duct at sampling site cross section, in.

L_p= post test leak rate, ft^3

M_d= molecular weight of stack gas, dry basis, lb/lb-mole

M_{nc}= weight of condensible particulate, mg

M_{nf}= weight of filterable particulate, mg

Ms= molecular weight of stack gas, wet basis, lb/lb-mole

N_2= percent nitrogen in stack gas by volume, dry basis, %

$NGfr$= Natural gas flow rate, scf/hr

$NOxER_1$= NOx emission rate, lb/hr

$NOxER_2$= NOx emission rate, lb/MMBtu

O_2= percent oxygen in stack gas by volume, dry basis, %

Ofr= Fuel oil flow rate, gal/hr

Δp= average velocity head of stack gas, inches H_2O

$\sqrt{\Delta p}$= average square root of Δp

P_b= barometric pressure, inches Hg

P_g= static pressure of stack, inches H_2O

P_s= absolute stack gas pressure, inches Hg

Q_a= volumetric flow rate @ stack conditions, acfm

Q_{hf}= heat input rate by f-factor, MM Btu/hr

Qh_{cs}= heat input rate by coal scales, MM Btu/hr

Qh_{fm}= heat input rate by fuel meter, MM Btu/hr

Q_{sd}= volumetric flow rate of stack gas, dry standard conditions, dscfm

Q_s= volumetric flow rate of stack gas, standard conditions, scfm

ϕ= elapsed time of test, minutes

T_m= average temperature of dry gas meter, °F

NOMENCLATURE

T_s= average stack temperature, °F

V_{lc}= weight of water collected in impingers, g

V_m = volume of gas sampled measured by dry gas meter, ft3

V_{mc}= volume of gas sampled corrected for leak rate, ft3

V_{mstd}= metered volume corrected to dry standard conditions, ft3

V_s= stack gas velocity, fps

V_{soln}= volume of liquid in impingers, ml

w= width of duct at sampling site cross section, in.

Y= dry gas meter calibration factor, dimensionless

0.84= S type pitot tube coefficient

85.49= pitot tube constant

18.0= molecular wt. water, lb/lb-mole

44.0= molecular wt. of CO_2

28.0= molecular wt. of N_2 and CO

32.0= molecular wt. of O_2

46.005= molecular wt. of NO_2

0.264= ratio of O_2 to N_2 in air, v/v

17.64= conversion factor, °R/in. Hg

460= conversion factor, °F to °R

24.04= gas constant

6.24E-08= conversion factor, mg/m^3 to lb/scf

60= conversion factor, minutes to hours

EXAMPLE EMISSION CALCULATIONS

Facility:
Source/Site:
Test Date:
Run #:EXAMPLE

---

1. Volume metered, corrected for leakage, dcf

$$V_{mc} = V_m - (L_p - 0.02)\ (\text{ø})$$

V_{mc} = **dcf**

2. Volume metered, standard conditions, dscf

$$V_{m(std)} = (17.64)\ (V_{mc})\ (Y)\ \frac{(P_b) + (\Delta H \div 13.6)}{(T_m + 460)}$$

$V_{m(std)}$ = **dscf**

3. Volume of water vapor collected, scf

$$V_{w(std)} = 0.04707 \times V_{lc}$$

$V_{w(std)}$ = **scf**

4. Moisture content, proportion by volume

$$B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

B_{ws} =

5. Molecular weight of stack gas, dry basis, lb/lb-mole

$$M_d = 0.440\ (CO_2) + 0.320\ (O_2) + 0.280\ (N_2 + CO)$$

M_d = **lb/lb-mole**

6. Molecular weight of stack gas, wet basis, lb/lb-mole

$$M_s = M_d\ (1 - B_{ws}) + 18.0\ (B_{ws})$$

M_s = **lb/lb-mole**

EXAMPLE EMISSION CALCULATIONS

Facility:
Source/Site:
Test Date:
Run #:EXAMPLE

---

7. Excess air, %

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

$\%EA =$ **%**

8. Average stack gas velocity, fps

$$v_s = 85.49 \ (C_p) \ (\sqrt{\Delta p}) \sqrt{\frac{(T_s + 460)}{(P_s) \ (M_s)}}$$

$v_s =$ **fps**

9. Volumetric flow rate @ stack conditions, acfm

$$Q_a = 60 \ (v_s) \ (dia)^2 \ (5.454E\text{-}03) \quad \text{ROUND} \qquad \text{or} \qquad 60 \ (v_s) \ (L) \ (W) \ (6.944E\text{-}03) \quad \text{SQUARE}$$

$Q_a =$ **acfm**

10. Volumetric flow rate @ dry standard conditions, dscfm

$$Q_{sd} = 17.64 \ (Q_a) \ (1 - B_{ws}) \ \frac{(P_s)}{(T_s + 460)}$$

$Q_{sd} =$ **dscfm**

11. F-factor, dscf/MMbtu

$$F_d = 106 \left(\frac{(3.64 \times \%H)+(1.53 \times \%C)+(0.57 \times \%S)+(0.14 \times \%N_2)-(0.46 \times \%O_2)}{GCV_{db}} \right)$$

$F_d =$ **dscf/MMbtu**

EXAMPLE EMISSION CALCULATIONS

Facility:
Source/Site:
Test Date:
Run #:EXAMPLE

12. Heat input rate (f-factor), MMBtu/hr

$$Q_{hf} = \left(\frac{Q_{std}}{\text{F-factor}}\right) \times \left(\frac{20.9 - O_2}{20.9}\right) \times 60$$

Q_{hf} = **MMBtu/hr**

13. Heat input rate, Fuel meter, gas, MMBtu/hr

$$Q_{hfm} = \left(\frac{NG_{fr} \times GCV}{1.0\ E06}\right)$$

Q_{hfm} = **MMBtu/hr**

14. NOx concentration, ppm

$$C_{gas} = (C - C_o) \times \frac{C_{ma}}{C_m - C_o}$$

C_{gas} = **ppm**

15. NOx concentration, lb/dscf

$$C_{NOx} = C_{gas} \times \left(\frac{46.005}{24.04}\right) \times 6.24E\text{-}08$$

C_{NOx} = **lb/dscf**

16. NOx emission rate, lb/hr

$$NOxER_1 = C_{NOx} \times 60 \times Q_{sd}$$

$NOxER_1$ = **lb/hr**

EXAMPLE EMISSION CALCULATIONS

Facility:
Source/Site:
Test Date:
Run #:EXAMPLE

17. NOx emission rate (by Fuel meter), lb/MMBtu

$$NOxER_2 = \frac{NOxER_1}{Q_{hfm}}$$

$NOxER_2$ = **lb/MMBtu**

18. NOx emission rate (by f-factor), lb/MMBtu

$$NOxER_2 = (\ \mathbf{C_{NOx}}\ )\ \ \mathbf{(F\text{-}Factor)}\ \ \frac{(20.9)}{(20.9 - \mathbf{O_2})}$$

$NOxER_2$ = **lb/MMBtu**

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 1

1. Volume metered, corrected for leakage, dcf

$$V_{mc} = \mathbf{46.848} - (\mathbf{0.02} - 0.02)\ (\mathbf{60.0})$$

$$V_{mc} = \mathbf{46.848\ dcf}$$

2. Volume metered, standard conditions, dscf

$$V_{m(std)} = 17.64\ (\mathbf{46.848})\ (\mathbf{0.992})\ \frac{(\mathbf{29.50}) + (\mathbf{2.00} \div 13.6)}{(\mathbf{86} + 460)}$$

$$V_{m(std)} = \mathbf{44.513\ dscf}$$

3. Volume of water vapor collected, scf

$$V_{w(std)} = 0.04707 \times \mathbf{112.1}$$

$$V_{w(std)} = \mathbf{5.276\ scf}$$

4. Moisture content, proportion by volume

$$B_{ws} = \frac{5.276}{5.276 + \mathbf{44.513}}$$

$$B_{ws} = \mathbf{0.106}$$

5. Molecular weight of stack gas, dry basis, lb/lb-mole

$$M_d = 0.440\ (\mathbf{4.2}) + 0.320\ (\mathbf{12.0}) + 0.280\ (\mathbf{83.8})$$

$$M_d = \mathbf{29.15\ lb/lb\text{-}mole}$$

6. Molecular weight of stack gas, wet basis, lb/lb-mole

$$M_s = 29.15\ (1\text{-}\mathbf{0.106}) + 18.0\ (\mathbf{0.106})$$

$$M_s = \mathbf{27.97\ lb/lb\text{-}mole}$$

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 1

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7. Excess air, %

$$\%EA = \left(\frac{\mathbf{12.0} - (0.5 \times \mathbf{0.0})}{(0.264 \times \mathbf{83.8}) - (\mathbf{12.0} - (0.5 \times \mathbf{0.0}))} \right) \times 100$$

$\%EA = \mathbf{118.5\ \%}$

8. Average stack gas velocity, fps

$$v_s = 85.49\ (\mathbf{0.84})\ (\mathbf{0.202}) \sqrt{\frac{(\mathbf{230} + 460)}{(\ \mathbf{27.97})\ (\mathbf{29.49})}}$$

$v_s = \mathbf{13.3\ fps}$

9. Volumetric flow rate @ stack conditions, acfm

$Q_a = 60\ (\mathbf{13.3})\ (\ 48.000^2\ )\ (5.454E\text{-}03)$

$Q_a = \mathbf{10{,}005\ acfm}$

10. Volumetric flow rate @ dry standard conditions, dscfm

$$Q_{sd} = 17.64\ \ (\mathbf{10{,}005})\ \ (1 - \mathbf{0.106})\ \ \frac{(\mathbf{29.49})}{(\mathbf{230} + 460)}$$

$Q_{sd} = \mathbf{6{,}744\ dscfm}$

11. F-factor, dscf/MMbtu (published)

$F_d = \mathbf{8{,}710\ dscf/MMbtu}$

12. Heat input rate, MMBtu/hr (F-factor)

$$Q_{hf} = \left(\frac{\mathbf{6{,}744}}{\mathbf{8{,}710}} \right) \times \left(\frac{20.9 - \mathbf{12.0}}{20.9} \right) \times 60$$

$Q_{hf} = \mathbf{19.78\ MMBtu/hr}$

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 1

13. Heat input rate, MMBtu/hr (Fuel Meter)

$$Q_{hfm} = \left(\frac{1{,}025 \times 16{,}800}{1.0\ E6} \right)$$

$$Q_{hfm} = \mathbf{17.22\ MMBtu/hr}$$

14. NOx concentration, ppm

$$C_{gas} = (\mathbf{40.0 - 0.0}) \times \frac{\mathbf{149.0}}{\mathbf{151.0 - 0.0}}$$

$$C_{gas} = \mathbf{39.5\ ppm}$$

15. NOx concentration, lb/dscf

$$C_{NOx} = \mathbf{39.5} \times \left(\frac{46.005}{24.04} \right) \times 6.24E\text{-}08$$

$$C_{NOx} = \mathbf{4.72E\text{-}6\ lb/dscf}$$

16. NOx emission rate, lb/hr

$$NOxER_1 = \mathbf{4.72E\text{-}6} \times 60 \times \mathbf{6{,}744}$$

$$NOxER_1 = \mathbf{1.9\ lb/hr}$$

17. NOx emission rate, lb/MMBtu, (Fuel meter)

$$NOxER_2 = \frac{(\mathbf{1.9})}{(\mathbf{17.22})}$$

$$NOxER_2 = \mathbf{0.11\ lb/MMBtu}$$

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 1

18. NOx emission rate, lb/MMBtu, (F-factor)

$$NOxER_2 = (\mathbf{4.72E\text{-}6}) (\mathbf{8{,}710}) \frac{(20.9)}{(20.9 - \mathbf{12.0})}$$

$NOxER_2 = \mathbf{0.10\ lb/MMBtu}$

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 2

1. Volume metered, corrected for leakage, dcf

V_{mc} = **47.361** - (**0.02** -0.02) (**60.0**)

V_{mc} = **47.361 dcf**

2. Volume metered, standard conditions, dscf

$$V_{m(std)} = 17.64\ (\mathbf{47.361})\ (\mathbf{0.992})\ \frac{(\mathbf{29.50}) + (\mathbf{2.00} + 13.6)}{(\mathbf{93} + 460)}$$

$V_{m(std)}$ = **44.431 dscf**

3. Volume of water vapor collected, scf

$V_{w(std)}$ = 0.04707 x **119.6**

$V_{w(std)}$ = **5.630 scf**

4. Moisture content, proportion by volume

$$B_{ws} = \frac{5.630}{5.630 + \mathbf{44.431}}$$

B_{ws} = **0.113**

5. Molecular weight of stack gas, dry basis, lb/lb-mole

M_d = 0.440 (**4.3**) + 0.320 (**11.8**) + 0.280 (**83.9**)

M_d = **29.16 lb/lb-mole**

6. Molecular weight of stack gas, wet basis, lb/lb-mole

M_s = 29.16 (1-**0.113**) + 18.0 (**0.113**)

M_s = **27.91 lb/lb-mole**

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 2

7. Excess air, %

$$\%EA = \left(\frac{11.8 - (0.5 \times 0.0)}{(0.264 \times 83.9) - (11.8 - (0.5 \times 0.0))} \right) \times 100$$

$\%EA =$ **114.0 %**

8. Average stack gas velocity, fps

$$v_s = 85.49\ (0.84)\ (0.211) \sqrt{\frac{(231 + 460)}{(27.91)\ (29.49)}}$$

$v_s =$ **13.9 fps**

9. Volumetric flow rate @ stack conditions, acfm

$$Q_a = 60\ (13.9)\ (48.000^2)\ (5.454E\text{-}03)$$

$Q_a =$ **10,465 acfm**

10. Volumetric flow rate @ dry standard conditions, dscfm

$$Q_{sd} = 17.64\ (10{,}465)\ (1 - 0.113)\ (231 + 460)^{\frac{(29.49)}{}}$$

$Q_{sd} =$ **6,992 dscfm**

11. F-factor, dscf/MMbtu (published)

$F_d =$ **8,710 dscf/MMbtu**

12. Heat input rate, MMBtu/hr (F-factor)

$$Q_{hf} = \left(\frac{6{,}992}{8{,}710} \right) \times \left(\frac{20.9 - 11.8}{20.9} \right) \times 60$$

$Q_{hf} =$ **20.97 MMBtu/hr**

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 2

13. Heat input rate, MMBtu/hr (Fuel Meter)

$$Q_{hfm} = \left(\frac{1{,}025 \times 17{,}400}{1.0\ E6} \right)$$

Q_{hfm} = **17.83 MMBtu/hr**

14. NOx concentration, ppm

$$C_{gas} = (\mathbf{41.0 - 1.0}) \times \frac{\mathbf{149.0}}{\mathbf{151.0 - 1.0}}$$

C_{gas} = **39.7 ppm**

15. NOx concentration, lb/dscf

$$C_{NOx} = \mathbf{39.7} \times \left(\frac{46.005}{24.04} \right) \times 6.24E\text{-}08$$

C_{NOx} = **4.75E-6 lb/dscf**

16. NOx emission rate, lb/hr

$NOxER_1$ = **4.75E-6** x 60 x **6,992**

$NOxER_1$ = **2.0 lb/hr**

17. NOx emission rate, lb/MMBtu, (Fuel meter)

$$NOxER_2 = \frac{(\mathbf{2.0})}{(\mathbf{17.83})}$$

$NOxER_2$ = **0.11 lb/MMBtu**

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 2

18. NOx emission rate, lb/MMBtu, (F-factor)

$$NOxER_2 = (\mathbf{4.75E\text{-}6}) (\mathbf{8{,}710}) \frac{(20.9)}{(20.9 - \mathbf{11.8})}$$

$NOxER_2 = \mathbf{0.10\ lb/MMBtu}$

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 3

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1. Volume metered, corrected for leakage, dcf

V_{mc} = **46.995** - (**0.02** -0.02) (**60.0**)

V_{mc} = **46.995 dcf**

2. Volume metered, standard conditions, dscf

$$V_{m(std)} = 17.64\ (\mathbf{46.995})\ (\mathbf{0.992})\ \frac{(\mathbf{29.50}) + (\mathbf{2.00} \div 13.6)}{(\mathbf{96} + 460)}$$

$V_{m(std)}$ = **43.850 dscf**

3. Volume of water vapor collected, scf

$V_{w(std)}$ = 0.04707 x **114.0**

$V_{w(std)}$ = **5.366 scf**

4. Moisture content, proportion by volume

$$B_{ws} = \frac{5.366}{5.366 + \mathbf{43.850}}$$

B_{ws} = **0.109**

5. Molecular weight of stack gas, dry basis, lb/lb-mole

M_d = 0.440 (**4.3**) + 0.320 (**11.9**) + 0.280 (**83.8**)

M_d = **29.16 lb/lb-mole**

6. Molecular weight of stack gas, wet basis, lb/lb-mole

M_s = 29.16 (1-**0.109**) + 18.0 (**0.109**)

M_s = **27.95 lb/lb-mole**

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 3

7. Excess air, %

$$\%EA = \left(\frac{11.9 - (0.5 \times 0.0)}{(0.264 \times 83.8) - (11.9 - (0.5 \times 0.0))} \right) \times 100$$

$\%EA =$ **116.4 %**

8. Average stack gas velocity, fps

$$v_s = 85.49\ (0.84)\ (0.211) \sqrt{\frac{(232 + 460)}{(27.95)\ (29.49)}}$$

$v_s =$ **13.9 fps**

9. Volumetric flow rate @ stack conditions, acfm

$$Q_a = 60\ (13.9)\ (48.000^2)\ (5.454E\text{-}03)$$

$Q_a =$ **10,465 acfm**

10. Volumetric flow rate @ dry standard conditions, dscfm

$$Q_{sd} = 17.64\ (10{,}465)\ (1 - 0.109)\ \frac{(29.49)}{(232 + 460)}$$

$Q_{sd} =$ **7,010 dscfm**

11. F-factor, dscf/MMbtu (published)

$F_d =$ **8,710 dscf/MMbtu**

12. Heat input rate, MMBtu/hr (F-factor)

$$Q_{hf} = \left(\frac{7{,}010}{8{,}710} \right) \times \left(\frac{20.9 - 11.9}{20.9} \right) \times 60$$

$Q_{hf} =$ **20.79 MMBtu/hr**

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 3

13. Heat input rate, MMBtu/hr (Fuel Meter)

$$Q_{hfm} = \left(\frac{1{,}025 \times 17{,}400}{1.0\ E6} \right)$$

$$Q_{hfm} = \mathbf{17.83\ MMBtu/hr}$$

14. NOx concentration, ppm

$$C_{gas} = (\ \mathbf{41.0} - \mathbf{0.0}\ ) \times \frac{\mathbf{149.0}}{\mathbf{152.0} - \mathbf{0.0}}$$

$$C_{gas} = \mathbf{40.2\ ppm}$$

15. NOx concentration, lb/dscf

$$C_{NOx} = \mathbf{40.2} \times \left(\frac{46.005}{24.04} \right) \times 6.24E\text{-}08$$

$$C_{NOx} = \mathbf{4.81E\text{-}6\ \ lb/dscf}$$

16. NOx emission rate, lb/hr

$$NOxER_1 = \mathbf{4.81E\text{-}6} \times 60 \times \mathbf{7{,}010}$$

$$NOxER_1 = \mathbf{2.0\ lb/hr}$$

17. NOx emission rate, lb/MMBtu, (Fuel meter)

$$NOxER_2 = \frac{(\ \mathbf{2.0}\ )}{(\mathbf{17.83}\ )}$$

$$NOxER_2 = \mathbf{0.11\ lb/MMBtu}$$

EMISSION CALCULATIONS

Facility:Siemens
Source/Site: Boiler 2-Outlet
Test Date: Thursday, August 11, 1994
Run #: 3

18. NOx emission rate, lb/MMBtu, (F-factor)

$$NOxER_2 = (\mathbf{4.81E\text{-}6}) (\mathbf{8{,}710}) \frac{(20.9)}{(20.9 - \mathbf{11.9})}$$

$NOxER_2 = \mathbf{0.10\ lb/MMBtu}$