EMISSIONS REPORT UNIVERSITY OF MONTANA WESTERN DILLON, MONTANA WOOD-FIRED CHIP-TEC BOILER

Test Dates:
Low-Fire: October 24, 2007
High-Fire: December 6, 2007

Prepared for:
Department of Natural Resources
Forestry Division
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Report Date:
February 22, 2008

EXECUTIVE SUMMARY

Bison Engineering, Inc. (Bison) was retained by the Department of Natural Resources (DNRC), Forestry Division to perform emissions testing for condensible particulate matter (CPM), particulate matter less than 2.5 microns ($PM_{2.5}$), nitrogen oxides (NOx) and carbon monoxide (CO) on the wood-fired Chip-Tec Boiler located at the University of Montana Western, Dillon, Montana. The following table presents the October 24, 2007, "low-fire" and December 6, 2007, "high-fire" emissions.

Table 1: Wood-Fired Chip-Tec Stack Emissions

University of Montana Western Wood-Fired Chip-Tec Boiler Stack Emissions			
Emissions		**Low-Fire** Oct. 24, 2007	**High-Fire** Dec. 6, 2007
$PM_{2.5}$ [1]	Concentration, gr/dscf	0.046	0.056
	Mass rates, lbs/hr	0.752	0.954
	Emission factor, lbs/MMBtu	0.204	0.172
NOx	Concentration, ppmdv	48.3	66.0
	Mass rates, lbs/hr	0.580	1.327
	Emission factor, lbs/MMBtu	0.208	0.170
CO	Concentration, ppmdv	32.3	173.9
	Mass rates, lbs/hr	0.230	2.040
	Emission factor, lbs/MMBtu	0.086	0.274
Heat input, MMBtu/hr		3.40	7.55
Percent of rated capacity		18%	40%

[1] $PM_{2.5}$ is the product of $PM_{2.5}$ filterable particulate matter and CPM.

Table Nomenclature

gr/dscf = grains per dry standard cubic feet @ 68°F, 1 atm.
lbs/hr = pounds per hour
lbs/MMBtu = pounds per million British Thermal Units
ppmdv = parts per million dry volume

CERTIFICATION OF REPORT INTEGRITY

Bison Engineering, Inc. (Bison) certifies that this report represents an accurate account of the air quality emissions testing performed at the University of Montana Western Steam Plant on October 24 and December 6, 2007.

Project Leader: Calvin W. Loomis, P.E.

Title: Project Engineer

Signature:

Date: Feb 21/08

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii

CERTIFICATION OF REPORT INTEGRITY iii

1.0 INTRODUCTION 1
- 1.1 Program Organization 1
- 1.2 Project Personnel 1
  - 1.2.1 Bison Engineering, Inc. 2
  - 1.2.2 Department of Natural Resources 2
  - 1.2.3 University of Montana Western 2

2.0 EMISSION SOURCE INFORMATION 3
- 2.1 Facility Description 3
- 2.2 Emission Source Description 3

3.0 TEST RESULTS SUMMARY 4
- 3.1 Summary of Emissions Testing 4
- 3.2 Production Data and Field Notes 5

4.0 TESTING PROCEDURES 6
- 4.1 Sampling Site Locations 6
- 4.2 Test Methods and Procedures 6
- 4.3 Analytical Methods 9

5.0 QUALITY ASSURANCE AND QUALITY CONTROL 11
- 5.1 Documentation and Tracking 11
- 5.2 Sampling Protocol 11
- 5.3 Quality Assurance 11
- 5.4 Volumetric Sampling Equipment Calibrations 12
- 5.5 Instrument Calibration, Maintenance and Standards 13
- 5.6 Data Acquisition, Reduction and Validation 13

LIST OF TABLES

Table 1. Wood-Fired Chip-Tec Stack Emissions ii
Table 2. Wood-Fired Chip-Tec Low-Fire Test Results 4
Table 3. Wood-Fired Chip-Tec High-Fire Test Results 5
Table 4. Equipment Calibration and Audit Procedures 12
Table 5. Meter Box Calibration Results 13

APPENDICES

APPENDIX A: LOW FIRE TEST DATA
APPENDIX B: HIGH FIRE TEST DATA
APPENDIX C: FUEL, FLY ASH, AND BOTTOM ASH SAMPLE ANALYSIS
APPENDIX D: NOMENCLATURE AND FORMULAE
APPENDIX E: CALIBRATIONS, AUDITS AND CERTIFICATIONS

1.0 INTRODUCTION

Bison Engineering, Inc. (Bison) was retained by the Department of Natural Resources (DNRC), Forestry Division to perform emissions testing for particulate matter less than 2.5 microns ($PM_{2.5}$), nitrogen oxides (NOx) and carbon monoxide (CO) on the wood-fired Chip-Tec Boiler at the University of Montana Western located in Dillon, Montana.

This report summarizes the results from the testing project and the operating conditions of the process during the testing. The appendices of this report contain the pretest protocol, spreadsheets, testing field data, production data, nomenclature and formulae, equipment/analyzer calibrations and audits, and Protocol 1 gas certifications.

1.1 Program Organization

Bison is a full service air quality consulting company that provides ambient air and meteorological monitoring, air quality permitting, air quality modeling, regulatory negotiations, process-to-emissions optimization and source testing services. Bison's ***Process and Emission Services*** team is led by Calvin Loomis, P.E., Project Engineer and Team Leader. Additional team members are Mike Chovanak, E.I.T., Project Engineer; Bill Shaw, P.E., Project Engineer; Dave Blankenship, Senior Environmental Technician; and Jim Wollenberg, Environmental Technician.

Contract Holder:	Department of Natural Resources (DNRC)	
	Address:	2705 Spurgin Road Missoula, Montana 59804
	Contact:	Angela Farr
	Phone:	406/542-4239
Facility Info:	University of Montana Western (WMC)	
	Address:	710 South Atlantic Dillon, Montana 59725
	Contact:	Lee Richardson
	Phone:	406/683-7037
Consultant:	Bison Engineering, Inc.	
	Address:	1400 11th Avenue Helena, MT 59601
	Contacts:	Cal Loomis, Project Engineer
	Phone:	(406) 442-5768 Fax: (406) 449-6653
	Email:	cwloomis@bison-eng.com

1.2 Project Personnel

The following personnel were on site during the emission test or were associated with the project.

1.2.1 Bison Engineering, Inc.

Cal Loomis, Project Engineer, and Jim Wollenberg, Environmental Technician, led the testing project.

1.2.2 Department of Natural Resources

Angela Farr is the primary contact for DNRC.

1.2.3 University of Montana Western (WMC)

Lee Richardson is the primary contact for WMC. Doug Chamberlain was the boiler operator during the emissions testing.

2.0 EMISSION SOURCE INFORMATION

2.1 Facility Description

WMC is a university campus located in Dillon, Montana.

2.2 Emission Source Description

The tested source is located on the campus in Dillon. The source is a 19 mmBTU wood-fired Chip-Tec boiler (close coupled gasified boiler) with a steam production capacity of 11,000 pounds of steam per hour. The pollution controls for the boiler are multicyclones.

3.0 TEST RESULTS SUMMARY

3.1 Summary of Emissions Testing

The following tables present the results from the October 24 and December 6, 2007, emissions test on the WMC wood-fired Chip-Tec boiler stack. Additional test data can be found in the appendix of this report.

Table 2: Wood-Fired Chip-Tec "Low-Fire" Test Results

University of Montana Western Wood-Fired Chip-Tec Boiler $PM_{2.5}$ NOx and CO "Low-Fire" Emissions October 24, 2007					
Parameter	**Units**	**Run 1** [1]	**Run 2**	**Run 3**	**Avg.**
Isokinetics, 100 ±20%		49	115	85	NA
D_{50} Cut rate, 10 ±1		10.2	10.2	10.2	NA
$PM_{2.5}$ [2]	gr/dscf	Voided due to plugged filter	0.0300	0.0304	0.0302
	lbs/hr		0.384	0.374	0.379
	lbs/MMBtu		0.179	0.182	0.181
NOx	ppmdv	41.8	40.2	62.9	48.3
	lbs/hr	0.66	0.43	0.65	0.58
	lbs/MMBtu	0.11	0.20	0.31	0.21
CO	ppmdv	23.9	26.8	46.4	32.3
	lbs/hr	0.23	0.17	0.29	0.23
	lbs/MMBtu	0.038	0.079	0.14	0.086
Boiler Operating Conditions					
Heat input, MMBtu/hr		6.00	2.14	2.07	3.4
% 19 MMBtu capacity		31	11	11	18

[1] $PM_{2.5}$ test run one was interrupted by a plugged filter which caused the low isokinetics.
[2] $PM_{2.5}$ is the product of $PM_{2.5}$ filterable particulate matter and condensible particulate matter (CPM).

Table 3: Wood-Fired Chip-Tec "High-Fire" Test Results

University of Montana Western Wood-Fired Chip-Tec Boiler $PM_{2.5}$ NOx and CO "High-Fire" Emissions December 6, 2007					
Parameter	**Units**	**Run 1**	**Run 2**	**Run 3**	**Avg.**
Isokinetics, 100 ±20%		108	91	88	NA
D_{50} Cut rate, 10 ±1		9.9	9.9	10.2	NA
$PM_{2.5}$ [1]	gr/dscf	0.055	0.060	0.052	0.056
	lbs/hr	0.94	1.03	0.90	0.954
	lbs/MMBtu	0.172	0.185	0.161	0.172
NOx	ppmdv	45.2	85.5	67.4	66.0
	lbs/hr	0.64	1.88	1.46	1.33
	lbs/MMBtu	0.118	0.220	0.173	0.17
CO	ppmdv	174.6	175.2	172.0	173.9
	lbs/hr	01.51	2.34	2.27	2.04
	lbs/MMBtu	0.279	0.274	0.269	0.274
Boiler Operating Conditions					
Heat input, MMBtu/hr		5.41	8.54	8.45	7.47
% 19 MMBtu capacity		28	45	44	40

[1] $PM_{2.5}$ is the product of $PM_{2.5}$ filterable particulate matter and condensible particulate matter (CPM).

3.2 Production Data and Field Notes

Low-fire: The boiler operated without interruption during the test; operating data is presented in the above table.

High-fire: Due to the warm ambient temperatures the boiler could only operate at 40% of its 19 MMBtu rated capacity. Operating data is presented in the above table.

Fuel samples were taken during the test project and sent to a lab for proximate and ultimate analysis and Fd determination. In addition to the fuel's combustion analysis, a fuel sample, and fly ash and bottom ash samples were sent to a lab for selected metals analysis. The lab results can be found in an appendix of this report.

4.0 TESTING PROCEDURES

4.1 Sampling Site Locations

Sample site locations were determined by Method 1.

4.2 Test Methods and Procedures

Bison testing personnel performed the following EPA methods as described in Title 40, Code of Federal Regulations (CFR), Part 60, Appendix A:

EPA Reference Method 1, *"Sample and Velocity Traverses for Stationary Sources."* The objective of Method 1 is to determine a suitable location for testing and to determine the velocity measurement points for the source. The distance upstream to atmosphere from the sampling ports (Distance A) is measured and the distance downstream to the nearest disturbance from the sample points (Distance B) is measured. Distances A and B are applied to Method 1, Figure 1-2 for velocity measurement points. These figures give the minimum number of measurement points according to the dimensions of the source. The number of points and the stack diameter are then applied to Method 1, Table 1-2 to determine equal area measurement points within the source. The results of Method 1 location and velocity point measurement locations are included in the report appendices.

EPA Reference Method 2, *"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type-S Pitot Tube)."* The objective of Method 2 is to measure stack gas velocity, collect temperature data, and calculate a volumetric flow. Method 2 velocity measurements are performed using a Type S pitot tube. Differential pressures are measured using an inclined manometer, and temperatures are measured using a k-type thermal indicator. Bison has incorporated 0.84 as the Type S pitot tube coefficient (Cp). The average velocity, temperature, static pressure, and source area are used to calculate volumetric flow within the source. This field data is recorded on field data sheets. Copies of the field data, results from the flow calculations, and calibration data can be found in the appendices to this report.

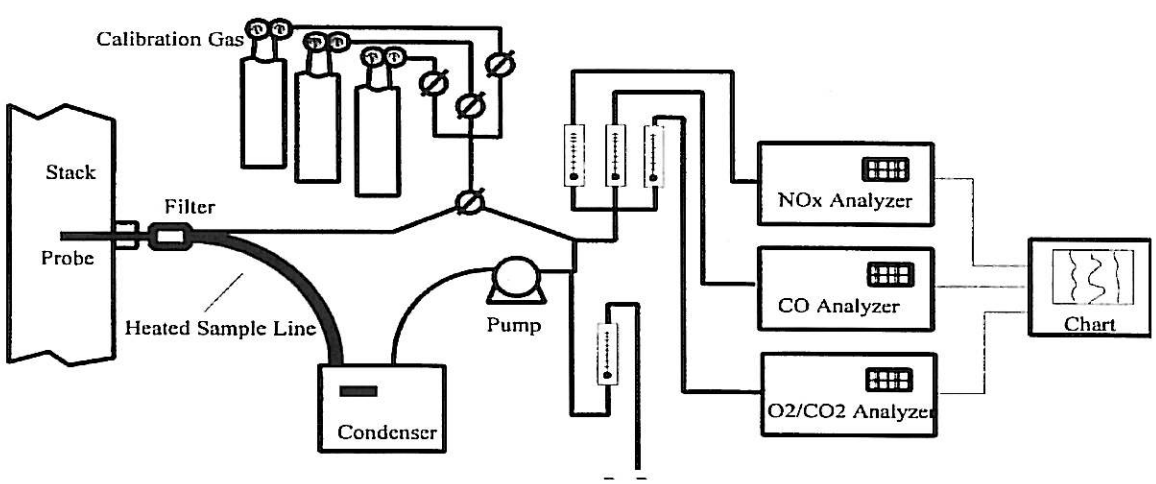
Method 3A, "*Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)."* The objective of Method 3A is to determine the molecular weight of the source stream by determining oxygen (O_2) and carbon dioxide (CO_2) concentrations in the stack gas stream. The principle is to extract a gas sample from a stationary source and route the sample through a conditioning system to a paramagnetic oxygen analyzer and an infrared carbon dioxide analyzer for the measurement of O_2 and CO_2 in percentages (%). The O_2 and CO_2 analyzers calibration adjustments are performed by sending EPA Protocol 1 gas directly to the analyzers. A system calibration is performed by sending calibration gas to the probe and through the system to the analyzers. Bison's CO_2/O_2 analyzer is a Servomex Series 1400 (Serial Numbers 01415/B198 and 014208/901,

respectively). The calibration error, system bias and system drift data, and measured concentrations were recorded on a stripchart or data acquisition system (DAS). A copy of this data is included in a report appendix.

Method 4, *"Determination of Moisture Content in the Stack Gases."* The objective of Method 4 is to determine the moisture content of a gas stream. The principle of the method is to extract a sample from the source at a constant rate and impinge it through chilled water and silica gel. The moisture is removed from the sample stream and the volume (or mass) of water extracted is determined. The sample volume and water volume (or mass) are used to calculate the moisture content of the stack gas. The results of pre- and post-test dry gas meter (DGM) calibrations can be found in the DGM calibrations table. The DGM calibration data can be found in an appendix of this report. The impinger waters are volumetrically measured on-site and the silica gels are transported to Bison's lab and weighed. The test data is hand-recorded on field data sheets and then entered into spreadsheets for moisture determination calculations. This data and the resulting moisture can be found in the appendices of this report.

EPA Reference Method 7E, "*Determination of Nitrogen Oxides Emissions from Stationary Sources."* The objective of Method 7E testing is to determine the NOx concentration from the source. Method 7E entails extraction of a gas sample from a stationary source and routing the sample through a conditioning system to an analyzer for the measurement of NOx (NO and NO_2) in ppmvd. The NO_2 analyzer calibration adjustment is performed by sending EPA Protocol 1 gas directly to the analyzer. A system bias check is performed by sending calibration gas to the probe and through the system to the analyzer. Bison uses a Thermo Environmental 42C (NO-NO_2-NO_x) analyzer, Serial Number 42CHL-56022-306. The calibration error, system bias and system drift data, and measured concentrations are recorded on a stripchart or DAS for permanent record.

Typical Layout of a Method 7E and 10 Sampling System



EPA Reference Method 10, "*Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure).*" The objective of Method 10 is to determine the CO concentrations from the source. Method 10 entails extraction of a gas sample from a stationary source and routing the sample through a conditioning system to an analyzer for the measurement of CO in ppmvd. The CO analyzer calibration adjustment is performed by sending EPA Protocol 1 gas directly to the analyzer. A system bias check is performed by sending calibration gas to the probe and through the system to the analyzer. Bison uses a Thermo Environmental Instruments 48C CO Analyzer, Serial Number 48C-55909-305. The calibration error, system bias and system drift data, and measured concentrations are recorded on a stripchart or DAS for permanent record.

EPA Reference Method 19, *"Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxides Emissions Rates."* Method 19 is employed for the determination of mass rate emissions. Results from Methods 3A, 7E and natural gas dry F factor (F_d) (from Table 19-1) are employed to calculate an NO_X emission rate (E) according to the following steps.

Step 1: Calculate NO_X in pounds per standard cubic feet (lbs/scf). Method 19, Table 19-1, provides factors to convert ppm NO_X to lb/scf.

$$C_d = NO_X \text{ ppm} \times 1.194\times10^{-7} \text{ lbs/scf/ppm} = NO_X \text{ lbs/scf}$$

Step 2: Calculate NO_X results in pounds per hour using Table 19-2 "Factors for Various Fuels," using the F_d factors and measured oxygen (O_2).

$$E = F_d \, {}^{dscf}/_{MMBtu} \; C_d \; \frac{20.9}{(20.9 - \%O_2)} = NOx \text{ lbs/MMBtu}$$

Where: E = pollutant emission rate (lbs/MMBtu)
C_d = pollutant concentration dry basis (lbs/scf)

Step 3: Using the fuel usage measured during the test and the heating factor of 969.2 Btu/scf n.g., calculate the NO_X results in pounds per hour as follows.

$$E \; {}^{lbs}/_{MMBtu} \times 9.692\times10^{-4} \; {}^{MMBtu}/_{scf\ n.g.} \times \text{fuel} \; {}^{scf\ n.g.}/_{hr} = NOx \text{ lbs/hr}$$

Conditional Test Method 40,*"Determination of PM_{10} and $PM_{2.5}$ Emissions (Constant Sampling Rate Procedure)" (Methods 2 & 4 Inclusive).* The objective of CTM 40 is to determine the particulate matter (PM) emissions equal to or less than an aerodynamic diameter of 2.5 and/or 10 microns from stationary sources. Bison uses a Method 5 sampling train with a stainless steel probe, an in-stack cyclone and an in-stack filter to gather the $PM_{2.5}$ and PM_{10} samples. CTM 40 incorporates Method 2 "velocity measurements" and Method 4 "moisture measurements."

Method 202, *"Determination of Condensable Particulate Emissions from Stationary Sources."* The objective of Method 202 is to determine the condensable particulate matter (CPM) that passes through the heated filter and is collected in the chilled back-half of the sampling train. The CPM is comprised of organic matter and inorganic matter. The principle of the method starts after sampling where impinger waters are decanted, measured for volume gain and placed in sample containers. The impingers are then rinsed twice, first with water, then with methylene chloride ($MeCl_2$). The samples are transported to a lab where Method 202 extractions are performed. The organic portion of the CPM is referred to as methylene chloride extractable matter (MECM).

4.3 Analytical Methods

Chain of Custody: Bison staff maintained possession of the PM samples throughout sampling, transport and analysis.

Sample Description: Sample descriptions were logged on the field data sheets.

Filter Analysis: Bison weighed filters in an environmentally controlled room. Before field use, the filters were desiccated for a minimum of 24 hours, then weighed and desiccated at 6-hour intervals until a constant pre-test tare was achieved. After the tests, the filters were desiccated for a minimum of 24 hours, then weighed and desiccated at 6-hour intervals until constant post-test weight was achieved. The difference between the average pre-test tare and average post-test weight was the filter mass capture. Sample descriptions are recorded on the field data forms.

Nozzle, Cyclone, Probe and Filter-bell Rinse Analysis: The nozzle, probe and filter-bell were rinsed with acetone. The rinsate was collected in a sample bottle, transferred to a pre-conditioned, tared aluminum sample boat and heated to evaporate the acetone. The boat was again conditioned and weighed to determine "front-half" rinse particulate matter. The rinse mass capture was added to the filter particulate capture to determine "front-half" filterable PM emissions.

Impinger Water: Post-test impinger water description of color and presence of film are recorded on field data sheets. The impinger waters are volumetrically measured after each test run. The water is then transferred to uniquely identified sample containers for transport to Bison's lab. At the lab, sample containers are checked for leakage then the waters are transferred to graduated cylinders where the volumes are checked for leakage. The samples are then poured into beakers and placed on a warming plate to evaporate. Once the water has evaporated to less than 50 mls, the water is transferred to a pre-conditioned, tared boat and placed on the warming plate until completely evaporated. After evaporation, the boats are then placed in a desiccator for a minimum of 6 hours after which they are weighed in 6-hour intervals until a constant weight is achieved.

Silica Gel: Bison transports pre-dried silica gel in airtight containers holding approximately 250 grams. Each container is weighed prior to use in a sampling train. After testing, the gel is placed back into the container and reweighed for moisture gain. Pre- and post-test silica gel weights are recorded in the lab, entered into the spreadsheets and may be recorded on field data sheets.

Fuel samples were taken during the testing project and sent to the following lab for ultimate analysis and Btu determination. The lab results are presented in an appendix of this report.

Hazen Research Inc.
4601 Indiana Street
Golden, Colorado 80403
Tel. 303 279-4501
Fax 303 278-1528
Contact: Gerard H. Cunningham, Fuel Laboratory Manager

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

5.1 Documentation and Tracking

Bison uses a project number for document control and tracking for all projects. Each project that Bison works on is assigned a project number. All documentation pertaining to that project is filed in the same place under that project number. This assures all pertinent information can be found easily at a later date.

The tracking number for this project is **WMC207784.**

Bison's testing project leader signs an "Emission Source Test Certification" to document and authenticate that the testing was performed according to the methods and applicable MDEQ requirements.

5.2 Sampling Protocol

Bison's test, laboratory, reporting, and quality assurance procedures conform to the requirements specified in the *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. III, Stationary Source Specific Methods,* published by the U.S. Environmental Protection Agency in August, 1977, as revised and amended (cat. #EPA-600/4-77-027b).

The individual test methods specify handling procedures for physical samples (liquids, traps, etc.). Bison follows the procedures outlined in the appropriate methods as described in EPA 40 CFR Part 60, Appendix A and Appendix B.

5.3 Quality Assurance

Bison's quality assurance program is designed to ensure that all source testing methods are followed and are performed by competent, experienced personnel. Bison's equipment is properly calibrated and maintained in good working order. Procedures for sample collection, recovery, and analysis are performed according to applicable EPA methods. Bison's practices conform to the procedures in the Environmental Protection Agency (EPA) *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume 3, EPA-600/4-77-0276, 1977, as amended.

Bison personnel calibrate equipment and instruments using standards when applicable or per the procedures of National Institute of Standards and Technology (NIST). Bison's equipment is manufactured to meet all applicable EPA criteria and parameters. Bison defines a calibration as the procedure of changing a measurement system or device to match a constant or standard measurement system or device; an "audit" checks the variance between the value and a standard or a precalibration.

Emission testing quality assurance checks and quality controls (QA/QC) require three steps: before, during, and after field testing. "Before" QA/QC procedures are performed in Bison's lab, "during" QA/QC checks are recorded on the field data sheets, and "after" QA/QC procedures are performed at Bison's lab. These data can be found in the appendices. The following table describes Bison's QA/QC, calibration and audit procedures and schedule.

Table 4: Equipment Calibration and Audit Procedures

Parameter or Unit	Schedule and Requirement	Method Reference
Acetone / DI water	Blank analysis on the rinse solution and submitted the results in the pretest protocol.	Method 5, 3.2
Isolated Type S pitot tubes	Calibration prior to initial field use.	Method 2, 10.1
	Re-examined after each field use.	Method 2, 10.1.5.2.1
Temperature gauges	Audited on-site and/or after each field use.	Method 2, 10.3.1
Probe heater	Calibration prior to initial field use.	Method 5, 5.4
Barometer	Calibrated against Hg barometer.	Method 2, 10.4
Metering system	Calibration prior to use.	Method 5, 10.3.1
	Calibration after use.	Method 5, 10.3.2
Analytical balance	Calibrated and/or audited each year by independent auditor.	na
	Audited during sample weighing.	na
Analyzers	Analyzer calibration error, ACE.	Method 7E, 8.5
	NO_2 to NO conversion test.	Method 7E, 8.2.4
Sample system	Sample system bias check, SB.	Method 7E, 8.5
	Zero and calibration drift tests.	Method , 7E.8.5

5.4 Volumetric Sampling Equipment Calibrations

Volumetric sampling by DGM must be initially calibrated across its full operating range then audited after each testing project. The post-test audit must be within 5% of its initial calibration. Should the DGM not be within the 5% criteria, the DGM factors must be used that will give the lowest sample volume. Calibration data can be found in an appendix to this report. The following table presents the results of the pre- and post-test DGM calibrations and audits.

Table 5: Meter Box Calibration Results

Bison Engineering Equipment Calibration Record				
Unit	Pre-Calibration	Post-Calibration	Results	Required
Meter Box 4, "Y"	1.049	1.041	0.01%	±5% from pre-calibration

Method 5, Section 5.3.3, states that, should the pre- and post-"Y" factor calibrations differ more than 5%, the lesser "Y" value shall be used in the calculations.

5.5 Instrument Calibration, Maintenance and Standards

Bison uses a field barometric pressure gauge that is calibrated prior to each field deployment against a mercury-in-glass standard barometer. Temperature calibrations are performed using a mercury-in-glass NIST-traceable thermometers.

Bison uses RATA-class calibration gases for all emission testing projects which are certified as EPA Protocol 1 gases and are purchased from Scott Specialty Gases. The calibration gas certifications are included in the appendix of this report.

Calibration adjustments of the analyzers are performed by sending the Protocol 1 gas directly to the analyzers. A system audit is performed before and after each test run by sending calibration gas to the probe and through the system to the analyzers. The results of these calibrations and audits can be found in the spreadsheets located in the appendices.

5.6 Data Acquisition, Reduction and Validation

Test data such as velocities, temperatures and isokinetic sampling are hand-recorded on field data sheets. The data is then entered into computer spreadsheets where QC/QA and emission calculations are performed according to the methods. An appendix of this report contains nomenclature and formulae for reference. All raw field data is supplied in an appendix to this report. The appendix contains some example calculations; additional examples will be supplied upon request.

Rounding of Significant Figures

If the first digit to be discarded is less than five, the last digit retained should not be changed. When the first digit discarded is greater than five, or if it is a five followed by at least one digit other than 0, the last figure retained should be increased by one unit. When the first digit discarded is exactly five, followed only by zeros, the last digit retained should be rounded upward if it is an odd number, but no adjustment made if it is an even number.

For example, if the emission standard is 90, than 90.357 would be rounded to 90, 90.639 would be rounded to 91, 90.500 would be rounded to 90, and 91.500 would be rounded to 92.

Standard	Number	Rounded To
90	90.357	90
90	90.639	91
90	91.500	92

APPENDIX A:
LOW-FIRE TEST DATA

Bison Engineering, Method 201A PM_{10} & CT40 $PM_{2.5}$ Spreadsheet

Client	Westen MT College				Number of Runs
Facility	College				3
Location	Dillon MT				
Source	Boiler				
Test date		Oct 24, 07	Oct 24, 07	Oct 24, 07	
Start time		8:50	10:23	11:50	
Test run		One	Two	Three	
Preliminary info					
Barometric pressure [Bp]	"Hg	24.8	24.8	24.8	
Stack Diameter	inch	24	24	24	
stack exit area	sqft	3.14	3.14	3.14	
Meter box ID		3	3	3	
meter box Yi		1.049	1.049	1.049	
meter box delta H@		1.849	1.849	1.849	
Pitot tube coefficient Cp		0.84	0.84	0.84	
Test Information					
nozzle size [nz]	inch	0.342	0.342	0.342	
filter number		0	0	0	
Sample points		12	12	12	
Test duration	min	59.5	61	72.7	
Isokinetics [i]	%	49	115	85	
D50 cut rate		10.19	10.23	10.23	
Sample volume, eq 4.3	dscf	13.02	21.19	17.95	
avg delta P	"H2O	0.085	0.036	0.033	
avg sqrt delta P	"H2O	0.291	0.188	0.181	
201A Constant sample rate delta H	"H2O	0.43	0.50	0.50	
CT40 Constant sample rate delta H	"H2O	0.40	0.47	0.47	
avg meter temp [Tm]	deg F	52.1	67.2	93.4	
Stack Information					AVERAGES
avg stack temp [ts]	deg F	243	193	195	210
ABS stack temp [Ts]	deg R	703	653	655	670
actual stack flow	acfm	3891	2455	2358	2901
actual stack velocity [Vs] eq. 2-7	ft/sec	20.6	13.0	12.5	15.4
Standard stack flow, Q eq. 2-8	dscfm	2219	1492	1433	1714
Standard stack flow, Q eq. 2-8	dscf/hr	133116	89522	85958	102866
stack moisture [bws], eq 4.4	% v/v	8.38	9.35	9.09	9
measured static pressure	"H2O	0	0	0	0
stack static pressure [ps]	"Hg	24.80	24.80	24.80	24.80
Oxygen content	%O2	11.1	15.7	15.7	14
Carbon dioxide content	%CO2	9.8	5.2	5.2	7
Wet (Actual) Molecular Weight, Ms	lb/lb.mole	29.0	28.4	28.4	28.6
Dry Molecular Weight, Md	lb/lb.mole	30.0	29.5	29.5	29.6
Lab Information					
Impinger H2O Gain	mls	20	40	30	
Impinger H2O volume [Vwc(STD)], eq 4.1	scf	0.94	1.88	1.41	
Silica Gel H2O Gain	grams (g)	5.3	6.4	8.1	
Silica Gel volume [Vsg(STD)], eq 4.2	scf	0.25	0.30	0.38	
Lab Data, cyclone PM2.5 weight gain	g	0.0071	0.0028	0.0115	
Lab Data, Filter PM2.5 weight gain	g	0.0503	0.0374	0.0305	
Lab data condensible PM (CPM)	g	0.0084	0.0031	0.0040	
Lab data MeCl Matter (MCEM)	g	0.0006	0.0008	0.0009	
cyclone > than PM10 weight gain	grains (gr)	0.0532	0.0378	0.0139	
cyclone PM10 weight gain	gr	0.0694	0.0185	0.0386	
cyclone PM2.5 weight gain	gr	0.1096	0.0432	0.1775	
Filter PM2.5 weight gain	gr	0.7762	0.5772	0.4707	
condensible PM (CPM)	gr	0.1296	0.0471	0.0617	
MeCl Matter (MCEM)	gr	0.0093	0.0123	0.0139	
Grain loading Emissions					AVERAGES
PM 2.5 cyclone & filter	gr/dscf	0.0680	0.0272	0.0262	0.0405
condensible PM (CPM)	gr/dscf	0.0100	0.0022	0.0034	0.0052
MeCl Matter (MCEM-CPM))	gr/dscf	0.0007	0.0006	0.0008	0.0007
EPA PM2.5 + CPM	gr/dscf	0.0787	0.0300	0.0304	0.0464
Mass Rate Emissions					AVERAGES
PM 2.5 cyclone & filter	lbs/hr	1.294	0.348	0.322	0.6548
condensible PM (CPM)	lbs/hr	0.189	0.028	0.042	0.0867
MeCl Matter (MCEM-CPM))	lbs/hr	0.014	0.007	0.010	0.0102
EPA PM2.5 + CPM	lbs/hr	1.497	0.384	0.374	0.7516
Emission Factor					AVERAGES
lab analysis Fd @ 0% oxygen	dscf/MMBtu @ 0%	10399	10399	10399	10399
lab analysis Fd @ stack conditions	dscf/MMBtu @ SK	22177	41796	41796	35256
EPA PM2.5 + CPM	lbs/MMBtu	0.249	0.179	0.182	0.2035
Boiler operating rate	MMBtu/hr	6.00	2.14	2.06	3.4003

Client	**UM-Western**
Location	**Dillon, MT**
Source	**Boiler**

Test date			10/24/07	10/24/07	10/24/07	
Preliminary info			**Run 1**	**Run 2**	**Run 3**	
Barometric pressure	Bp	"Hg	24.8	24.8	24.8	
Method 1 Information						
Stack Diameter	ID	inch	24	24	24	
stack exit area	A	sqft	3.14	3.14	3.14	
Sample points			12	12	12	
Method 2 or 2A Information						
Pitot tube coefficient			0.84	0.84	0.84	
Stagnation pressure		in H2O	0.1	0.1	0.1	
Absolute stack gas pressure	Ps	in Hg	24.81	24.81	24.81	
avg Delta P		in H2O	0.09	0.04	0.03	
avg sqrt Delta P			0.29	0.19	0.18	0.220
avg stack temp	Ts	deg F	243	193	195	210.333
actual stack velocity, eq 2.9	Vs	ft/sec	20.6	13.0	12.5	15.377
actual stack flow		acfm	3887	2451	2353	2897.000
Standard stack flow per minute		dscfm	2217	1490	1440	1715.667
Standard stack flow per hour, eq 2.10	Qsd	dscfh	133036	89385	86428	102949.667
Method 3 or 3A Information						
Percent oxygen by volume dry		%O2	11.1	15.7	15.7	14.167
Percent carbon dioxide dry		%CO2	9.8	5.2	5.2	6.733
Dry Molecular Weight eq 3.1	Md	lb/lb.mole	30.012	29.46	29.46	29.644
Wet (Actual) Molecular Weight eq 2.5	Mw	lb/lb.mole	29.05	28.43	28.54	28.673
Method 4 Information						
DGM calibrations factor	Y		1.049	1.049	1.049	
DGM avg inlet/outlet temperature		deg F	52.69	67.21	93.38	
Sample duration		min	38.1	60	60	
Volume of gas collected, eq 4.3	Vmstd	dscf	13.0	21.2	19.5	
Impinger H2O volume gain		mls	20	40	30	
Impinger H2O volume, eq 4.1	Vwcstd	scf	0.94	1.88	1.41	
Silica Gel H2O weight gain		g	5.3	6.34	8.1	
Silica Gel volume, eq 4.2	Vwsgstd	scf	0.250	0.299	0.382	
Water vapor proportion by vol, eq 4.4	Bws	% v/v	8.40	9.34	8.42	Three run
Emissions						**AVERAGES**
NOx source concentration		ppmvd	41.84	40.20	62.86	48.303
NOx mass rate		lbs/hr	0.66	0.43	0.65	0.580
NOx		lbs/dscf	4.96E-06	4.81E-06	7.52E-06	5.764E-06
CO source concentration		ppmvd	23.88	26.76	46.37	32.336
CO mass rate		lbs/hr	0.23	0.17	0.29	0.230
CO		lbs/dscf	1.73E-06	1.90E-06	3.36E-06	2.329E-06
Emission Factors per Reference Method 19, Eq. 19.1						**AVERAGES**
lab analysis Fd @ 0% oxygen		dscf/MMBtu @ 0%	10399	10399	10399	**10399**
lab analysis Fd @ stack conditions		dscf/MMBtu @ SK	22177	41796	41796	**35256**
NOx pounds per milllion Btu, lab Fd		lbs/MMBtu, lab	0.110	0.201	0.314	**0.208**
CO pounds per milllion Btu, lab Fd		lbs/MMBtu, lab	0.038	0.079	0.140	**0.086**
Boiler operating rate		MMBtu/hr	6.00	2.14	2.07	**3.402**

Test Run 1 **Bison Engineering, Method 201A PM_{10} & CT40 $PM_{2.5}$ Spreadsheet**

Data by		Checked by	

Facility:	Westen MT College		Location:	Dillon MT	Date:	Oct 24, 07	
Operators:	cwl Jw	Filter #	Source:	Boiler	Start time: 8:50	End time:	

PRELIMINARY INFO.

Pm	Bp			24.8	("Hg)
	Diam	Lngth	Wdth	Rnd sqft	Rect. sqft
(inches)	24			3.14	0
	Stack AREA			3.14	(sqft)
	Yi			1.049	
	Delta H@			1.849	

PRE TEST INFO

	Assumed moisture	11.5	(%)
	Assumed Meter Temp	55.0	(deg F)
	Target Run Time	60.0	(min)
	Total Number of Points	12	

TRAVERSE INFO

Pg	Static, gage pressure	0.00	("H2O)
	Stack Temp, ts	200.0	(deg F)
O_2	Abs stack Temp, Ts	660	(deg R)
CO_2	Oxygen, dry	11.1	(% v/v d)
	Oxygen, wet	9.8235	(% v/v w)
	Carbon Dioxide, dry	9.8	(% v/v d)
	Molecular weight, dry	30.012	(lb/lb.mole)
	Molecular weight, wet	28.63062	(lb/lb.mole)

Revised Sept 08/01 by CWL

201A Calculations

us	201A stack viscosity		202.13	(micropoise)
Qs	201A Cylone flow rate		0.561	(ft^3/min)
ΔH	**201A Delta H ==>**		0.43	("H20)
	RANGE	0.38 - 50 °F	0.51	+ 50 °F

CT40 Calculations

us	CT40 stack viscosity		200.39	(micropoise)
C	Cunningham Corr. Factor		1.10	
D_{50LL}	Lower limit cut diameter		9.45	(micrometers
D_{50T}	Cut diam for cyclone		10.23	(micrometers
Qs	CT40 Cylone flow rate		0.539	(ft^3/min)
Nre	Reynolds number		2501	Nre < 3162 *
ΔH	**CT40 Delta H ==>**		0.40	("H20)
	RANGE	0.35 - 50 °F	0.47	+ 50 °F

NOZZLE SELECTION

Nd					
201A	•136 •15 •164 •182 •197 •215 •233 •264 •3 •342 •39				
CT40	N1•125 N2•138 N3•156 N4•172 N5•188 N6•20 N7•22 N8•25				
H_2O	Nozzle Diameter estamate	0.286	Selected >	0.342	
H_2O	delta P (min)	ERR	AVG	ERR	AVG
H_2O	delta P (max)	NA	ERR	NA	ERR
H_2O	Alt - delta P (min)	ERR	ERR	ERR	ERR
H_2O	Alt - delta P (max)	0.101	ERR	0.093	ERR

POST TEST INFO

Impinger water 20 Silica gel 5.3 (g)

CALCULATED RESULTS

Ps	Stack pressure, Ps	24.8	(" Hg)
Bws	% H2O in Stack	8.38	(Bws)
Mw	Actual Wet Molecular Weight	29.00	(lb/lb.mole)
Vs	Dry STD sample Volume	13.02	(dscf)
	Final Sampling Time	59.5	(min)
us	Post test stack viscosity	216.09	(micropoise)
C	Post test Cunningham corr. factor	1.11	
D_{50LL}	Post test lower limit cut diameter	9.39	(micrometers)
D_{50T}	Post test cut diam for cyclone	10.19	(micrometers)
Qs std	Post test cyclone flow rate	0.59	(ft^3/min)
I	Isokinetic Avg, { 80 < I < 120 }	49	(%)
D50	D50 Cut Rate, { 9 < d50 < 11 }	10.2	(um)

Test No	Pre traverse dP	Pre traverse sqrt dP	Point Time	Run Time	MetrVol 922.20	Vel head delta P	Vel head sqrt dP	201A CT40 delta H	Stack Temp	Meter Temp In	Meter Temp Out	Meter Temp Avg	Assumed % I	Actual %I	Rolling %I	STACK Vel. ft/sec	STACK Flow acfm	STACK Flow dscfm
1	0.100	0.32	5.4	5.4	924.31	0.100	0.32	0.40	243	54	44	49	74.41	72	72	22.45	4232	2414
2	0.095	0.31	5.3	10.7	925.71	0.095	0.31	0.40	246	49	43	46	52.19	50	61	21.93	4133	2347
3	0.076	0.28	4.7	15.4	927.51	0.076	0.28	0.40	223	51	46	48.5	82.64	80	67	19.29	3636	2135
4	0.084	0.29	4.9	20.3	929.20	0.084	0.29	0.40	248	56	48	52	71.96	70	68	20.65	3892	2204
5	0.049	0.22	3.8	24.1	931.00	0.049	0.22	0.40	254	57	50	53.5	128.96	125	79	15.84	2985	1676
6	0.067	0.26	4.4	28.5	934.80	0.067	0.26	0.40	247	62	52	57	198.90	192	98	18.43	3474	1970
7	0.076	0.28	4.7	33.2	936.70	0.076	0.28	0.40	243	64	53	58.5	86.89	84	96	19.57	3689	2104
8	0.074	0.27	4.6	37.8		0.074	0.27	0.40	243			ERR	**********	-48298	-5953	19.31	3640	2076
9	0.103	0.32	5.5	43.3		0.103	0.32	0.40	243			ERR	0.00	0	-5292	22.78	4295	2449
10	0.105	0.32	5.5	48.8		0.105	0.32	0.40	243			ERR	0.00	0	-4763	23.00	4336	2473
11	0.095	0.31	5.3	54.1		0.095	0.31	0.40	243			ERR	0.00	0	-4330	21.88	4125	2352
12	0.101	0.32	5.4	59.5		0.101	0.32	0.40	243			ERR	0.00	0	-3969	22.56	4253	2426
	avg dP	avg. √dP	sample volume		14.501	avg. dP	avg. √dP	dH	Ts		Tm					ft/sec	acfm	dscfm
	0.085	0.291				0.085	0.291	0.40	243.25	ts °F	52.07	tm °F				20.64	3891	2219
avg sqrt dP squared		0.085							703.25	Ts °R	512.07	Tm °R						

* Nre < 3162 continue with calculated ΔH
* Nre > 3162 (recalculate D_{50LL} with Eq.10) use cell Y109 for operating ΔH
* Nre > 3162 Eq.37 for D50

Test Run 2 **Bison Engineering, Method 201A PM_{10} & CT40 $PM_{2.5}$ Spreadsheet**

Data by		Checked by	

Facility:	Westen MT College	Location:	Dillon MT	Date:	Oct 24, 07
Operators:	Filter #	Source:	Boiler	Start time: 10:23	End time:

PRELIMINARY INFO.

Pm	Bp			24.8	("Hg)
	Diam	Lngth	Wdth	Rnd sqft	Rect. sqft
(inches)	24			3.14	0
	Stack AREA			3.14	(sqft)
	Yi			1.049	
	Delta H@			1.849	

PRE TEST INFO

	Assumed moisture	7.5	(%)
	Assumed Meter Temp	65.0	(deg F)
	Target Run Time	60.0	(min)
	Total Number of Points	12	

TRAVERSE INFO

Pg	Static, gage pressure	0.00	("H2O)
	Stack Temp, ts	200.0	(deg F)
O_2	Abs stack Temp, Ts	660	(deg R)
CO_2	Oxygen, dry	15.7	(% v/v d)
	Oxygen, wet	14.5225	(% v/v w)
	Carbon Dioxide, dry	5.2	(% v/v d)
	Molecular weight, dry	29.46	(lb/lb.mole)
	Molecular weight, wet	28.6005	(lb/lb.mole)

201A Calculations

us	201A stack viscosity		207.54	(micropoise)
Qs	201A Cylone flow rate		0.576	(ft^3/min)
ΔH	**201A Delta H ==>**		**0.50**	("H20)
	RANGE	0.43 - 50 °F	0.59	+ 50 °F

CT40 Calculations

us	CT40 stack viscosity	206.58	(micropoise)
C	Cunningham Corr. Factor	1.10	
D_{50LL}	Lower limit cut diameter	9.46	(micrometers
D_{50T}	Cut diam for cyclone	10.23	(micrometers
Qs	CT40 Cylone flow rate	0.556	(ft^3/min)
Nre	Reynolds number	2498	Nre < 3162 *
ΔH	**CT40 Delta H ==>**	**0.47**	("H20)
	RANGE	0.40 - 50 °F	0.55 + 50 °F

NOZZLE SELECTION

Nd					
201A	•136 •15 •164 •182 •197 •215 •233 •264 •3 •342 •39				
CT40	N1•125 N2•138 N3•156 N4•172 N5•188 N6•20 N7•22 N8•25				
H_2O	Nozzle Diameter estamate	0.290	Selected >	0.342	
H_2O	delta P (min)	ERR	AVG	ERR	AVG
H_2O	delta P (max)	NA	ERR	NA	ERR
H_2O	Alt - delta P (min)	ERR	ERR	ERR	ERR
H_2O	Alt - delta P (max)	0.106	ERR	0.099	ERR

POST TEST INFO

Impinger water 40 Silica gel 6.4 (g)

CALCULATED RESULTS

Ps	Stack pressure, Ps	24.8	(" Hg)
Bws	% H2O in Stack	9.35	(Bws)
Mw	Actual Wet Molecular Weight	28.39	(lb/lb.mole)
Vs	Dry STD sample Volume	21.19	(dscf)
	Final Sampling Time	61.0	(min)
us	Post test stack viscosity	204.27	(micropoise)
C	Post test Cunningham corr. factor	1.10	
D_{50LL}	Post test lower limit cut diameter	9.46	(micrometers)
D_{50T}	Post test cut diam for cyclone	10.23	(micrometers)
Qs std	Post test cyclone flow rate	0.55	(ft^3/min)
I	Isokinetic Avg, { 80 < I < 120 }	115	(%)
D50	D50 Cut Rate, { 9 < d50 < 11 }	10.2	(um)

Revised Sept 08/01 by CWL

Test No	Pre traverse dP	sqrt dP	Point Time	Run Time	MetrVol 938.61	Vel head delta P	sqrt dP	201A CT40 delta H	Stack Temp	Meter Temp In	Out	Avg	Assumed % I	Actual %I	Rolling %I	STACK Vel. ft/sec	Flow acfm	Flow dscfm
1	0.100	0.32	5.4	5.4	940.81	0.040	0.20	0.47	201	64	61	62.5	109.91	112	112	13.92	2623	1574
2	0.095	0.31	5.7	11.1	942.81	0.045	0.21	0.47	194	64	58	61	89.03	91	101	14.68	2768	1679
3	0.076	0.28	5.5	16.6	944.81	0.041	0.20	0.47	192	67	59	63	96.38	98	100	13.99	2638	1605
4	0.084	0.29	5.5	22.1	946.81	0.041	0.20	0.47	192	69	60	64.5	95.87	98	100	13.99	2638	1605
5	0.049	0.22	4.4	26.5	948.81	0.027	0.16	0.47	194	69	61	65	147.90	151	110	11.37	2144	1300
6	0.067	0.26	4.4	30.9	950.81	0.027	0.16	0.47	199	72	62	67	147.68	151	117	11.42	2152	1296
7	0.076	0.28	4.8	35.7	953.00	0.032	0.18	0.47	196	71	62	66.5	136.30	139	120	12.40	2337	1414
8	0.074	0.27	5.4	41.1	954.91	0.040	0.20	0.47	188	72	63	67.5	93.43	95	117	13.78	2597	1590
9	0.103	0.32	5.1	46.2	956.91	0.035	0.19	0.47	186	76	64	70	110.28	113	116	12.87	2426	1490
10	0.105	0.32	5.4	51.6	958.90	0.040	0.20	0.47	184	78	66	72	96.81	99	115	13.74	2589	1595
11	0.095	0.31	5.0	56.6	960.91	0.034	0.18	0.47	189	77	66	71.5	114.13	116	115	12.71	2396	1465
12	0.101	0.32	4.4	61.0	962.91	0.027	0.16	0.47	200	84	68	76	145.53	148	118	11.42	2154	1295
	avg dP	avg. √dP	sample volume		24.299	avg. dP	avg. √dP	dH	Ts		Tm					ft/sec	acfm	dscfm
	0.085	0.291				0.036	0.188	0.40	192.92	ts °F	67.21	tm °F				13.02	2455	1492
avg sqrt dP squared		0.085							652.92	Ts °R	527.21	Tm °R						

* Nre < 3162 continue with calculated ΔH
* Nre > 3162 (recalculate D_{50LL} with Eq.10) use cell Y109 for operating ΔH
* Nre > 3162 Eq.37 for D50

Test Run 3 **Bison Engineering, Method 201A PM_{10} & CT40 $PM_{2.5}$ Spreadsheet**

Data by		Checked by	

Facility:	Westen MT College	Location:	Dillon MT	Date:	Oct 24, 07
Operators:	Filter #	Source:	Boiler	Start time: 11:50	End time:

PRELIMINARY INFO.

Pm	Bp			24.8	("Hg)
	Diam	Lngth	Wdth	Rnd sqft	Rect. sqft
(inches)	24			3.14	0
	Stack AREA			3.14	(sqft)
	Yi			1.049	
	Delta H@			1.849	

PRE TEST INFO

	Assumed moisture	7.5	(%)
	Assumed Meter Temp	65.0	(deg F)
	Target Run Time	60.0	(min)
	Total Number of Points	12	

TRAVERSE INFO

Pg	Static, gage pressure	0.00	("H2O)
	Stack Temp, ts	200.0	(deg F)
O_2	Abs stack Temp, Ts	660	(deg R)
CO_2	Oxygen, dry	15.7	(% v/v d)
	Oxygen, wet	14.5225	(% v/v w)
	Carbon Dioxide, dry	5.2	(% v/v d)
	Molecular weight, dry	29.46	(lb/lb.mole)
	Molecular weight, wet	28.6005	(lb/lb.mole)

201A Calculations

us	201A stack viscosity		207.54	(micropoise)
Qs	201A Cylone flow rate		0.576	(ft^3/min)
ΔH	**201A Delta H ==>**		0.50	("H20)
	RANGE	0.43 - 50 °F	0.59	+ 50 °F

CT40 Calculations

us	CT40 stack viscosity	206.58	(micropoise)
C	Cunningham Corr. Factor	1.10	
D_{50LL}	Lower limit cut diameter	9.46	(micrometers
D_{50T}	Cut diam for cyclone	10.23	(micrometers
Qs	CT40 Cylone flow rate	0.556	(ft^3/min)
Nre	Reynolds number	2498	Nre < 3162 *
ΔH	**CT40 Delta H ==>**	0.47	("H20)
	RANGE	0.40 - 50 °F	0.55 + 50 °F

NOZZLE SELECTION

201A	•136 •15 •164 •182 •197 •215 •233 •264 •3 •342 •39
CT40	N1•125 N2•138 N3•156 N4•172 N5•188 N6•20 N7•22 N8•25

H_2O	Nozzle Diameter estamate	0.361	Selected >	0.342	
H_2O	delta P (min)	ERR	AVG	ERR	AVG
H_2O	delta P (max)	NA	ERR	NA	ERR
H_2O	Alt - delta P (min)	ERR	ERR	ERR	ERR
H_2O	Alt - delta P (max)	0.106	ERR	0.099	ERR

POST TEST INFO

Impinger water 30 Silica gel 8.1 (g)

CALCULATED RESULTS

Ps	Stack pressure, Ps	24.8	(" Hg)
Bws	% H2O in Stack	9.09	(Bws)
Mw	Actual Wet Molecular Weight	28.42	(lb/lb.mole)
Vs	Dry STD sample Volume	17.95	(dscf)
	Final Sampling Time	72.7	(min)
us	Post test stack viscosity	204.95	(micropoise)
C	Post test Cunningham corr. factor	1.10	
D_{50LL}	Post test lower limit cut diameter	9.46	(micrometers)
D_{50T}	Post test cut diam for cyclone	10.23	(micrometers)
Qs std	Post test cyclone flow rate	0.55	(ft^3/min)
I	Isokinetic Avg, { 80 < I < 120 }	85	(%)
D50	D50 Cut Rate, { 9 < d50 < 11 }	10.2	(um)

Revised Sept 08/01 by CWL

Test	Pre traverse		Point	Run	MetrVol	Vel head		201A CT40	Stack	Meter Temp			Assumed	Actual	Rolling	STACK Vel.	Flow	Flow
No	dP	sqrt dP	Time	Time	963.50	delta P	sqrt dP	delta H	Temp	In	Out	Avg	% I	%I	%I	ft/sec	acfm	dscfm
1	0.040	0.20	5.3	5.3	965.40	0.025	0.16	0.47	188	97	79	88	115.61	118	118	10.89	2052	1260
2	0.045	0.21	5.6	10.9	967.40	0.028	0.17	0.47	191	96	79	87.5	109.18	111	114	11.55	2177	1330
3	0.041	0.20	5.6	16.5	969.41	0.028	0.17	0.47	201	99	81	90	110.06	112	114	11.64	2194	1320
4	0.041	0.20	5.7	22.2	971.41	0.029	0.17	0.47	209	98	82	90	106.36	108	112	11.91	2246	1336
5	0.027	0.16	7.2	29.4	973.50	0.046	0.21	0.47	209	104	84	94	69.36	71	104	15.01	2829	1682
6	0.027	0.16	6.7	36.1	975.51	0.040	0.20	0.47	203	103	86	94.5	76.46	78	100	13.93	2626	1576
7	0.032	0.18	6.2	42.3	977.61	0.034	0.18	0.47	194	100	86	93	93.24	95	99	12.76	2404	1463
8	0.040	0.20	6.3	48.6	979.60	0.035	0.19	0.47	192	100	86	93	85.57	87	97	12.92	2436	1486
9	0.035	0.19	5.6	54.2	981.50	0.028	0.17	0.47	190	106	87	96.5	101.96	104	98	11.54	2175	1332
10	0.040	0.20	5.6	59.8	983.30	0.028	0.17	0.47	188	108	89	98.5	96.10	98	98	11.52	2172	1334
11	0.034	0.18	6.5	66.3	985.11	0.038	0.19	0.47	188	104	89	96.5	71.72	73	96	13.42	2530	1554
12	0.027	0.16	6.4	72.7	980.70	0.036	0.19	0.47	184	108	90	99	-180.97	-184	72	13.02	2455	1517
	avg dP	avg. √dP	sample volume		21.610	avg. dP	avg. √dP	dH	Ts		Tm					ft/sec	acfm	dscfm
	0.036	0.188				0.033	0.181	0.40	194.75	ts °F	93.38	tm °F				12.51	2358	1432
avg sqrt dP squared		0.035							654.75	Ts °R	553.38	Tm °R						

* Nre < 3162 continue with calculated ΔH
* Nre > 3162 (recalculate D_{50LL} with Eq.10) use cell Y109 for operating ΔH
* Nre > 3162 Eq.37 for D50

BEAKER/FILTER TARES, FINAL WEIGHTS and GAINS

BISON ENGINEERING LABORATORY RECORD

Facility:	Westen MT College	Location	Dillon MT	Date	Oct 24, 07
Operators:	cwl	Source	Boiler		

Test Run	Sample Description	Sample Volume (mls, #)	Lab Avg TARE grams		Lab Avg FINAL grams		Weight Gains: Net Gains grams	Weight Gains: Gains grams	Blanks per volumes	Final Lab Results
8:50	PM10 cyclone rinse vol & wgts			-		=	0.0000	PM Gain	Acetone	PM gain less blank
	Cyclone PM rinse vol & wgts	45	2.5250	-	2.5321	=	0.0070	0.0574	0.0000	0.0574 grams
	filter # & wgts	0	0.1521	-	0.2025	=	0.0504	Back half	Water	CM gain less blank
	Impinger CM vol & wgts	220	2.5653	-	2.5737	=	0.0083	0.0083	0.0000	0.0083 grams
	MeCL, MCEM vol & wgts	365	2.5610	-	2.5616	=	0.0005	0.0005	MeCL	MCEM gain less blank
	Impinger H2O init & fin vol, mls		200	-	220	=	20	mls	0.0000	0.0005 grams
	silica gel H2O int & fin wgts., grams			-		=	0	grams		
10:23	PM10 cyclone rinse vol & wgts	0		-		=	0.0000	PM Gain	Acetone	PM gain less blank
	Cyclone PM rinse vol & wgts	21	2.5631	-	2.5660	=	0.0028	0.0403	0.0000	0.0402 grams
	filter # & wgts	0	0.1497	-	0.1872	=	0.0375	Back half	Water	CM gain less blank
	Impinger CM vol & wgts	240	2.6027	-	2.6057	=	0.0030	0.003	0.0000	0.003 grams
	MeCL, MCEM vol & wgts	366	2.5508	-	2.5516	=	0.0007	0.0007	MeCL	MCEM gain less blank
	Impinger H2O init & fin vol, mls		200	-	240	=	40	mls	0.0000	0.0007 grams
	silica gel H2O int & fin wgts., grams			-		=	0	grams		
11:50	PM10 cyclone rinse vol & wgts	0		-		=	0.0000	PM Gain	Acetone	PM gain less blank
	Cyclone PM rinse vol & wgts	56	2.5370	-	2.5486	=	0.0116	0.0421	0.0000	0.0421 grams
	filter # & wgts	0	0.1466	-	0.1772	=	0.0305	Back half	Water	CM gain less blank
	Impinger CM vol & wgts	230	2.5583	-	2.5623	=	0.0040	0.004	0.0000	0.004 grams
	MeCL, MCEM vol & wgts	367	2.6173	-	2.6182	=	0.0008	0.0008	MeCL	MCEM gain less blank
	Impinger H2O init & fin vol, mls		200	-	230	=	30	mls	0.0000	0.0008 grams
	silica gel H2O int & fin wgts., grams			-		=	0	grams		
	Acetone Blank vol	100	1.612	-	1.612	=	Blank Gain	0.0000	Percent residue	0.00000 %
	Water Blank vol.	100	1.3126	-	1.3126	=	Blank Gain	0.0000	Percent residue	0 %
	MeCL Blank vol.	100	1.3091	-	1.3091	=	Blank Gain	0.0000	Percent residue	0 %

Report all weights to 0.0001 g. Record sample volumes in colum 4. "Constant weight" means <= 0.0005 g difference between 2 weighings at least 6 hours apart OR 2 <= 1% of the average total weight less average tare weight.

Acetone Blank must be no greater than 0.001 percent residue M5-3.2, negative blank gains, within the tolorance of the scale, shall be counted as zero gain.

Vol (ml)	Sample Identification	Pan #	Date	Tare 1 (g)	Date	Tare 2 (g)	CHECK	Average	Pan #	Date	Final 1 (g)	Date	Final 2 (g)	CHECK	Average	Gain
35	Dillon Acetone Rinse greater than PM-10 R-1	1331	10/24/2007	2.5563	10/25/2007	2.5564	0.0001	2.5564	1331	10/25/2007	2.5598	10/26/2007	2.5598	0.0000	2.5598	0.00345
59	Dillon Acetone Rinse PM-10 R-1	1332	10/24/2007	2.5249	10/25/2007	2.5248	-0.0001	2.5249	1332	10/25/2007	2.5294	10/26/2007	2.5293	-0.0001	2.5294	0.00450
					PM >	5.0812								PM >	5.0892	0.0080
45	Dillon Acetone Rinse PM-2.5 R-1	1333	10/24/2007	2.5250	10/25/2007	2.5249	-0.0001	2.5250	1333	10/25/2007	2.5320	10/26/2007	2.5321	0.0001	2.5321	0.00710
	WMC DNRC low fire run 1	2955	10/16/2007	0.1524	10/17/2007	0.1521	-0.0003	0.1523	2955	10/25/2007	0.2027	10/26/2007	0.2023	-0.0004	0.2025	0.0503
					PM2.5 >	2.6770								PM2.5 >	2.7346	0.0573
64	Dillon Acetone Rinse greater than PM-10 R-2	1334	10/24/2007	2.5382	10/25/2007	2.5381	-0.0001	2.5382	1334	10/25/2007	2.5406	10/26/2007	2.5406	0.0000	2.5406	0.00245
73	Dillon Acetone Rinse PM-10 R-2	1335	10/24/2007	2.5615	10/25/2007	2.5613	-0.0002	2.5614	1335	10/25/2007	2.5625	10/26/2007	2.5627	0.0002	2.5626	0.00120
					PM >	5.0994								PM >	5.1032	0.0036
21	Dillon Acetone Rinse PM-2.5 R-2	1336	10/24/2007	2.5633	10/25/2007	2.5631	-0.0002	2.5632	1336	10/25/2007	2.5660	10/26/2007	2.5660	0.0000	2.5660	0.00280
	WMC DNRC low fire run 2	2956	10/16/2007	0.1499	10/17/2007	0.1497	-0.0002	0.1498	2956	10/25/2007	0.1874	10/26/2007	0.1870	-0.0004	0.1872	0.0374
					PM2.5 >	2.7128								PM2.5 >	2.7532	0.0402
42	Dillon Acetone Rinse greater than PM-10 R-3	1337	10/24/2007	2.5857	10/25/2007	2.5858	0.0001	2.5858	1337	10/25/2007	2.5866	10/26/2007	2.5867	0.0001	2.5867	0.00090
90	Dillon Acetone Rinse PM-10 R-3	1338	10/24/2007	2.5639	10/25/2007	2.5638	-0.0001	2.5639	1338	10/25/2007	2.5662	10/26/2007	2.5665	0.0003	2.5664	0.00250
					PM >	5.1496								PM >	5.1530	0.0034
56	Dillon Acetone Rinse PM-2.5 R-3	1339	10/24/2007	2.5371	10/25/2007	2.5370	-0.0001	2.5371	1339	10/25/2007	2.5485	10/26/2007	2.5486	0.0001	2.5486	0.01150
	WMC DNRC low fire run 3	2957	10/16/2007	0.1468	10/17/2007	0.1466	-0.0002	0.1467	2957	10/25/2007	0.1770	10/26/2007	0.1774	0.0004	0.1772	0.0305
					PM2.5 >	2.6836								PM2.5 >	2.7258	0.0420
50	Dillon MECl R-1	1340	10/24/2007	2.5611	10/25/2007	2.5609	-0.0002	2.5610	1340	10/25/2007	2.5614	10/26/2007	2.5618	0.0004	2.5616	0.00060
50	Dillon MECl R-2	1341	10/24/2007	2.5509	10/25/2007	2.5507	-0.0002	2.5508	1341	10/25/2007	2.5516	10/26/2007	2.5516	0.0000	2.5516	0.00080
50	Dillon MECl R-3	1342	10/24/2007	2.6173	10/25/2007	2.6172	-0.0001	2.6173	1342	10/25/2007	2.6182	10/26/2007	2.6181	-0.0001	2.6182	0.00090
220	Dillon H2O R-1	1343	10/24/2007	2.5653	10/25/2007	2.5653	0.0000	2.5653	1343	10/25/2007	2.5737	10/26/2007	2.5737	0.0000	2.5737	0.00840
240	Dillon H2O R-2	1344	10/24/2007	2.6027	10/25/2007	2.6026	-0.0001	2.6027	1344	10/25/2007	2.6057	10/26/2007	2.6057	0.0000	2.6057	0.00305
230	Dillon H2O R-3	1345	10/24/2007	2.5583	10/25/2007	2.5583	0.0000	2.5583	1345	10/25/2007	2.5623	10/26/2007	2.5623	0.0000	2.5623	0.00400
100	Acetone Blank	1346	10/24/2007	2.5834	10/25/2007	2.5834	0.0000	2.5834	1346	10/25/2007	2.5833	10/26/2007	2.5829	-0.0004	2.5831	-0.00030

Nitrogen Oxide

Calibration Error Check & Sampling System Bias

Zero & Calibration Drift

nitrogen oxide emissions based on MW of 46

Company	UM-Western	**Source**	Boiler	**Testers on site**	0
Facility	Heating Plant	**Date**	10/24/07	**Ambient Temp.**	35 ° F
Location	Dillon, MT	**Sample location**	Dillon, MT	**Comments:**	

Run #		(Rack) Analyzer Cal. Response	Initial Values System Cal. Response	Initial Values System Cal. Bias % of Span	Final Values System Cal. Response	Final Values System Cal. Bias % of Span	Drift % of Span	Analyzer Range & Units	Avg. Gas Conc.	Effluent Gas Conc.	Instrument Calibration Reference Gas
one	Zero	0.0	0.0	0.00	0.0	0.00	0.00	ppmvd			
	Upscale	99.0	98.0	-0.20	95.0	-0.80	-0.60	500	41.5	41.84	97.3
two	Zero	0.0	0.0	0.00	0.0	0.00	0.00	ppmvd			
	Upscale	99.0	95.0	-0.80	97.0	-0.40	0.40	500	39.7	40.20	97.3
three	Zero	0.0	0.0	0.00	0.0	0.00	0.00	ppmvd			
	Upscale	99.0	97.0	-0.40	97.0	-0.40	0.00	500	62.7	62.86	97.3
			LIMITS	+/- 5%		+/- 5%	+/- 3%		AVG	36.23	

Zero and Calibration Gases		
Zero gas	Mid Cal	High Cal
O2 CO2	97.3	251

ZERO Cal. Gas Analyzer Response	Analyzer Calib. Error	MID Cal. Gas Analyzer Response	Analyzer Calib. Error	HIGH Cal. Gas Analyzer Response	Analyzer Calib. Error
0	0.00	99	0.34	249	-0.40
0	0.00		-19.46		-50.20
LIMIT	+/- 2%		+/- 2%		+/- 2%

	Run 1 NOx	Run 2 NOx	Run 3 NOx	Run 4 NOx
1	43	42	57	
2	40	52	63	
3	39	38	68	
4	49	34		
5	41	40		
6	37	32		
	41.50	39.67	62.67	ERR

Carbon Monoxide
Calibration Error Check & Sampling System Bias
Zero & Calibration Drift

carbon monoxide emissions based on MW of 28

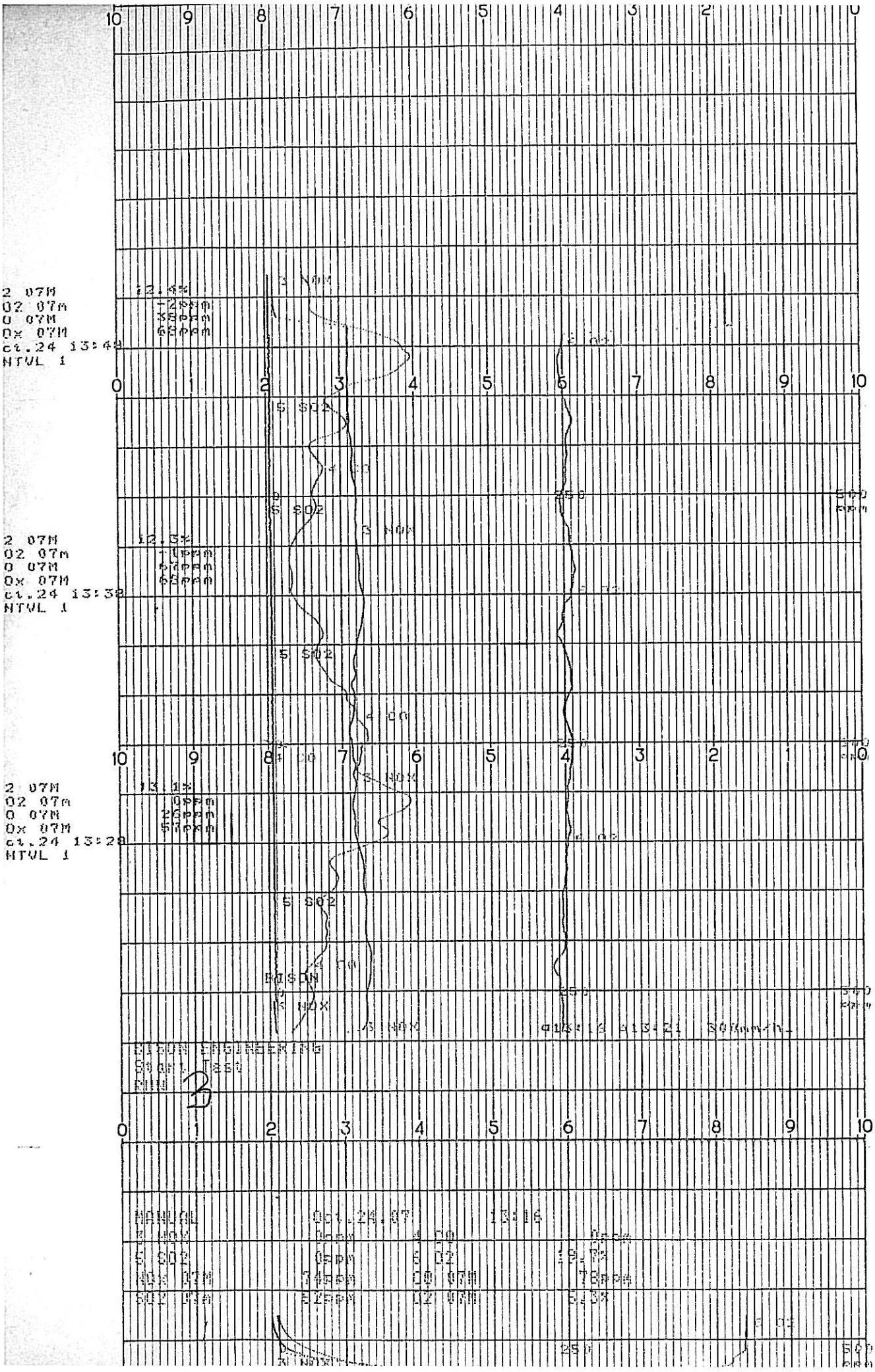
Company:	UM-Western	**Source:**	Boiler
Facility:	Heating Plant	**Date:**	10/24/07
Location:	Dillon, MT		

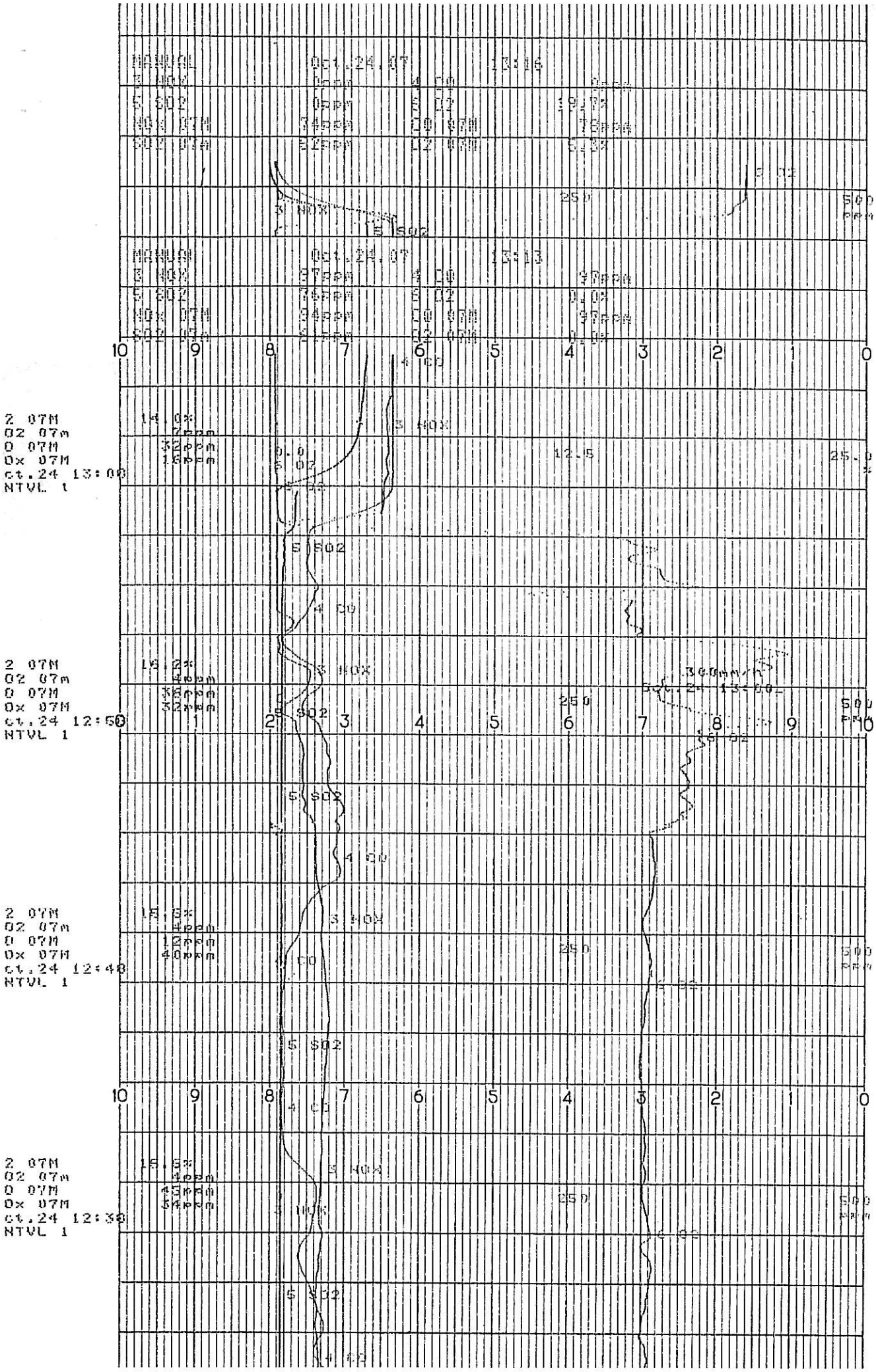
Run #		(Rack) Analyzer Cal. Response	Initial Values System Cal. Response	Initial Values System Cal. Bias % of Span	Final Values System Cal. Response	Final Values System Cal. Bias % of Span	Drift % of Span	Analyzer Range & Units	Avg. Gas Conc.	Effluent Gas Conc.	Instrument Calibration Reference Gas
one	Zero	0.0	0.0	0.00	0.0	0.00	0.00	ppmvd			
	Upscale	100.0	99.0	-0.20	98.0	-0.40	-0.20	500	22.8	23.88	103
two	Zero	0.0	0.0	0.00	0.0	0.00	0.00	ppmvd			
	Upscale	100.0	98.0	-0.40	97.0	-0.60	-0.20	500	25.3	26.76	103
three	Zero	0.0	0.0	0.00	0.0	0.00	0.00	ppmvd			
	Upscale	100.0	97.0	-0.60	97.0	-0.60	0.00	500	43.7	46.37	103
			LIMITS	+/- 5%		+/- 5%	+/- 3%		AVG	ERR	

Zero and Calibration Gases		
Zero gas	Mid Cal	High Cal
O2 CO2	103	250

ZERO Cal. Gas Analyzer Response	Analyzer Calib. Error	MID Cal. Gas Analyzer Response	Analyzer Calib. Error	HIGH Cal. Gas Analyzer Response	Analyzer Calib. Error
0	0.00	100	-0.60	251	0.20
	0.00		-20.60		-50.00
LIMIT	+/- 2%		+/- 2%		+/- 2%

	Run 1 CO	Run 2 CO	Run 3 CO	Run 4 CO
1	16	25	26	
2	11	3	67	
3	20	31	38	
4	4	45		
5	43	12		
6	43	36		
	22.83	25.33	43.67	ERR


2 07M
02 07M
0 07M
Ox 07M
ct.24 13:48
NTVL 1
2 07M
02 07M
0 07M
Ox 07M
ct.24 13:38
NTVL 1
2 07M
02 07M
0 07M
Ox 07M
ct.24 13:28
NTVL 1
S SO2
S NOX
S CO
PASSIN
S NOX
0300cm
0315cm


2 07M
O2 07m
O 07M
Ox 07M
ct.24 13:00
NTVL 1
2 07M
O2 07m
O 07M
Ox 07M
ct.24 12:50
NTVL 1
2 07M
O2 07m
O 07M
Ox 07M
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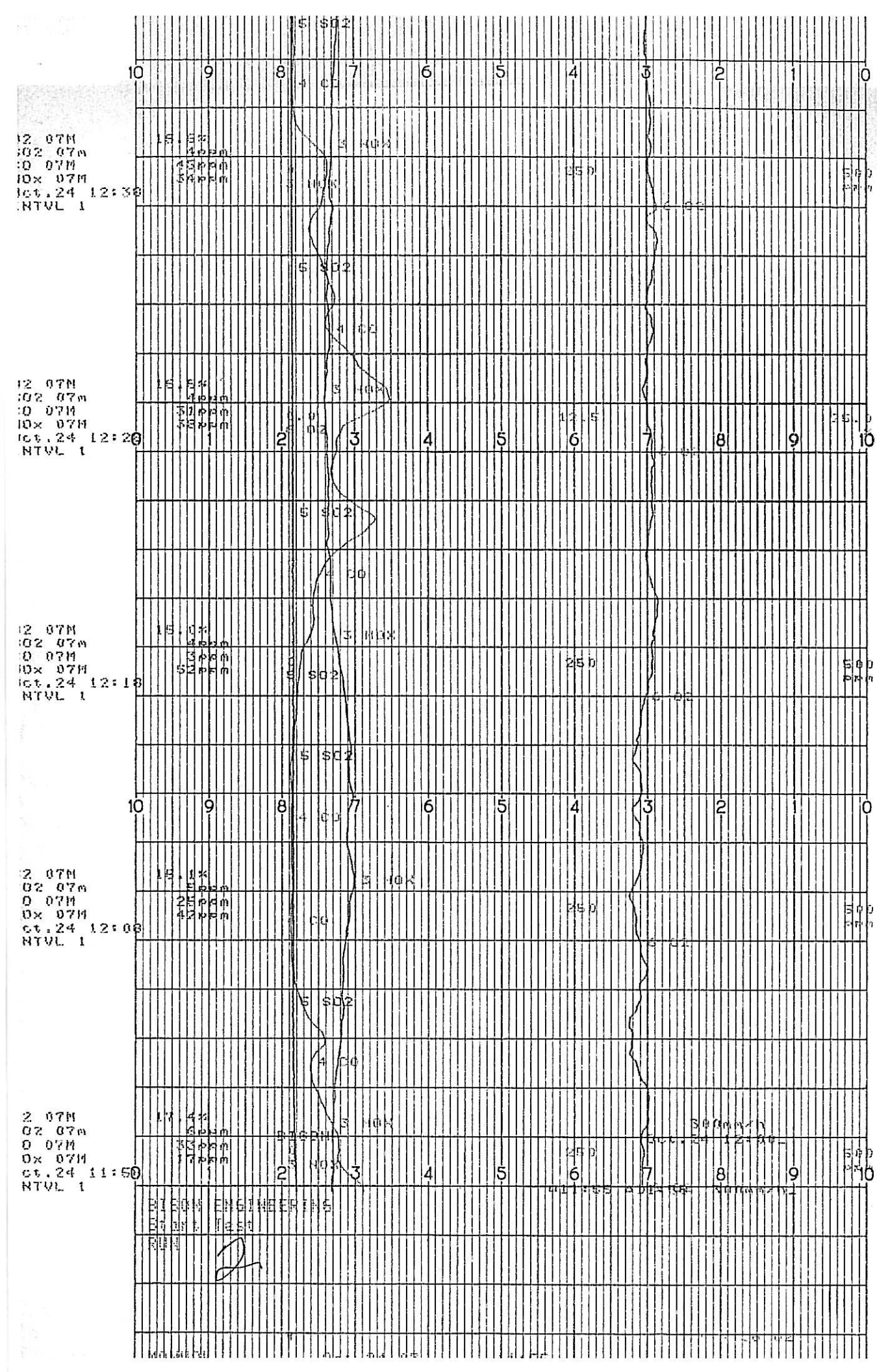
NTVL 1
2 07M
O2 07m
O 07M
Ox 07M
ct.24 12:30
NTVL 1
0330cm
0345cm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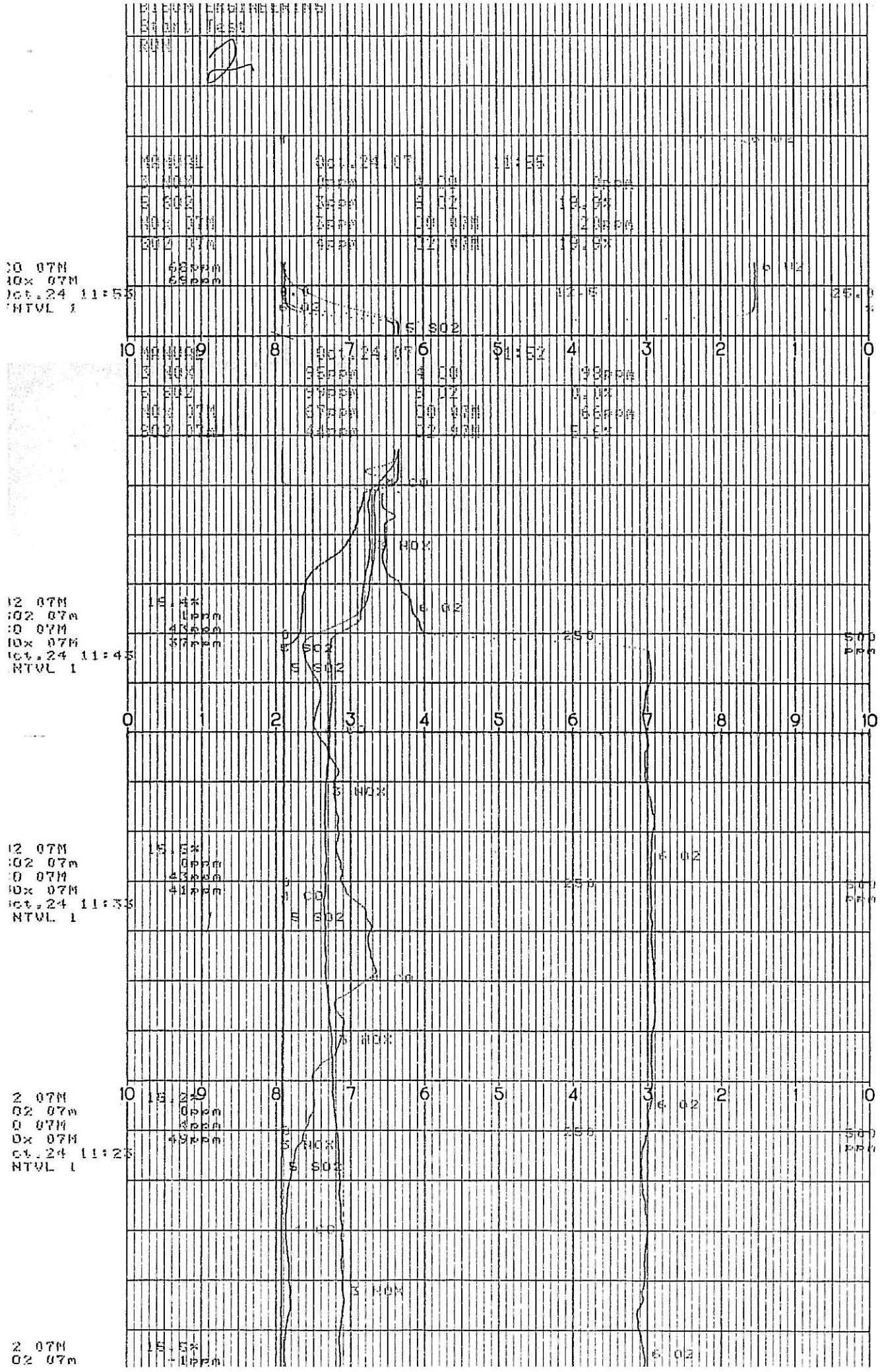
0360cm
10 9 8 7 6 5 4 3 2 1 0
5 SO2
4 CO
3 NOX
15.5%
40ppm
43ppm
34ppm
250
500
12:30
15.5%
40ppm
30ppm
32ppm
12:20
15.0%
40ppm
33ppm
52ppm
12:10
15.1%
8ppm
28ppm
42ppm
12:00
17.4%
8ppm
32ppm
17ppm
11:50
BLACK ENGINEERING
Black Tech
RUN


0 07M
10x 07M
Oct.24 11:55
NTVL 1
5 SO2
6 O2
NOX
12 07M
SO2 07m
0 07M
10x 07M
Oct.24 11:45
NTVL 1
15.4%
1ppm
43ppm
37ppm
5 SO2
250
500
ppm
5 NOX
15.5%
0ppm
43ppm
41ppm
5 CO
2 07M
O2 07m
0 07M
0x 07M
Oct.24 11:25
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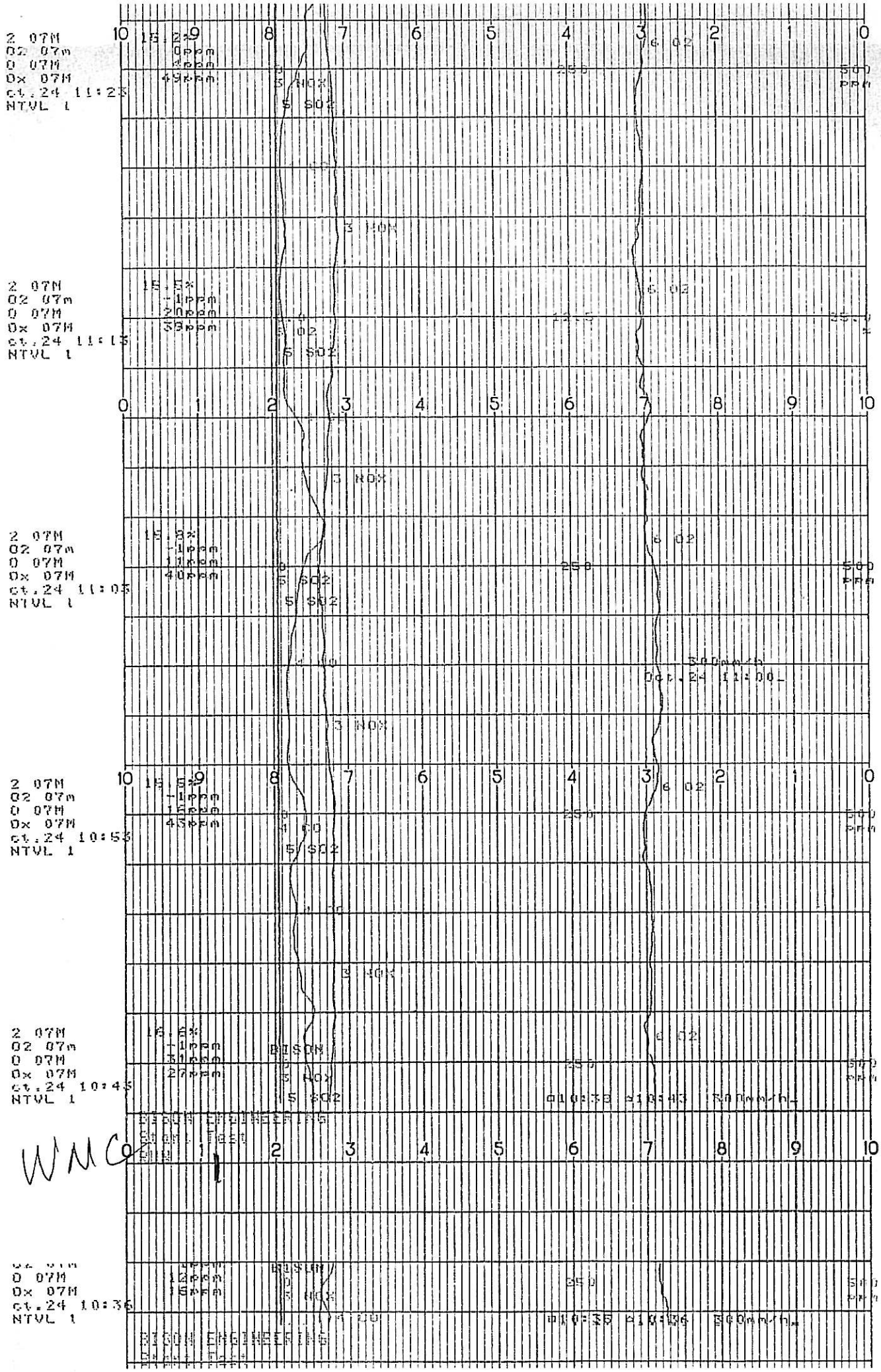
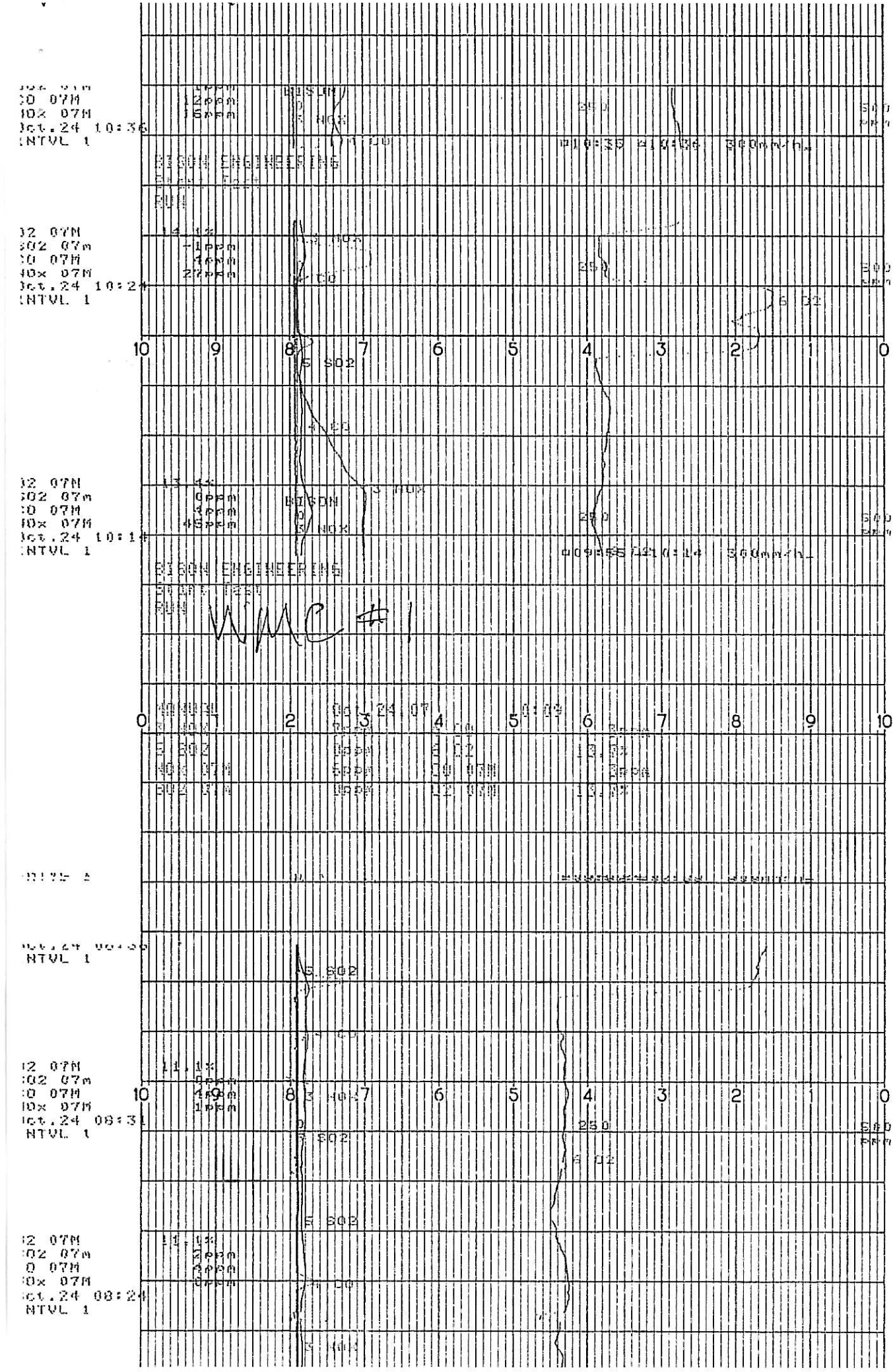
15.2%
0ppm
49ppm
5 NOX
5 SO2
CO
15.5%
-1ppm
0375cm
0390cm



WMC

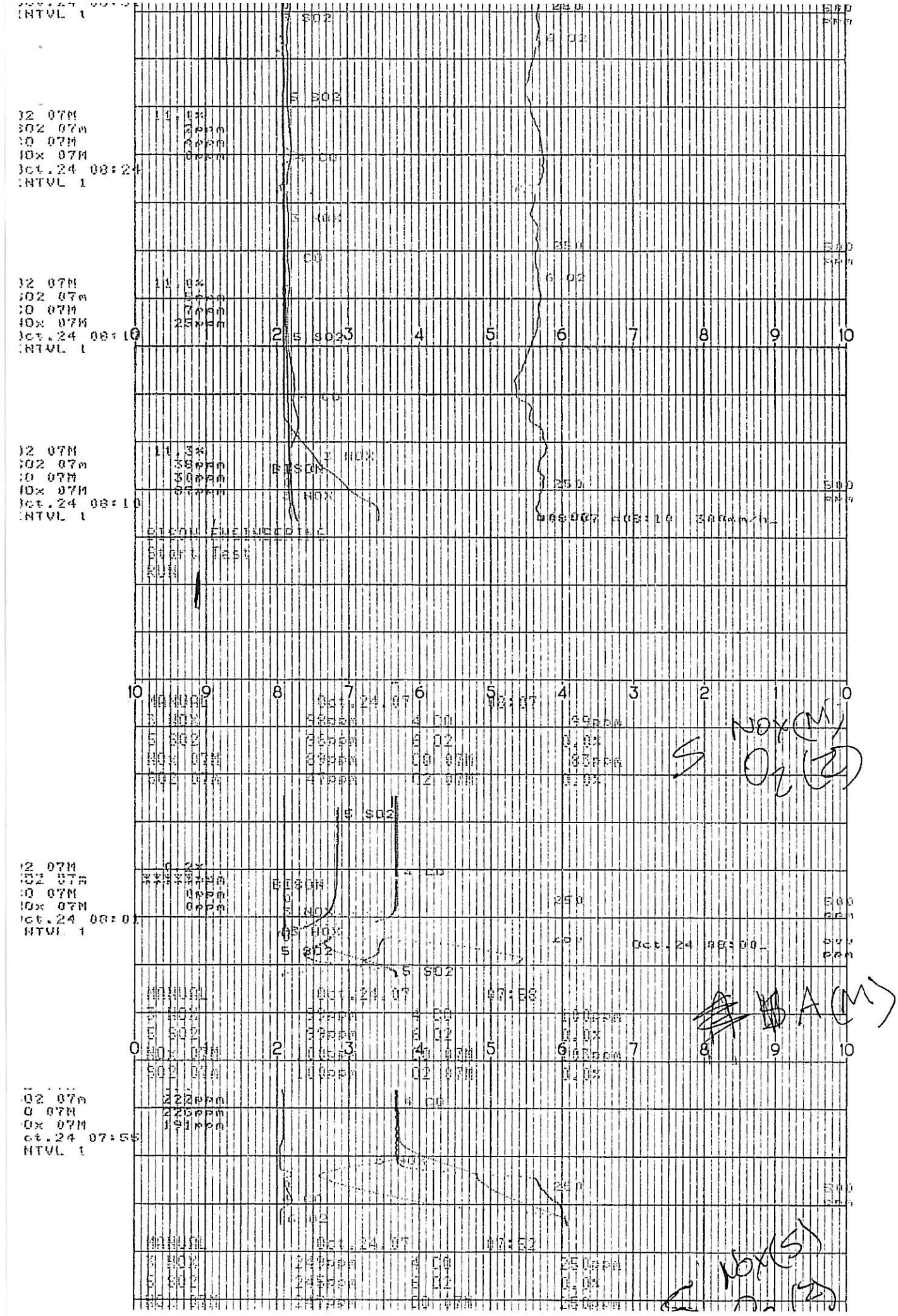
0390cm

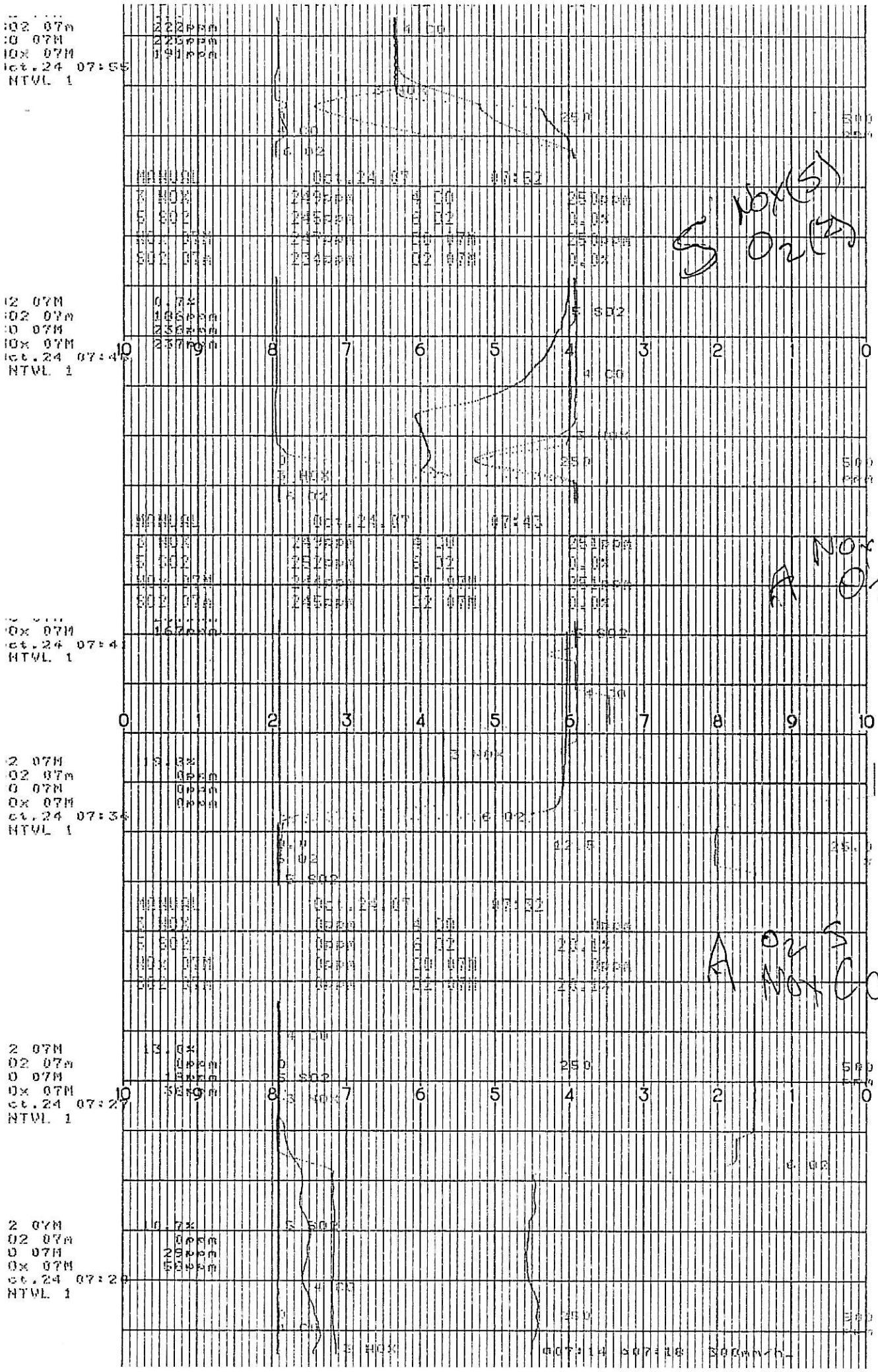
0405cm



0420cm

0435cm


0435cm
0450cm
S SO2
S NOx(M)
S O2(M)
A(M)
S NOx(S)
S O2(S)
Oct.24 08:00
Oct.24 07:55
INTVL 1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NTVL 1
NTVL 1
NTVL 1
NTVL 1
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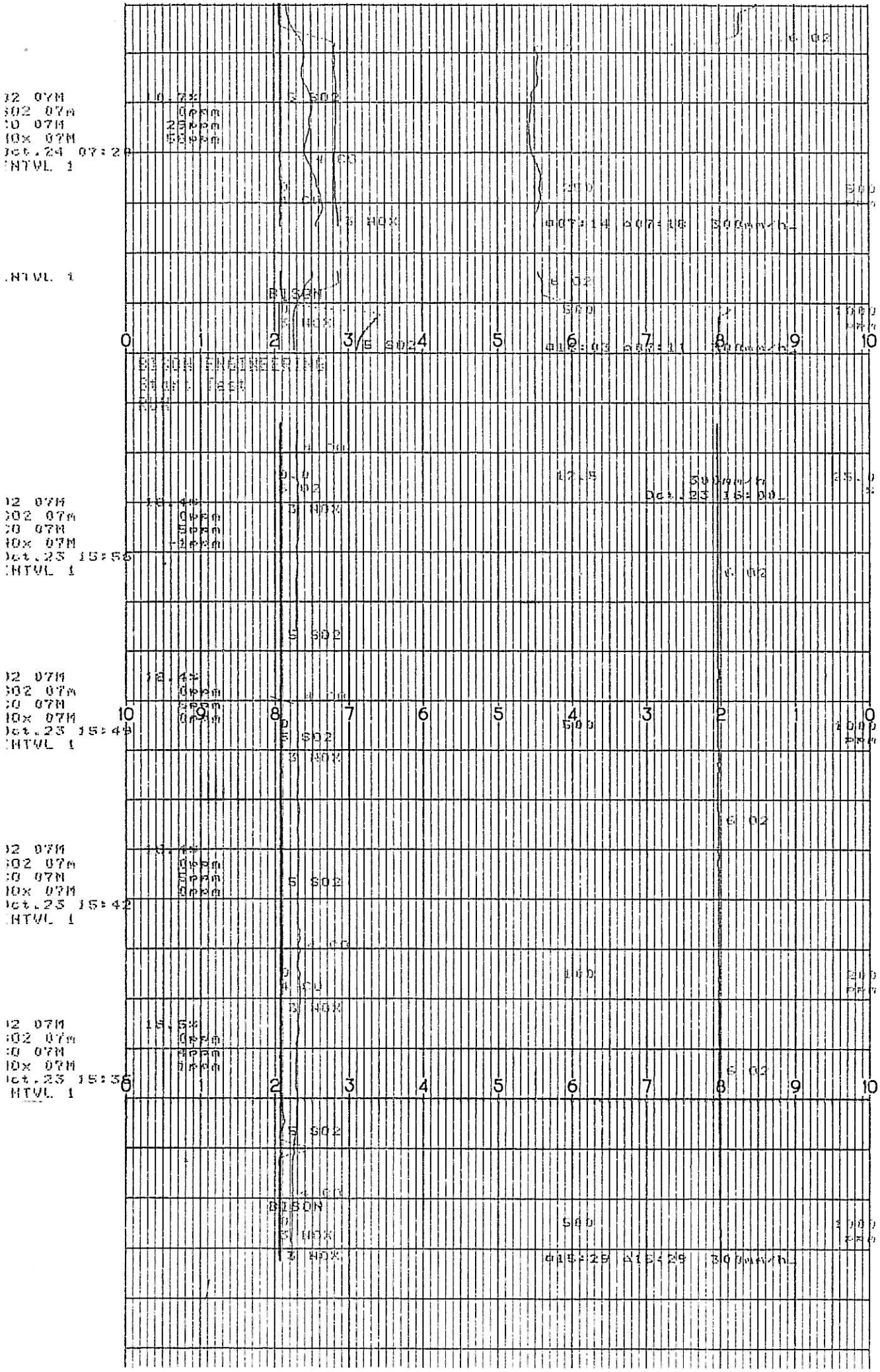
0480cm


0480cm
0495cm
SO2
NOx
BISON
0 1 2 3 4 5 6 7 8 9 10

APPENDIX B:
HIGH-FIRE TEST DATA

CT40 PM2.5

Client	UM-Western				Number of Runs
Facility	Heating Plant				
Location	Dillon, Mt				3
Source	Boiler				
Test date		12-6-07	12-6-07	12-6-07	
Start time		10:09	0	0	
Test run		one	Two	Three	
Preliminary info					
Barometric pressure [Bp]	"Hg	24.72	24.72	24.72	
Stack Diameter	inch	24	24	24	
stack exit area	sqft	3.14	3.14	3.14	
Meter box ID		3	3	3	
meter box Yi		1.003	1.049	1.049	
meter box delta H@		1.768	1.849	1.849	
Pitot tube coefficient Cp		0.84	0.84	0.84	
Test Information					
nozzle size [nz]	inch	0.300	0.264	0.264	
filter number		2934	2935	2936	
Sample points		24	24	24	
Test duration	min	90	100	100	
Isokinetics [i]	%	108	91	88	
D50 cut rate		9.99	9.89	10.16	
Sample volume, eq 4.3	dscf	30.26	34.02	32.62	
avg delta P	"H2O	0.075	0.169	0.162	
avg sqrt delta P	"H2O	0.272	0.411	0.399	
Constant sample rate delta H	"H2O	0.424	0.470	0.444	
avg meter temp [Tm]	deg F	50.1	65.3	71.1	
Stack Information					AVERAGES
avg stack temp [Ts]	deg F	264	232	208	235
actual stack flow	acfm	3733	5515	5256	4835
actual stack velocity [Vs]	ft/sec	20	29	28	26
Standard stack flow	dscfm	1997	3101	3062	2720
Standard stack flow	dscf/hr	119806	186089	183717	
stack moisture [bws], eq 4.4	% v/v	11.31	10.85	10.70	11
measured static pressure	"H2O	0.05	0.05	0.05	0
stack static pressure [ps]	"Hg	24.72	24.72	24.72	24.72
Oxygen content	%O2	11	10.8	10.8	11
Carbon dioxide content	%CO2	8.3	8.3	8.3	8
Wet (Actual) Molecular Weight, Ms	lb/lb.mole	28.4	28.5	28.5	28.5
Dry Molecular Weight, Md	lb/lb.mole	29.8	29.8	29.8	29.8
Lab Information					
Impinger H2O Gain	mls	82	88	83	84
Impinger H2O volume [Vwc(STD)], eq 4.1	scf	3.86	4.14	3.91	3.97
Silica Gel H2O Gain	grams (g)	7.1	7.9	7.4	7.5
Silica Gel volume [Vsg(STD)], eq 4.2	scf	0.33	0.37	0.35	0.35
2.5 < Particulate Matter < 10 weight gain	g	0.0227	0.0105	0.0131	0.0154
2.5 < Particulate Matte < 10	gr	0.3503	0.1620	0.2022	0.2382
< PM2.5 weight gain	g	0.0045	0.0032	0.0055	0.0044
< PM2.5	gr	0.0694	0.0494	0.0849	0.0679
Filter weight gain	g	0.0974	0.1235	0.1009	0.1073
Filter weight gain	gr	1.5031	1.9059	1.5571	1.6554
Condensible Particulate Matter (CPM)	g	0.0055	0.0057	0.0043	0.0052
CPM	gr	0.0849	0.0880	0.0664	0.0797
- Factor (dry), from lab analysis (@0% O2)	dscf/MMBtu	10399	10399	10399	
F-Factor (dry) corrected to Run O2 content	dscf/MMBtu	21953	21519	21519	
Emissions					AVERAGES
Particulate Matter < 2.5 microns (PM2.5)	gr/dscf	0.055	0.060	0.052	0.056
PM2.5, concentration	lbs/dscf	7.825E-06	8.580E-06	7.481E-06	7.962E-06
PM2.5, mass rate	lbs/hr	0.94	1.03	0.90	0.954
PM2.5, emission factor	lbs/MMBtu	0.172	0.185	0.161	0.172
Boiler operating rate	MMBtu/hr	5.46	8.65	8.54	7.55

Client		**UM-Western**				
Location		**Dillon, MT**				
Source		**Boiler**				
Test date			12/6/07	12/6/07	12/6/07	
Preliminary info			**Run 1**	**Run 2**	**Run 3**	
Barometric pressure	Bp	"Hg	24.72	24.72	24.72	
Method 1 Information						
Stack Diameter	ID	inch	24	24	24	
stack exit area	A	sqft	3.14	3.14	3.14	
Sample points			24	24	24	
Method 2 or 2A Information						
Pitot tube coefficient			0.84	0.84	0.84	
Stagnation pressure		in H2O	0.05	0.05	0.05	
Absolute stack gas pressure	Ps	in Hg	24.72	24.72	24.72	
avg Delta P		in H2O	0.08	0.17	0.16	
avg sqrt Delta P			0.27	0.41	0.40	
avg stack temp	Ts	deg F	264	232	208	
actual stack velocity, eq 2.9	Vs	ft/sec	19.9	29.2	27.9	
actual stack flow		acfm	3740	5509	5247	
Standard stack flow per minute		dscfm	1979	3063	3031	
Standard stack flow per hour, eq 2.10	Qsd	dscfh	118732	183799	181865	
Method 3 or 3A Information						
Percent oxygen by volume dry		%O2	11	10.8	10.8	
Percent carbon dioxide dry		%CO2	8.3	8.3	8.3	
Dry Molecular Weight eq 3.1	Md	lb/lb.mole	30	30	30	
Wet (Actual) Molecular Weight eq 2.5	Mw	lb/lb.mole	28.56	28.56	28.56	
Method 4 Information						
DGM calibrations factor	Y		1.003	1.049	1.049	
DGM avg inlet/outlet temperature		deg F	50.33	68.58	70.88	
Sample duration		min	90	100.1	96.5	
Volume of gas collected, eq 4.3	Vmstd	dscf	30.2	33.8	32.6	
Impinger H2O volume gain		mls	82	88	83	
Impinger H2O volume, eq 4.1	Vwcstd	scf	3.86	4.14	3.91	
Silica Gel H2O weight gain		g	7.1	7.9	7.4	
Silica Gel volume, eq 4.2	Vwsgstd	scf	0.335	0.372	0.349	
Water vapor proportion by vol, eq 4.4	Bws	% v/v	12.18	11.78	11.54	Three run
Emissions						**AVERAGES**
NOx source concentration		ppmvd	45.20	85.46	67.43	66.028
NOx mass rate		lbs/hr	0.64	1.88	1.46	1.327
NOx		lbs/dscf	5.39E-06	1.02E-05	8.03E-06	7.882E-06
CO source concentration		ppmvd	174.55	175.20	171.99	173.915
CO mass rate		lbs/hr	1.51	2.34	2.27	2.040
CO		lbs/dscf	1.27E-05	1.27E-05	1.25E-05	1.264E-05
Emission Factors per Reference Method 19, Eq. 19.1						**AVERAGES**
lab analysis Fd @ 0% oxygen		dscf/MMBtu @ 0%	10399	10399	10399	**10399**
lab analysis Fd @ stack conditions		dscf/MMBtu @ SK	21953	21519	21519	**21664**
NOx pounds per milllion Btu, lab Fd		lbs/MMBtu, lab	0.118	0.220	0.173	**0.170**
CO pounds per milllion Btu, lab Fd		lbs/MMBtu, lab	0.279	0.274	0.269	**0.274**
Boiler operating rate		MMBtu/hr	5.41	8.54	8.45	**7.467**

Bison Engineering, CT40 PM2.5 Spreadsheet **Test Run 1**

Facility:	UM-Western		**Location:**	Dillon, Mt	**Date:**		12-6-07
Operators:	ws	**Filter #** 2934	**Source:**	Boiler	**Run #**	one	**Start time:** 10:09

PRELIMINARY INFO.

Pm	Bp			24.72	("Hg)
	Diam	Lngth	Wdth	Rnd sqft	Rect. sqft
(inches)	24			3.14	0
	Stack AREA			3.14	(sqft)
	Yi			1.003	
	Delta H@			1.768	

PRE TEST INFO

	Assumed moisture	11.50	(%)
	Assumed Meter Temp	54.00	(deg F)
	Run Time	90.00	(min)
	Total Number of Points	24	

TRAVERSE INFO

Pg	Static, gage pressure	0.05	("H2O)
	Stack Temp	250.0	(deg F)
O2	Oxygen	11.00	(% v/v)
CO2	Carbon Dioxide	8.30	(% v/v)

PM10 OPERATING DATA

us	assumed Stack viscosity	215.560	(micropoise)
Qs	assumed Cylone flow rate	0.613	(ft^3/min)

OPERATING PRESSURE HEAD

OPERATING Delta H ==> 0.42 ("H20)

NOZZLE SELECTION

.136 .15 .164 .182 .197 .215 .233 .264 .3 .342 .39

Nd **Nozzle Diameter** 0.3 (inches)

MIN AND MAX DELTA P PARAMETERS

delta P (min)	ERR	("H20)
AVERAGE Delta P ===>	ERR	
delta P (max)	0.178	("H20)

LOW FLOW - ALTERNATIVE READINGS

Low Flow - delta P (min)	0.021	("H20)
AVE (low flow) Delta P ==>	0.104	
Low Flow - delta P (max)	0.187	("H20)

POST TEST INFO

Impinger water 82 Silica gel 7.1 (g)

CALCULATED RESULTS

Ps	Stack pressure, Ps	24.72	(" Hg)
	Stack Area (rnd), (sqft)	3.14	(sqft)
Tm	Avg Meter Temperature	50.08	(deg F)
Ts	Avg Stack Temperature	263.75	(deg F)
Bws	% H2O in Stack	11.31	(Bws)
Mw	Wet Molecular Weight	28.44	(lb/lb.mole)
Md	Dry Molecular Weight	29.77	(lb/lb.mole)
	Avg sqrt delta P	0.272	
Vs	Sample Volume	30.26	(dscf)
us	Stack Viscosity	219.44	(micropoise)
Qs std	Actual Cyclone Flow Rate	0.63	(ft^3/min)
I	Isokinetic Avg, { 80 < I > 120 }	108	(%)
D50	D50 Cut Rate, { 9 < d50 > 10 }	9.99	(um)

Revised Sept 08/01 by CWL

METHOD 201A PM10 TESTING

Test No	Pre traverse dP	Pre traverse sqrt dP	Point Time	Run Time	MetrVol 593.170	Vel head delta P	Calc. delta H	Stack Temp	Meter Temp In	Meter Temp Out	Meter Temp Avg	Point % I	Rolling %I
1	0.105	0.3240	4.45	4.5	594.950	0.100	0.415	228	49	50	49.5	92.6	92.6
2	0.109	0.3302	4.67	9.1	596.670	0.110	0.417	238	48	50	49	82.0	87.3
3	0.100	0.3162	4.45	13.6	598.330	0.100	0.416	237	47	50	48.5	87.1	87.2
4	0.087	0.2950	4.23	17.8	599.880	0.090	0.419	248	48	51	49.5	90.9	88.2
5	0.071	0.2665	3.73	21.5	601.330	0.070	0.422	257	48	52	50	109.9	92.5
6	0.082	0.2864	3.98	25.5	602.830	0.080	0.422	258	48	51	49.5	99.7	93.7
7	0.044	0.2098	2.82	28.3	603.930	0.040	0.421	256	48	50	49	146.1	101.2
8	0.054	0.2324	3.15	31.5	605.160	0.050	0.422	258	47	52	49.5	130.7	104.9
9	0.058	0.2408	3.45	34.9	606.400	0.060	0.422	256	48	53	50.5	109.5	105.4
10	0.067	0.2588	3.73	38.7	607.790	0.070	0.422	253	49	53	51	104.9	105.3
11	0.061	0.2470	3.45	42.1	609.120	0.060	0.421	251	50	52	51	116.9	106.4
12	0.073	0.2702	3.73	45.8	610.590	0.070	0.421	248	49	55	52	110.3	106.7
13	0.105	0.3240	4.45	50.3	612.380	0.100	0.424	264	51	50	50.5	95.3	105.8
14	0.097	0.3114	4.45	54.7	614.110	0.100	0.432	295	50	54	52	93.8	105.0
15	0.096	0.3098	4.45	59.2	615.780	0.100	0.431	294	50	51	50.5	90.8	104.0
16	0.098	0.3130	4.45	63.7	617.480	0.100	0.431	296	49	51	50	92.6	103.3
17	0.088	0.2966	4.23	67.9	619.120	0.090	0.428	285	48	52	50	98.6	103.0
18	0.067	0.2588	3.73	71.6	620.550	0.070	0.428	288	49	49	49	110.9	103.5
19	0.044	0.2098	2.82	74.4	621.710	0.040	0.426	280	49	49	49	156.6	106.3
20	0.052	0.2280	3.15	77.6	622.840	0.050	0.426	276	50	50	50	121.5	107.0
21	0.068	0.2608	3.73	81.3	624.340	0.070	0.425	268	50	51	50.5	114.5	107.4
22	0.067	0.2588	3.73	85.0	625.710	0.070	0.425	268	51	50	50.5	104.5	107.3
23	0.071	0.2665	3.73	88.8	627.180	0.070	0.424	264	51	50	50.5	111.9	107.5
24	0.054	0.2324	3.15	91.9	628.430	0.050	0.424	264	51	50.00	50.5	133.2	108.5
25		0.0000	0.00	91.9			ERR				ERR	ERR	ERR
avg dP		0.07575	Volume		35.260	dP	dH	Ts		Tm			
avg sqrt dP		0.2728				0.08	0.08	263.75		50.08			

avg sqrt dP squared 0.074

STACK

ACTUAL Vel. ft/sec	ACTUAL Flow acfm	STANDARD Vel. dsft/sec	STANDARD Flow dscfm
22.46	4234	12.63	2381
23.73	4473	13.16	2480
22.61	4262	12.55	2366
21.62	4075	11.82	2227
19.19	3617	10.35	1952
20.53	3869	11.06	2085
14.49	2732	7.83	1476
16.23	3059	8.75	1648
17.75	3346	9.59	1808
19.13	3607	10.38	1957
17.69	3334	9.63	1815
19.07	3594	10.42	1964
23.04	4344	12.32	2322
23.53	4436	12.06	2273
23.52	4433	12.07	2275
23.55	4439	12.05	2272
22.18	4180	11.52	2171
19.60	3694	10.14	1911
14.73	2777	7.70	1452
16.43	3097	8.64	1628
19.33	3644	10.28	1937
19.33	3644	10.28	1937
19.28	3634	10.30	1942
16.29	3072	8.71	1642
0.00	0	0.00	0
ft/sec	acfm	dsft/sec	dscfm
19.81	3733	10.59	1997

Bison Engineering, CT40 PM2.5 Spreadsheet

Test Run 2

FACILITY:	UM-Western			LOCATION:	Dillon, Mt	DATE:	12-6-07
Operators:	cwl	Filter #	2935	SOURCE:	Boiler	RUN #: Two	Start time:

PRELIMINARY INFO.

Pm	Bp				24.72	("Hg)
	Diam	Lngth	Wdth	Rnd sqft	Rect. sqft	
(inches)	24	0	0	3.14	0	
	Stack AREA			3.14		(sqft)
	Yi			1.049		
	Delta H@			1.849		

PRE TEST INFO

	Assumed moisture	11.50	(%)
	Assumed Meter Temp	65.00	(deg F)
	Run Time	100.00	(min)
	Total Number of Points	24	

TRAVERSE INFO

Pg	Static, gage pressure	0.05	("H2O)
	Stack Temp	231.0	(deg F)
O2	Oxygen	10.80	(% v/v)
CO2	Carbon Dioxide	8.30	(% v/v)

PM10 OPERATING DATA

us	assumed Stack viscosity	215.560	(micropoise)
Qs	assumed Cylone flow rate	0.609	(ft^3/min)

OPERATING PRESSURE HEAD

OPERATING Delta H ==> 0.47 ("H20)

NOZZLE SELECTION

.136 .15 .164 .182 .197 .215 .233 .264 .3 .342 .39

Nd Nozzle Diameter 0.264 (inches)

MIN AND MAX DELTA P PARAMETERS

delta P (min)	ERR	("H20)
AVERAGE Delta P ===>	ERR	
delta P (max)	0.270	("H20)

LOW FLOW - ALTERNATIVE READINGS

Low Flow - delta P (min)	0.035	("H20)
AVE (low flow) Delta P ==>	0.175	
Low Flow - delta P (max)	0.316	("H20)

POST TEST INFO

Impinger water 88 Silica gel 7.9 (g)

CALCULATED RESULTS

Ps	Stack pressure, Ps	24.72	(" Hg)
	Stack Area (rnd), (sqft)	3.14	(sqft)
Tm	Avg Meter Temperature	65.33	(deg F)
Ts	Avg Stack Temperature	231.67	(deg F)
Bws	% H2O in Stack	10.85	(Bws)
Mw	Wet Molecular Weight	28.48	(lb/lb.mole)
Md	Dry Molecular Weight	29.76	(lb/lb.mole)
	Avg sqrt delta P	0.411	
Vs	Sample Volume	34.02	(dscf)
us	Stack Viscosity	210.97	(micropoise)
Qs std	Actual Cyclone Flow Rate	0.61	(ft^3/min)
I	Isokinetic Avg, { 80 < I > 120 }	91	(%)
D50	D50 Cut Rate, { 9 < d50 > 10 }	9.89	(um)

29.25857

Revised Sept 08/01 by CWL

METHOD 201A PM10 TESTING

Test No	Pre traverse dP	Pre traverse sqrt dP	Point Time	Run Time	MetrVol 299.400	Vel head delta P	Calc. delta H	Stack Temp	Meter Temp In	Meter Temp Out	Meter Temp Avg	Point % I	Rolling %I
1	0.160	0.4000	4.05	4.0	300.980	0.160	0.448	220	74	63	68.5	92.7	92.7
2	0.170	0.4123	4.17	8.2	302.520	0.170	0.448	220	74	64	69	84.9	88.8
3	0.180	0.4243	4.17	12.4	304.150	0.170	0.452	234	73	67	70	90.6	89.4
4	0.180	0.4243	4.17	16.6	305.830	0.170	0.452	232	74	65	69.5	93.4	90.4
5	0.190	0.4359	4.17	20.7	307.460	0.170	0.452	231	75	66	70.5	90.4	90.4
6	0.190	0.4359	4.17	24.9	309.060	0.170	0.450	232	72	63	67.5	89.3	90.2
7	0.190	0.4359	4.41	29.3	310.690	0.190	0.445	230	67	59	63	81.9	89.0
8	0.190	0.4359	4.41	33.7	312.300	0.190	0.444	227	65	60	62.5	80.8	88.0
9	0.190	0.4359	4.41	38.1	313.900	0.190	0.445	226	66	61	63.5	80.1	87.1
10	0.180	0.4243	4.17	42.3	315.570	0.170	0.445	225	66	61	63.5	93.4	87.8
11	0.170	0.4123	4.05	46.4	317.300	0.160	0.441	227	55	63	59	103.9	89.2
12	0.150	0.3873	3.92	50.3	318.850	0.150	0.440	225	54	62	58	99.3	90.1
13	0.130	0.3606	4.05	54.3	320.570	0.160	0.442	229	55	64	59.5	103.3	91.1
14	0.140	0.3742	4.17	58.5	322.000	0.170	0.444	230	58	65	61.5	80.6	90.3
15	0.160	0.4000	4.17	62.7	323.930	0.170	0.445	230	60	66	63	108.4	91.5
16	0.170	0.4123	4.05	66.7	325.470	0.160	0.447	232	60	68	64	91.9	91.6
17	0.170	0.4123	4.05	70.8	327.100	0.160	0.449	237	61	69	65	97.4	91.9
18	0.170	0.4123	4.17	74.9	328.740	0.170	0.449	236	61	71	66	92.0	91.9
19	0.170	0.4123	4.17	79.1	330.420	0.170	0.451	238	62	72	67	94.2	92.0
20	0.170	0.4123	4.17	83.3	332.120	0.170	0.451	238	63	72	67.5	95.3	92.2
21	0.18	0.4243	4.29	87.6	333.980	0.18	0.451	239	62	73	67.5	98.5	92.5
22	0.17	0.4123	4.17	91.7	335.400	0.17	0.451	238	62	73	67.5	79.6	91.9
23	0.16	0.4000	4.05	95.8	336.900	0.16	0.452	242	62	73	67.5	89.6	91.8
24	0.15	0.3873	4.05	99.8	338.430	0.16	0.452	242	62	73	67.5	91.4	91.8
25		0.0000	0.00	99.8			ERR				ERR	ERR	ERR
avg dP		0.17	Volume		39.030	dP	dH	Ts		Tm			
avg sqrt dP		0.41185				0.17	0.17	231.67		65.33			

avg sqrt dP squared 0.17

STACK			
ACTUAL		STANDARD	
Vel. ft/sec	Flow acfm	Vel. dsft/sec	Flow dscfm
28.23	5321	16.14	3043
29.10	5484	16.64	3137
29.39	5540	16.47	3105
29.35	5532	16.50	3110
29.33	5528	16.51	3112
29.35	5532	16.50	3110
30.98	5840	17.47	3292
30.92	5828	17.50	3299
30.89	5823	17.52	3302
29.20	5504	16.58	3125
28.37	5348	16.06	3028
27.43	5170	15.58	2936
28.41	5356	16.04	3023
29.31	5524	16.52	3114
29.31	5524	16.52	3114
28.47	5367	16.00	3017
28.58	5387	15.95	3006
29.44	5548	16.45	3101
29.48	5556	16.43	3096
29.48	5556	16.43	3096
30.35	5722	16.89	3184
29.48	5556	16.43	3096
28.68	5406	15.89	2995
28.68	5406	15.89	2995
0.00	0	0.00	0
ft/sec	acfm	dsft/sec	dscfm
29.26	5515	16.45	3101

Bison Engineering, CT40 PM2.5 Spreadsheet

Test Run 3

FACILITY:	UM-Western		LOCATION:	Dillon, Mt	DATE:		12-6-07
Operators:	ws	Filter # 2936	SOURCE:	Boiler	RUN #:	Three	Start time:

PRELIMINARY INFO.

Pm	Bp				24.72	("Hg)
	Diam	Lngth	Wdth		Rnd sqft	Rect. sqft
(inches)	24	0	0		3.14	0
	Stack AREA				3.14	(sqft)
	Yi				1.049	
	Delta H@				1.849	

PRE TEST INFO

	Assumed moisture	11.50	(%)
	Assumed Meter Temp	60.00	(deg F)
	Run Time	100.00	(min)
	Total Number of Points	24	

TRAVERSE INFO

Pg	Static, gage pressure	0.05	("H2O)
	Stack Temp	235.0	(deg F)
O2	Oxygen	10.80	(% v/v)
CO2	Carbon Dioxide	8.30	(% v/v)

PM10 OPERATING DATA

us	assumed Stack viscosity	211.390	(micropoise)
Qs	assumed Cylone flow rate	0.598	(ft^3/min)

OPERATING PRESSURE HEAD

OPERATING Delta H ==> 0.44 ("H20)

NOZZLE SELECTION

.136 .15 .164 .182 .197 .215 .233 .264 .3 .342 .39

Nd Nozzle Diameter 0.264 (inches)

MIN AND MAX DELTA P PARAMETERS

delta P (min)	ERR	("H20)
AVERAGE Delta P ===>	ERR	
delta P (max)	0.259	("H20)

LOW FLOW - ALTERNATIVE READINGS

Low Flow - delta P (min)	0.034	("H20)
AVE (low flow) Delta P ==>	0.168	
Low Flow - delta P (max)	0.303	("H20)

POST TEST INFO

Impinger water 83 Silica gel 7.4 (g)

CALCULATED RESULTS

Ps	Stack pressure, Ps	24.72	(" Hg)
	Stack Area (rnd), (sqft)	3.14	(sqft)
Tm	Avg Meter Temperature	71.15	(deg F)
Ts	Avg Stack Temperature	208.29	(deg F)
Bws	% H2O in Stack	10.70	(Bws)
Mw	Wet Molecular Weight	28.50	(lb/lb.mole)
Md	Dry Molecular Weight	29.76	(lb/lb.mole)
	Avg sqrt delta P	0.399	
Vs	Sample Volume	32.62	(dscf)
us	Stack Viscosity	204.79	(micropoise)
Qs std	Actual Cyclone Flow Rate	0.56	(ft^3/min)
I	Isokinetic Avg, { 80 < I > 120 }	88	(%)
D50	D50 Cut Rate, { 9 < d50 > 10 }	10.16	(um)

Revised Sept 06/01 by CWL

METHOD 201A PM10 TESTING

Test No	Pre traverse dP	sqrt dP	Point Time	Run Time	MetrVol 339.250	Vel head delta P	Calc. delta H	Stack Temp	Meter Temp In	Out	Avg	Point % I	Rolling %I
1	0.22	0.4690	4.90	4.9	340.870	0.22	0.450	214	73	72	72.5	66.1	66.1
2	0.21	0.4583	4.79	9.7	342.700	0.21	0.451	216	74	73	73.5	78.2	72.1
3	0.21	0.4583	4.79	14.5	344.530	0.21	0.451	214	75	74	74.5	77.9	74.1
4	0.21	0.4583	4.79	19.3	346.380	0.21	0.452	214	76	75	75.5	78.6	75.2
5	0.20	0.4472	4.68	24.0	348.130	0.20	0.451	208	76	75	75.5	77.8	75.7
6	0.13	0.3606	3.77	27.7	349.620	0.13	0.450	204	76	74	75	101.6	80.0
7	0.10	0.3162	3.31	31.0	350.960	0.10	0.449	201	76	74	75	118.6	85.5
8	0.11	0.3317	3.47	34.5	352.340	0.11	0.449	202	75	74	74.5	111.2	88.8
9	0.12	0.3464	3.62	38.1	353.740	0.12	0.449	204	75	74	74.5	103.6	90.4
10	0.12	0.3464	3.62	41.7	355.140	0.12	0.449	206	75	73	74	103.8	91.7
11	0.13	0.3606	3.77	45.5	356.610	0.13	0.449	208	74	73	73.5	100.9	92.6
12	0.13	0.3606	3.77	49.3	358.110	0.13	0.449	207	74	72	73	102.9	93.4
13	0.12	0.3464	3.62	52.9	359.520	0.12	0.448	206	74	72	73	104.7	94.3
14	0.12	0.3464	3.62	56.5	360.920	0.12	0.447	204	73	70	71.5	104.1	95.0
15	0.12	0.3464	3.62	60.1	362.320	0.12	0.446	203	72	69	70.5	104.3	95.6
16	0.13	0.3606	3.77	63.9	363.760	0.13	0.445	203	71	68	69.5	99.2	95.8
17	0.14	0.3742	3.91	67.8	365.200	0.14	0.445	205	71	68	69.5	92.2	95.6
18	0.15	0.3873	4.05	71.9	366.710	0.15	0.445	208	70	67	68.5	90.6	95.4
19	0.16	0.4000	4.18	76.1	368.210	0.16	0.445	210	70	66	68	84.6	94.8
20	0.20	0.4472	4.68	80.7	369.980	0.20	0.445	212	69	65	67	80.2	94.1
21	0.20	0.4472	4.68	85.4	371.720	0.20	0.444	212	69	64	66.5	78.9	93.3
22	0.21	0.4583	4.79	90.2	373.430	0.21	0.443	213	67	63	65	74.1	92.5
23	0.22	0.4690	4.90	95.1	375.210	0.22	0.442	212	66	62	64	73.7	91.6
24	0.22	0.4690	4.90	100.0	377.089	0.22	0.442	213	66	61	63.5	77.9	91.1
25		0.0000	0.00	100.0			ERR				ERR	ERR	ERR
avg dP		0.16167	Volume		37.839	dP	dH	Ts		Tm			
avg sqrt dP		0.39856				0.16	0.16	208.29		71.15			

avg sqrt dP squared 0.159

STACK

ACTUAL Vel. ft/sec	ACTUAL Flow acfm	STANDARD Vel. dsft/sec	STANDARD Flow dscfm
32.94	6209	19.04	3590
32.23	6076	18.58	3502
32.18	6067	18.61	3507
32.18	6067	18.61	3507
31.27	5894	18.24	3438
25.13	4738	14.75	2780
21.99	4146	12.96	2444
23.08	4351	13.59	2561
24.15	4552	14.17	2671
24.18	4559	14.15	2667
25.21	4752	14.70	2772
25.19	4748	14.72	2774
24.18	4559	14.15	2667
24.15	4552	14.17	2671
24.13	4548	14.18	2673
25.11	4734	14.76	2782
26.10	4920	15.29	2883
27.08	5104	15.79	2977
28.01	5280	16.29	3070
31.36	5912	18.18	3428
31.36	5912	18.18	3428
32.16	6062	18.62	3510
32.89	6200	19.07	3595
32.92	6205	19.06	3592
0.00	0	0.00	0
ft/sec	acfm	dsft/sec	dscfm
27.88	5256	16.24	3062

BEAKER/FILTER TARES, FINAL WEIGHTS and GAINS

BISON ENGINEERING LABORATORY RECORD

Facility:	UM-Western	Location	Dillon, Mt	Date	12-6-07
		Source	Boiler		

Test Run	Sample Description	Sample Volume (mls, #)	Lab Avg TARE grams	Lab Avg FINAL grams		Weight Gains: Net Gains grams	Weight Gains: Gains grams
one	> PM10 rinse vol & wgts	45	2.5799	2.6307	=	0.0508	PM Gain
	2.5< PM <10 rinse vol & wgts	62	2.5304	2.5532	=	0.0227	0.1201
	filter # & wgts	2934	0.3496	0.4471	=	0.0974	Back half
	impinger CM vol & wgts	200	2.5331	2.53860	=	0.0055	0.0055
	< PM 2.5 rinse vol & wgts	113	2.5511	2.5556	=	0.0045	0.0045
	impinger H2O init & fin vol, mls		200	282	=	82	mls
	silica gel H2O int & fin wgts., grams		226.5	233.6	=	7.1	grams
Two	> PM10 rinse vol & wgts	59	2.5218	2.5491	=	0.0273	PM Gain
	2.5< PM <10 rinse vol & wgts	86	2.5388	2.5494	=	0.0105	0.1340
	filter # & wgts	2935	0.3506	0.4742	=	0.1235	Back half
	impinger CM vol & wgts	200	2.5395	2.5452	=	0.0057	0.0057
	< PM 2.5 rinse vol & wgts	108	2.5456	2.5488	=	0.0032	0.0032
	impinger H2O init & fin vol, mls		200	288	=	88	mls
	silica gel H2O int & fin wgts., grams		224.2	232.1	=	7.9	grams
Three	> PM10 rinse vol & wgts	75	2.5358	2.5543	=	0.0184	PM Gain
	2.5< PM <10 rinse vol & wgts	81	2.5312	2.5444	=	0.0131	0.1140
	filter # & wgts	2936	0.3437	0.4447	=	0.1009	Back half
	impinger CM vol & wgts	200	2.5501	2.5545	=	0.0043	0.0043
	< PM 2.5 rinse vol & wgts	104	2.5380	2.5435	=	0.0055	0.0055
	impinger H2O init & fin vol, mls		200	283	=	83	mls
	silica gel H2O int & fin wgts., grams		229.7	237.1	=	7.4	grams
Acetone Blank vol		100	2.5112	2.5112	=	Blank Gain	0.0000
Water Blank vol.		100	2.5812	2.5815	=	Blank Gain	0.0003

Blanks per volumes	
Acetone	0.0000
Water	0.0006
MeCL	0.0000

Final Lab Results	
PM gain less blank	0.1201 grams
CM gain less blank	0.0049 grams
MCEM gain less blank	0.0045 grams

Blanks per volumes	
Acetone	0.0000
Water	0.0006
MeCL	0.0000

Final Lab Results	
PM gain less blank	0.1340 grams
CM gain less blank	0.0051 grams
MCEM gain less blank	0.0032 grams

Blanks per volumes	
Acetone	0.0000
Water	0.0006
MeCL	0.0000

Final Lab Results	
PM gain less blank	0.1140 grams
CM gain less blank	0.0037 grams
MCEM gain less blank	0.0055 grams

Percent residue	0.00000 %
Percent residue	0.00030 %

Report all weights to 0.0001 g. Record sample volumes in colum 4. "Constant weight" means </= 0.0005 g difference between 2 weighings at least 6 hours apart OR 2 </= 1% of the average total weight less average tare weight.

Acetone Blank must be no greater than 0.001 percent residue M5-3.2, negative blank gains, within the tolorance of the scale, shall be counted as zero gain.

Nitrogen Oxide

Calibration Error Check & Sampling System Bias

Zero & Calibration Drift

nitrogen oxide emissions based on MW of 46

Company	UM-Western	Source	Boiler	Testers on site	0
Facility	Heating Plant	Date	12/6/07	Ambient Temp.	35 ° F
Location	Dillon, MT	Sample location	Dillon, MT	Comments:	

Run #		(Rack) Analyzer Cal. Response	Initial Values System Cal. Response	Initial Values System Cal. Bias % of Span	Final Values System Cal. Response	Final Values System Cal. Bias % of Span	Drift % of Span	Analyzer Range & Units	Avg. Gas Conc.	Effluent Gas Conc.	Instrument Calibration Reference Gas
one	Zero	0.0	0.0	0.00	0.0	0.00	0.00	ppmvd			
	Upscale	250.0	246.0	-0.73	238.0	-2.18	-1.45	550	43.8	45.20	250
two	Zero	0.0	0.0	0.00	1.0	0.18	0.18	ppmvd			
	Upscale	250.0	238.0	-2.18	253.0	0.55	2.73	550	84.3	85.46	250
three	Zero	0.0	1.0	0.18	2.0	0.36	0.18	ppmvd			
	Upscale	250.0	253.0	0.55	253.0	0.55	0.00	550	69.3	67.43	250
			LIMITS	+/- 5%		+/- 5%	+/- 3%		AVG	49.02	

choice
250
or
520

Zero and Calibration Gases		
Zero gas	Mid Cal	High Cal
O2 CO2	250	520

ZERO Cal. Gas Analyzer Response	Analyzer Calib. Error	MID Cal. Gas Analyzer Response	Analyzer Calib. Error	HIGH Cal. Gas Analyzer Response	Analyzer Calib. Error
0	0.00	250	0.00	518	-0.36
0	0.00		-45.45		-94.55
LIMIT	+/- 2%		+/- 2%		+/- 2%

	Run 1 NOx	Run 2 NOx	Run 3 NOx	Run 4 NOx
1	2	88	69	89
2	85	85	60	90
3	73	81	79	94
4	15	83		
5				
6				
	43.75	84.25	69.33	91.00

Carbon Monoxide
Calibration Error Check & Sampling System Bias
Zero & Calibration Drift

carbon monoxide emissions based on MW of 28

Company:	UM-Western	**Source:**	Boiler
Facility:	Heating Plant	**Date:**	12/6/07
Location:	Dillon, MT		

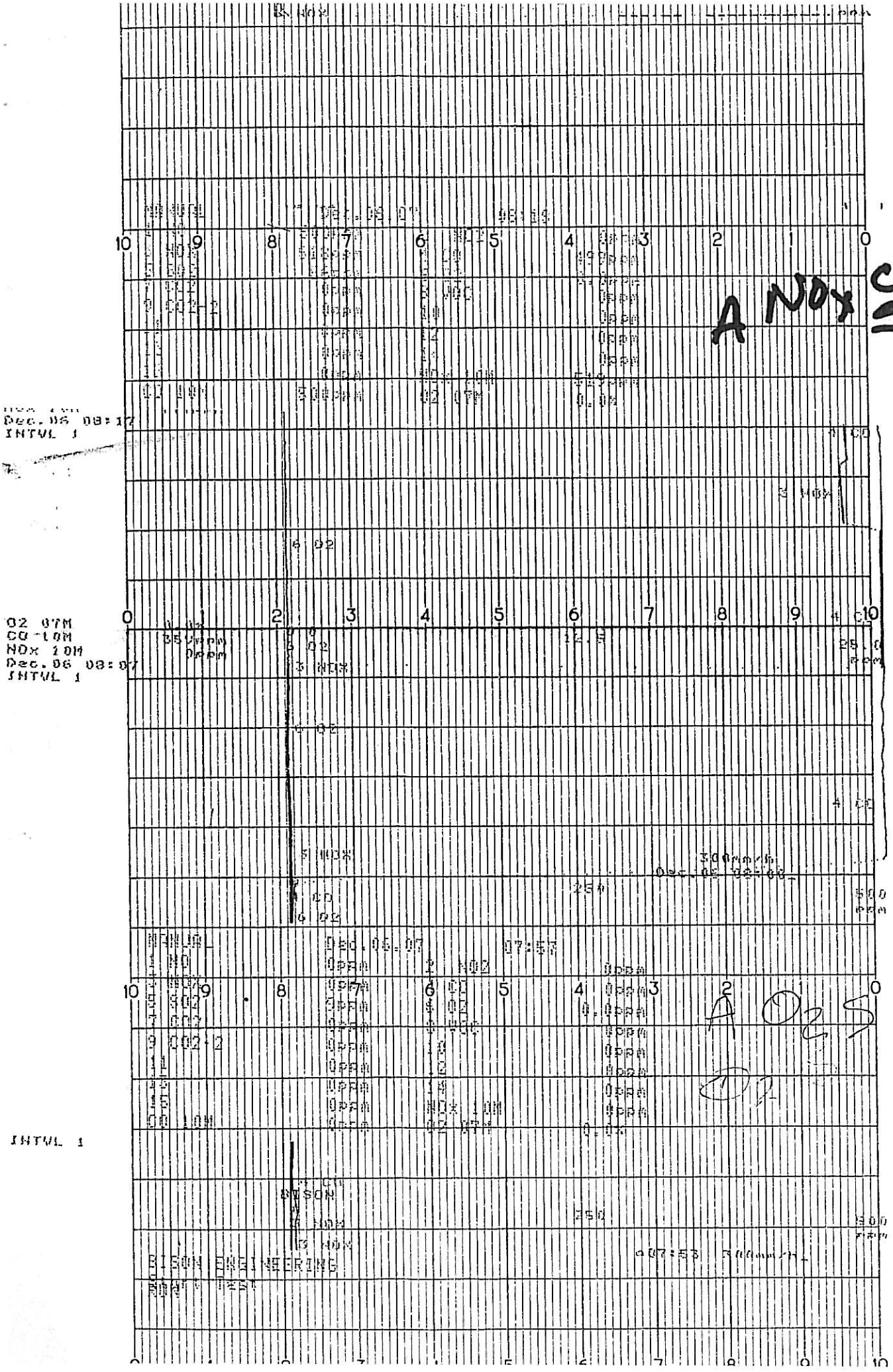
Run #		(Rack) Analyzer Cal. Response	Initial Values System Cal. Response	Initial Values System Cal. Bias % of Span	Final Values System Cal. Response	Final Values System Cal. Bias % of Span	Drift % of Span	Analyzer Range & Units	Avg. Gas Conc.	Effluent Gas Conc.	Instrument Calibration Reference Gas
one	Zero	0.0	-1.0	-0.20	1.0	0.20	0.40	ppmvd			
	Upscale	254.0	255.0	0.20	255.0	0.20	0.00	500	177.3	174.55	251
two	Zero	0.0	1.0	0.20	0.0	0.00	-0.20	ppmvd			
	Upscale	254.0	255.0	0.20	251.0	-0.60	-0.80	500	176.8	175.20	251
three	Zero	0.0	0.0	0.00	0.0	0.00	0.00	ppmvd			
	Upscale	254.0	251.0	-0.60	252.0	-0.40	0.20	500	172.3	171.99	251
			LIMITS	+/- 5%		+/- 5%	+/- 3%		AVG	216.76	

Your choice 251 or 499

Zero and Calibration Gases		
Zero gas	Mid Cal	High Cal
O2 CO2	251	499

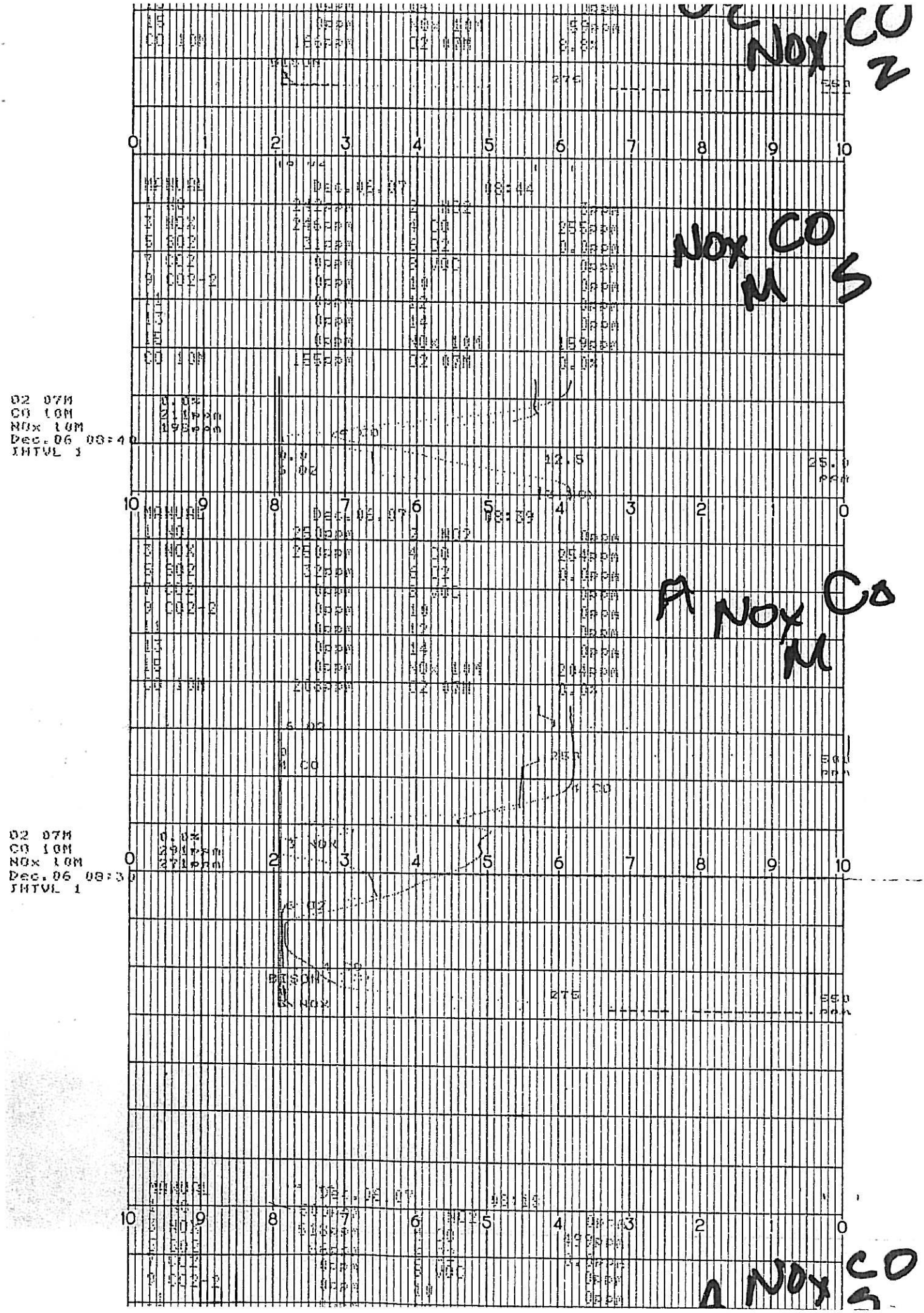
ZERO Cal. Gas Analyzer Response	Analyzer Calib. Error	MID Cal. Gas Analyzer Response	Analyzer Calib. Error	HIGH Cal. Gas Analyzer Response	Analyzer Calib. Error
0	0.00	254	0.60	499	0.00
	0.00		-50.20		-99.80
LIMIT	+/- 2%		+/- 2%		+/- 2%

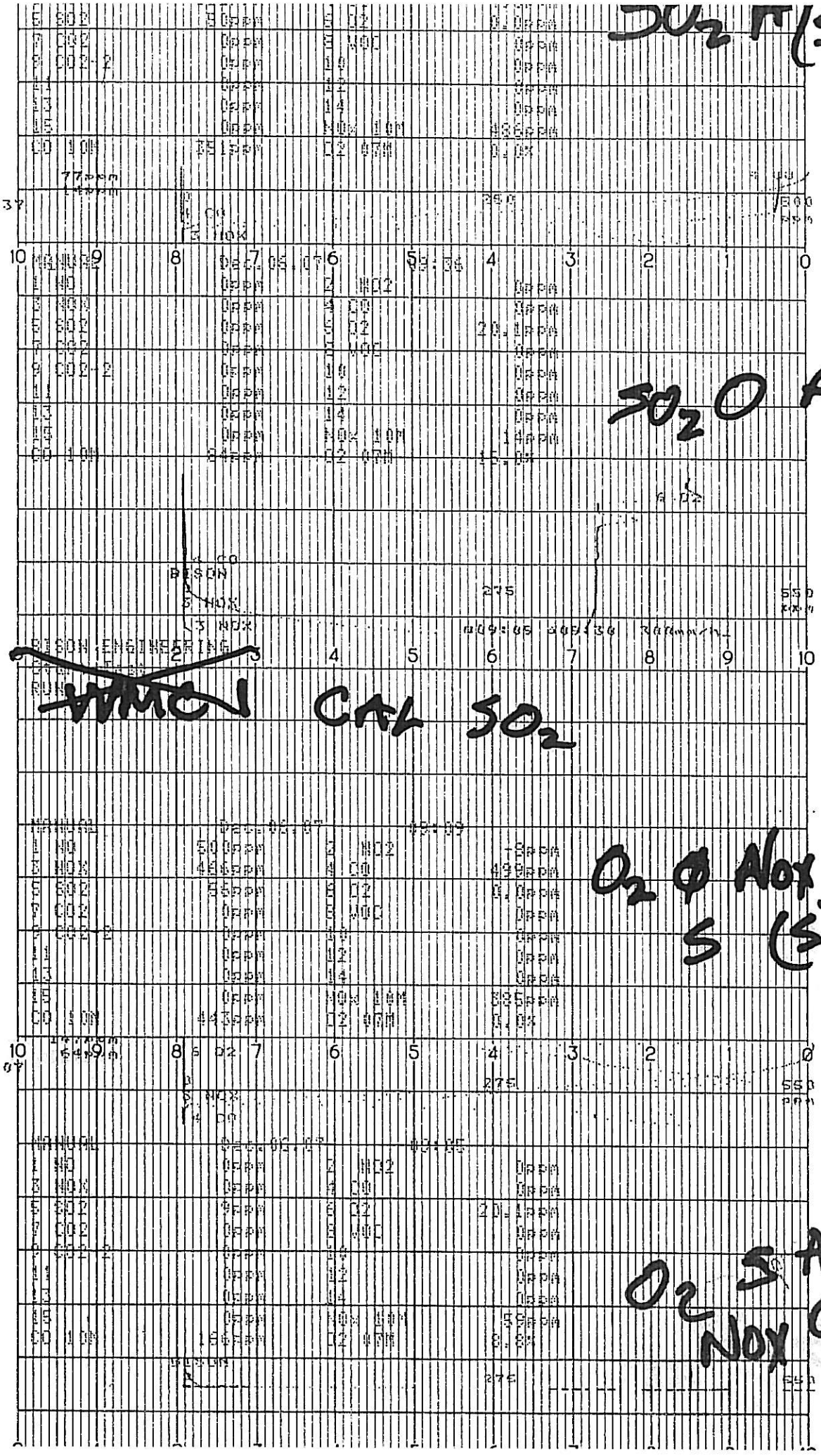
	Run 1 CO	Run 2 CO	Run 3 CO	Run 4 CO
1	162	144	122	229
2	192	177	157	165
3	178	239	238	126
4		147		
5				
6				
	177.33	176.75	172.33	173.33

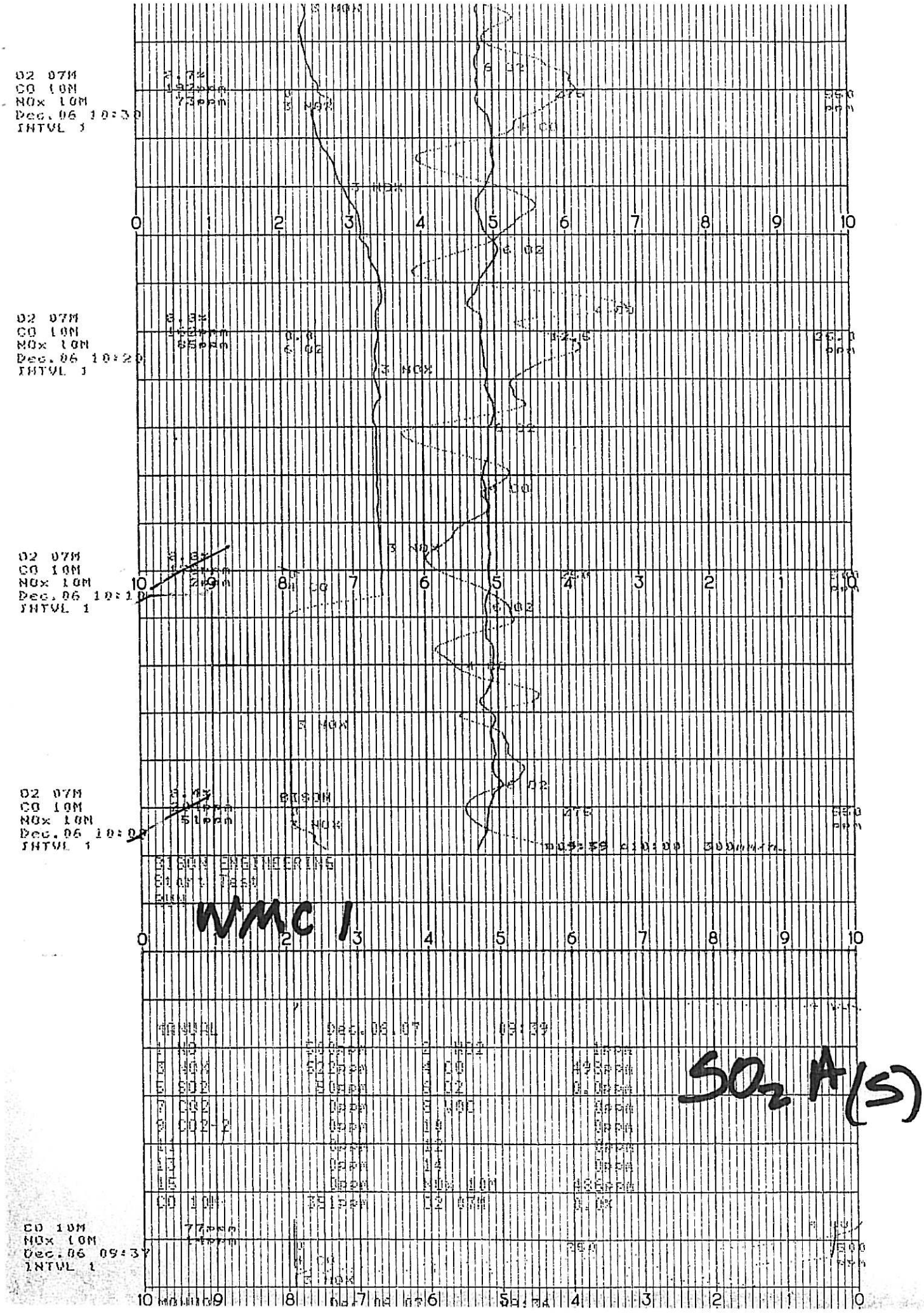


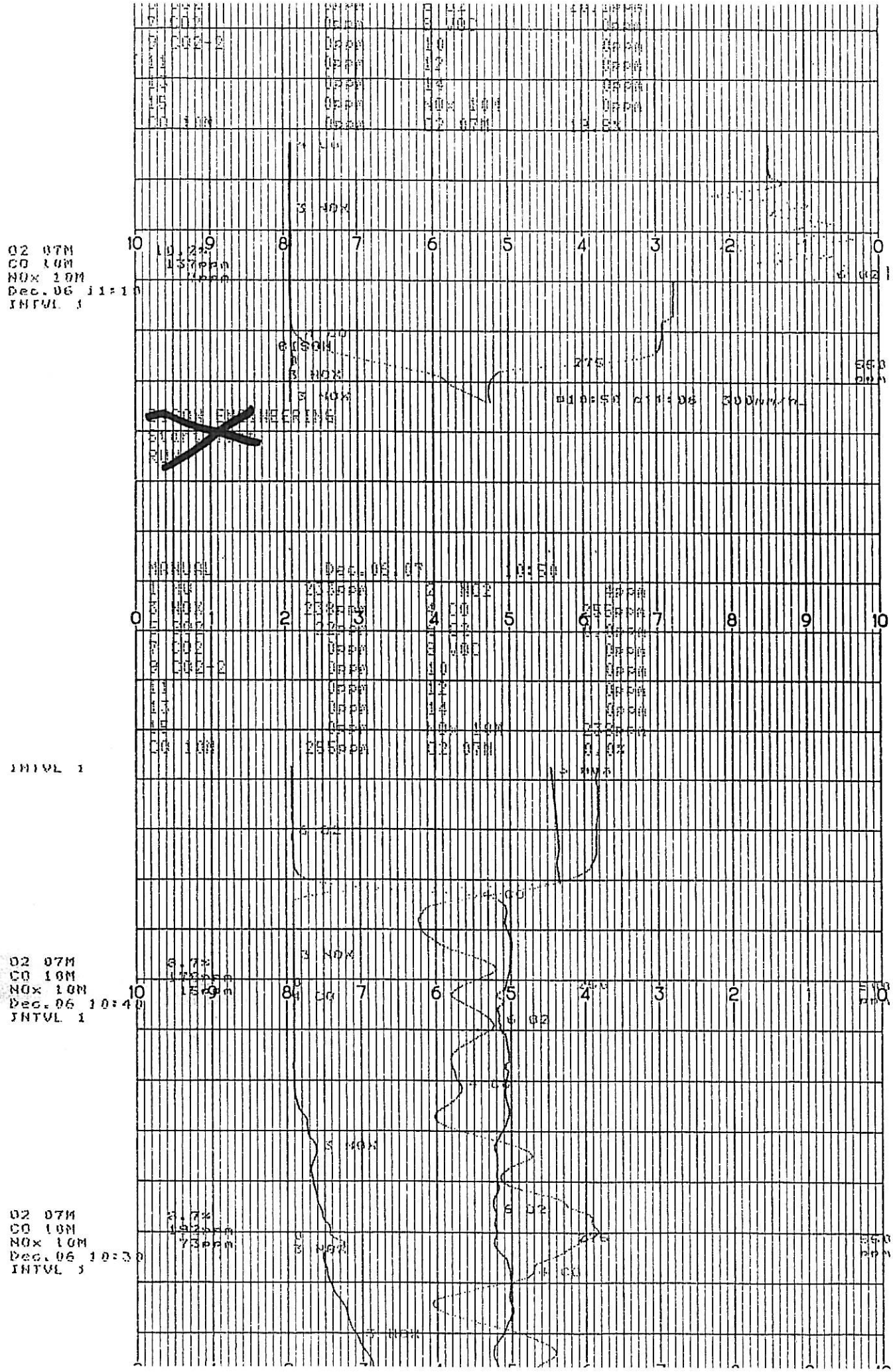
1545cm

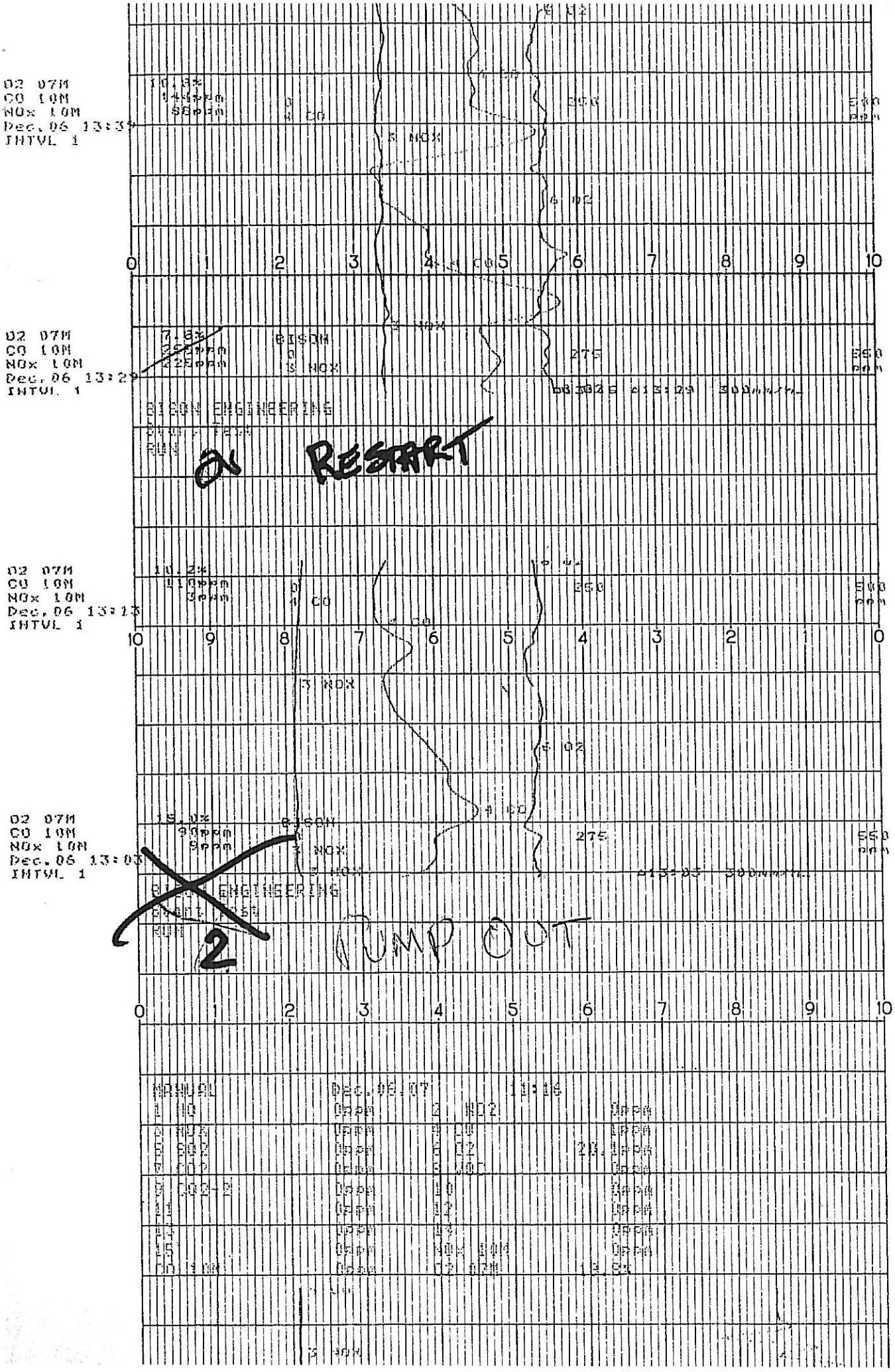
1560cm

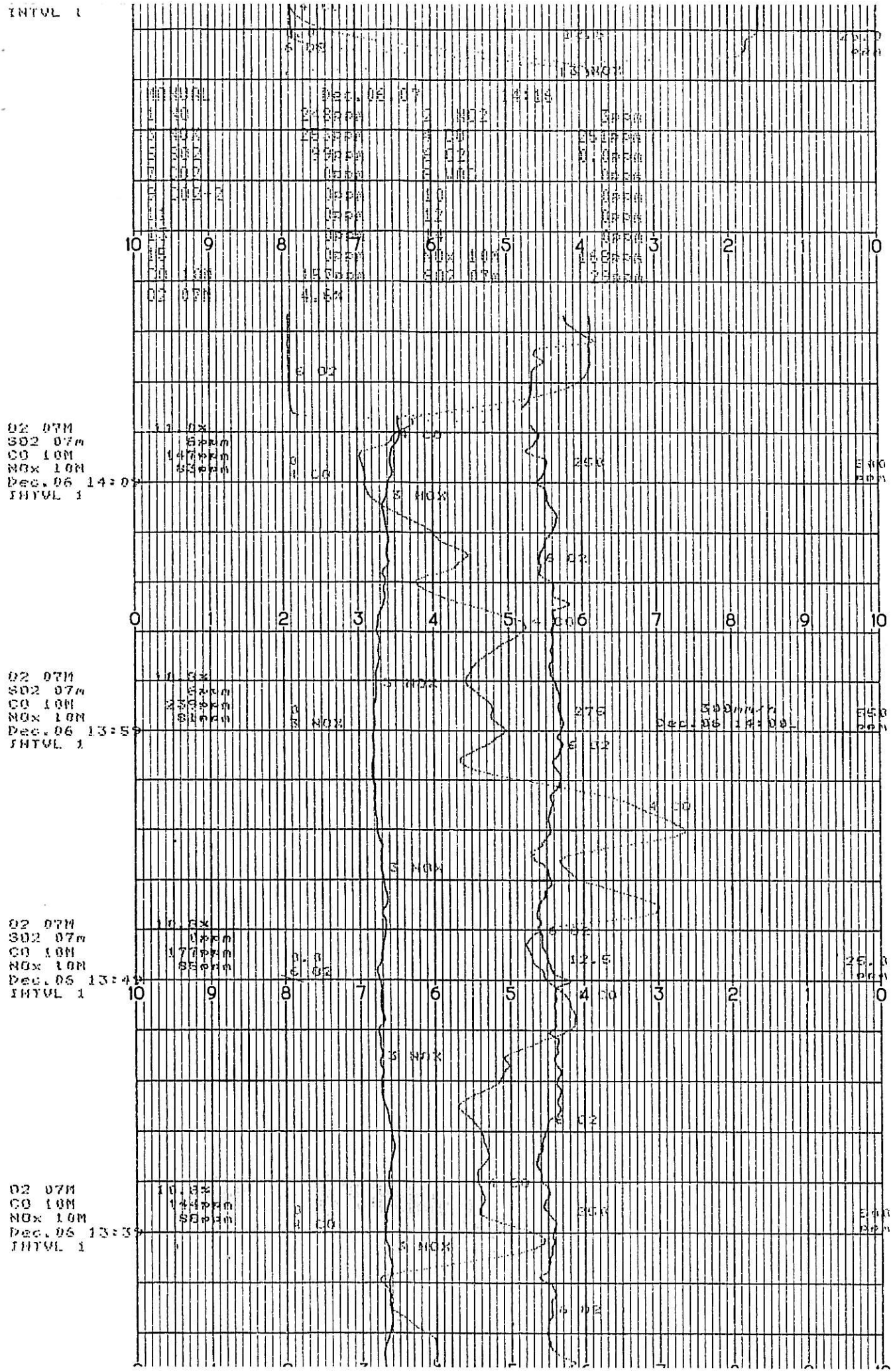

CO
NOx
2
NOx CO
M S
O2 07M
CO 10M
NOx 10M
Dec.06 08:40
INTVL 1
A NOx CO
M
O2 07M
CO 10M
NOx 10M
Dec.06 08:30
INTVL 1
NOx
A NOx CO


SO2 M (S)
SO2 O A
CAL SO2
O2 Ø NOx CO S (S)
O2 S A NOX CO2
1500cm
1515cm


O2 07M
CO 10M
NOx 10M
Dec.06 10:30
INTVL 1
O2 07M
CO 10M
NOx 10M
Dec.06 10:20
INTVL 1
O2 07M
CO 10M
NOx 10M
Dec.06 10:10
INTVL 1
O2 07M
CO 10M
NOx 10M
Dec.06 10:00
INTVL 1
WMC 1
CO 10M
NOx 10M
Dec.06 09:37
INTVL 1
SO2 A(S)

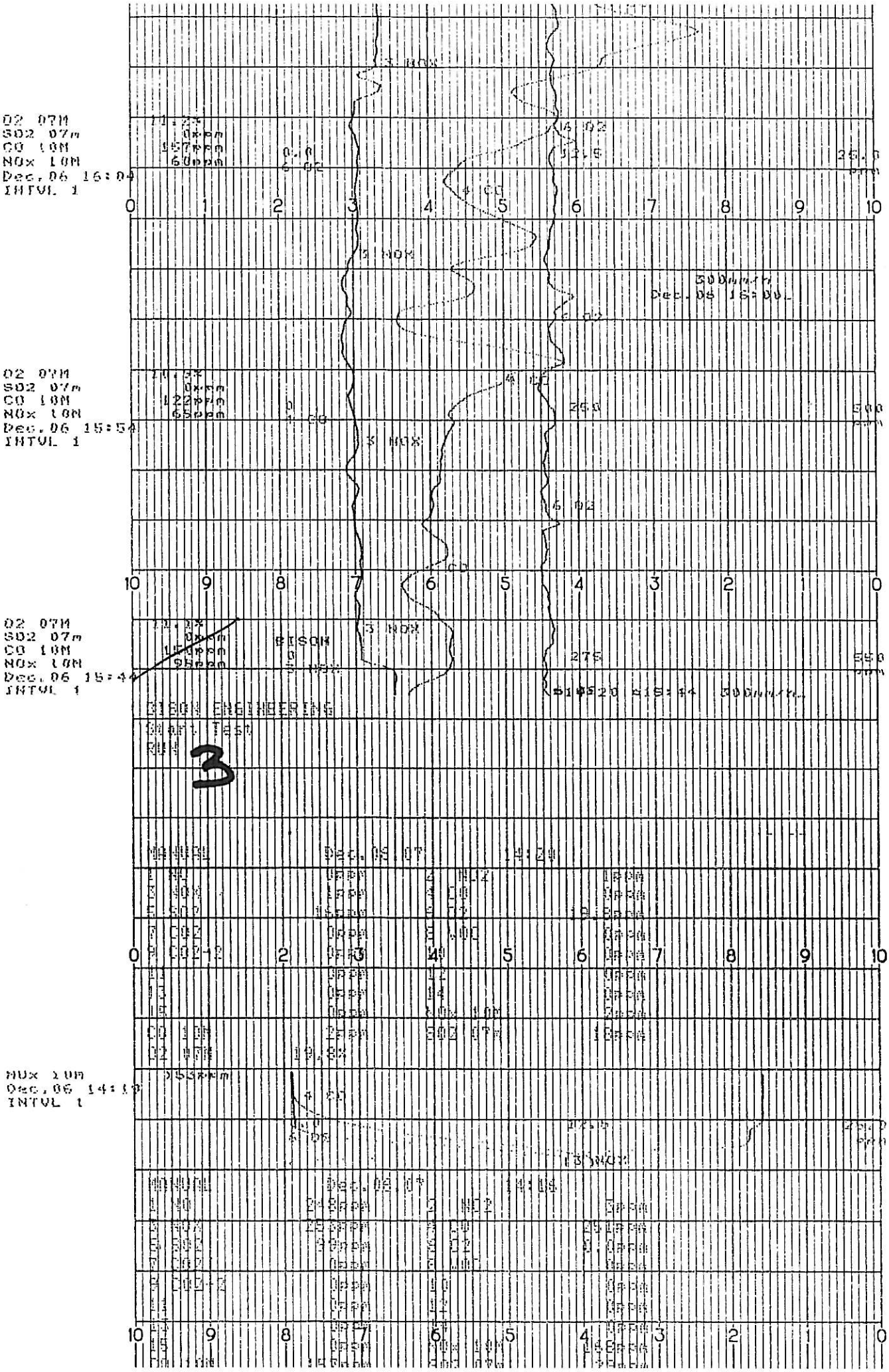

O2 07M
CO 10M
NOx 10M
Dec. 06 11:10
INTVL 1
INTVL 1
O2 07M
CO 10M
NOx 10M
Dec. 06 10:40
INTVL 1
O2 07M
CO 10M
NOx 10M
Dec. 06 10:30
INTVL 1

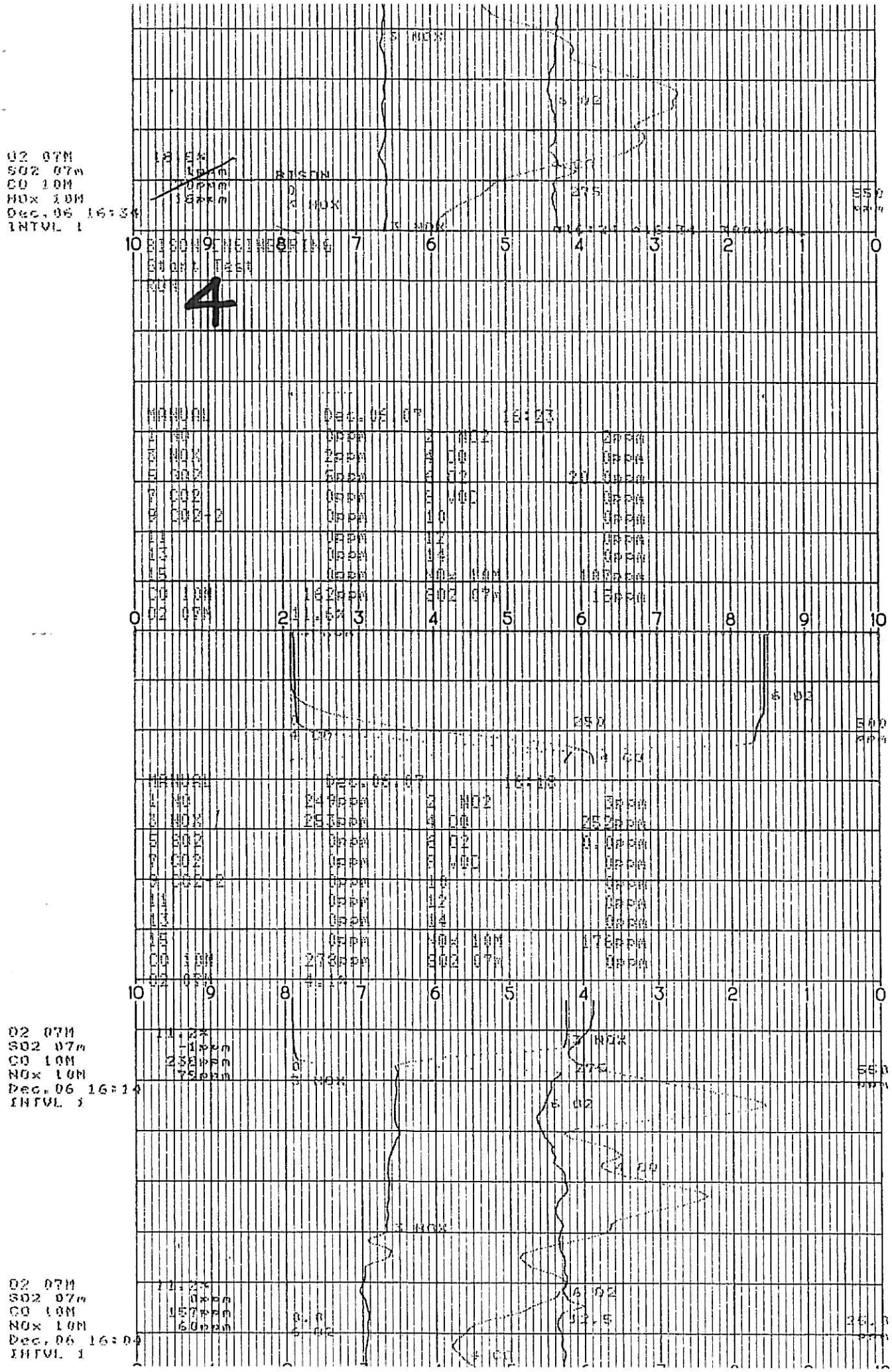

O2 07M
CO 10M
NOx 10M
Dec. 06 13:39
INTVL 1
O2 07M
CO 10M
NOx 10M
Dec. 06 13:29
INTVL 1
BISON ENGINEERING
RESTART
O2 07M
CO 10M
NOx 10M
Dec. 06 13:13
INTVL 1
O2 07M
CO 10M
NOx 10M
Dec. 06 13:03
INTVL 1
BISON ENGINEERING
2
DUMP OUT
0 1 2 3 4 5 6 7 8 9 10
10 9 8 7 6 5 4 3 2 1 0

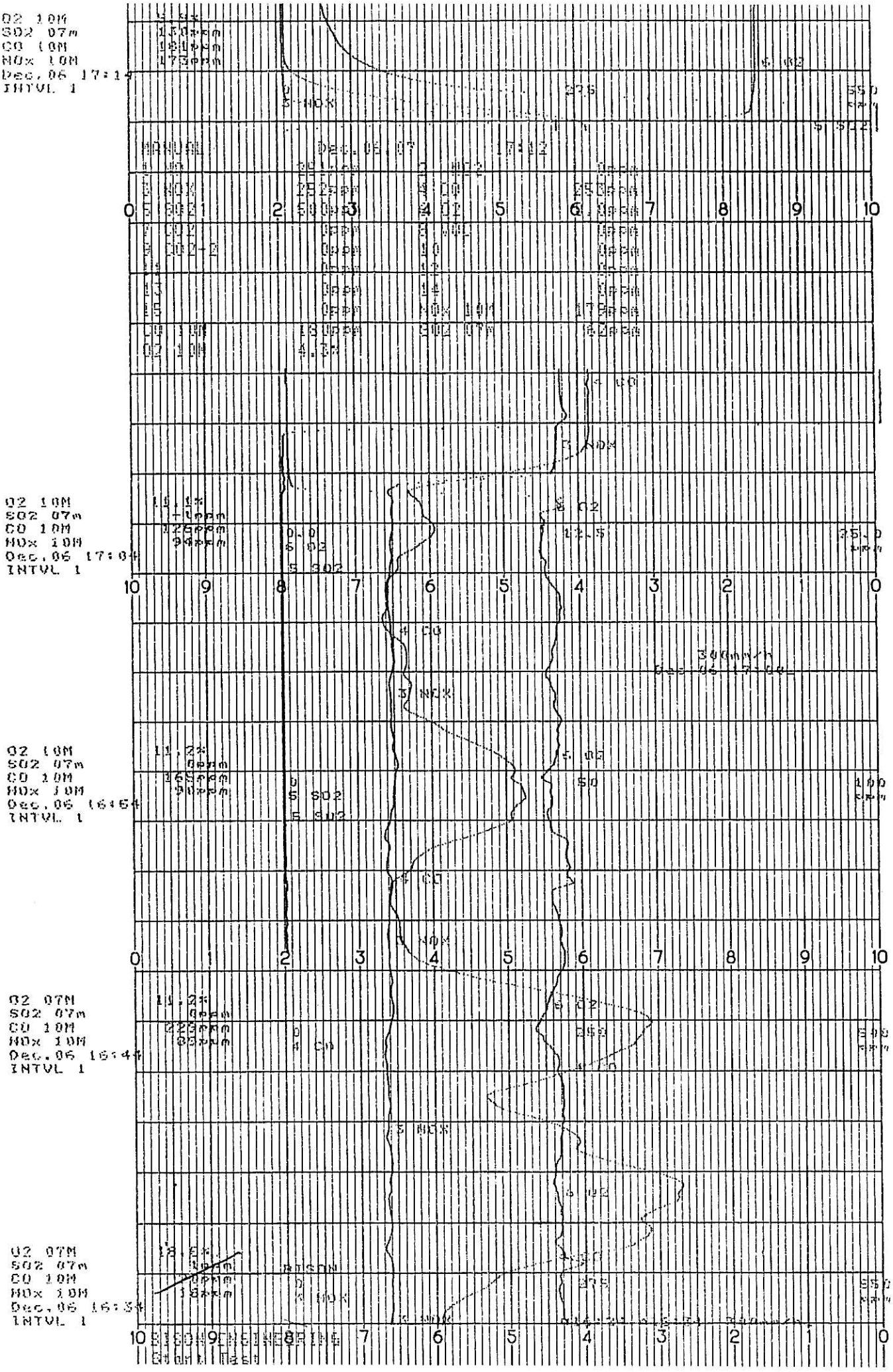


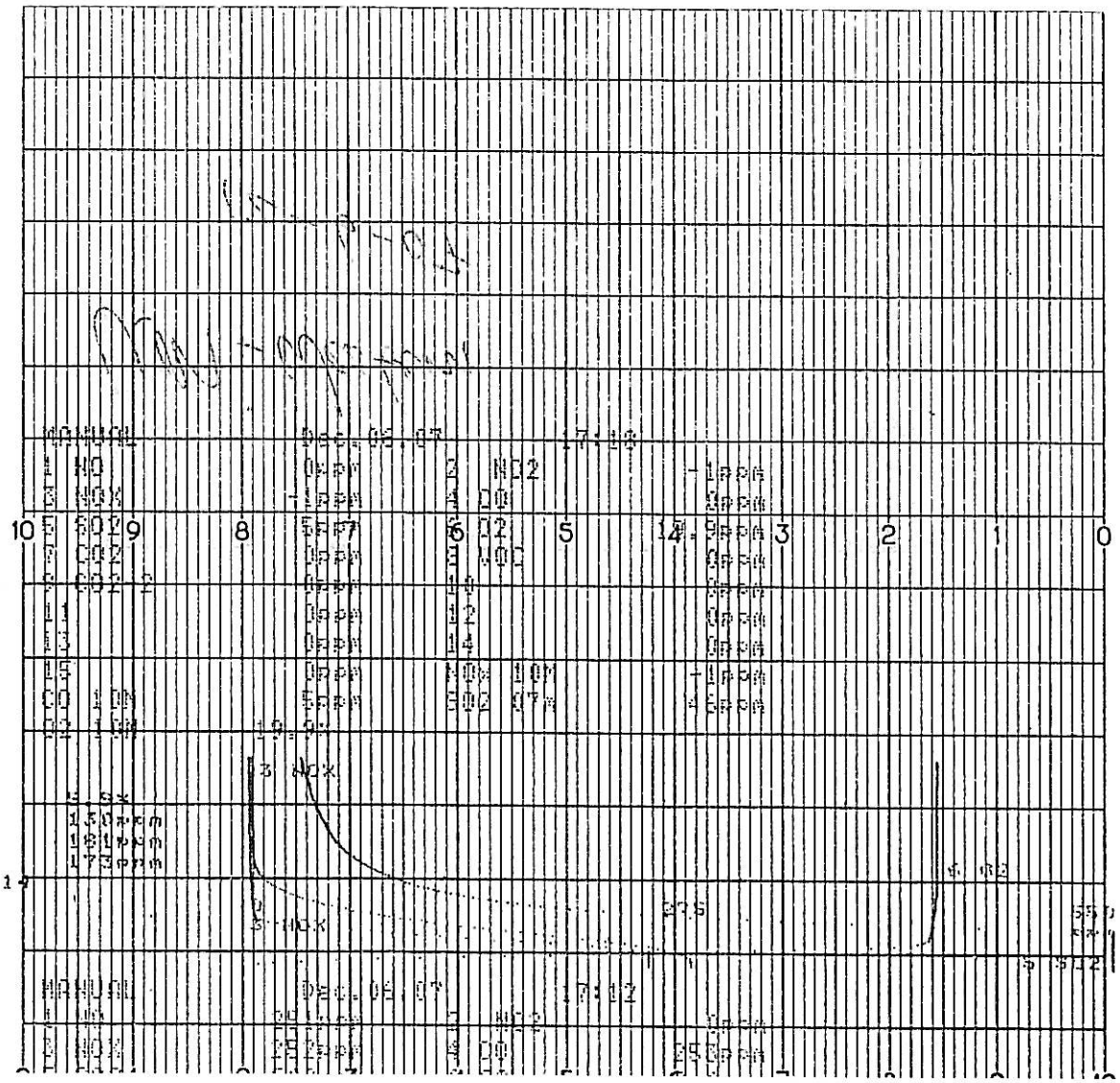
1410cm

1420cm


O2 07M
SO2 07m
CO 10M
NOx 10M
Dec. 06 16:04
INTVL 1
O2 07M
SO2 07m
CO 10M
NOx 10M
Dec. 06 15:54
INTVL 1
O2 07M
SO2 07m
CO 10M
NOx 10M
Dec. 06 15:44
INTVL 1
NOx 10M
Dec. 06 14:10
INTVL 1
3


O2 07M
SO2 07m
CO 10M
NOx 10M
Dec. 06 16:34
INTVL 1
O2 07M
SO2 07m
CO 10M
NOx 10M
Dec. 06 16:14
INTVL 1
O2 07M
SO2 07m
CO 10M
NOx 10M
Dec. 06 16:04
INTVL 1


O2 10M
SO2 07m
CO 10M
NOx 10M
Dec.06 17:14
INTVL 1
O2 10M
SO2 07m
CO 10M
NOx 10M
Dec.06 17:04
INTVL 1
O2 10M
SO2 07m
CO 10M
NOx 10M
Dec.06 16:54
INTVL 1
O2 07M
SO2 07m
CO 10M
NOx 10M
Dec.06 16:44
INTVL 1
O2 07M
SO2 07m
CO 10M
NOx 10M
Dec.06 16:34
INTVL 1


10
9
8
7
6
5
4
3
2
1
0
NOx
SO2
3 NOx
5 NOx
5 SO2
O2 10M
SO2 07m
CO 10M
NOx 10M
Dec.06 17:14
INTVL 1

The University of Montana
Western
710 South Atlantic
Dillon, Montana 59725-359
(406) 683-7011

12/6/07

WMC heating plant
boiler #2 testing
conditions - 10AM
OA temp. 30°F.
steam pressure set point 15PSI

Doug Chamberlain
boiler operator

Test run #1

10AM -	system pressure		Firing rate
10AM -	12.2	- test start	45%
10:15AM -	12.8		45%
10:30AM -	13.3		45%
10:45AM -	14.5		45%
11AM -	15.7		45%
11:20AM -	~~[illegible]~~ 15.1	14.23	45%
11:35AM -	14.5		45%
11:50AM -	15.7	- test end	45%

Test run #2 OA temp 37°F

1PM -	11.7	- start test	45%
1:15PM -	12.9		45%
1:30PM -	14.3		45%
1:45PM -	15.7		45%
2PM -	15.7	14.45	34%
2:15PM -	15.1		43%
2:30PM -	15.1		45%
2:45PM -	15.7		41%

Test Run #3 OA Temp 38°

3:45 PM	Start Test #3	45%
4:02 PM		35%
4:15 PM		36%
4:34 PM		38%
4:45		39%
5:01		45%
5:15		45%

The University of Montana Western
710 South Atlantic
Dillon, Montana 59725-359
(406) 683-7011

APPENDIX C:
FUEL, FLY ASH, AND BOTTOM ASH SAMPLE ANALYSIS

Hazen Research, Inc.
4601 Indiana Street
Golden, CO 80403 USA
Tel: (303) 279-4501
Fax: (303) 278-1528

Date November 16 2007
HRI Project 002-VN5
HRI Series No. K23/07-1
Date Rec'd. 11/07/07
Cust. P.O.#

Bison Engineering, Inc.
Cal Loomis
1400 11th Avenue
Helena, MT 59601

Sample Identification
Wood 10/24/07 Wester MT
College WMC 207784

Reporting Basis >	As Rec'd	Dry	Air Dry
Proximate (%)			
Moisture	33.07	0.00	2.29
Ash	1.50	2.24	2.19
Volatile	51.38	76.76	75.00
Fixed C	14.05	21.00	20.52
Total	100.00	100.00	100.00
Sulfur	0.03	0.05	0.05
Btu/lb (HHV)	5985	8943	8738
MMF Btu/lb	6083	9164	
MAF Btu/lb		9148	
Air Dry Loss (%)	31.50		
Ultimate (%)			
Moisture	33.07	0.00	2.29
Carbon	37.87	56.58	55.28
Hydrogen	4.12	6.15	6.01
Nitrogen	0.10	0.15	0.15
Sulfur	0.03	0.05	0.05
Ash	1.50	2.24	2.19
Oxygen*	23.31	34.83	34.03
Total	100.00	100.00	100.00
Chlorine**			

Forms of Sulfur (as S,%)

Sulfate		
Pyritic		
Organic		
Total	0.03	0.05

Water Soluble Alkalies (%)

Na2O
K2O

Lb. Alkali/MM Btu=
Lb. Ash/MM Btu= 2.51
Lb. SO2/MM Btu= 0.11
HGI= @ % Moisture
As Rec'd. Sp.Gr.=
Free Swelling Index=
F-Factor(dry),DSCF/MM BTU= 10,399

Report Prepared By:

Gerard H. Cunningham
Fuels Laboratory Supervisor

* Oxygen by Difference.
** Not usually reported as part of the ultimate analysis.

Form #CUST-02

BISON ENGINEERING INC. - CHAIN OF CUSTODY RECORD

(406) 442-5768; FAX (406) 449-6653

Client Description **Wester MT College**

Project No. **WMC207784**

Total No. of Samples **One (1)**

Bison Engineering Signature

Analytical Methods: **Ultimate and Proximate plus Btu**

Date	Sample I.D.	Description
Oct 24, 07	bark	PM Test wood fuel sample

Date	Sample I.D.	Description
	--	
	--	
	--	
	--	
	--	
	--	
	--	
	--	
	--	
	--	

Date Received 11/7/07 Date Relinquished

Company Name/Address Horizon

Signature Buster

Date Received Date Relinquished

Company Name/Address

Signature

Date Received Date Relinquished

Company Name/Address

Signature

NOTE:

Alpine Analytical, Inc.
1315 Cherry, Helena, MT 59601 (406)449-6282

Case Narrative

On November 15, 2007, three soil samples from a project identified as "WMC207784" were received by our laboratory for analysis. The chain of custody indicated that the soil samples were to be analyzed for Metals. The samples were received cool, intact and hand delivered by Cal Loomis.

Results are summarized on the following page.

Should you have any questions regarding this analysis feel free to give us a call at 449-6282 or 800-814-6282.

We appreciate the fact that you have chosen us as your analytical lab.

Sincerely yours,

Harry Howell
Laboratory Manager

Alpine Analytical, Inc.
1315 Cherry, Helena, MT 59601 (406)449-6282

Client: **Western MT College**
Project ID: WMC207784
Site ID: None Given
Date Sampled: 24-Oct-07
Date Received: 15-Nov-07
Chain of Custody #: 001795

	Wood bark	**Fly Ash**	**Bottom Ash**
Units	mg/Kg	mg/Kg	mg/Kg
Arsenic	12	<0.01	<0.01
Antimony	0.03	<0.01	<0.01
Aluminum	60	0.71	0.34
Barium	45	11	75
Beryllium	<0.01	<0.01	<0.01
Cadmium	0.31	<0.01	<0.01
Chromium	1.05	<0.01	0.87
Cobalt	0.02	0.19	0.64
Copper	16	0.34	<0.01
Iron	89	<0.01	<0.01
Lead	0.20	<0.01	0.06
Manganese	104	0.24	<0.01
Mercury	<0.01	<0.01	<0.01
Nickel	<0.01	2.10	7.69
Selenium	0.13	0.14	0.06
Silver	<0.01	<0.01	<0.01
Thallium	<0.01	<0.01	<0.01
Zinc	46	<0.01	<0.01
Phosphorus	26	54	<0.01

Alpine Analytical, Inc.
1315 Cherry, Helena, MT 59601 (406)449-6282

SOIL ANALYSIS

Client: **Western MT College**

Date Reported: 21-Nov-07

Sample ID: **Wood bark**
Project ID: WMC207784
Site ID: None Given

Chain of Custody No.: 001795

Laboratory ID: 14M140
Sample Matrix: Soil

Date / Time Sampled: 24-Oct-07 @ --:--
Date / Time Received: 15-Nov-07 @ 13:40

Parameter	Analytical Result	PQL	Date / Time Analyzed	Method
Arsenic, mg/Kg	12	0.01	20-Nov-07 @ 09:15	Method 29
Antimony, mg/Kg	0.03	0.01	20-Nov-07 @ 09:15	Method 29
Aluminum, mg/Kg	60	0.01	20-Nov-07 @ 09:15	Method 29
Barium, mg/Kg	45	0.01	20-Nov-07 @ 09:15	Method 29
Beryllium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Cadmium, mg/Kg	0.31	0.01	20-Nov-07 @ 09:15	Method 29
Chromium, mg/Kg	1.05	0.01	20-Nov-07 @ 09:15	Method 29
Cobalt, mg/Kg	0.02	0.01	20-Nov-07 @ 09:15	Method 29
Copper, mg/Kg	16	0.01	20-Nov-07 @ 10:30	Method 29
Iron, mg/Kg	89	0.10	20-Nov-07 @ 10:30	Method 29
Lead, mg/Kg	0.20	0.01	20-Nov-07 @ 09:15	Method 29
Manganese, mg/Kg	104	0.01	20-Nov-07 @ 10:30	Method 29
Mercury, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Nickel, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Selenium, mg/Kg	0.13	0.01	20-Nov-07 @ 09:15	Method 29
Silver, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Thallium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Zinc, mg/Kg	46	0.01	20-Nov-07 @ 09:15	Method 29
Phosphorus, mg/Kg	26	0.01	20-Nov-07 @ 15:27	Method 29

Comments: **ND** - None Dectected
PQL - Practical Quantitation Limit

References: *Method 29 - Determination of Metals Emissions From Stationary Sources*

Reviewed by: _____

Alpine Analytical, Inc.
1315 Cherry, Helena, MT 59601 (406)449-6282

SOIL ANALYSIS

Client: **Western MT College**

Date Reported: 21-Nov-07

Sample ID: **Fly Ash**
Project ID: WMC207784
Site ID: None Given

Chain of Custody No.: 001795

Laboratory ID: 14M141
Sample Matrix: Soil

Date / Time Sampled: 24-Oct-07 @ --:--
Date / Time Received: 15-Nov-07 @ 13:40

Parameter	Analytical Result	PQL	Date / Time Analyzed	Method
Arsenic, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Antimony, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Aluminum, mg/Kg	0.71	0.01	20-Nov-07 @ 09:15	Method 29
Barium, mg/Kg	11	0.01	20-Nov-07 @ 09:15	Method 29
Beryllium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Cadmium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Chromium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Cobalt, mg/Kg	0.19	0.01	20-Nov-07 @ 09:15	Method 29
Copper, mg/Kg	0.34	0.01	20-Nov-07 @ 10:30	Method 29
Iron, mg/Kg	<0.01	0.10	20-Nov-07 @ 10:30	Method 29
Lead, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Manganese, mg/Kg	0.24	0.01	20-Nov-07 @ 10:30	Method 29
Mercury, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Nickel, mg/Kg	2.10	0.01	20-Nov-07 @ 09:15	Method 29
Selenium, mg/Kg	0.14	0.01	20-Nov-07 @ 09:15	Method 29
Silver, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Thallium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Zinc, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Phosphorus, mg/Kg	54	0.01	20-Nov-07 @ 15:27	Method 29

Comments: **ND** - None Dectected
PQL - Practical Quantitation Limit

References: *Method 29 - Determination of Metals Emissions From Stationary Sources*

Reviewed by: _____

Alpine Analytical, Inc.
1315 Cherry, Helena, MT 59601 (406)449-6282

SOIL ANALYSIS

Client: **Western MT College**

Date Reported: 21-Nov-07

Sample ID: **Bottom Ash**
Project ID: WMC207784
Site ID: None Given

Chain of Custody No.: 001795

Laboratory ID: 14M142
Sample Matrix: Soil

Date / Time Sampled: 24-Oct-07 @ --:--
Date / Time Received: 15-Nov-07 @ 13:40

Parameter	Analytical Result	PQL	Date / Time Analyzed	Method
Arsenic, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Antimony, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Aluminum, mg/Kg	0.34	0.01	20-Nov-07 @ 09:15	Method 29
Barium, mg/Kg	75	0.01	20-Nov-07 @ 09:15	Method 29
Beryllium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Cadmium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Chromium, mg/Kg	0.87	0.01	20-Nov-07 @ 09:15	Method 29
Cobalt, mg/Kg	0.64	0.01	20-Nov-07 @ 09:15	Method 29
Copper, mg/Kg	<0.01	0.01	20-Nov-07 @ 10:30	Method 29
Iron, mg/Kg	<0.01	0.10	20-Nov-07 @ 10:30	Method 29
Lead, mg/Kg	0.06	0.01	20-Nov-07 @ 09:15	Method 29
Manganese, mg/Kg	<0.01	0.01	20-Nov-07 @ 10:30	Method 29
Mercury, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Nickel, mg/Kg	7.69	0.01	20-Nov-07 @ 09:15	Method 29
Selenium, mg/Kg	0.06	0.01	20-Nov-07 @ 09:15	Method 29
Silver, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Thallium, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Zinc, mg/Kg	<0.01	0.01	20-Nov-07 @ 09:15	Method 29
Phosphorus, mg/Kg	<0.01	0.01	20-Nov-07 @ 15:27	Method 29

Comments: **ND** - None Dectected
PQL - Practical Quantitation Limit

References: *Method 29 - Determination of Metals Emissions From Stationary Sources*

Reviewed by: _____

Alpine Analytical, Inc.
1315 Cherry, Helena, MT 59601 (406)449-6282

QUALITY CONTROL DATA - METALS

Date Reported: 21-Nov-07

Laboratory ID: QC06
Sample Matrix: Soil

Parameter	Analytical Result	True Value	Range	Method
Arsenic, mg/Kg	0.095	0.100	0.085 - 0.115	Method 29
Antimony, mg/Kg	0.100	0.100	0.085 - 0.115	Method 29
Aluminum, mg/Kg	0.099	0.100	0.085 - 0.115	Method 29
Barium, mg/Kg	0.098	0.100	0.085 - 0.115	Method 29
Beryllium, mg/Kg	0.106	0.100	0.085 - 0.115	Method 29
Cadmium, mg/Kg	0.098	0.100	0.085 - 0.115	Method 29
Chromium, mg/Kg	0.102	0.100	0.085 - 0.115	Method 29
Cobalt, mg/Kg	0.099	0.100	0.085 - 0.115	Method 29
Copper, mg/Kg	3.2	3.0	2.6 - 3.4	Method 29
Iron, mg/Kg	52	50	45 - 55	Method 29
Lead, mg/Kg	0.098	0.100	0.085 - 0.115	Method 29
Manganese, mg/Kg	0.097	0.100	0.085 - 0.115	Method 29
Mercury, mg/Kg	0.098	0.100	0.085 - 0.115	Method 29
Nickel, mg/Kg	0.106	0.100	0.085 - 0.115	Method 29
Selenium, mg/Kg	0.472	0.500	0.375 - 0.625	Method 29
Silver, mg/Kg	0.100	0.100	0.085 - 0.115	Method 29
Thallium, mg/Kg	0.099	0.100	0.085 - 0.115	Method 29
Zinc, mg/Kg	0.104	0.100	0.085 - 0.115	Method 29
Phosphorus, mg/L	1.84	1.71	1.29 - 2.13	Method 29

Parameter	Blank Result	Analytical Result	Duplicate Result	% Difference
Arsenic, mg/Kg	<0.01	<0.01	<0.01	NA
Antimony, mg/Kg	<0.01	<0.01	<0.01	NA
Aluminum, mg/Kg	<0.01	0.71	0.71	0.0%
Barium, mg/Kg	<0.01	11	11	0.1%
Beryllium, mg/Kg	<0.01	<0.01	<0.01	NA
Cadmium, mg/Kg	<0.01	<0.01	<0.01	NA
Chromium, mg/Kg	<0.01	<0.01	<0.01	NA
Cobalt, mg/Kg	<0.01	0.19	0.19	0.0%
Copper, mg/Kg	<0.01	0.34	0.34	0.0%
Iron, mg/Kg	<0.01	<0.01	<0.01	NA
Lead, mg/Kg	<0.01	<0.01	<0.01	NA
Manganese, mg/Kg	<0.01	0.24	0.24	0.0%
Mercury, mg/Kg	<0.01	<0.01	<0.01	NA
Nickel, mg/Kg	<0.01	2.10	2.10	0.0%
Selenium, mg/Kg	<0.01	0.14	0.14	0.0%
Silver, mg/Kg	<0.01	<0.01	<0.01	NA
Thallium, mg/Kg	<0.01	<0.01	<0.01	NA
Zinc, mg/Kg	<0.01	<0.01	<0.01	NA
Phosphorus, mg/Kg	<0.01	54	54	-0.9%

Comments: Extracted by Method 3050.

References: *Method 29 - Determination of Metals Emissions From Stationary Sources*

Reviewed by: _____

Form #CUST-02

BISON ENGINEERING INC. - CHAIN OF CUSTODY RECORD

001795

(406) 442-5768; FAX (406) 449-6653

Client Description **Western MT College**

Bison Engineering Signature

Project No. **WMC207784**

Analytical Methods: **Method 29 metals with Hg**

Total No. of Samples **Three (3)**

Date	Sample I.D.	Description	Date	Sample I.D.	Description
Oct 24, 07	Wood bark	Wood sample		14m140	
	Fly Ash	Fly ash sample		14m141	
	Bottom Ash	Bottom ash sample		14m142	
				--	
				--	
				--	
				--	
				--	
				--	
				--	
				--	
				--	

Date Received 11/15/07 @ 1340 Date Relinquished

Company Name/Address **Alpine Labs**, Helena

Signature Gary Howell

Date Received Date Relinquished

Company Name/Address

Signature

Date Received Date Relinquished

Company Name/Address

Signature

NOTE:

STANDARD LABORATORIES, INC.

01/10/08

CUSTOMER: ENERGY LABORATORIES, INC.

H07120262-001 12/21/07

JOB NO.: 200704235001
LOCATION: CASPER, WY
APPROVAL:

PROXIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	38.00		
ASH	1.27	2.05	
VOLATILE	46.15	74.43	
FIXED C	14.58	23.52	
SULFUR	0.05	0.08	
BTU/#	5392	8696	
		8878	

ULTIMATE ANALYSIS (%)

	AS RECD	DRY	EQM
MOISTURE	38.00		
ASH	1.27	2.05	
SULFUR	0.05	0.08	
NITROGEN	0.56	0.90	
CARBON	39.24	63.29	
HYDROGEN	3.61	5.83	
OXYGEN	17.27	27.85	

MINERAL ANALYSIS OF ASH (%)

FORMS OF SULFUR (%)

	AS RECD	DRY

FUSION TEMPERATURE OF ASH (F)

	OXIDIZING	REDUCING

ADDITIONAL DATA

AIR DRY LOSS	33.33
LBS H20/MM BTU	70.47
LBS ASH/MM BTU	2.36
LBS SULFUR/MM BTU	0.09
BASE/ACID RATIO	
T250	DEG F
% ALKALI AS Na2O	
SPECIFIC GRAVITY	
FREE SWELLING INDEX	

GRINDABILITY (HGI)

AT % MOISTURE

WATER SOLUBLE ALKALIES (%)

	AS RECD	DRY

Form #CUST-02

BISON ENGINEERING INC. - CHAIN OF CUSTODY RECORD

(406) 442-5768; FAX (406) 449-6653

Client Description **Wester MT College**

Project No. **WMC207784**

Total No. of Samples **One (1)**

Bison Engineering Signature

Analytical Methods: **Ultimate and Proximate plus Btu and Fd factor**

Date	Sample I.D.	Description	Date	Sample I.D.	Description
Dec 21, 07	bark	PM Test wood fuel sample			H0712026 2-001
				--	
				--	
				--	
				--	
				--	
				--	
				--	
				--	
				--	
				--	

Date Received 12-21-07 Date Relinquished 13 45

Company Name/Address **ENERGY LABS** – Standard Laboratories

Signature

Date Received Date Relinquished

Company Name/Address

Signature

Date Received Date Relinquished

Company Name/Address

Signature

NOTE:

APPENDIX D:
NOMENCLATURE AND FORMULAE

Nomenclature

A_n sampling nozzle cross-sectional area , ft^2

A_s stack cross-sectional area, ft^2
Note: Method 2 refers to this as A

a mean particle projected area

Btu unit heat value (British thermal unit)

B_{wm} percent moisture in gas at meter

B_{ws} percent moisture in stack gas

C_1 viscosity constant, 51.12 micropoise for K (51.05 micropoise for °R)

C_2 viscosity constant, 0.372 micropoise/K (0.207 micropoise/°R)

C_3 viscosity constant, 1.05×10^{-4} micropoise/K^2 (3.24×10^{-5} micropoise/$°R^2$)

C_4 viscosity constant, 53.147 micropoise/ fraction O_2

C_5 viscosity constant, 74.143 micropoise/ fraction H_2O

C_a concentration of acetone blank residue, mg/g

C_{cond} concentration of condensibles, grain/dscf

C_{cors} concentration of coarse particulate, gr/dscf

C_p pitot tube calibration coefficient, 0.84 for type S pitot tube

Cp(std) standard pitot-static tube calibration coefficient

C_{PM10} concentration of PM_{10} particulate, gr/dscf

C_s particulate concentration in stack gas, mass/volume

cs12 particulate concentration corrected to 12 percent CO_2

c_{s50} particulate concentration corrected to 50 percent excess air

cws particulate concentration on a wet basis, mass/wet volume

$C_{X\,(corr)}$ actual gas concentration corrected to required percent O_2

D_{50} diameter of particles having a 50 percent probability of penetration, µm

D_e equivalent diameter

D_h hydraulic diameter

$DH_@$ pressure drop across orifice meter for 0.75 CFM at standard conditions

DH pressure drop across orifice meter

D_n source sampling nozzle diameter

D_{p50} 50% effective cutoff diameter of particle, µ

D_s diameter of the stack, feet

E emission rate or mass/unit heat (Btu input)

e base of natural logarithms (ln10 = 2.302585)

%EA percent excess air

E_{hr} emission rate per hour, lb/hr

ER_{cond} emission rate of condensibles, lb/hr

ER_{cors} emission rate of coarse particulate, lb/hr

ER_{mmBtu} emission rate per mmBtu or ton of fuel, etc.

ER_{PM10} emission rate of PM_{10} particulate, lb/hr

ER_X emission rate of compound which replaces x

F_c F factor for CO_2, used with percent CO_2, wet or dry basis

F_d F factor for dry effluent, used with percent O_2, dry basis

f_o stack gas fraction O_2, by volume, dry basis

F_o fuel factor

F_w F factor for wet effluent, used with percent O_2, wet basis

ΔH average pressure differential across orifice meter at control box

$\Delta H_@$ orifice pressure, inches H_2O

ΔH_d	orifice pressure head, inches H_2O, needed for cyclone flow rate
%I	percent sampling rate variation, where 100% = ideal isokinetic conditions
j	equal area centroid
K_1	0.001333 m^3/ml for metric units 01.1 ft^3/ml for English units *Equation 4-1*
K_2	0.001335 m^3/g for metric units 1. ft^3/g for English units *Equation 4-2*
K_3	0.3858 ∘K/mm Hg for metric units 1. °R/in. Hg for English units *Equation 4-3*
K_p	pitot tube equation dimensional constant, 85.49
L	length of duct cross-section at sampling site
L_1	plume exit diameter
L_2	stack diameter
m	mass
M_a	acetone residue weight after evaporation, mg
mBtu	thousand Btu
M_{cond}	mass of condensibles
M_{cors}	mass of coarse particulate
M_d	dry stack gas molecular weight
m_f	filter weight gain, mg
M_{fine}	mass of PM_{10} particulate
mmBtu	million Btu
m_n	total weight of collected particulate, mg
$m_{n,\,pm10}$	total weight of collected PM_{10} particulate, mg
M_s	wet stack gas molecular weight
M_w	molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole)
M_{wx}	molecular weight of gas species, g/gmol
n	number of particles
N_{re}	Reynolds Number
θ	total sampling time, min.
O_1	plume opacity at exit
O_2	in-stack plume opacity
ΔP	stack differential pressure recorded by the probe's type S pitot tube
Δp	velocity head of stack gas, mm H_2O (in. H_2O) - *Equation 2-8*
$\sqrt{\Delta P}$	average of the square roots of ΔP (may also be referred to as ASΔP)
$\sqrt{\Delta P_1}$	square root of ΔP at point 1 of the current test
$\sqrt{\Delta P_1}'$	square root of ΔP at point 1 of the previous traverse
$\sqrt{\Delta P}'$	average of the square roots of ΔP from the previous traverse (may also be referred to as ASΔP')
$\%CO_2$	percent CO_2 by volume, dry basis
$\%O_2$	percent O_2 by volume, dry basis
%CO	percent CO by volume, dry basis
$\%N_2$	percent N_2 by volume, dry basis
P_{atm}	atmospheric pressure
P_b	barometric pressure ($P_b = P_{atm}$)
P_{bar}	barometric pressure at measurement site, mm Hg (in. Hg)
P_g	stack static pressure, mm Hg (in. Hg)
P_i	pitch angle at traverse point i, degree
P_m	absolute pressure at the meter
pmr	pollutant mass rate
P_p	absolute barometric pressure at the sample location, inches Hg
P_s	absolute pressure in the stack

P_{std} standard absolute pressure, 760 mm Hg (29.92 in. Hg)

pts number of traverse points during the test, minimum of 6, maximum of 12

ρ_w density of water, 0.9982 g/ml (0.002201 lb/ml)

q time in minutes

Q_a stack gas volumetric flow rate, acfm

Q_s average stack gas wet volumetric flow rate, cfm (ft^3/min)

Q_{sc} actual gas flow rate through the cyclone, acfm

Q_{sc}' predicted actual gas flow rate through the cyclone, acfm

$Q_{s(std)}$ total cyclone flow rate at standard conditions, dscm/min (dscf/ min)

Q_{std} dry volumetric stack gas flow rate corrected to standard conditions

Q_w wet stack gas standard volumetric flow, ft^3/min, wscfm

r path length

R ideal gas constant, 0.06236 (mm Hg) (m^3)/(g-mole) (K) for metric units and 21.85 (in. Hg) (ft^3)/(lb-mole) (°R) for English units

R_i resultant angle at traverse point i, degree

R_{max} multiplier for V_n

R_{min} multiplier for V_n

T_m absolute temperature at meter, K (°R)

t_s stack temperature, °C (°F)

T_s absolute stack temperature, K (°R)

$T_{s(avg)}$ average stack gas temperature, absolute, °R

T_{std} standard absolute temperature, 293 K (528°R)

T_t duration of test

μ_s stack gas absolute viscosity, μ poise

V_f final volume of condenser water, ml

V_i initial volume, if any, of condenser water, ml

V_m dry gas volume measured by dry gas meter, dcm (dcf)

ΔV_m incremental dry gas volume measured by dry gas meter at each traverse point, dcm (dcf)

V_{max} maximum allowed nozzle velocity , fps

V_{min} minimum allowed nozzle velocity, fps

$V_{m(std)}$ dry gas volume measured by the dry gas meter, corrected to standard conditions, dscm (dscf)

V_n target nozzle velocity, fps

v_s average stack gas velocity, m/sec (ft/sec)

V_w volume of water vapor

$V_{w(std)}$ volume of water vapor in the gas sample, corrected to standard conditions, scf (standard cubic feet)

$V_{wc(std)}$ volume of water vapor condensed corrected to standard conditions, scm (scf)

$V_{wsg(std)}$ volume of water vapor collected in silica gel corrected to standard conditions, scm (scf)

Volume H_2O metric units = 0.00134 m^3/ml x ml H_2O
English units = 0.04707 ft^3/mlxmlH_2O

W width of the duct cross-section at the sampling site

W_f final weight of silica gel or silica gel plus impinger, g

W_i initial weight of silica gel or silica gel plus impinger, g

W_{lc} weight of collected water, g

X_d fraction of dry gas

Y dry gas meter calibration factor

Y_i yaw angle at traverse point i, degree
0.280 molecular weight of N_2 or CO divided by 100

1. molecular weight of O_2 divided by 100

	0.440 molecular weight of CO_2 divided by 100
	18.0 molecular weight of water, g/g-mole (lb/lb-mole)
3,600	conversion factor, sec/hr

Subscripts:

atm	atmospheric
ave	average
b	barometric
d	dry gas basis
f	final
g	gauge
i	initial
m	at meter
n	at nozzle
p	of pitot tube
s	at stack
SCF	standard cubic feet
std	standard conditions
w	wet basis

FORMULAE

1. Dry Gas Volume - Corrected to STP (40 CFR 60, App. A, Eq. 5-1)

$$V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m} \right) \left[\frac{P_{b_{ar}} + \frac{\overline{\Delta H}}{13.6}}{P_{std}} \right]$$

Y is obtained from post-test meter calibrations.

2. Water Vapor Volume - Corrected to STP (40 CFR 60, App. A, Eq. 5-2)

$$V_{w(std)} = V_{lc} \left(\frac{\rho_w}{M_w} \right) \left(\frac{RT_{std}}{P_{std}} \right)$$

Note: $W_{lc} = V_{lc}\, \rho_w$

3. Stack Gas Moisture Content (40 CFR 60 App. A, Eq. 5-3, modified)

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

4. Stack Gas Dry and Wet Molecular Weight (40 CFR 60 App. A, Eq. 3-1, 2-5)

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

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

5. Average Stack Gas Velocity (40 CFR 60 App. A, Eq. 2-9)

$$v_s = K_p C_p \left(\frac{\sum_1^n \sqrt{\Delta p}}{n} \right) \sqrt{\frac{T_{s(avg)}}{P_S M_S}}$$

6. Average Stack Gas Wet Volumetric Flow Rate

$$Q_s = 60 v_s A_s$$

7. Average Stack Gas Dry Flow Rate Corrected to Standard Conditions (40 CFR 60 App. A, Eq. 2-10, modified)

$$Q_{std} = Q_s (1 - B_{ws}) \frac{T_{std}}{T_{s(avg)}} \frac{P_s}{P_{std}}$$

8. TSP Particulate Concentration Corrected to Standard Conditions (40 CFR 60 App. A, Eq. 5-6, modified)

$$c_{s_{lb}} = 2.205 \, x \, 10^{-6} \frac{m_n}{V_{m(std)}}$$

$$c_{s_{gr}} = 15.43 \, x \, 10^{-3} \frac{m_n}{V_{m(std)}}$$

Note: $C_{s,lb}$ = lb/dscf
$C_{s,gr}$ = grains/dscf
m_n = mg

9. TSP Emission Rate per Hour

$$E_{hr} = c_s Q_{std} 60$$

10. Percent Isokinetic Sampling Variation (40 CFR 60 App. A, Eq. 5-8)

$$I\% = \frac{T_{s(avg)} V_{m(std)} P_{std} 100}{T_{std} v_s \Theta A_n P_s 60 (1 - B_{ws})}$$

11. Percent moisture at 100 percent saturation (%SVP) equation:

$$\% SVP = \left[\frac{100}{P_S}\right] x 10^{\left[6.6911 - \frac{3144}{(T_{ws} - 390.86)}\right]}$$

where: P_s = stack pressure (absolute), inches of mercury
T_{ws} = saturated stack temperature, degrees F

12. Emission Rate Compressor Engines (g/BHP-Hr)

$$E = \frac{(e)\ PPM\ Q_{STD}}{BHP}$$

13. Brake Horsepower for Compressor Engines

$$BHP = [43.6\ x\ MMCFD\ x \left(\frac{T_{ts}}{T_{std2}}\right) x \left(\frac{K}{(K-1)}\right) x \left(R_2^{\frac{(k-1)}{k}} - 1\right) x\ LE\ x\ FE] + Fan\ HP$$

14. Pounds Per Hour Emission Rate

$$lb/hr = E * BHP * \frac{lb}{453.59\ g}$$

15. Analyzer Calibration error, in general, % diff. ≤ 2%

$$\% Diff. = \left(\frac{Cal.\ gas\ ppm - Analyzer\ response\ ppm}{Analyzer\ span\ ppm}\right) x100$$

16. System bias, in general <5% for both zero and upscale gases

$$system\ Bias = \left(\frac{system\ cal.\ response\ ppm - Analyzer\ response\ ppm}{span\ gas\ ppm}\right) x100$$

17. Calibration drift <3% for both zero and upscale gases during each run

$$Cal.\ Drift = \left(\frac{final\ sys\ Cal.\ resp.\ ppm - initial\ sys\ cal.\ resp.\ ppm}{span\ gas\ ppm}\right) x100$$

18.

$$System\ Calibration\ Bias = \left(\frac{System\ Cal.\ Response\ ppm - Analyzer\ Cal.\ Response\ ppm}{span\ gas\ ppm}\right) x100$$

19.

$$Drift = \left(\frac{Final\ System\ Cal.\ Response\ ppm - Initial\ System\ Cal.\ Response\ ppm}{Span\ gas\ ppm}\right) x100$$

20. Analyzer calibration error, in general, %diff. ≤ 2%

$$\%\ Diff. = \left(\frac{Cylinder\ ppm - analyzer\ response\ ppm}{span\ gas\ ppm}\right) x100$$

21. Parts per million by volume (ppmv) to pounds per hour (lbs/hr)

lbs/hr = 1.558×10^{-7} x molecular weight x flow, dscfm x ppmv

lbs/hr = (ppmv) ($1.558\ e^{-7}$) (MW) (dscfm)

ppm = parts per million
dscfm = dry standard cubic feet per minute
MW = molecular weight

22. Corrected concentrations to 12% CO_2

$$Cs_{12} = Cs \frac{12}{\%CO_2}$$

23. Correcting concentrations to 6% O_2

$$Cs_{\%O_2d} = Cs \left[\frac{20.9 - 6\ \%O_2}{20.9 - \%O_{2d}} \right]$$

24. Concentration moisture corrections

$$Cd = (Cw) / (1 - Bws)$$

Cd = concentration dry
Cw = concentration wet
Bws = moisture content

25. Fuel Burning Rule

Fuel Input: Measure fuel introduced to the boiler bank. For example,

$$E = 0.882 * H^{-0.1664}$$
$$E = 0.882\ (12{,}500\ lb_{fuel}/hr \times 4800\ Btu/lb_{fuel})/1\times10^6)^{-0.1664}$$
$$E = 0.882\ (60\ MMBtu/hr)^{-0.1664}$$
$$E = 0.4463\ lb/MMBtu$$

Where E is the maximum allowable particulate emissions rate in lbs per MMBtu.

Steam Production: Measure steam produced by the boiler bank. For example,

$$E = 0.882 * H^{-0.1664}$$
$$E = 0.882\ [(30{,}000\ lb_{steam}/hr \times 1{,}200\ Btu/lb_{steam})/(60\%_{boiler\ efficiency})/(1\times10^6)]^{-0.1664}$$
$$E = 0.882\ (60\ MMBtu/hr)^{-0.1664}$$
$$E = 0.4463\ lb/MMBtu$$

Where E is the maximum allowable particulate emissions rate in lbs per MMBtu.

APPENDIX E:
CALIBRATIONS, AUDITS AND CERTIFICATIONS

Nozzle Kit C

Avg diameter	------ Nozzle Calibration ------ diameter 1	diameter 2	diameter 3	Nozzle ID	
0.137	0.137	0.138	0.137	B3	
0.138	0.138	0.138	0.139	N3	
0.181	**0.182**	**0.180**	**0.181**	**60**	**LOST**
0.249	0.249	0.251	0.248	B9	
0.256	0.254	0.258	0.256	B8	
0.264	0.264	0.264	0.265	8	
0.297	0.296	0.298	0.297	1	
0.313	0.311	0.314	0.315	11	
0.378	0.379	0.378	0.378	12	
0.388	0.388	0.388	0.389	13	
0.419	0.419	0.417	0.420	77	
0.446	0.446	0.445	0.447	14	
0.508	0.507	0.510	0.508	16	

calibrated 8/1/2005 by Bill Shaw

Form #M5-09

PITOT CALIBRATION (SHEET A)

Probe I.D. 2A

Type (vol, Meth. 5): Meth 5

Nominal Length: 2'

Date: Jan 5, 2007

Calibrated by: WS

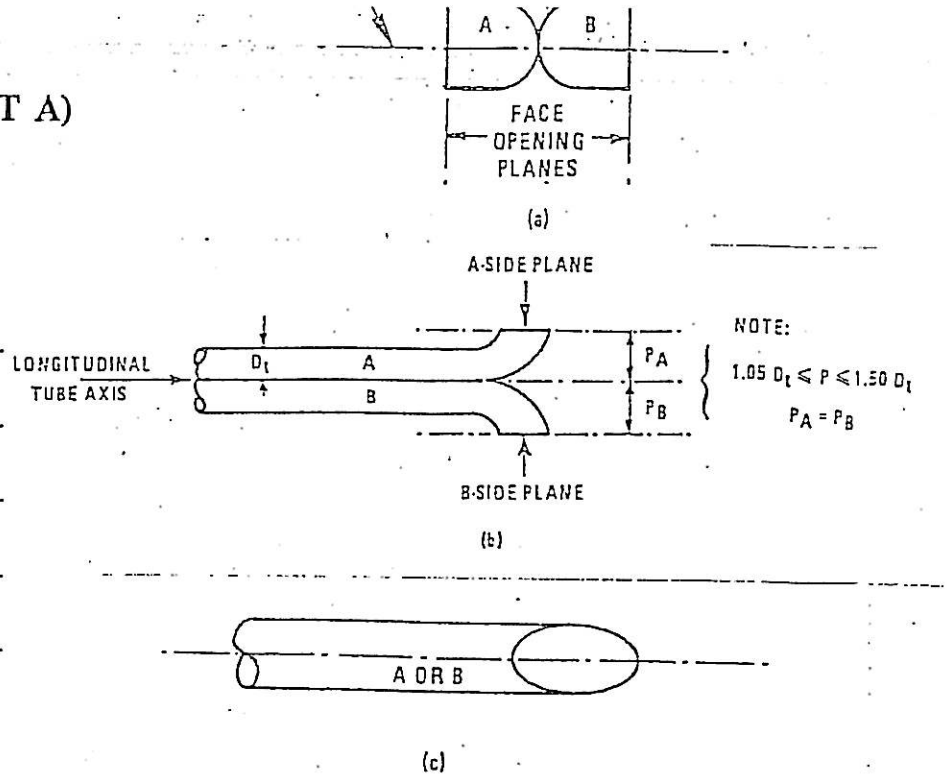


Figure 2-2. Properly constructed Type S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening planes parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline coefficient values of 0.84 may be assigned to pitot tubes constructed this way.

DIMENSIONS

D_t: 0.375

P_A: 0.503

P_B: 0.503

$\alpha 1$: 0

$\alpha 2$: 0

$\beta 1$: 0

$\beta 2$: 0

W_1: 0

Z_1: 0

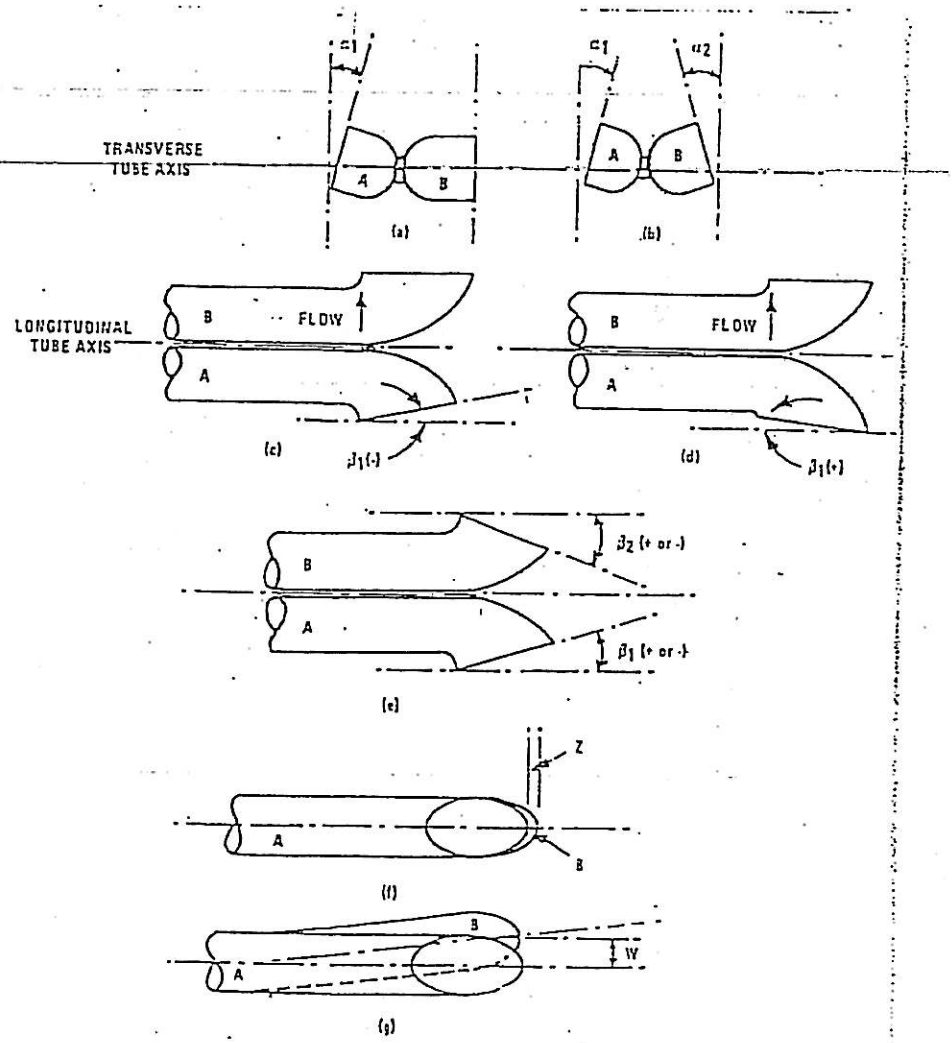


Figure 2-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of Cp(s) so long as $\alpha 1$ and $\alpha 2$ 10°, $\beta 1$ and $\beta 2$ 5°, z 0.32 cm (1/8 in.) and w 0.08 cm (1/32

Rev. 12/93

Form #M5-09

PITOT CALIBRATION (SHEET B)

Probe I.D. 2A

Type (vol, Meth. 5): Meth 5

Nominal Length: 2'

Date: Jan 5, 2007

Calibrated by: WS

DIMENSIONS

W_2: 6 inches

X: 0.95 inches

Y: 3.35 inches

Z_1: 1.375 inches

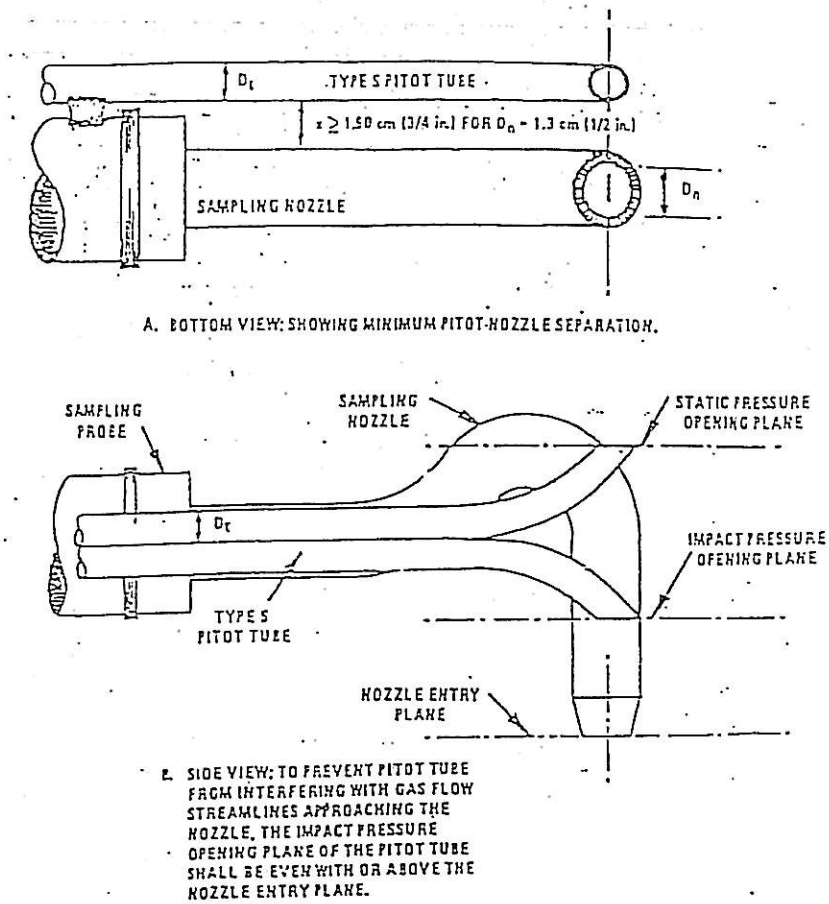


Figure 2-6. Proper pitot tube-sampling nozzle configuration to prevent aerodynamic interference; buttonhook-type nozzle; centers of nozzle and pitot opening aligned; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

[Figure 2-6 amended by 52 FR 34639, September 14, 1987]

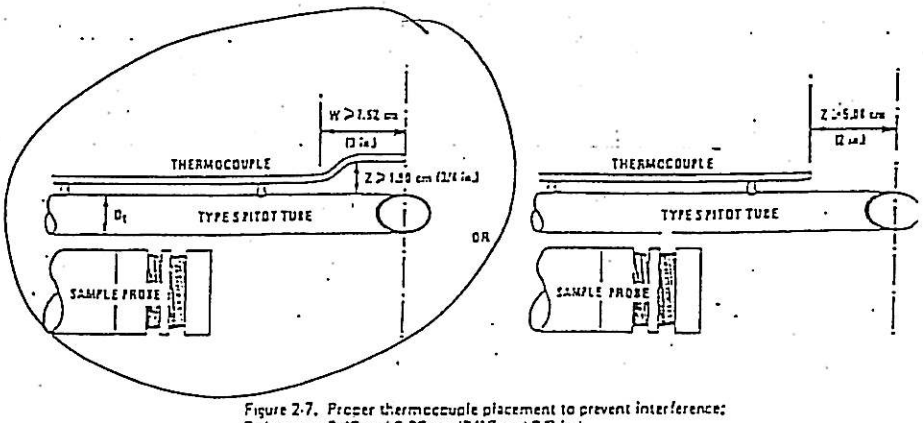


Figure 2-7. Proper thermocouple placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

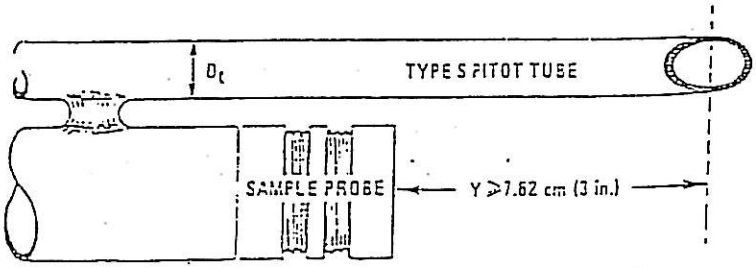


Figure 2-8. Minimum pitot-sample probe separation needed to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

Rev. 12/93

BISON ENGINEERING

Method 2, section 10.1.5.2.1 Type S Pitot Tube

Post Test Calibration of Pitot Tube

Date: _____

Pitot tube ID #: _____

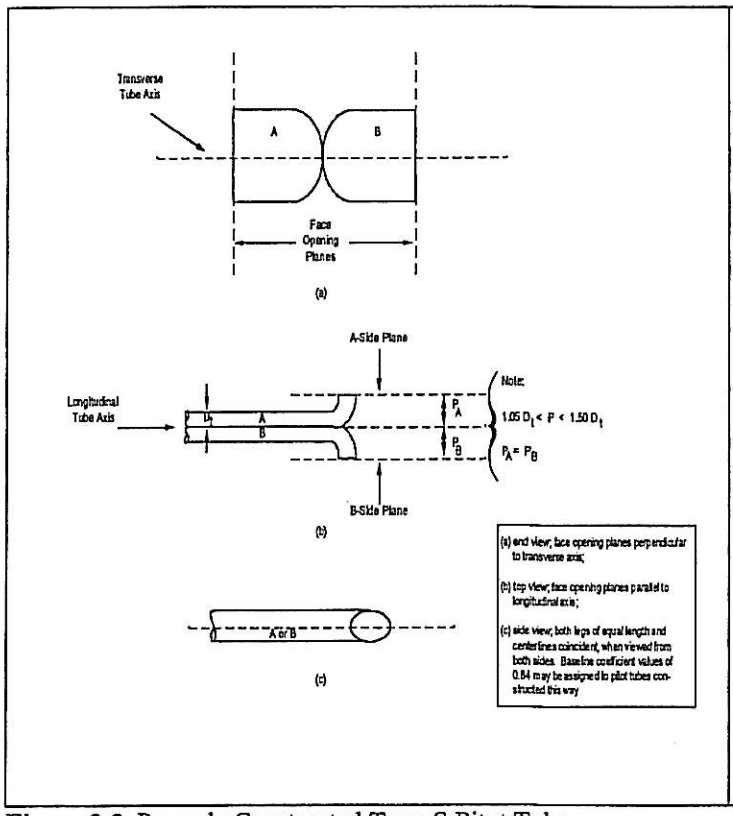


Figure 2-2. Properly Constructed Type S Pitot Tube.

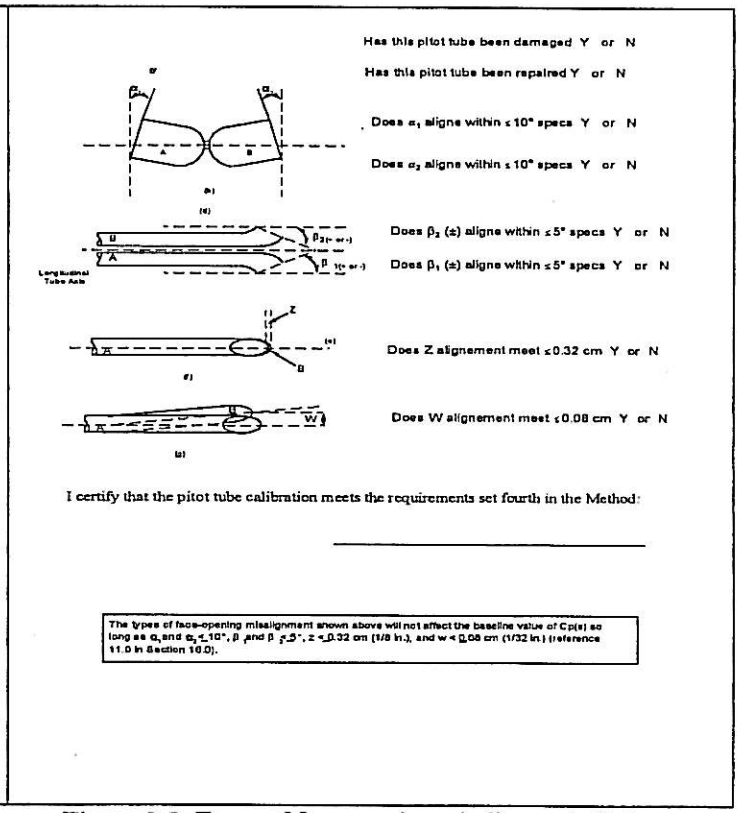


Figure 2-3. Types of face-opening misalignments that can result from field use or improper construction of type S pitot tubes.

During examination, do the openings still align within the specifications illustrated in Figures 2-2 & 2-3 ?

Yes or No

Calibration perfomed by: _____

EPA Reference Method 2. Section 10.0 Calibration and Standardization

10.1.5.2.1 Isolated Pitot Tubes. After each field use, the pitot tube shall be carefully reexamined in top, side, and end views. If the pitot face openings are still aligned within the specifications illustrated in Figure 2-2 and Figure 2-3, it can be assumed that the baseline coefficient of the pitot tube has not changed. If, however, the tube has been damaged to the extent that it no longer meets the specifications of Figure 2-2 and Figure 2-3, the damage shall either be repaired to restore proper alignment of the face openings, or the tube shall be discarded.

BISON ENGINEERING

Method 2, section 10.- Type S Pitot Tube Assembly

Post Test Calibration of Probe Assembly Components

Date: _____

Pitot tube ID #: _____

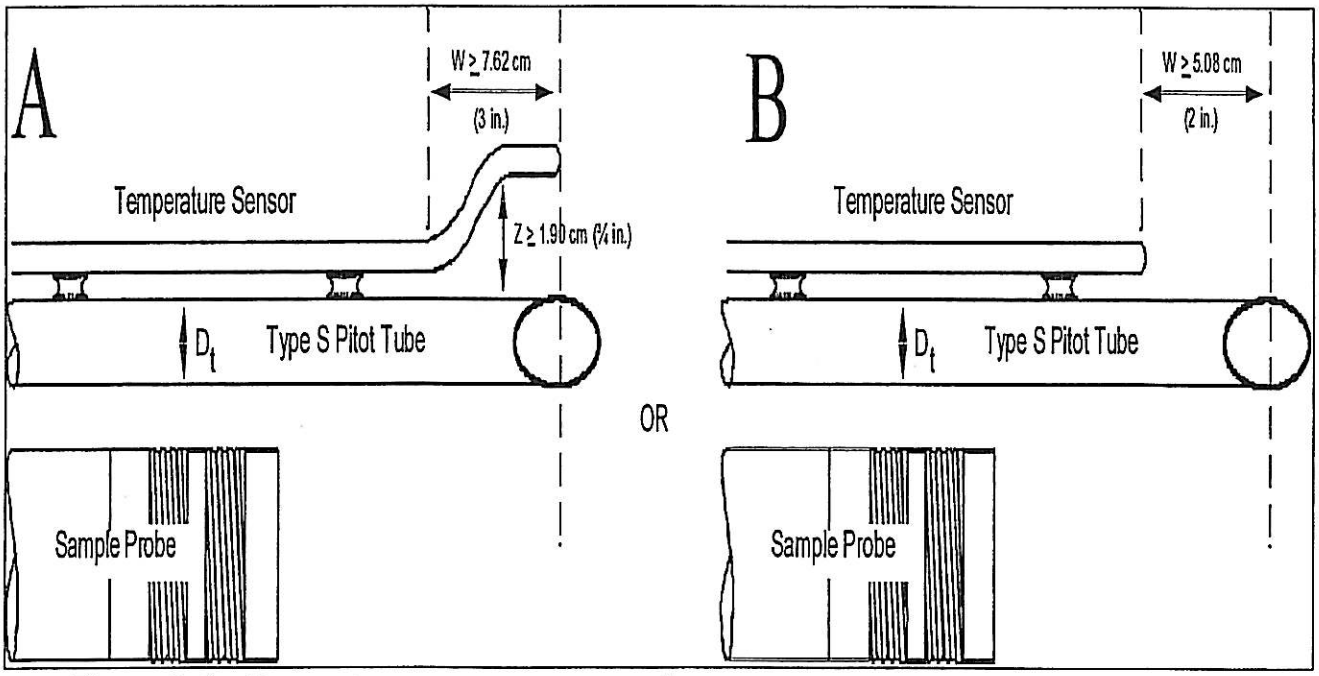


Figure 2-4. Proper temperature sensor placement to
to prevent interference; Dt between 0.48 and 0.95 cm (3/16" and 3/8")

A **Is the temperature sensor distance W > 3" from pitot tube opening ?** _____

and, is the temperature sensor distance Z > ¾" from pitot tube opening ? _____

B **or, is the temperature sensor distance W ≥ 2" from pitot tube opening ?** _____

Calibration perfomed by: _____

APEX INSTRUMENTS METHOD 5 PRE-TEST CONSOLE CALIBRATION
USING CALIBRATED CRITICAL ORIFICES
5-POINT ENGLISH UNITS

Meter Console Information	
Box Number	4
Console Serial Number	
DGM Model Number	
DGM Serial Number	

Calibration Conditions			
Date	Time	26-Jan-05	3:15
Barometric Pressure		26.0	in Hg
Theoretical Critical Vacuum[1]		12.3	in Hg
Calibration Technician		jw	

Factors/Conversions		
Std Temp	528	°R
Std Press	29.92	in Hg
K_1	17.647	oR/in Hg

[1]For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.

[2]The Critical Orifice Coefficient, K', must be entered in English units, $(ft^3 \cdot {}^oR^{1/2})/(in.Hg \cdot min)$.

Calibration Data

Run Time	Metering Console					Critical Orifice				
Elapsed	DGM Orifice ΔH	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final	Serial Number	Coefficient	Amb Temp Initial	Amb Temp Final	Actual Vacuum
(Θ)	(P_m)	(V_{mi})	(V_{mf})	(t_{mi})	(t_{mf})		K'	(t_{amb})	(t_{amb})	
min	in H_2O	cubic feet	cubic feet	°F	°F		see above2	°F	°F	in Hg
22.5	0.2	536.248	542.779	58	58	QM40	0.2349	55	56	21
14.5	0.5	542.779	548.995	58	58	QM48	0.3456	56	56	19
11.0	0.9	548.995	555.105	58	58	Qm55	0.4455	56	56	18
23.5	1.7	555.105	572.545	58	59	Qm 63	0.5982	56	56	17
12.0	2.9	572.545	584.150	59	59	QM73	0.7848	56	56	14

Results

Standardized Data				Dry Gas Meter				
				Calibration Factor		Flowrate	ΔH @	
Dry Gas Meter		Critical Orifice		Value	Variation	Std & Corr	0.75 SCFM	Variation
($V_{m(std)}$)	($Q_{m(std)}$)	($Vcr_{(std)}$)	($Q_{cr(std)}$)	(Y)	(ΔY)	($Q_{m(std)(corr)}$)	(ΔH@)	(ΔΔH@)
cubic feet	cfm	cubic feet	cfm			cfm	in H2O	
5.789	0.257	6.052	0.269	1.046	0.006	0.269	1.587	-0.155
5.514	0.380	5.736	0.396	1.040	0.000	0.396	1.726	-0.016
5.426	0.493	5.609	0.510	1.034	-0.006	0.510	1.754	0.012
15.507	0.660	16.090	0.685	1.038	-0.002	0.685	1.824	0.082
10.344	0.862	10.779	0.898	1.042	0.002	0.898	1.818	0.076
				1.040	Y Average		1.742	ΔH@ Average

AVERAGE **Y=** **1.040**

AVERAGE **H=** **1.742**

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR Title 40, Part 60, Appendix A-3, Method 5, 16.2.3

Signature _____ Date _____

APEX INSTRUMENTS METHOD 5 POST-TEST CONSOLE CALIBRATION
USING CALIBRATED CRITICAL ORIFICES
3-POINT ENGLISH UNITS

Meter Console Information	
Box Number	4
Console Serial Number	
DGM Model Number	
DGM Serial Number	

Calibration Conditions			
Date	Time	29-Nov-07	1:30
Barometric Pressure		26.2	in Hg
Theoretical Critical Vacuum[1]		12.4	in Hg
Calibration Technician		MTC	

Factors/Conversions		
Std Temp	528	°R
Std Press	29.92	in Hg
K_1	17.647	oR/in Hg

[1]For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.

[2]The Critical Orifice Coefficient, K', must be entered in English units, $(ft^3 \cdot {}^oR^{1/2})/(in.Hg \cdot min)$.

Calibration Data

Run Time	Metering Console					Critical Orifice				
Elapsed	DGM Orifice ΔH	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final	Serial Number	Coefficient	Amb Temp Initial	Amb Temp Final	Actual Vacuum
(Θ)	(P_m)	(V_{mi})	(V_{mf})	(t_{mi})	(t_{mf})		K'	(t_{amb})	(t_{amb})	
min	in H_2O	cubic feet	cubic feet	°F	°F		see above2	°F	°F	in Hg
5.0	2.9	281.000	285.683	51	55	OM73	0.7848	70	70	15
5.0	2.9	285.683	290.369	55	57	QM73	0.7848	70	70	15
5.0	2.9	290.369	295.068	58	61	QM73	0.7848	70	70	15

Results

Standardized Data				Dry Gas Meter				
				Calibration Factor		Flowrate	ΔH @	
Dry Gas Meter		Critical Orifice		Value	Variation	Std & Corr	0.75 SCFM	Variation
($V_{m(std)}$)	($Q_{m(std)}$)	($Vcr_{(std)}$)	($Q_{cr(std)}$)	(Y)	(ΔY)	($Q_{m(std)(corr)}$)	(ΔH@)	(ΔΔH@)
cubic feet	cfm	cubic feet	cfm			cfm	in H2O	
4.258	0.852	4.469	0.894	1.050	-0.005	0.894	1.873	0.011
4.236	0.847	4.469	0.894	1.055	0.000	0.894	1.862	0.001
4.219	0.844	4.469	0.894	1.059	0.005	0.894	1.850	-0.012
Pretest Gamma	1.049	% Deviation	0.5	1.055	Y Average		1.862	ΔH@ Average

Y= 1.055

H= 1.862

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR Title 40, Part 60, Appendix A-3, Method 5, 16.2.3

Signature _____ Date _____

APEX INSTRUMENTS METHOD 5 POST-TEST CONSOLE CALIBRATION
USING CALIBRATED CRITICAL ORIFICES
3-POINT ENGLISH UNITS

Meter Console Information	
Box Number	4
Console Serial Number	
DGM Model Number	
DGM Serial Number	

Calibration Conditions			
Date	Time	11-Dec-07	8:30
Barometric Pressure		26.1	in Hg
Theoretical Critical Vacuum[1]		12.3	in Hg
Calibration Technician		WS	

Factors/Conversions		
Std Temp	528	°R
Std Press	29.92	in Hg
K_1	17.647	oR/in Hg

[1]For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.

[2]The Critical Orifice Coefficient, K', must be entered in English units, $(ft^3 \cdot °R^{1/2})/(in.Hg \cdot min)$.

Calibration Data

Run Time	Metering Console					Critical Orifice				
Elapsed	DGM Orifice ΔH	Volume Initial	Volume Final	Outlet Temp Initial	Outlet Temp Final	Serial Number	Coefficient	Amb Temp Initial	Amb Temp Final	Actual Vacuum
(Θ)	(P_m)	(V_{mi})	(V_{mf})	(t_{mi})	(t_{mf})		K'	(t_{amb})	(t_{amb})	
min	in H_2O	cubic feet	cubic feet	°F	°F		see above2	°F	°F	in Hg
5.0	0.48	409.550	411.684	65	65	QM48	0.3456	72	73	20
5.0	0.48	411.684	413.831	65	66	QM48	0.3456	73	73	20
6.0	0.48	413.831	416.389	66	66	QM48	0.3456	73	73	20

Results

Standardized Data				Dry Gas Meter				
				Calibration Factor		Flowrate	ΔH @	
Dry Gas Meter		Critical Orifice		Value	Variation	Std & Corr	0.75 SCFM	Variation
($V_{m(std)}$)	($Q_{m(std)}$)	($Vcr_{(std)}$)	($Q_{cr(std)}$)	(Y)	(ΔY)	($Q_{m(std)(corr)}$)	(ΔH@)	(ΔΔH@)
cubic feet	cfm	cubic feet	cfm			cfm	in H2O	
1.873	0.375	1.952	0.390	1.043	0.001	0.390	1.557	0.001
1.882	0.376	1.951	0.390	1.037	-0.005	0.390	1.557	0.000
2.240	0.373	2.342	0.390	1.045	0.004	0.390	1.556	-0.001
Pretest Gamma	1.040	% Deviation	0.1	1.041	Y Average		1.557	ΔH@ Average

AVERAGE **Y=** 1.041

AVERAGE **H=** 1.557

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR Title 40, Part 60, Appendix A-3, Method 5, 16.2.3

Signature _____ Date _____

RATA CLASS

Dual-Analyzed Calibration Standard

Scott Specialty Gases

500 WEAVER PARK RD,LONGMONT,CO 80501 Phone: 888-253-1635 Fax: 303-772-7679

CERTIFICATE OF ACCURACY: Interference Free™ Multi-Component EPA Protocol Gas

Assay Laboratory

SCOTT SPECIALTY GASES
500 WEAVER PARK RD
LONGMONT,CO 80501

P.O. No.: 127
Project No.: 08-37395-001

Customer
BISON ENGINEERING

1400 11TH AVE
HELENA MT 59601

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: ALM056058 **Certification Date:** 06Mar2006 **Exp. Date:** 05Mar2008
Cylinder Pressure*:** 2000 PSIG

COMPONENT	CERTIFIED CONCENTRATION (Moles)		ACCURACY**	TRACEABILITY
CARBON MONOXIDE	103	PPM	+/- 1%	Direct NIST and NMi
NITRIC OXIDE	97.2	PPM	+/- 1%	Direct NIST and NMi
SULFUR DIOXIDE *	97.4	PPM	+/- 1%	Direct NIST and NMi
NITROGEN - OXYGEN FREE		BALANCE		
TOTAL OXIDES OF NITROGEN	97.3	PPM		Reference Value Only

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.
* This Protocol has been certified using corrected NIST SO2 standard values, per EPA guidance dated 7/24/96 and will not correlate with uncorrected Protocol

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 1679	02Apr2007	ALM030197	94.90 PPM	CARBON MONOXIDE
NTRM 1684	01Jun2009	AAL070928	98.40 PPM	NITRIC OXIDE
NTRM 1694	01Sep2007	ALM065508	98.10 PPM	SULFUR DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
FTIR//000929062	09Feb2006	FTIR
FTIR//000929062	06Mar2006	FTIR
FTIR//000929062	17Feb2006	FTIR

ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

First Triad Analysis

CARBON MONOXIDE
Date: 27Feb2006 Response Unit:PPM
Z1=0.01740 R1=95.41964 T1=103.8644
R2=95.46199 Z2=0.02127 T2=103.8796
Z3=0.03684 T3=103.8823 R3=95.49774
Avg. Concentration: 103.3 PPM

NITRIC OXIDE
Date: 27Feb2006 Response Unit:PPM
Z1=0.05527 R1=97.23757 T1=97.62575
R2=97.25473 Z2=0.07968 T2=97.64353
Z3=0.10065 T3=97.89547 R3=97.25720
Avg. Concentration: 97.47 PPM

SULFUR DIOXIDE *
Date: 27Feb2006 Response Unit:PPM
Z1=0.00508 R1=98.40598 T1=97.77593
R2=98.47578 Z2=0.04949 T2=97.90580
Z3=0.05071 T3=98.03166 R3=98.49261
Avg. Concentration: 97.55 PPM

Second Triad Analysis

Date: 06Mar2006 Response Unit: PPM
Z1=-0.03021 R1=94.98006 T1=103.4922
R2=94.99007 Z2=-0.00800 T2=103.4982
Z3=-0.00502 T3=103.5683 R3=95.01363
Avg. Concentration: 103.4 PPM

Date: 06Mar2006 Response Unit: PPM
Z1=0.05870 R1=98.59938 T1=96.97598
R2=98.64833 Z2=0.09899 T2=97.04503
Z3=0.11778 T3=97.30914 R3=98.67307
Avg. Concentration: 96.87 PPM

Date: 06Mar2006 Response Unit: PPM
Z1=0.00276 R1=98.46165 T1=97.46495
R2=98.50621 Z2=0.05270 T2=97.64663
Z3=0.05864 T3=97.71375 R3=98.59486
Avg. Concentration: 97.19 PPM

Calibration Curve

Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99995E-1
Constants: A=0.00000E+0
B=9.82170E-1 C=6.30000E-4
D=1.00000E-6 E=0.00000E+0

Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99992E-1
Constants: A=0.00000E+0
B=9.83522E-1 C=1.76000E-4
D=0.00000E+0 E=0.00000E+0

Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99990E-1
Constants: A=0.00000E+0
B=9.93627E-1 C=1.20000E-5
D=0.00000E+0 E=0.00000E+0

APPROVED BY: Devon VonFeldt for Jon Witzak

RATA CLASS

Dual-Analyzed Calibration Standard

Scott Specialty Gases

500 WEAVER PARK RD,LONGMONT,CO 80501 Phone: 888-253-1635 Fax: 303-772-7678

CERTIFICATE OF ACCURACY: Interference Free™ Multi-Component EPA Protocol Gas

Assay Laboratory

SCOTT SPECIALTY GASES
500 WEAVER PARK RD
LONGMONT,CO 80501

P.O. No.: 127
Project No.: 08-46033-001

Customer
BISON ENGINEERING

1411 4TH AVENUE NORTH
BILLINGS MT 59101

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: ALM010856 **Certification Date:** 08Sep2006 **Exp. Date:** 07Sep2008
Cylinder Pressure*:** 1930 PSIG

COMPONENT	CERTIFIED CONCENTRATION (Moles)		ACCURACY**	TRACEABILITY
CARBON MONOXIDE	251	PPM	+/- 1%	Direct NIST and NMi
NITRIC OXIDE	249	PPM	+/- 1%	Direct NIST and NMi
SULFUR DIOXIDE *	252	PPM	+/- 1%	Direct NIST and NMi
NITROGEN - OXYGEN FREE		BALANCE		
TOTAL OXIDES OF NITROGEN	250.	PPM		Reference Value Only

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.
* This Protocol has been certified using corrected NIST SO2 standard values, per EPA guidance dated 7/24/96 and will not correlate with uncorrected Prot

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 2636	02Oct2008	AAL10141L	248.5 PPM	CARBON MONOXIDE
NTRM 1685	01Jan2010	AAL071113	246.1 PPM	NITRIC OXIDE
NTRM 0260	01May2008	ALM008786	254.4 PPM	SULFUR DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
FTIR//000929062	08Sep2006	FTIR
FTIR//000929062	05Sep2006	FTIR
FTIR//000929062	31Aug2006	FTIR

ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

CARBON MONOXIDE

First Triad Analysis
Date: 29Aug2006 Response Unit:PPM
Z1=0.04792 R1=249.5035 T1=252.5257
R2=249.5808 Z2=0.11426 T2=252.7346
Z3=0.12646 T3=252.8684 R3=249.6671
Avg. Concentration: 251.6 PPM

Second Triad Analysis
Date: 08Sep2006 Response Unit: PPM
Z1=-0.10806 R1=247.9224 T1=250.6513
R2=248.2544 Z2=-0.00009 T2=250.6667
Z3=0.06548 T3=250.7302 R3=248.2757
Avg. Concentration: 251.0 PPM

Calibration Curve
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99996E-1
Constants: A=0.00000E+0
B=9.64210E-1 C=2.83000E-4
D=0.00000E+0 E=0.00000E+0

NITRIC OXIDE

First Triad Analysis
Date: 29Aug2006 Response Unit:PPM
Z1=0.05249 R1=247.0030 T1=248.7378
R2=247.0890 Z2=0.05678 T2=248.8495
Z3=0.06862 T3=249.0857 R3=247.2463
Avg. Concentration: 247.9 PPM

Second Triad Analysis
Date: 08Sep2006 Response Unit: PPM
Z1=-0.06017 R1=244.5606 T1=247.8871
R2=245.4305 Z2=0.03140 T2=248.2080
Z3=0.12712 T3=248.5693 R3=245.6923
Avg. Concentration: 249.1 PPM

Calibration Curve
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99988E-1
Constants: A=0.00000E+0
B=9.91019E-1 C=1.89000E-4
D=0.00000E+0 E=0.00000E+0

SULFUR DIOXIDE *

First Triad Analysis
Date: 29Aug2006 Response Unit:PPM
Z1=-0.00334 R1=253.2833 T1=250.7239
R2=253.3319 Z2=0.09707 T2=250.8101
Z3=0.10703 T3=250.9546 R3=253.4408
Avg. Concentration: 251.9 PPM

Second Triad Analysis
Date: 08Sep2006 Response Unit: PPM
Z1=-0.00128 R1=253.7831 T1=250.4879
R2=253.7858 Z2=0.13693 T2=250.7486
Z3=0.14929 T3=250.9426 R3=253.9354
Avg. Concentration: 251.3 PPM

Calibration Curve
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99997E-1
Constants: A=0.00000E+0
B=9.93126E-1 C=1.50000E-5
D=0.00000E+0 E=0.00000E+0

APPROVED BY: _____
Jon Witzak

RATA CLASS

Dual-Analyzed Calibration Standard

Scott Specialty Gases

500 WEAVER PARK RD,LONGMONT,CO 80501 Phone: 888-253-1635 Fax: 303-772-7673

CERTIFICATE OF ACCURACY: Interference Free™ Multi-Component EPA Protocol Gas

Assay Laboratory

SCOTT SPECIALTY GASES
500 WEAVER PARK RD
LONGMONT,CO 80501

P.O. No.: 127
Project No.: 08-39[illegible]1-001

Customer
WINGATE INN GILLETTE-BISON ENGINEER

4753-4809 E BOXELDER RD
BOXELDER/CLIFF DAVIS DR
GILLETTE WY 82718

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: ALM048842 **Certification Date:** 19Apr2006 **Exp. Date:** 18Apr2008
Cylinder Pressure*:** 1780 PSIG

COMPONENT	CERTIFIED CONCENTRATION (Moles)		ACCURACY**	TRACEABILITY
CARBON MONOXIDE	250	PPM	+/- 1%	Direct NIST and NMi
NITRIC OXIDE	250	PPM	+/- 1%	Direct NIST and NMi
SULFUR DIOXIDE *	250	PPM	+/- 1%	Direct NIST and NMi
NITROGEN - OXYGEN FREE		BALANCE		
TOTAL OXIDES OF NITROGEN	251.	PPM		Reference Value Only

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.
* This Protocol has been certified using corrected NIST SO2 standard values, per EPA guidance dated 7/24/96 and will not correlate with uncorrected Pro[illegible]

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 2636	01May2007	ALM013082	246.7 PPM	CARBON MONOXIDE
NTRM 1685	01Jan2008	AAL070284	241.6 PPM	NITRIC OXIDE
NTRM 0260	02Oct2006	ALM057546	266.6 PPM	SULFUR DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
FTIR//000929062	10Apr2006	FTIR
FTIR//000929062	07Apr2006	FTIR
FTIR//000929062	17Apr2006	FTIR

ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

First Triad Analysis | **Second Triad Analysis** | **Calibration Curve**

CARBON MONOXIDE

First Triad:
Date: 12Apr2006 Response Unit:PPM
Z1=-0.01649 R1=246.9890 T1=249.9096
R2=247.0024 Z2=0.01112 T2=250.2701
Z3=0.01872 T3=250.3660 R3=248.0224
Avg. Concentration: 249.5 PPM

Second Triad:
Date: 19Apr2006 Response Unit: PPM
Z1=-0.00465 R1=246.0028 T1=249.9116
R2=246.2910 Z2=0.03140 T2=250.4128
Z3=0.03845 T3=250.4546 R3=246.3423
Avg. Concentration: 250.7 PPM

Calibration Curve:
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99988E-1
Constants: A=0.00000E+0
B=5.12953E-1 C=1.64000E-4
D=0.00000E+0 E=0.00000E+0

NITRIC OXIDE

First Triad:
Date: 12Apr2006 Response Unit:PPM
Z1=0.07556 R1=241.4602 T1=248.5258
R2=241.6442 Z2=0.08592 T2=248.7066
Z3=0.10821 T3=248.8458 R3=241.7047
Avg. Concentration: 248.7 PPM

Second Triad:
Date: 19Apr2006 Response Unit: PPM
Z1=0.02775 R1=239.9358 T1=249.0128
R2=240.2888 Z2=0.03077 T2=249.1091
Z3=0.08024 T3=249.5760 R3=240.3769
Avg. Concentration: 250.7 PPM

Calibration Curve:
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99982E-1
Constants: A=0.00000E+0
B=6.83622E-1 C=9.00000E-5
D=0.00000E+0 E=0.00000E+0

SULFUR DIOXIDE *

First Triad:
Date: 12Apr2006 Response Unit:PPM
Z1=-0.02648 R1=266.6114 T1=249.9349
R2=266.6680 Z2=-0.02434 T2=249.9937
Z3=-0.00851 T3=250.0807 R3=266.7930
Avg. Concentration: 249.9 PPM

Second Triad:
Date: 19Apr2006 Response Unit: PPM
Z1=-0.01493 R1=266.9659 T1=249.2865
R2=267.0502 Z2=-0.01034 T2=249.3886
Z3=-0.00719 T3=249.7363 R3=267.0560
Avg. Concentration: 249.1 PPM

Calibration Curve:
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99991E-1
Constants: A=0.00000E+0
B=9.95187E-1 C=1.40000E-5
D=0.00000E+0 E=0.00000E+0

APPROVED BY: Jon Witzak

RATA CLASS

Dual-Analyzed Calibration Standard

Scott Specialty Gases
500 WEAVER PARK RD,LONGMONT,CO 80501 Phone: 888-253-1635 Fax: 303-772-7673

CERTIFICATE OF ACCURACY: Interference Free™ Multi-Component EPA Protocol Gas

Assay Laboratory

SCOTT SPECIALTY GASES
500 WEAVER PARK RD
LONGMONT,CO 80501

P.O. No.: 127
Project No.: 08-49346-003

Customer
BISON ENGINEERING

1400 11TH AVE
HELENA MT 59601

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

Cylinder Number: AAL15817 **Certification Date:** 07May2007 **Exp. Date:** 06May2009
Cylinder Pressure*:** 1920 PSIG

COMPONENT	CERTIFIED CONCENTRATION (Moles)		ACCURACY**	TRACEABILITY
CARBON MONOXIDE	499	PPM	+/- 1%	Direct NIST and NMi
NITRIC OXIDE	519	PPM	+/- 1%	Direct NIST and NMi
SULFUR DIOXIDE *	501	PPM	+/- 1%	Direct NIST and NMi
NITROGEN - OXYGEN FREE		BALANCE		
TOTAL OXIDES OF NITROGEN	520.	PPM		Reference Value Only

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.
* This Protocol has been certified using corrected NIST SO2 standard values, per EPA guidance dated 7/24/96 and will not correlate with uncorrected Prot

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 1680	01Nov2008	ALM057024	498.0 PPM	CARBON MONOXIDE
NTRM 1686	01Jan2010	AAL071094	497.7 PPM	NITRIC OXIDE
NTRM 1661	15Aug2009	ALM021025	506.4 PPM	SULFUR DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	DATE LAST CALIBRATED	ANALYTICAL PRINCIPLE
FTIR//000929062	04May2007	FTIR
FTIR//000929062	04May2007	FTIR
FTIR//000929062	04May2007	FTIR

ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

First Triad Analysis | **Second Triad Analysis** | **Calibration Curve**

CARBON MONOXIDE

First Triad:
Date: 30Apr2007 Response Unit:PPM
Z1=0.08048 R1=500.0555 T1=500.3517
R2=500.1236 Z2=0.09363 T2=500.8530
Z3=0.16147 T3=500.8564 R3=500.3145
Avg. Concentration: 498.5 PPM

Second Triad:
Date: 07May2007 Response Unit: PPM
Z1=-0.05625 R1=499.9287 T1=501.5257
R2=501.5788 Z2=0.02644 T2=502.1588
Z3=0.03145 T3=502.1756 R3=502.7218
Avg. Concentration: 498.5 PPM

Calibration Curve:
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99990E-1
Constants: A=0.00000E+0
B=8.85968E-1 C=4.22000E-4
D=0.00000E+0 E=0.00000E+0

NITRIC OXIDE

First Triad:
Date: 30Apr2007 Response Unit:PPM
Z1=0.04674 R1=498.1976 T1=519.8882
R2=498.6772 Z2=0.08523 T2=520.5487
Z3=0.15572 T3=520.8992 R3=499.2781
Avg. Concentration: 519.4 PPM

Second Triad:
Date: 07May2007 Response Unit: PPM
Z1=-0.10307 R1=497.2921 T1=520.1822
R2=499.1079 Z2=-0.02726 T2=520.2101
Z3=0.20597 T3=520.5426 R3=500.7379
Avg. Concentration: 518.9 PPM

Calibration Curve:
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99984E-1
Constants: A=0.00000E+0
B=1.00937E+0 C=2.17000E-4
D=0.00000E+0 E=0.00000E+0

SULFUR DIOXIDE *

First Triad:
Date: 30Apr2007 Response Unit:PPM
Z1=0.01308 R1=508.7038 T1=503.9088
R2=509.3313 Z2=0.05651 T2=504.4347
Z3=0.07772 T3=504.9363 R3=510.1699
Avg. Concentration: 501.5 PPM

Second Triad:
Date: 07May2007 Response Unit: PPM
Z1=0.03336 R1=508.0848 T1=500.6550
R2=508.7124 Z2=0.06484 T2=502.0922
Z3=0.07095 T3=502.7104 R3=509.0445
Avg. Concentration: 499.6 PPM

Calibration Curve:
Concentration=A+Bx+Cx2+Dx3+Ex4
r=9.99993E-1
Constants: A=0.00000E+0
B=1.00272E+0 C=1.40000E-5
D=0.00000E+0 E=0.00000E+0

APPROVED BY: _____
Jon Witzak