REPEALED - refer to 2016 Air Monitoring Directive, as amended

AIR MONITORING DIRECTIVE

The Air and Water Approvals Division intends to publish and distribute regular updates of the Air Monitoring Directive. In order to be kept informed of advances in this important publication, it is essential that the following information be provided to Alberta Environmental Protection.

NAME ______________________________

TITLE OF DEPARTMENT ______________________________

ORGANIZATION ______________________________

ADDRESS ______________________________

____

CITY ________________ PROVINCE/STATE ________________

COUNTRY ________________ POSTAL CODE ________________

PHONE ________________

Please complete and return this form to:

Air Emissions Branch
~~Air and Water Approvals Division~~
~~Alberta Environmental Protection~~
~~4th Floor, Oxbridge Place~~
~~9820 - 106 Street~~
~~Edmonton, Alberta~~
~~T5K 2J6~~
(403) 427-5883

Alberta Environment
Monitoring Division
11th Floor, Oxbridge Place
9820 – 106th Street
Edmonton, Alberta T5K 2J6

REPEALED - refer to 2016 Air Monitoring Directive, as amended

Alberta
ENVIRONMENT
Environmental Protection Services
Standards and Approvals Division

9820 106 Street, Edmonton, Alberta, Canada T5K 2L6 403/427-5883 Telex 037-2006, TWX 610-831-2636

June 26, 1989

Dear Licensee:

RE: Air Monitoring Directive (AMD)

The Licence to Operate your plant under the Clean Air Act has a requirement to monitor source emissions and ambient air quality, and to report the same. The Air Monitoring Directive attached to this letter sets out the manner in which the monitoring and reporting is to be carried out. This Directive is introduced under the authority of the Clean Air Act Section 4(6) and the Clean Air Act (General) Regulations Sections 4 and 11.

Insofar as this Directive is general and addresses all the major air contaminants, you are to refer to your Licence conditions for specific requirements and apply the relevant sections of the AMD. For example, if your Licence to Operate calls for the monitoring and reporting of ambient SO_2 concentrations, then refer to the sections of the AMD regarding the setting up and the operation of the SO_2 ambient monitoring station, and how the data is to be reported to Alberta Environment.

The Air Monitoring Directive is intended to ensure that the monitoring and reporting requirements of the Licence to Operate are carried out in a consistent, standardized fashion. Please note the AMD 86-1 which was circulated and quoted in some licence conditions was not published. Any drafts of AMD 86-1 should be discarded. This AMD supercedes all other previous air monitoring directives.

This Directive is effective immediately and special approval is required for any departure from its requirements. Application should be made immediately to this office for consideration of any such monitoring or reporting changes.

If you need any clarification of any of these requirements in the AMD, please call the Air Quality Branch, Standards and Approvals Division.

Thank you.

Yours truly,

J. C. Lack, P. Eng.
Director
Standards and Approvals Division

A.R. Schulz, P. Eng.
Director
Pollution Control Division

Attachment: AMD

sc/1700D

Air Monitoring Directive

Monitoring And Reporting Procedures For Industry

Alberta
ENVIRONMENT
Environmental Protection Services

AIR MONITORING DIRECTIVE

MONITORING & REPORTING PROCEDURES FOR INDUSTRY

NOTE:

Separate sample monthly and annual reports for following industries.

Sour Gas
Petroleum Refining
Oil Sands
Heavy Oil
Pulp and Paper
Power Generation
Fertilizer
Chemical
Coal Processing
Wood Products
Cement Manufacturing

I. INTRODUCTION

A. General

Licences to Operate, issued under the Clean Air Act, may contain sections which specify the monitoring and reporting requirements. This Directive is designed to specify and standardize acceptable monitoring methods and reporting formats and is issued pursuant to Sections 4 and 11 of the Clean Air (General) Regulation 216/75.

The data obtained from monitoring must be summarized, tabulated and forwarded to Alberta Environment in the format (unless approved otherwise by the Director of Standards and Approvals) and frequency specified for each industry sector.

The intent of this Directive is to emphasize the air quality assessment aspect in the required monthly and annual reports by stressing common analytical procedures for improved data quality assurance. Monthly reports will be used to document air monitoring data, assess quality control measures, document various types of problems, and to identify the need for immediate corrective action or follow-up.

This Directive is divided into two main sections: The first section deals with air monitoring operations; and the second covers the reporting requirements.

Appendix A contains the detailed procedures for applicable monitoring requirements for all industry sectors while Appendix B contains only the sample report applicable to your industry.

The final decision in response to any question dealing with the interpretation of the Directive rests with the Director of the Standards and Approvals Division.

B. Applicability to Specific Industry Sectors

Prior to this AMD, air monitoring directives were formulated for each specific industry on an individual basis. In order to ensure the use of common monitoring practices and reporting formats a consolidation of the major industry air monitoring directives has been made. This change should also facilitate the consistent implementation of future amendments where these may be necessary.

This Directive supercedes the following Air Monitoring Directives: AMD-81-1 (Oil & Gas Industry), AMD-79-1 (Fertilizer Industry), AMD-77-1 (Power Generating Industry), AMD-77-2 (Wood Products Industry), AMD-80-1 (Pulp & Paper Industry, AMD-79-3 (Source Emission Survey Report Format), and AMD-79-4 (Cement Manufacturing Industry). Only those sections, which pertain to the individual industry and individual plant's Licence to Operate, need be taken into consideration.

C. Data Confidentiality

On December 7, 1984, Ministerial Order No. 17/84 (referred to as the "Release of Monitoring Information Order") was effected by the Hon. F.D. Bradley, Minister of the Environment.

The order states that:

> "On receipt of a completed application in the form provided in the Schedule requesting the release of stack emission data, water discharge data, or ambient monitoring information pursuant to section 15.2 (1) of the Clean Air Act or Section 18.1 (1) of the Clean Water Act, or both, the Director of Pollution Control shall release to the applicant the requested information."

This order has been of concern to industries which are required to submit confidential information such as production data. Any information released to an applicant is limited to the scope of the above order. Production data, for example, is not within the scope of the order and therefore, will not be released. To facilitate data management and security of confidential information within Alberta Environment, separate files are maintained for this type of data.

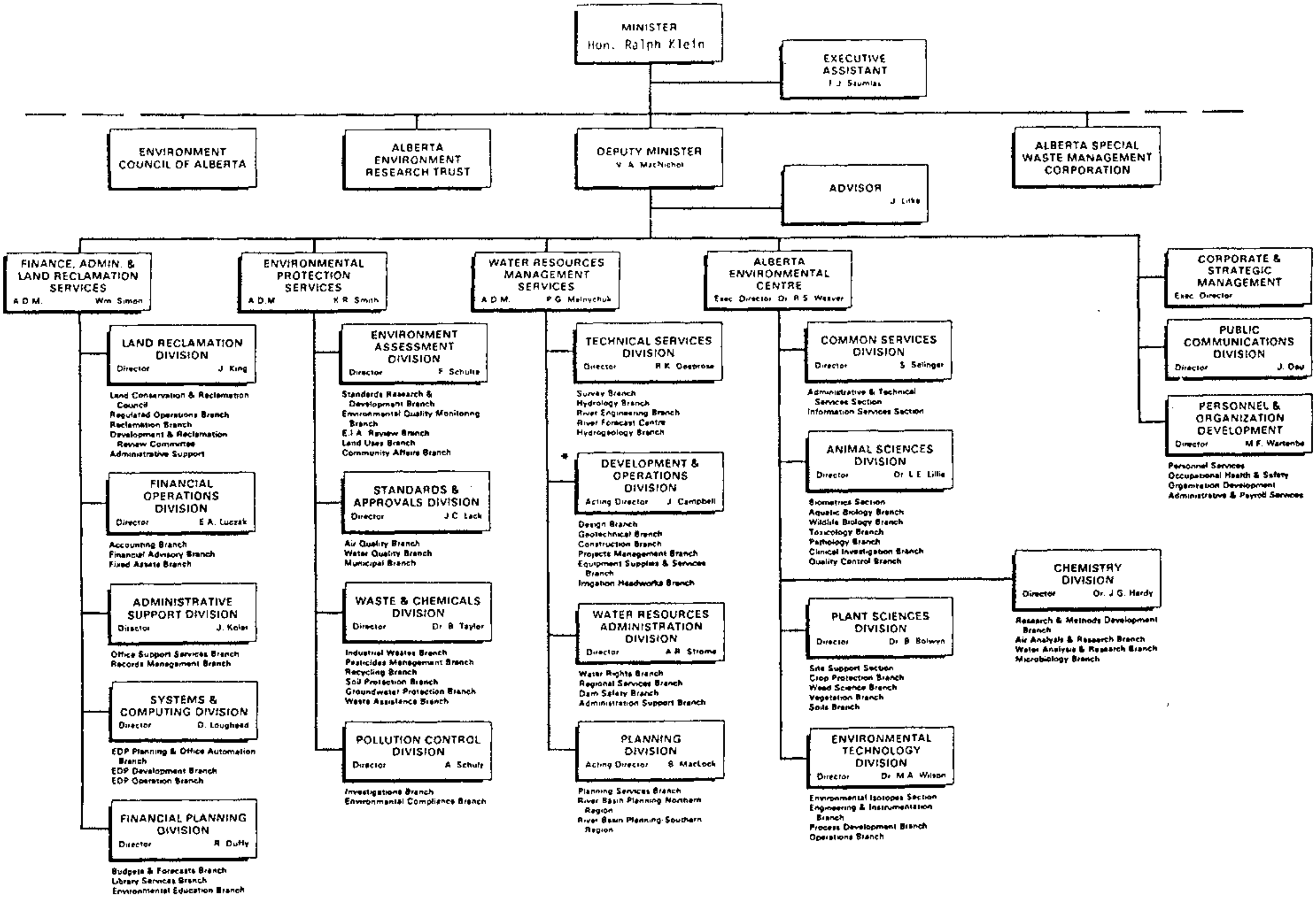
For the industries which are required by Licence to submit confidential data, separate report summaries have been prepared and are contained in the appropriate sections of this Directive.

D. Description of Roles of the Divisions of Pollution Control and Standards and Approvals

This section is included to provide a general outline of the respective responsibilities of the Divisions of Pollution Control and Standards and Approvals. A department organizational chart is also included and shown in Figure 1.

The Division of Standards and Approvals is responsible for the setting of effluent source standards for air and water contaminants. These standards appear in legislation, licences, or guidelines published by the Department. Another major responsibility of this Division is an approvals function such as the issuance of Permits to Construct and Licences to Operate. The Division also receives monitoring reports for review and authorizes pollution abatement measures to be undertaken by the offending facilities.

The Division of Pollution Control has the responsibility of investigating public complaints, contraventions of plant permits and licences, pollution incidents, and enforcement of environmental regulations. It is also responsible for responding to environmental emergencies. All reports of non-compliance, exceedances of emission limits and environmental standards should be made to this Division. The Division has field offices in Calgary, Red Deer, Whitecourt, Fort McMurray, Lethbridge, and Grande Prairie.


MINISTER
Hon. Ralph Klein
EXECUTIVE ASSISTANT
F J Saumlas
ENVIRONMENT COUNCIL OF ALBERTA
ALBERTA ENVIRONMENT RESEARCH TRUST
DEPUTY MINISTER
V A MacNichol
ALBERTA SPECIAL WASTE MANAGEMENT CORPORATION
ADVISOR
J Lilke
FINANCE, ADMIN. & LAND RECLAMATION SERVICES
A D M. Wm Simon
LAND RECLAMATION DIVISION
Director J King
Land Conservation & Reclamation Council
Regulated Operations Branch
Reclamation Branch
Development & Reclamation Review Committee
Administrative Support
FINANCIAL OPERATIONS DIVISION
Director E A. Luczak
Accounting Branch
Financial Advisory Branch
Fixed Assets Branch
ADMINISTRATIVE SUPPORT DIVISION
Director J. Kolar
Office Support Services Branch
Records Management Branch
SYSTEMS & COMPUTING DIVISION
Director D. Lougheed
EDP Planning & Office Automation Branch
EDP Development Branch
EDP Operation Branch
FINANCIAL PLANNING DIVISION
Director R Duffy
Budgets & Forecasts Branch
Library Services Branch
Environmental Education Branch
ENVIRONMENTAL PROTECTION SERVICES
A D M K R Smith
ENVIRONMENT ASSESSMENT DIVISION
Director F Schulte
Standards Research & Development Branch
Environmental Quality Monitoring Branch
E.I.A. Review Branch
Land Uses Branch
Community Affairs Branch
STANDARDS & APPROVALS DIVISION
Director J C Lack
Air Quality Branch
Water Quality Branch
Municipal Branch
WASTE & CHEMICALS DIVISION
Director Dr B Taylor
Industrial Wastes Branch
Pesticides Management Branch
Recycling Branch
Soil Protection Branch
Groundwater Protection Branch
Waste Assistance Branch
POLLUTION CONTROL DIVISION
Director A Schulz
Investigations Branch
Environmental Compliance Branch
WATER RESOURCES MANAGEMENT SERVICES
A D M. P G Melnychuk
TECHNICAL SERVICES DIVISION
Director R K Oestrose
Survey Branch
Hydrology Branch
River Engineering Branch
River Forecast Centre
Hydrogeology Branch
*
DEVELOPMENT & OPERATIONS DIVISION
Acting Director J Campbell
Design Branch
Geotechnical Branch
Construction Branch
Projects Management Branch
Equipment Supplies & Services Branch
Irrigation Headworks Branch
WATER RESOURCES ADMINISTRATION DIVISION
Director A R Strome
Water Rights Branch
Regional Services Branch
Dam Safety Branch
Administration Support Branch
PLANNING DIVISION
Acting Director B MacLock
Planning Services Branch
River Basin Planning Northern Region
River Basin Planning-Southern Region
ALBERTA ENVIRONMENTAL CENTRE
Exec Director Dr R S Weaver
COMMON SERVICES DIVISION
Director S Selinger
Administrative & Technical Services Section
Information Services Section
ANIMAL SCIENCES DIVISION
Director Dr L E Lillie
Biometrics Section
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Wildlife Biology Branch
Toxicology Branch
Pathology Branch
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Director Dr. J G. Hardy
Research & Methods Development Branch
Air Analysis & Research Branch
Water Analysis & Research Branch
Microbiology Branch
PLANT SCIENCES DIVISION
Director Dr B Bolwyn
Site Support Section
Crop Protection Branch
Weed Science Branch
Vegetation Branch
Soils Branch
ENVIRONMENTAL TECHNOLOGY DIVISION
Director Dr M A Wilson
Environmental Isotopes Section
Engineering & Instrumentation Branch
Process Development Branch
Operations Branch
CORPORATE & STRATEGIC MANAGEMENT
Exec. Director
PUBLIC COMMUNICATIONS DIVISION
Director J. Dau
PERSONNEL & ORGANIZATION DEVELOPMENT
Director M F. Wartenbe
Personnel Services
Occupational Health & Safety
Organization Development
Administrative & Payroll Services

II. MONITORING

A. Site Selection

The location of new compliance monitoring stations must be based on an objective procedure (such as geographic coverage factors as described in Appendix A-1) using a dispersion model such as Alberta Environment's PLUMES or SULDEP. Further information can be found in the Alberta Environment publication entitled "Users Manual for Alberta Environment Dispersion Models". The use of any alternate programs should be agreed on with Alberta Environment prior to use. The decision methodology and the dispersion modelling results must be submitted to Standards and Approvals Division for review prior to establishing the specific site.

Once the general monitoring site is determined, factors such as other existing or planned sources and other monitoring stations in the area must be taken into consideration in establishing the specific site.

Separate networks of stations in a given area should complement each other. Therefore, consideration must be given to the following points when selecting a specific site selection:

- results of past and current monitoring
- sites which are accessible
- sites which, if at all possible, do not require generators for power
- effects of topography
- local interferences
- security

Site criteria for both new stations and stations to be relocated are outlined in Appendix A-1. Any proposed locations must be approved in writing by the Division of Standards and Approvals prior to use.

Portable generators are to be located as far from the intake as possible, preferably downwind (dictated by prevailing wind direction). A general rule one might apply is to separate the power generator from the intake by at least 30 m.

1. Network and Site Documentation

The documentation described in Appendix A-2 governs new air monitoring networks. Prior to the installation of the stations at new or existing plants, this documentation is to be forwarded to the Division of Standards and Approvals for approval.

B. Instrument Selection

The Department does not endorse specific monitoring instrumentation to be used.

Continuous ambient monitoring in the most general sense implies a dedicated monitor with measurements taken (and recorded) at least every 30 seconds. The requirement for the 30 second poll time will be imposed for any new installation or when replacement of the existing system occurs. Prior to final equipment selection, the Division of Standards and Approvals must be contacted to ensure the applicability of the equipment in each case and to provide written acceptance of the monitor.

The Department does not accept the use of tape samplers for continuous monitoring of H_2S.

C. Monitoring Operations and Guidelines

1. Continuous Ambient Monitoring Operation and Guidelines

a) General

i) Each instrument and accompanying data recording system is to be operational 90% of the time (minimum), on a monthly basis. In cases where continuous ambient monitoring periods cover three months or less, minimum 90% operational time is required for each instrument for the overall monitoring period. If this is not met, the monitoring must be extended to make up for the downtime. The time periods utilized for calibrations (internal and external multi-point) are not considered downtime.

ii) All recorder charts, digital print-outs or computer tape are to be retained for a period of 24 months and made available to the Pollution Control Division or the Standards and Approvals Division upon request.

iii) Where electronic data logging systems are used, a strip chart recorder must be used as a backup for recording analyzer response when requested by Alberta Environment. When quality assurance audits conducted by Alberta Environment indicates problems with the digital data recording system or the analyzer, then alternate recording devices may be requested by Alberta Environment.

iv) In digital systems, "continuous" means that concentration values are determined at least every 30 seconds. See Section II-B for discussion with respect to existing system.

v) Typical performance specifications for each monitor are contained in Appendix A-10.

vi) Notification of continuous ambient monitoring: For those facilities required to monitor for less than 12 months per year, the Air Quality Branch of the Standards and Approvals Division should be notified in writing at least two weeks prior to the commencement of the monitoring program.

Where the scheduled monitoring program dates change after notification has been given, the Air Quality Branch should be advised of the same as soon as possible by telephoning 427-5872.

b) Sampling Procedures

i) The sample to be collected must be representative in terms of time, location and conditions.

ii) Although not mandatory it is highly recommended that a sampling manifold be used when two or more monitors are used in the same location.

iii) A typical design of a manifold is shown in Appendix A-10. For a monitor sampling without a manifold, an inverted funnel is placed at the end of the sample inlet. In both cases, the placement of the sample inlet has to meet the site selection criteria in Appendix A-1.

iv) When a manifold is used, the residence time of an air sample in the manifold shall not exceed 20 seconds. The flowrate in the manifold shall be at least 3 times the sum of all sampling flow rates required by individual instruments. A flowrate greater than the above requirements is acceptable, but it shall not be raised to a point at which analyzer response and accuracy are affected by the venturi effect.

v) The sampling line shall be as short as possible. It shall not exceed 10 meters. Heating tapes on the sampling line shall be used if condensation is a problem.

vi) Bending of the sampling line shall be kept to a minimum.

vii) The materials used in the construction of the manifold and sample line shall be inert to the pollutants to be monitored. Commonly used materials include glass and teflon. A list of the acceptable materials for sampling of pollutants are listed in Appendix A-10.

viii) Sample inlets shall be inserted into the sides and extended into the centre of the manifold.

ix) The manifold and sampling lines shall be cleaned at frequent intervals so that no observable accumulation of dust is present.

x) A water and large particulate knock-out trap shall be incorporated into the inlet end of the manifold.

xi) A compatible particulate filter shall be used for any instrument requiring sampling filtration.

xii) No leak shall be present in the sampling system.

c) Sample Analysis

Since data can only be as accurate and precise as the instrument used, the performance of instruments is to be checked by operators regularly. For continuous monitoring, function checks and control checks are performed as follows:

i) Function checks are to be done on each visit to the monitoring station. The checks include observation of any abnormal performance of instruments such as excessive noise, unstable baseline, positive and/or negative drift, spiking, long response time, incorrect rotameter readings, warning light indications, pump failure or power failure. The operators should be familiar with the performance specifications of the instruments and the appropriate corrective actions if the performance is not up to specifications.

ii) Control checks, consisting of zero and span of the analyzer should be conducted on a daily basis on all continuous air monitors. In place of the air sample, zero air (from scrubbed air or gas cylinder) is used for zero checks and a known concentration of the pollutant being analyzed is used for span checks. These checks can be controlled by automatic timers and valves. The zero and span checks provide an indication of the instrument response as well as an indication of the variability of measurements.

iii) The span check response must demonstrate stable response and be within the range of the instrument recorder. Span checks which indicate "off scale" responses on the recording system are not acceptable. The total zero span cycle shall not exceed one hour. The commencement of the zero/span cycle should be at the beginning of the hour and it is preferable that the zero/span checks be delayed (or skipped) if an "excessive reading" occurring at the time.

iv) Whenever a zero-corrected span check in excess of ± 10% of the span concentration (established by the previous multipoint calibration) is encountered, corrective action on the instrument is to be taken followed by appropriate span and calibration checks.

d) <u>Data Validation and Data Reporting</u>

i) Inspection of data (in the form of tabulation) is carried out on a regular basis. The purpose of the manual inspection is to spot errors, and/or illogical variations between successive values in continuous monitoring data. If an error is suspected but correction is uncertain, the questionable data are removed from the data table and the operating time for the data removed is recorded as downtime. When data are declared invalid, the reasons and the corrective measure(s) taken are to be outlined along with the calibration results as specified in Section II-C-1.(c)(ii) in the report.

ii) The data reporting precision of various pollutant concentration values is standardized as follows:

POLLUTANT	REPORTING PRECISION	DECIMAL PLACES IN PPM
Sulphur Dioxide	0.01 ppm	2
Hydrogen Sulphide	0.001 ppm	3
Nitrogen Oxides	0.01 ppm	2
Ozone	0.001 ppm	3
Carbon Monoxide	0.5 ppm	1
Total Hydrocarbons	0.1 ppm	1
Ammonia	0.1 ppm	1

iii) The normal round-off procedure is followed. Rounding up takes place when the digit after the last decimal is 5 or larger. Rounding down occurs when the following digit is 4 or smaller.

iv) The data reporting includes supporting data. These are the results of the current calibration as well as the deviations from the previous calibration.

v) All monitoring data is to be reported on Mountain Standard Time (MST).

e) Calibration

Multipoint calibration is a measure of instrument response against different standard sample concentrations. It is a necessary proof of performance of the instrument. The three commonly used calibration methods for continuous air monitors are: (1) dilution based on standardized gas cylinders, (2) dilution based on calibrated permeation devices, and (3) gas phase titration. The three methods, together with a discussion on flow measurements, are described in Appendix A-10.

i) Multipoint calibration is done a minimum of once a month for each continuous air monitor. In addition calibration is required under the following conditions: (1) within three days after the initial start-up and stabilization of a newly installed instrument, (2) prior to shut-down or moving of an instrument which has been working to specification, and (3) when major repair has been done on the instrument (i.e. changing the sample pump, servicing or replacement of a photomultiplier tube, or replacing or cleaning any part of the reaction chamber, etc.)

ii) All standards and measurement devices used in calibration must be traceable to primary standards. The primary standards which are of unquestionable accuracy, are standards certified by the National Bureau of Standards (NBS).

The performance of the instrument calibrators should be cross-checked at least once every year. The reference calibrator is to be traceable to the calibrators used by Alberta Environment.

The field audit program carried out by Alberta Environment should in most cases provide this cross-check. Cross-checks may be requested by industry and every effort will be made to either cross-check in the field or at our central facility in Edmonton as time allows. It is the responsibility of the owner of the calibrator to make arrangements to have this cross-check done.

Calibration standards are prepared from gaseous mixtures in cylinders or from permeation devices, both of which are certified by the manufacturer to be traceable to NBS Standard Reference materials (NBS-SRM) or certified weights. The calibration standards are checked against NBS-SRM, or cross checked if no NBS-SRM is available, to verify the certification and long term stability. The test atmospheres for different monitors are generated by one or more of the following calibration standards as shown in Table 1:

Table 1

CALIBRATION STANDARDS FOR AMBIENT MONITORING INSTRUMENTS

PARAMETER	CALIBRATION TECHNIQUES			
	Cylinder Dilution	Permeation Device	Gas Phase Titration	UV Photometer
SO_2	X	X		
H_2S	X	X		
NO	X			
NO_2		X	X	
O_3			X	X
CO	X			
Hydrocarbons	X			
NH_3	X	X		

iii) The range of the instrument on which the calibration is done must be the same as the normal operating range. Recommended operating ranges are as follows:

	RANGE(S)
Sulphur Dioxide	0 - 1 ppm
Hydrogen Sulphide	0 - 0.1 ppm
Oxides of Nitrogen	0 - 1 ppm
Ozone	0 - 0.5 ppm
Carbon Monoxide	0 - 50 ppm
Total Hydrocarbons	0 - 10, 0 - 20, 0 - 50 ppm
Ammonia	0 - 10 ppm

The deviation from recommended range should not be greater than a factor of 0.5 to 1.5 with the recording medium accuracy of 1% or better of full scale.

iv) A calibration curve is generated from at least three, non-zero concentrations of the gas and a calibration zero using a zero gas (zero air in a cylinder or scrubbed air which does not interfere with the measurement).

v) Calibration points are spaced above and below the maximum pollutant levels specified in the Clean Air (Maximum Levels) Regulation or applicable guideline. They should be spaced at about 15%, 30% and 60% of the full range for a three-point calibration.

vi) The results of the calibration are plotted on a graph as indicated concentrations (C_i) versus calculated concentrations (C_c). The ratio of C_c/C_i for the highest calibration concentration is defined as the correction factor of the instrument. Similar ratios for other calibration points are compared with the correction factor for checking linearity. The final correlation may be obtained from least square linear regression of C_i on C_c.

vii) In a calibration, the instrument is adjusted to give a correction factor as close to 1.0 as possible. Exceptions are instruments such as the Philips 9700 SO_2 analyzer for which no adjustments are provided. The analyzer must run within ±15% of the manufacturer's specifications, namely 1.14 for the Phillips SO_2 analyzer and 0.75 for the Phillips H_2S analyzer.

viii) The calibration results are supported by recorder traces (or digital printouts or graphical plots in the case of digital systems) to demonstrate the stability and accuracy of the measurement. For digital systems, data points are to be on a 30 second basis. See Section II-B our discussion with respect to existing systems. Twenty minutes of stable response are required for each point. The maximum time required to reach a stable response for the initial point shall not exceed 20 minutes.

ix) For calibration, all gases are introduced upstream of the inlet filter. Any filter changes are made prior to the calibration.

x) Calibration and acceptance limits are outlined in Appendix A-10. In addition, suggested calibration procedures and examples of calibration reports are outlined in Appendix A-10. Copies of calibration reports are to be kept in the corresponding monitoring station and made readily available to Alberta Environment upon request.

xi) Calibrations conducted by the company or by their consultant and found to be unacceptable may result in the data from the previous calibration to the current one being declared invalid. Alberta Environment may request additional calibrations and/or monitoring to be performed. A calibration may be rejected due to the use of improper procedures, excessive noise, excessive drift and significant differences in the calibration factor or the slope of calibration curves for calibrations conducted in consecutive months prior to making any adjustment (i.e. greater than 15%).

xii) Calibrators using permeation devices must have a stable oven temperature for a period of not less than 24 hours continuously prior to the calibration being performed.

If calibrators are transferred from one location to another, they must either be kept running while they are being transferred or allowed to stabilize at the new location for the required period before a calibration is performed.

f) SO_2 Monitors

Instruments for SO_2 monitoring are to be calibrated by use of a permeation device or dilution of bottled gases traceable to primary standards.

During the calibration of SO_2 instruments, the calibration points are to be selected above and below 0.17 ppm (ambient one hour average Alberta Clean Air (Maximum Levels) regulation) with calibration points near the 15%, 30% and 60% of the full scale range for a three point calibration used on the monitoring instrument.

g) H_2S Monitors

Instruments for H_2S monitoring are to be calibrated by use of a permeation device or dilution of bottled gases traceable to primary standards.

During the calibration of H_2S instruments, the lowest calibration point is to be at a value of less than 0.025 ppm while the highest calibration point is to be at a value of less than 0.100 ppm. In areas where SO_2 is present, the efficiency of the SO_2 scrubber must be checked for the possible interference of SO_2 in H_2S measurements. This is best done by having both permeation devices in the same chamber. Therefore the scrubber is challenged throughout the calibration. Any measurable response to SO_2 is unacceptable.

h) $NO/NO_2/NO_x$ Monitors

For NO/NO_x monitors, three-point calibrations are to be conducted monthly using bottled gases referenced to primary standards. Gas phase titration is the preferred method for NO_2 calibrations although the use of permeation tubes referenced to primary standards are acceptable. Where there is an individual NO_2 output, three upscale points are to be performed along with a calculation of converter efficiency. The converter efficiency must be at least 85%. During the calibration of NO/NO_x, instruments calibration points are to be selected such that points are included above and below the pertinent ambient maximum levels regulations (i.e. NO_2 one hour average maximum ambient concentration = 0.21 ppm). It is also recommended that the calibration points fall near 15%, 30% and 60% of the full scale range used on the monitoring instrument.

In areas where NH_3 is present a test should be conducted for NH_3 conversion to NO.

i) NH_3 Monitors

Three point calibrations are to be conducted monthly using either bottled gases or permeation tubes referenced to primary standards. The instrument calibration points should include NH_3 concentrations above and below 2.0 ppm. It is recommended that the calibration points fall near 15%, 30% and 60% of the full scale range of the monitoring instrument. In systems where converters are used, the converter efficiency must be determined. The efficiency of the converters must be at least 85%.

j) CO Monitors

Two point calibrations, including zero, for carbon monoxide monitors using bottled gases, will be accepted. A calibration point in the range of 10 - 20 ppm CO is to be used. Multipoint calibrations by dilution based on a standardized gas cylinder may be required in problem areas when requested by Alberta Environment.

k) Total Hydrocarbon Monitors

Two point calibrations, including zero, for total hydrocarbon monitors using bottled gases, will be accepted. Methane in air is to be used as the standard gas for the total hydrocarbon monitor. A calibration point in the range of 5 to 20 ppm hydrocarbon (expressed as methane equivalent) is to be used. Multipoint calibrations by dilution based on a standardized gas cylinder may be required in problem areas when requested by Alberta Environment.

L) Wind Monitors

Wind direction and speed data are measured as hourly averages. Scalar averages are acceptable, but vector averages are desirable.

When using a data logger, wind direction must be determined to the nearest degree. Chart systems must be capable of resolving 10 degrees but may report to eight compass points. Wind speed must be measured to the nearest km/h.

Wind direction sensors must be orientated with respect to "True North". Magnetic compasses may be used, but survey benchmarks or the Local Apparent Noon procedure described in Appendix A-10 Section 3.2 are more accurate. In component systems, one sensor must face true north and the other sensor must face east.

All wind instruments must have a starting threshold no greater than 1.5 km/h and comply with the other specifications set out in Appendix A-10 Section 3.1. A wind is to be reported as "calm" only if the hourly average speed is less than 1 km/h. A frequency of calms exceeding 5% in any one month may indicate instrument or site deficiencies and should be investigated. Results of the investigation should be included on the monthly report.

The wind instrument must be removed from the tower at least once every two years for mechanical inspection, electronic alignment and calibration. A copy of the calibration must be submitted with the appropriate monthly report (for the month in which the calibration was conducted). The date of the last calibration must be noted on each monthly wind table. Up to 10% of the operating time in the month may be used for calibration without being counted as down time. If the data or calibration appear questionable, then

Alberta Environment may require a complete wind tunnel calibration as described in Appendix A-10 Section 2.4.

A service record for the wind instrument should be kept for audit by Alberta Environment. The check procedures in Appendix A-10 Section 3.3 will assist in determining when service is required.

A Doppler accoustic radar (SODAR) or a wind tower of minimum height of 30 meters with wind at two levels may replace multiple wind monitors at multiple station networks. Approval for such substitution must be obtained from Standards and Approvals Division.

m) Other Monitors

For monitoring methods not detailed in this Directive, the company should obtain approval from the Division of Standards and Approvals for methodology to be used and the corresponding quality assurance program. The company should provide the Division of Standards and Approvals with information on their quality assurance program and that information should include details as listed below:

- Calibration method used
- Frequency of calibrations
- Periodic system checks (i.e. zero and span checks)
- Ongoing maintenance program (schedule)
- Record keeping/data storage

n) Quality Assurance

Calibration audits will be carried out on all stations by Alberta Environment. If the audit indicates that a particular instrument is unacceptable, then modification or corrective action will be required.

2. Static and Intermittent Monitoring Requirements

a) Exposure Stations

i) General:

- Exposure periods shall coincide as closely as possible to each calendar month.

- All data shall be reported in the tables shown in Appendix B. Note that a copy of the report submitted by the laboratory responsible for the analysis must be included with the monthly report and that the results must be certified with the signature of an authorized staff member of the laboratory.

ii) Total Sulphation and Hydrogen Sulphide:

- The accepted procedures for determination of total sulphation in ambient air are given in Appendix A-3.

- Only the zinc acetate method for the detection of H_2S is acceptable at this time. The acceptable procedure for determination of hydrogen sulphide in ambient air is given in Appendix A-4.

- The guidelines for total sulphation and hydrogen sulphide exposure results are 0.50 and 0.10 SO_3 equivalent mg/day/100 sq. cm., respectively.

- Existing networks may change over to total sulphation plates from cylinders provided that both systems are maintained for a minimum of three months at each station. New networks may use total sulphation plates from the outset.

iii) Fluorides:

The guideline for fluoride exposure results is 40.0 µg. water soluble fluorides/100 sq. cm./30 days.

The accepted procedure for determination of fluorides (water soluble) is given in Appendix A-5.

iv) Dustfall:

Care shall be exercised at all times in the preparation, handling, and analysis of dustfall samples.

Procedures for analysis of dustfall samples can be found in Appendix A.6.

v) Nitrogen Dioxide:

The accepted procedure for determination of nitrogen dioxide in ambient air is given in Appendix A-12.

b) High Volume Samplers

i) Care shall be exercised at all times in the handling and analysis of high volume air sampler filters.

ii) Calibration of the high volume samplers shall be carried out every three months.

iii) A standard reference method for high volume air sampling is outlined in Appendix A-8. Calibration must be performed in accordance to the standard method or by other proven equivalent methods.

iv) A standard method using the high-volume sampling for the measurement of coal particles is also included in Appendix A-8. Blank correction is necessary if the ashless filters leave an ash residue on combustion.

v) The sampling schedule shall be according to the schedule given in Appendix A-8 and every sixth day after the first date of January 2nd given on the schedule.

v) All high volume sampler locations must be approved by the Air Quality Branch of the Standards and Approvals Division.

All data shall be reported in the table shown in Appendix B.

3. Soil Monitoring Guidelines

a) The soil monitoring program has been revised and was replaced beginning in 1987 with the new soil monitoring guidelines outlined in detail in Appendix A-7. The guidelines are the result of reviews conducted by a technical committee represented by both industry and government.

b) The soil monitoring guidelines apply to all facilities that handle elemental sulphur from solid sulphur handling operations such as blocks, base pads, granulating facilities, prilling tower, and loading facilities.

c) All plants that have soil monitoring as a condition of their Clean Air Licence to Operate should adhere to these new guidelines.

d) These guidelines are flexible and provide suggestions as to sampling design for individual operators to develop their programs. Each operator is to design a site specific monitoring program.

e) Operations with liquid sulphur handling only or those without sulphur block and/or solid sulphur handling facilities are normally exempt from the soil monitoring requirements.

4. Vegetation Monitoring

a) Fertilizer plants that produce phosphoric acid are required by Licence to conduct total fluorine analysis on vegetation samples gathered in areas surrounding the plant site. In areas where vegetation is quite likely to be ingested by ruminants (i.e. forage crops, cereal grains, etc.) the vegetation survey should include a high proportion of these crops as opposed to other samples (i.e. tree leaves, etc.) The optimum time for obtaining the vegetation samples would be at the peak of the growing season for the particular species of sample (i.e. late summer for cereal grains, late June for first alfalfa cuttings, etc.). All vegetation samples should be initially analyzed for fluorine on an unwashed basis. If the total fluorine content exceeds 35 parts per million by total weight, then an analysis should be conducted for an "in vivo" (or washed) concentration of fluorine on the sample. An acceptable procedure for vegetation fluoride analysis is the Technicon™ Auto Analyzer™II Industrial Method #206-72A with modifications as made by the Alberta Research Councils' - Industrial Services Laboratory. Equivalent methods would also be acceptable, however, Alberta Environment should be consulted prior to use.

b) The vegetation fluoride analysis methodology is described in Appendix A-9.

5. Other Monitoring

Prior to ambient monitoring of other parameters such as VCM, ethylene, ethylene oxide, benzene, and other organic compounds, the sampling and analytical procedures must be approved by the Division of Standards and Approvals. Participation in interlaboratory studies may be required as part of the quality assurance program.

D. Continuous Stack Emission Monitoring Operations and Guidelines

1. General

The Department, in conjunction with the Energy Resources Conservation Board is presently drafting guidelines for the selection, installation, operation and maintenance of continuous emission monitor (CEM) systems for SO_2. The draft guidelines will be circulated to all affected industry sectors for comment in the near future.

Once the CEM system guidelines for SO_2 have been completed, work will begin on developing operational guidelines for other types of CEM systems such as opacity, NO_x, Total Reduced Sulphur compounds (TRS), and other pollutants for which CEM systems are presently required by licence.

In the meantime, all CEM systems should be operated and calibrated according to the CEM manufacturers recommendations, using U.S. Environmental Protection Agency (EPA) guidelines as a reference. Major operational/calibration problems are to be reviewed with Alberta Environment (ERCB in the case of the sour gas industry-only).

2. Record Keeping

All CEM system recorder charts, digital printouts or computer tapes are to be retained for a minimum period of two years and made available on request to the Pollution Control Division or the Standards and Approvals Division (or the ERCB for the sour gas industry).

E. Manual Stack Surveys

1. Sampling Procedures

Manual stack surveys are to be conducted in accordance with the sampling and analysis procedures outlined in the Alberta Stack Sampling Code (Publication SSC-1/76) and the Alberta Environment Methods Manual for Chemical Analysis of Atmospheric Pollutants 1978 (Edition No. 3) or any other method as may be specified or approved by the Director of Standards and Approvals.

Metal analysis required by licence is to include those elements listed in Appendix A-11.

If stack sampling cannot be conducted in accordance with Code requirements due to plant or process conditions, the Air Quality Branch of the Standards and Approvals Division should be contacted in advance .

Where the stack sampling location and access to is unsheltered it is recommended that the stack survey be conducted during the spring, summer, or early fall to minimize serious problems associated with cold weather sampling.

2. Notification of Planned Stack Surveys

The Investigations Branch of the Pollution Control Division has a quality assurance program for source sampling conducted by industry, a part of which involves witnessing a segment of the stack surveys conducted by industry.

To assist in the scheduling of source emission surveys to be witnessed, advance notification of at least two weeks in writing of any scheduled stack survey that is to be used to determine licence compliance is required. Where the planned test date(s) change after notification has been given, the Investigations Branch should be advised of the same as soon as possible by telephoning 427-6209 (with the exception of the sour gas industry).

For the sour gas industry the Energy Resources Conservation Board is to be notified in writing at the beginning of each year of stack survey dates used to assess licence compliance.

3. Report Preparation

Requirements for preparation of source sampling reports are discussed in Section III-B-2 and Appendix B-2.

4. Jurisdiction

Administration of stack sampling and report requirements for all industries (except the sour gas industry) is the responsibility of the Investigations Branch of the Pollution Control Division in Alberta Environment. The Investigations Branch should be contacted regarding any concerns on sampling procedures or report format.

In the sour gas industry only, any questions regarding stack sampling and reporting requirements should be directed to the Environment Protection Department of the ERCB.

III. REPORTING

The purpose of this section is to standardize report content and format.

All routine air monitoring reports (excepting those regarding uncontrolled, unauthorized, or accidental release of air contaminants covered under Section 12 of the Clean Air General Regulations 216/75) shall be addressed as follows:

Director, Standards and Approvals Division
Alberta Environment
4th Floor, Oxbridge Place
9820 - 106 Street
Edmonton, Alberta T5K 2J6

A. Excessive Pollutant Reports

The Clean Air General Regulation 216/75, Section 12 details the kind of information and reporting parameters necessary for the reporting of air contaminants in excess of limits specified in Licences to Operate and for reporting uncontrolled, unauthorized or accidental releases. An excerpt of this regulation reads:

"12. (1) Where

a) any uncontrolled release of an air contaminant occurs, or

b) any controlled release of an air contaminant not authorized by a licence occurs, or

c) any accidental release or discharge of an air contaminant, occurs, the operator or person in charge of the plant from which the release or discharge occurs shall report the occurrence to the Director of Pollution Control within 24 hours of its discovery, or notification by another person of the release or discharge.

(2) Within 72 hours of a release or discharge referred to in subsection (1) the owner of the plant or his agent shall notify the Director of Pollution Control of the occurrence in writing including at least the following details:

a) Date and time of the release or discharge.

b) Duration of the release or discharge.

c) Composition of the release or discharge showing:

   - the concentration,
   - the emission rate (where possible to compute), and
   - the total amount, by weight,

d) a detailed description of the circumstances leading to the release or discharge,

e) steps or procedures which were taken to minimize the release or discharge,

f) steps or procedures which will be taken to prevent similar releases or discharges, and

g) an undertaking to report both immediate and long term detrimental effects of the release or discharge."

Telephone notification of excess air contaminant levels is to be made by telephoning the Investigations Branch at 422-4505 (24-hour number).

1. Stack or Source

The following are to be considered when reporting excess stack or source emissions:

a) The licences issued under the Clean Air Act may contain requirements limiting the emission rate or concentration of air contaminants from individual plant stacks as well as restricting the release points. A non-compliance of the licence to operate occurs when any condition within a plant licence has not been met, and it must be reported in the manner detailed on pages 31 and 32.

b) For the purpose of reporting the daily mass emissions from continuous emission monitoring systems, a calendar day basis is recommended. For new plants or those plants conducting major changes to their production process data recording system, the calendar day should be incorporated. This will maintain consistency in the reporting of 24 hour verbal/72 hour written notifications, as well as the information included in the monthly reports submitted to Alberta Environment. Reporting on the calendar day basis is compatible with the Alberta Environment computer programs which summarize the data on an industry basis.

c) In the Sour Gas Industry, the reporting of low incinerator stack exit temperatures is made to the Pollution Control Division. The minimum stack exit temperatures are noted in the operator's Clean Air Licence for the facility. Operator's are not required to report low stack exit temperatures which deviate from the Clean Air Licence by less than 15°C for less than 15 minutes.

2. Uncontrolled, Unlicenced and Accidental Releases

Any incidents involving uncontrolled, unlicenced, and accidental releases must be reported within 24 hours of discovery or sooner if the terms and conditions of a Licence to Operate specify a shorter reporting time period.

3. Ambient

The Director of Pollution Control requires the reporting of ambient air contaminant concentrations in excess of the levels specified in the Clean Air (Maximum Levels) Regulation.

The following are to be considered when reporting excess ambient air contaminant levels:

a) Whenever the hourly average concentrations (based on integer clock hour intervals) exceed the following levels:

0.010 ppm for H_2S
13 ppm for CO
0.17 ppm for SO_2
0.21 ppm for NO_2
2.0 ppm for NH_3

then the air contaminant levels must be reported in the manner previously detailed. They must also be reported whenever the average daily concentrations (based on Mountain Standard Time and calendar days) exceed:

0.06 ppm for SO_2
0.11 ppm for NO_2

b) Similarly, whenever an eight hour average concentration of CO exceeds 5 ppm, it must be reported.

B. Monthly Reports

1. General

This section refers to all industries which have monthly reporting requirements in their licence:

a) One copy of all the air monitoring data is to be compiled and submitted before the end of the month following that for which the observations were made. If a report is delayed, then the reasons for the delay are to be submitted prior to the reporting deadline by telephone, letter, telecopy, or telefax.

b) For the Power Generating Industry only, an additional copy of the "Monthly Report Summary" is to be forwarded directly to the ERCB.

c) The monthly report, in the format specified in Appendix B-1, or alternate format as agreed upon with the Director of Standards and Approvals, is to contain completed copies of the information required by the licence to operate. Any questions relating to monthly reports are to be referred to the Air Quality Branch, Standards and Approvals Division.

d) All data submitted must be certified by the Company. Signature by a company official on the "Monthly Report Summary" certifies the data. If data is subsequently determined to be incorrect then this data is to be identified clearly as such and a corrected copy is to be submitted to the Department within 14 days.

e) A covering letter should be included and is to contain:

   i) An explanation of all exposure station results in excess of the following Alberta Environment Guidelines:

Total Sulphation = 0.50 SO_3 equivalent mg/day/100 cm^2

Hydrogen Sulphide = 0.10 SO_3 equivalent mg/day/100 cm^2

Fluoride = 40.0 µg water soluble fluorides/100 cm^2/30 days

ii) An explanation for any hydrogen sulphide exposure levels greater than total sulphation levels at the same station.

iii) An explanation of any total dustfall level in excess of 158 mg/100 cm^2/30 days or 53 mg/100 cm^2/ 30 days in commercial and industrial areas or residential areas respectively.

iv) An explanation of any high volume sampling results in excess of 100 µg/m^3/24 hours.

v) An explanation of any high volume sampling results indicating a substantial increase over usual levels (i.e. >50% difference).

vi) A discussion of the problems encountered if any monitoring instrument is operational less than 90% of the time.

vii) An explanation of any reporting or monitoring irregularities.

viii) Reference to any previous correspondence related to reporting of excess ambient or source air contaminant levels which may have occurred during the reporting month.

2. Ambient Monitoring

a) Continuous

i) Results for ambient air monitoring compiled during the month are to be submitted in the format (or one similar to that) as shown in Appendix B-1.

ii) Where continuous ambient monitoring is required by licence, a calibration report is to be included for each monitoring instrument. The format for this report is contained in Appendix A-10.

(b) Static and Intermittent

i) Results are to be submitted in the format as shown in Appendix B-1.

3. Stack Sampling

a) Manual stack surveys which were conducted during the report month are to be submitted by the end of the month following the month in which the survey was conducted (i.e. a survey conducted in May, 1988 would require the submission of results by the end of June, 1988). The stack survey reports may be submitted with the regular monthly report or as a separate report.

b) For the sour gas industry only, manual stack survey results are to be submitted to the Environmental Protection Department of Energy Resources Conservation Board.

c) For the Power Generating Industry only, in addition to section 3(a) above, a summary of the manual stack survey results are to be submitted to the ERCB.

4. Continuous Emission Monitoring Results

a) Results for continuous emission monitoring compiled during the month are to be submitted in the format as shown in Appendix B-1 (or as approved otherwise by the Director of Standards and Approvals).

5. Production Reports

All production data that is required to be submitted to the Department is to be tabulated and submitted on the confidential "Monthly Production Summary" form enclosed within Appendix B-1. This form should be separated from the main monthly report.

C. ANNUAL REPORTS

1. General

a) Annual reports are to be submitted no later than March 15 of the year following the report year, unless valid reasons for the delay are forwarded. The report year corresponds with the calendar year, beginning with the 1989 report year. Any changes to annual report content as stated in this AMD will not take effect until the 1989 report year.

b) The annual report is a review of the monitoring performed within the year. The data submitted in the monthly reports need not be duplicated in the annual, only the summaries described within this section need to be submitted.

c) The annual report will be used to review long-term trends. Yearly summaries and/or assessments are to be included in the report and are to cover the topics outlined in the following sections.

2. Ambient Air Assessment

a) The annual report is to contain a summary of the number of hours of SO_2, H_2S, NO_2, NH_3 and CO readings in excess of the Clean Air (Maximum Levels) Regulations or guideline (in the case of NH_3) per month for each monitoring unit. Major reasons and mitigative measures for these excess readings are to be stated. Comparisons with the previous five years of operation are to be made on a year-to-year basis.

b) The report is to contain monthly frequency distribution tables for each station showing:

i) average SO_2 concentrations and their time frequency distribution for the following five concentration ranges in ppm: (0-0.02,0.03-0.06,0.07-0.11,0.12-0.17,0.18-0.34,>0.34).

ii) average H_2S concentrations and their time frequency distribution for the following concentration ranges in ppb (0-3;4-10;11-50;>50).

iii) average NO_2 concentrations and their time frequency distribution for the following concentration ranges in ppm: (0-0.05;0.06-0.11;0.12-0.21>0.21).

iv) average NH_3 concentrations and their time frequency distribution for the following concentration ranges in ppm: (0-1.0,1.1-2.0, and >2.0)

Examples of the above frequency distribution tables are shown in Appendix B-3.

Log probability charts will be accepted as a means of characterizing monthly and yearly frequency distributions as well.

c) Frequency distribution tables for hourly wind speed and direction are to be drawn up on an annual basis for each station, and should conform to the example in Appendix B-4.

d) The review of total sulphation and H_2S exposure cylinder data is to include tables of monthly and annual averages for each station, an evaluation of their trends and the number of times each station exceeded the respective guideline. An example of this summary is shown in Appendix B-3. On an annual basis for networks of greater than 8 stations, isopleths (lines of equal value) are to be mapped for both total sulphation and H_2S exposure cylinder results. In situations where the total sulphation and H_2S readings did not exceed 0.05 and 0.01 SO_3 equivalent mg/day/100 cm^2 respectively at any time during the year the mapping of the isopleths for that network is not required to be done.

In cases where monitoring networks are interconnected or overlap, the review is encouraged for the entire area with stations from all plants included in the results.

e) The review of intermittent high volume air samplers including the general trend of results, the annual geometric means and the number of times each sample exceeded the 100 ug/m^3 24-hour average concentration level.

f) A summary of expansions or modifications to operations that will affect atmospheric emissions is to be included.

g) For the sour gas and oil sands industries the status of sulphur block activity is to be covered in the report detailing the amount of sulphur removed, what method of removal was utilized, monitoring performed (i.e. soils, vegetation, groundwater, dustfall), remedial action taken, and number of block fires with cause, duration and environmental concerns mentioned.

3. Stack Emission and Source Assessment

a) The annual report is to summarize the results of the manual stack survey program for that year. Operational problems resulting in high stack emissions encountered and rectified during the sampling period should be noted and discussed.

b) A summary of excess readings, as determined by manual stack surveys or continuous stack emission instrumentation or material mass balance , is to be summarized with appropriate explanations of the cause and remedial action taken. An example of this summary is given in Appendix B-3.

c) The number of occurrences and the duration of uncontrolled, unlicenced and accidental releases is to be summarized along with estimates of mass emissions released per incident as H_2S and/or SO_2 and the total emissions expressed as SO_2.

4. Inventory of Sulphur Emissions

In order to summarize sulphur emissions from each plant, an inventory of sulphur emissions is to be compiled and reported on a yearly basis. This inventory is to include emissions of H_2S (as H_2S) and SO_2 (as SO_2), separately for each release point (licenced and non-licenced). The method used for calculating the sulphur emissions should be noted with the inventory (i.e. continuous emission monitoring, stack survey, material mass balance, etc.). The inventory is to include emissions from all significant release points. "Significant" would include all sources of H_2S or SO_2 greater than 10 tonnes per year.

5. Inventory of Oxides of Nitrogen Emissions

An inventory of oxides of nitrogen (expressed as equivalent NO_2) is to be compiled and reported on a yearly basis. This inventory is to include emissions from all release points. The method used for calculating the inventory should be noted. The requirement for a NO_x inventory is not intended to incur additional monitoring but to make use of the "best data" that exists. The best data may be in the form of continuous emission monitoring, stack surveys, calculation by fuel/emission factors, process mass balances etc. The inventory should include all significant NO_x emission sources within the plant. "Significant" would include all sources of NO_x emitting greater than 10 tonnes per year (as equivalent NO_2). The option is left up to the company on the manner the NO_x inventory is derived; as long as the procedure used and the degree of data variance is indicated with the data submitted.

APPENDIX "A"

MONITORING

APPENDIX A-1

STANDARD SITE CRITERIA

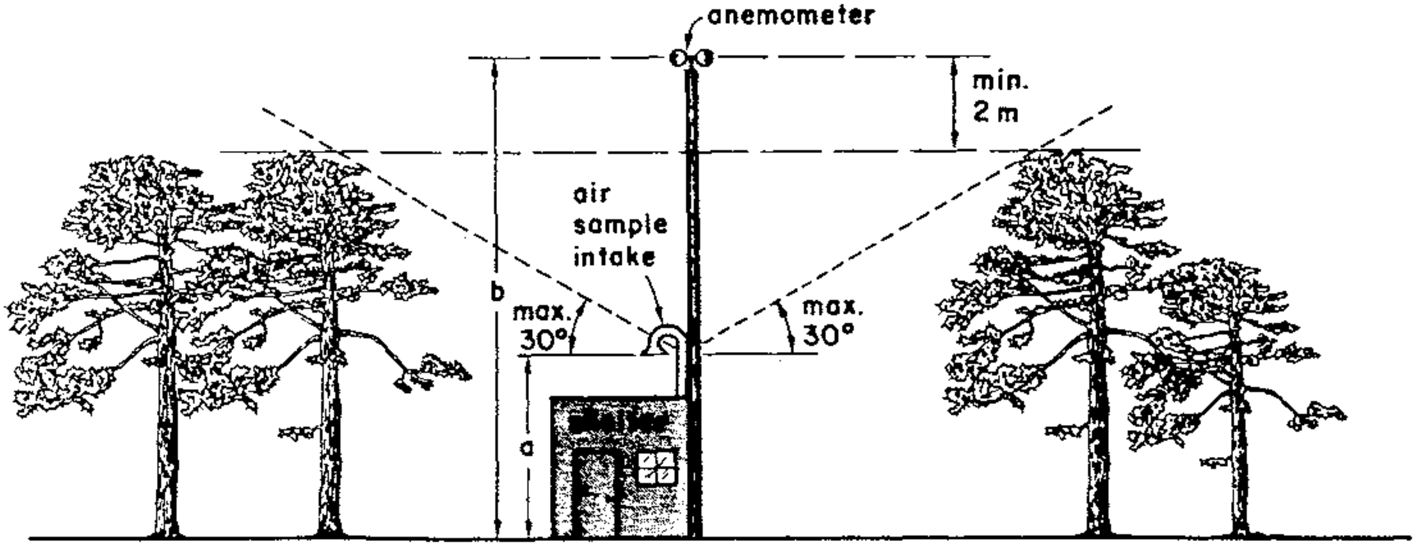
COMPLIANCE MONITORING NETWORK DESIGN

Standard Site Criteria

An air monitoring station shall meet the criteria given in the following table:

Site Characteristics / Station Component	Continuous Monitoring Sampling Inlet	Wind Instrument	Static Monitors
Height above ground	shelter height + at least 0.5 m (3 m minimum)	>2.5 times shelter height (10m minimum)	1 - 3 m
Other requirements	Elevation angle < 30° from the sample inlet to the top of any obstacle	(1) Height > 2 m above any obstacle (2) Uniform surroundings for 100m radius <u>OR</u> Distance from obstacle > 10 times the obstacle height	Elevation angle <30° from the sample inlet to the top of any obstacle

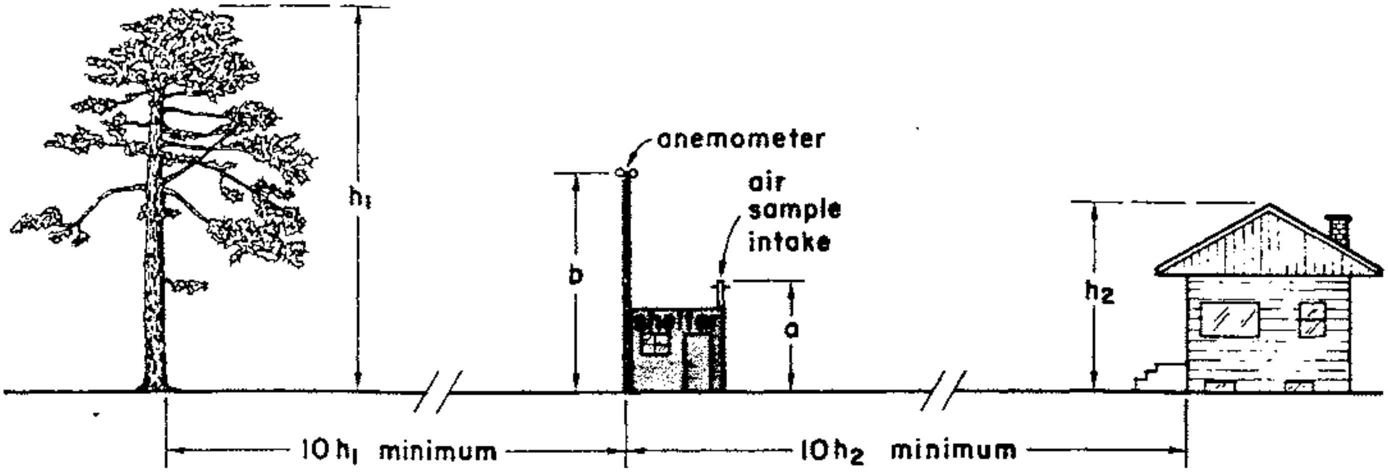
The diagrams on the following page illustrate the criteria.



LEGEND

a = shelter height + min. 0.5m (3m min.) & requirements as shown.
b = >2.5 times shelter height (10m min.) & requirements as shown.

OR



LEGEND

a = shelter height + min. 0.5 (3m min.) & requirements as shown.
b = >2.5 times shelter height (10m min.) & requirements as shown.

DIAGRAMATIC REPRESENTATION OF A
STANDARD MONITORING SITE

Site Selection Using Geographic Coverage Factors:

For each potential monitoring site the geographic coverage factor G is calculated as G = W . D . R where W is the frequency of wind from the source to the site, D is the dispersion weighting computed below and R is the sensitivity of the receptor (from 1 to 3) representating low, medium, high. The dispersion weighting may be any of the following:

1. Maximum short-term concentration,
2. Long-term average concentrations,
3. Concentration occurring under the most frequent wind speed and stability class,
4. Probability of detecting concentrations above some specified concentration,
5. Probability that the measured concentration will be within a fixed fraction of its true value n times in N occurrences with specified percent confidence (method of Noll).

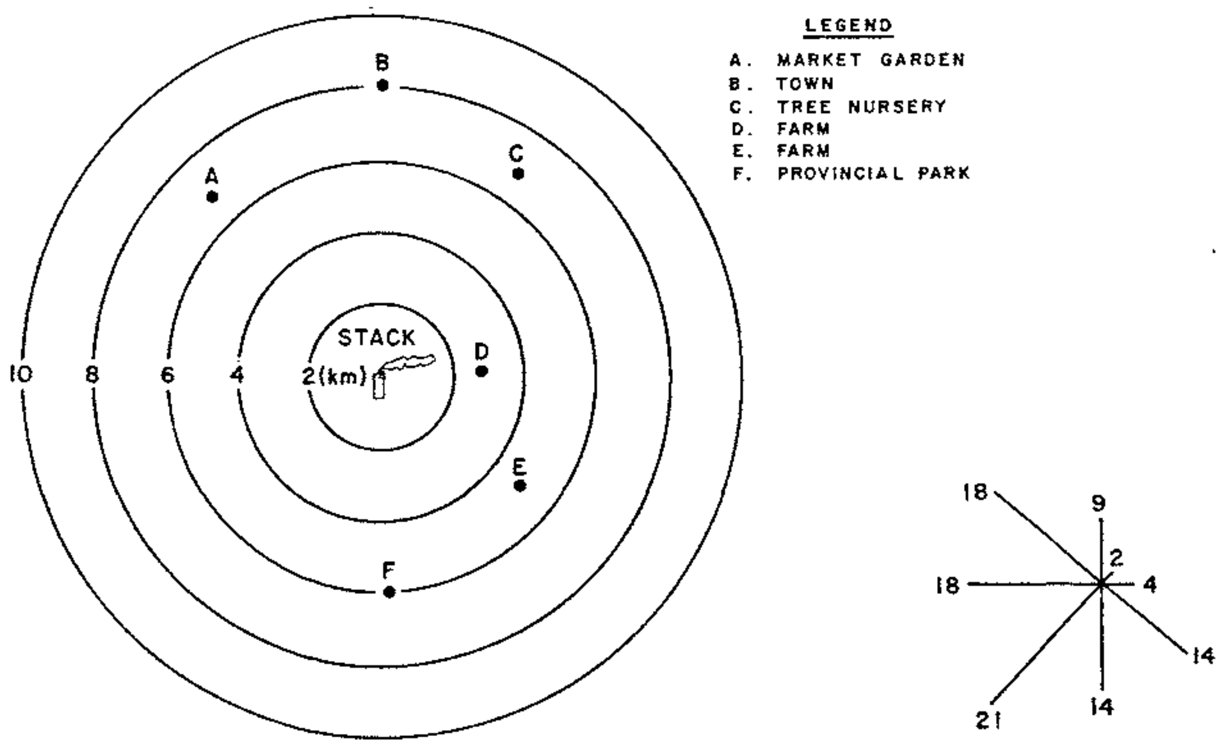
The site with the largest geographic coverage factor will be the first choice, the site with the second largest geographic coverage factor will be the second choice, and so on until the number of sites required for the network have been selected.

As an example of this technique, consider the situation depicted in the accompanying figure. The highest concentrations resulting from the operation of the stack in the centre of (A) occur under Pasquill Class C stability with a wind speed near the long-term average (see the following figure). The downwind concentration profile is shown in (C) and the windrose in (B). Since the maximum occurs near 4 km, this would be the primary search radius. Unfortunately, no accessible or otherwise suitable sites could be found at this distance. The only potential sites in the region were those labelled A to F. Receptor sensitivities do not necessarily differ, but in this case, it seems reasonable to regard the tree nursery and the market garden as having high sensitivity (assign R=3) and the other sites as having low relative sensitivity (assign R=1). The Geographic Coverage Factors are calculated as follows:

$G(A) = (14)(.13)(3) = 5.46$
$G(B) = (14)(.12)(1) = 1.68$
$G(C) = (21)(.13)(3) = 8.19$
$G(D) = (18)(.16)(1) = 2.88$
$G(E) = (18)(.17)(1) = 3.06$
$G(F) = (9)(.15)(1) = 1.35$

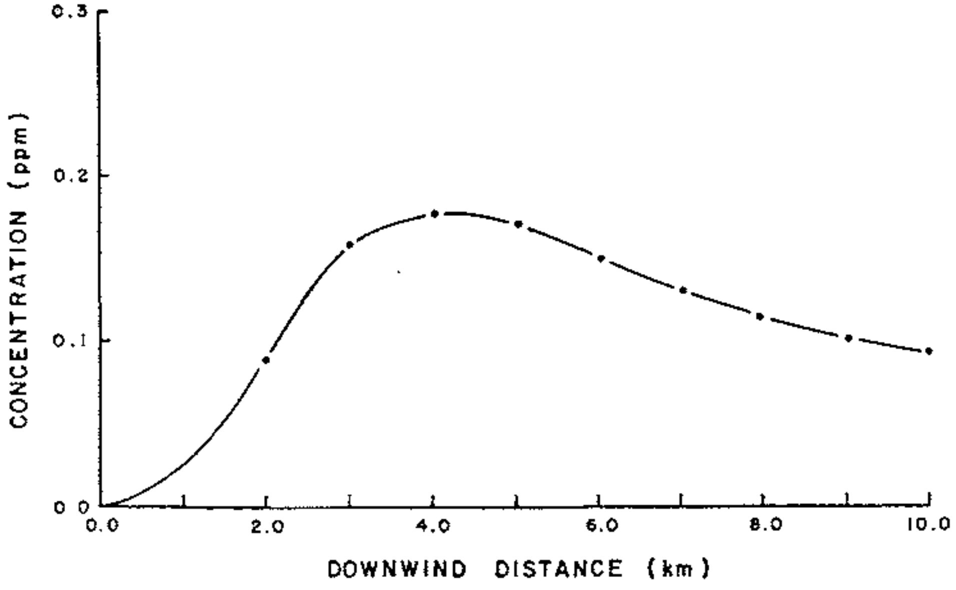
Thus, the first choice would be C, the tree nursery, and the second choice A, the market garden. Note, however, that if all potential sites had equal sensitivity, the first choice would be E and the second choice D.

Other dispersion weightings could give different, but equally valid, results.



(A) POTENTIAL MONITORING SITES

(B) WIND ROSE



(C) DOWNWIND CONCENTRATION PROFILE

INFORMATION USED IN CALCULATING GEOGRAPHIC COVERAGE FACTORS FOR MONITORING NETWORK DESIGN.

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APPENDIX A - 2

STANDARD NETWORK AND SITE DOCUMENTATION

STANDARD NETWORK AND SITE DOCUMENTATION

Complete documentation for an air monitoring network of one or more stations shall include:

1. A recent area map showing roadways, railway lines, airports, lakes, rivers, human settlements and other significant landmarks with the station locations clearly indicated.

2. A topographic map showing the station locations (preferred scale is 1:50,000 with elevation contours at 25 foot intervals).

3. The area and topographic maps shall indicate the location of the plant and all storage tanks and facilities.

4. A windrose (preferably a ten year average) of the area for existing and new stations (if readily available).

5. A copy of the completed static station documentation table.

6. For each continuous monitoring station:

    a) A copy of the completed site documentation forms.

    b) A current aerial photograph (if it is readily available) covering an approximate area of one square kilometer with the station at the centre of the photograph.

    c) A plan view sketch of the immediate surroundings within a 500 metre radius showing all topographical features, significant vegetation, buildings and other local disturbances (clearings, pits, towers, etc.) with relevant distances to approximate scale. Heights of obstacles should be noted on the sketch.

    d) A cross-sectional sketch through tall obstacles which gives the relevant heights and elevation angles. This sketch is to show obstacles on both sides of the continuous monitoring station within a 500 meter radius and also along the line drawn from the plant through the monitoring station.

e) Color print(s) showing the details of the sampling inlet(s) or manifold in relation to the station.

f) A color print of the structure housing the instruments from the door side with the direction of the exposure marked on the bottom.

g) Four prints showing the station environs looking from the shelter to the East, to the South, to the West and to the North with the appropriate direction marked clearly on the bottom.

h) If the station does not conform to the standard site criteria, additional photographs and sketches illustrating the irregularities.

STATION NAME ____________________ STATION LOCATION ______________________

Pollutant Measured		Manufacturer	Model No.	Serial No.	Range Used	Detection Principle	Sampling Height In Metres Above	
							Ground	Shelter
Sulphur Dioxide	Analyzer							
	Recorder					N/A	N/A	N/A
Hydrogen Sulphide	Analyzer							
	Recorder					N/A	N/A	N/A
Hydro-Carbon	Analyzer							
	Recorder					N/A	N/A	N/A
Wind	Instrument							
	Recorder					N/A	N/A	N/A
Other	Instrument							
	Recorder					N/A	N/A	N/A

STATIC STATION DOCUMENTATION TABLE

PLANT OPERATOR ____________________ PLANT LOCATION ________________________

Static Station Number	Height Above Ground (m)	Topographical Description

REPEALED - refer to 2016 Air Monitoring Directive, as amended

APPENDIX A-3

DETERMINATION OF TOTAL SULPHATION

(STATIC MONITORING)

Method Nos. 14545, 14546

(extracted from "Methods Manual for Chemical
Analysis of Atmospheric Pollutants 1985,"
Third Edition, Alberta Environmental Centre)

TOTAL SULPHATION
(Turbidimetric)
METHOD NO. 14545 - MARCH 1985

1. Introduction

Sulphur gases such as sulphur dioxide, hydrogen sulphide and mercaptans are common air pollutants. They originate mainly from the burning of sulphur containing fuels such as coal and gasoline and from the sulphur recovery process of the sour gas plants. These gases are oxidized by lead dioxide to lead sulphate. This oxidation is known under the name of total sulphation. The lead dioxide candle or plate (Huey plate) is commonly used for monitoring sulphur pollution of the atmosphere.

2. Principle

The lead dioxide candle or plate is exposed in the field for approximately four weeks. The exposed lead dioxide is removed from the support media and digested with sodium carbonate solution. The unreacted lead dioxide is removed by filtration. The filtrate is acidified to pH 2.5 and the sulphate is precipitated as $BaSO_4$. The resulting turbidity of the $BaSO_4$ suspension is measured in a spectrophotometer at 420 nm.

3. Scope

The detection limit is 2 mg/L SO_4 in the test solution.

4. Interference

Colour interferes. Such interference is eliminated by using a sample blank.

5. Apparatus

a) Jars (20 cm circumference) and Huey plates.

b) Surgical gauze, Curity or equivalent (60 cm length, 5 cm width).

c) Blender.

d) Spectrophotometer.

e) Nessler tube, matched 50 ml, 2.5 cm diameter.

f) Spoon, 0.5 g capacity.

6. Reagents

a) Lead dioxide (MCB Technical, or equivalent).

b) Methanol, 100%.

c) Gum tragacanth (2%) - dissolve 20 g in 100 mL methanol and dilute to 1 litre with distilled water.

d) Sodium carbonate solution (2%) - dissolve 20 g anhydrous sodium carbonate in distilled water and dilute to 1 litre.

e) Sodium carbonate solution (1%) - dissolve 100 g anhydrous sodium carbonate in distilled water and dilute to 10 litres.

f) Dilute hydrochloric acid solution (1+2) - dissolve 100 mL conc. HCl in 200 mL distilled water.

g) Sulphate reagent - Sulfaver IV (Hach Chemical Company, or equivalent).

h) Stock sulphate solution (1000 mg/L SO_4) - dissolve 1.479 g of anhydrous sodium sulphate in 1% Na_2CO_3 solution and dilute to 1000 mL with 1% Na_2CO_3 solution.

i) Working standards - dilute each of the following aliquots of the stock to 900 mL with 1% Na_2CO_3 solution, adjust the pH to 2.5 by adding 1+2 HCl with constant stirring. Stir for 10 minutes to drive off the CO_2. Dilute to 1000 mL in a volumetric flask with distilled water:

mL Stock/1000 mL	Conc. mg/L SO_4
2.0	2.0
5.0	5.0
10.0	10.0
20.0	20.0
40.0	40.0
50.0	50.0

7. Procedure

a) Sampling

i) Preparation of the candle - wrap a tape of surgical gauze, 60 cm long and 5 cm wide around a jar of 20 cm circumference. Secure the gauze to the jar with cotton thread and paint it with a PbO_2 mixture prepared as follows:

Add 300 mL of 2% gum solution slowly to approximately 300 g of PbO_2, in portions, with continuous stirring until a smooth paste entirely free from lumps is obtained. Spread the lead dioxide paste evenly on the surgical gauze around the jar with a small brush. Each cylinder should contain approximately 8 - 10 g of PbO_2.

ii) Preparation of Huey Plate - grind 4 g of Gelman paper in a grinding mill and transfer it to a blender containing 400 mL of water. Blend for one minute. Add 64 g of PbO_2 and 22 mL of 2% gum tragacanth solution to the blender and blend for another 4 minutes. Attach a circular glass fibre disc to the plate with acetone by pouring 1 mL acetone into the plate and allowing it to evaporate at room temperature in a fume hood. Pipet 10 mL of the blended suspension into the Huey plate and allow it to dry in an oven at 50 - 55°C.

iii) Expose the cylinder and/or two plates in the field for approximately 4 weeks.

b) Analysis

i) Measure the exposed areas of the painted gauze on the candle and/or the Huey plates in cm^2.

ii) Remove the tape from the jar and place it in a 400 mL beaker. Put the two Huey plates along with the gauze into a 250 mL beaker. Care must be taken with this step to ensure that no $PbSO_4$ is lost during the transfer. Set up sample blanks by using an unexposed candle and two Huey plates. Use 2% Na_2CO_3 solution for the reagent blank.

iii) Add 100 mL 2% sodium carbonate solution to the beaker containing the candle tape, and 50 mL to the beaker containing the Huey plates.

iv) Stir the mixtures and allow them to stand for at least three hours.

v) Heat the samples for 45 minutes at approximately 80°C, keeping the volume above 60 mL with distilled water for the candle tape and 30 mL for the Huey plates.

vi) Filter the hot samples, rinse the beakers and wash the contents of the filter several times with hot distilled water.

vii) Cool the filtrates to room temperature and acidify them with 1+1 HCl to a pH of approximately 2.5, with constant stirring. Stir for 10 minutes to drive off the CO_2.

viii) Adjust the volume of the filtrate to 200 mL for candle sample and to 100 mL for the Huey plate sample, with distilled water.

ix) Pipet 50.0 mL of sample, sample blank, reagent blank and working standards into 50 mL Nessler tubes. Add approximately 0.5 g of Sulfaver IV to each tube and stir well. Wait for 10 minutes.

x) Use the reagent blank for setting the spectrophotometer to 100% transmittance of 420 nm and read the percent transmittance for all the samples, sample blanks and standards.

8. Calculation

a) Prepare a calibration curve by plotting mg/L SO_4 vs percent transmittance. Read the concentration for the exposed and unexposed samples from the graph in units of mg/L SO_4. Subtract the value for unexposed sample from the exposed one to get the actual value. Calculate mg $BaSO_4$ as follows:

$$\text{mg } BaSO_4 = \frac{\text{mg/L } SO_4 \times \text{total sample volume in mL} \times 2.43}{1000}$$

WHERE

$$2.43 = \frac{\text{mol. weight of } BaSO_4}{\text{mol. weight of } SO_4}$$

b) The following equation is used to express the total sulphation in units of mg SO_3/day/100 cm^2:

$$\text{mg } SO_3\text{/day/100 } cm^2 = \frac{\text{mg } BaSO_4 \times 0.343 \times 100}{d \times a}$$

WHERE

d = no. of days exposed

a = surface area of the tape or Huey plate in cm^2

$$0.343 = \frac{\text{mol. weight of } SO_3}{\text{mol. weight of } BaSO_4}$$

100 = conversion to 100 cm^2

9. Reference

ASTM, Part 26, 1977, p. 536.

TOTAL SULPHATION
(Automated Colorimetric)
(METHOD NO. 14546 - MARCH 1985)

1. Introduction

Sulphur gases such as sulphur dioxide, hydrogen sulphide and mercaptans are common air pollutants. They originate mainly from the burning of sulphur containing fuels such as coal and gasoline and from the sulphur recovery process of the sour gas plants. These gases are oxidized by lead dioxide to lead sulphate. This oxidation candle or plate (Huey plate) is commonly used for monitoring sulphur pollution of the atmosphere.

2. Principle

The lead dioxide candle or plate is exposed in the field for approximately four weeks.

The exposed lead dioxide is removed from the support media and digested manually with sodium carbonate solution. A portion of the digested and filtered sample is transferred to a sampling cup in an automatic sampler and sulphate content is determined using an automated system. All the analytical steps necessary for the test such as pH adjustment, removal of CO_2, heavy metal interference and the colorimetric determination of sulphate are processed by the automated system. In this method the colour reagent used contains equimolar quantities of methylthymol blue and barium chloride in an aqueous-ethanol solution, adjusted to a pH between 2.5 and 3.0 with 1N hydrochloric acid. When a sample containing sulphate is allowed to react with this reagent, barium sulphate is produced. After allowing sufficient time for the reaction between the barium ion and the sulphate ion, the pH of the reaction mixture is changed to 12-13 with 0.18N sodium hydroxide solution. At this high pH any barium ion remaining in solution will complex with equimolar quantity of methylthymol blue leaving a certain amount of uncomplexed methylthymol blue in solution which is equivalent to the quantity of sulphate removed as barium sulphate. The uncomplexed methylthymol blue is then determined by measuring its absorbance at 460 nm.

3. Scope

The detection limit is 2 mg/L SO_4 in the test solution.

4. Interference

Cations such as Ca, Al and Fe would normally produce negative interference by complexing with the methylthymol blue. A cation exchange column is used to remove these interferences. Anions such as PO_4, SO_3 and sulphide cause positive interference. However, these ions normally are not present in the samples.

5. Apparatus

a) Jars (20 cm circumference) and Huey plates.

b) Surgical gause, Curity or equivalent (60 cm length, 5 cm width).

c) Blender.

d) An automated system consisting of:

  i) Sampler
  ii) Manifold
  iii) Proportioning pump
  iv) Heating Coil
  v) Colorimeter equipped with 50 mm flow cell and 460 nm interference filter
  vi) Chart recorder or computer interface
  vii) Mixing coil provided with debubbler for removing CO_2

6. Reagents

a) Lead dioxide (MCB Technical, or equivalent).

b) Methanol, 100%.

c) Gum Tragacanth (2%) - dissolve 20 g gum in 100 mL methanol and dilute to 1 litre with distilled water.

d) Barium chloride solution - dissolve 1.526 g of barium chloride dehydrate in 500 mL of distilled water. Dilute to 1000 mL with distilled water. Store in a brown bottle.

e) Methylthymol blue solution - dissolve 0.1182 g of methythymol blue in 75 mL of distilled water and 25 mL barium chloride solution. Add 4 mL of 1N HCl which changes the colour to bright orange. Dilute to 500 mL with ethanol. The pH of this solution should be 2.6. Prepare the solution daily.

f) Buffer solution (pH 10.5 ± .5) - dissolve 6.75 g of ammonium chloride in 500 mL of distilled water. Add 57 mL of conc. ammonium hydroxide and dilute to 1 litre with distilled water.

g) Buffered EDTA solution - dissolve 40 g of tetrasodium EDTA in pH 10.5 buffer and dilute to 1 litre with buffer.

h) Sodium hydroxide solution (0.18N) - dissolve 7.2 g of sodium hydroxide in 800 mL of distilled water. Allow it to cool and dilute to 1 litre with distilled water.

i) Sodium carbonate solution (2% and 1%) - dissolve 20 g anhydrous sodium carbonate in one litre of distilled water. To prepare 1% solution, dilute 2% solution with equal volume of distilled water.

j) Hydrochloric acid (2N) - dilute 166 mL of conc. HCl to 1 litre with distilled water.

k) Stock sulphate solution (1000 mg/L SO_4) - dissolve 1.479 g of anhydrous sodium sulphate in 1% Na_2CO_3 solution and dilute to 1000 mL with 1% Na_2CO_3 solution.

l) Working standards - dilute each of the following aliquots of the stock with 1% sodium carbonate solution to 1000 mL in a volumetric flask.

mL stock/1000 mL	conc. mg/L SO_4
2.0	2.0
5.0	5.0
10.0	10.0
20.0	20.0
40.0	40.0
50.0	50.0

m) Cation exchange resin, Dowex 50W-X8, 20 - 50 mesh, or equivalent.

7. Procedure

a) Sampling

i) Preparation of the candle - wrap a tape of surgical gauze, 60 cm long and 5 cm wide around a jar of 20 cm circumference. Secure the gauze to the jar with cotton thread and paint it with a PbO_2 mixture prepared as follows:

Add 300 mL of 2% gum solution slowly to approximately 300 g of PbO_2, in portions, with continuous stirring until a smooth paste entirely free from lumps is obtained. Spread the lead dioxide paste evenly on the surgical gauze around the jar with a small brush. Each cylinder should contain approximately 8 - 10 g of PbO_2.

ii) Preparation of Huey Plate - grind 4 g of Gelman paper in a grinding mill and transfer it to a blender containing 400 mL of water. Blend for one minute. Add 64 g of PbO_2 and 22 mL of 2% gum tragacanth solution to the blender and blend for another 4 minutes. Attach a circular glass fibre disc to the plate with acetone by pouring 1 mL acetone into the plate and allowing it to evaporate at room temperature in a fume hood. Pipet 10 mL of the blended suspension into the Huey plate and allow it to dry in an oven at 50 - 55°C.

iii) Expose the cylinder and/or two plates in the field for approximately 4 weeks.

b) Analysis

i) Measure the exposed areas of the painted gauze on the candle and/or the Huey plates in cm^2.

ii) Remove the tape from the jar and place it in a 400 mL beaker. Put the two Huey plates along with the gauze into a 250 mL beaker. Care must be taken with this step to ensure that no $PbSO_4$ is lost during the transfer. Set up a sample blank by using an unexposed candle and two Huey plates. Use 2% Na_2CO_3 solution for reagent blank.

iii) Add 100 mL 2% sodium carbonate solution to the beaker containing the candle tape and 50 mL to the beaker containing Huey plates.

iv) Stir the mixtures and allow them to stand for at least three hours.

v) Heat the samples for 45 minutes at approximately 80°C keeping the volume above 60 mL with distilled water for the candle tape and 30 mL for the Huey plates.

vi) Filter the hot samples, rinse the beakers and wash the contents of the filter several times with hot distilled water.

vii) Cool the filtrates to room temperature and adjust the volume of the filtrate to 200 mL for the candle sample and to 100 mL for the Huey plate sample with distilled water.

viii) Transfer a portion of the sample to the sampler.

ix) Set up the manifold of the automated system as shown in the figure.

x) Allow both recorder and colorimeter to warm up for 30 minutes.

xi) Run a base line with all reagents, feeding 1% Na_2CO_3 solution through the sample line.

xii) Arrange standards in sampler in order of increasing concentration and place unknown samples in the sampler. Every 10th position of the sampler should contain a 1% Na_2CO_3 wash solution.

Note

At the end of each day, the system should be washed with a solution of EDTA. This may be done by placing the methylthymol blue line and the sodium hydroxide line in water for a few minutes then into the EDTA for 10 minutes. Wash system with water for 15 minutes before shutting down.

8. Calculation

a) Prepare a calibration curve by plotting mg/L SO_4 vs peak heights. Read the concentration for the exposed and unexposed samples from the graph in units of mg/L SO_4. Subtract the value for unexposed sample from the exposed one to get the actual value. Calculate mg $BaSO_4$ as follows:

$$\text{mg } BaSO_4 = \frac{\text{mg/L } SO_4 \times \text{total sample volume in mL} \times 2.43}{1000}$$

WHERE

$$2.43 = \frac{\text{mol. weight of } BaSO_4}{\text{mol. weight of } SO_4}$$

b) The following equation is used to express the total sulphation in units of mg SO_3/day/100 cm^2.

$$\text{mg } SO_3\text{/day/100 cm}^2 = \frac{\text{mg } BaSO_4 \times 0.343 \times 100}{d \times a}$$

WHERE

d = no. of days exposed
a = surface area of the tape or Huey plates in cm^2

$$0.343 = \frac{\text{mol. weight of } SO_3}{\text{mol. weight of } BaSO_4}$$

100 = conversion to 100 cm^2

9. Precision and Accuracy for Candles

a) In a single laboratory (Alberta Environmental Centre) using total sulphation candles at concentrations of 3, 13, 33 and 45 mg/L SO_4, the coefficients of variation were 6.6%, 3.8%, 1.4% and 1.0%, respectively.

b) In a single laboratory (Alberta Environmental Centre) using total sulphation candles at concentrations of 6 and 45 mg/L SO_4, the recoveries were 88.6% and 95.0%, respectively.

10. Precision and Accuracy for Huey Plates

a) In a single laboratory (Alberta Environmental Centre) using total sulphation Huey plates at concentrations of 5, 10 and 17 mg/L

SO_4, the coefficients of variation were 6.1%, 5.2% and 3.3%, respectively.

b) In a single laboratory (Alberta Environmental Centre) using total sulphation Huey plates at concentrations of 3 and 22 mg/L SO_4, the recoveries were 90.0% and 96.0%, respectively.

11. References

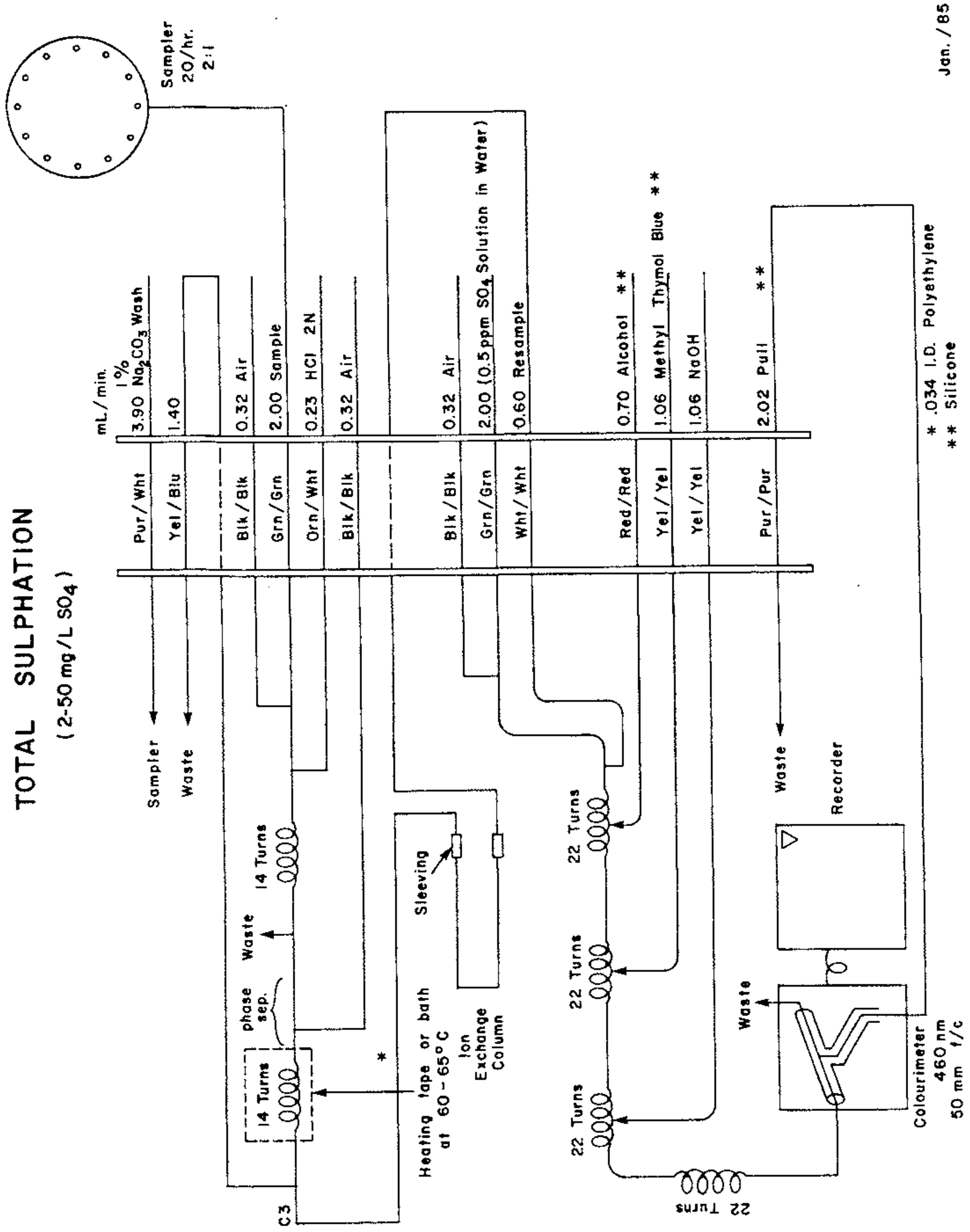
a) ASTM, Part 26, 1977, p. 536.

b) Technicon Industrial Method No. 118-74, December 1972.

REPEALED - refer to 2016 Air Monitoring Directive, as amended

TOTAL SULPHATION

(2-50 mg/L SO_4)



Jan./85

REPEALED - refer to 2016 Air Monitoring Directive, as amended

APPENDIX A-4

DETERMINATION OF HYDROGEN SULPHIDE (STATIC MONITORING)

Method No. 13030
(extracted from "Methods Manual for Chemical
Analysis of Atmospheric Pollutants 1985,"
Third Edition, Alberta Environmental Centre)

HYDROGEN SULPHIDE
(Iodometric Titration)
(METHOD NO. 13030 - OCTOBER 1978)

1. Introduction

Hydrogen sulphide is a toxic and malodorous air pollutant. It has adverse effects on lead-based paints and is corrosive to certain metals. It originates from pulp and paper plants, and oil and gas refineries.

2. Principle

A five cm wide tape of filter paper, impregnated with a 5% solution of zinc acetate, is exposed to the atmosphere for approximately 4 weeks. Hydrogen sulphide present in the ambient air reacts with zinc acetate and forms zinc sulphide. The sample is analyzed by decomposing zinc sulphide to hydrogen sulphide with hydrochloric acid, and the sulphide is determined by iodometric titration.

3. Scope

The method is applicable only to ambient air on a cumulative basis. The detection limit in the test solution is 2 mg/L sulphide.

4. Interference

Sulphur dioxide and mercaptans interfere.

5. Apparatus

a) Jars (20 cm circumference)

b) Filter paper tape (Whatman No. 2, 60 x 5 cm, or equivalent).

6. Reagents

a) Zinc acetate/glycerine solution - dissolve 5 g zinc acetate and 5 ml glycerine in 100 mL distilled water.

b) Sodium thiosulphate solution (0.025N) - dissolve 12.41 g of sodium thiosulphate, $Na_2S_2O_3.5H_2O$, in distilled water and dilute to 2000 mL with distilled water. Standardize against standard potassium dichromate.

c) Potassium dichromate solution (0.100N) - dissolve exactly 4.904 g of potassium dichromate (dried for 2 hours at 103°C) in distilled water in a 1000 mL volumetric flask and dilute to volume.

d) Starch solution - prepare a paste by adding 10 g of starch to 20 mL of distilled water. Add 2 litres of boiling water to the paste and stir until all starch dissolves. Add a small amount of salicylic acid to prevent mold formation.

e) Standardization of sodium thiosulphate - pipet 10.0 mL of 0.100N potassium dichromate solution into a 400 mL beaker containing 25 mL of water, 2 g KI and 5 mL of 1+5 HCl. Allow the reaction to proceed in the dark for 5 minutes, dilute to approximately 200 mL and titrate with 0.025N $Na_2S_2O_3$ adding 0.5 mL of starch near the end point. At the end point the colour changes from opaque blue to clear.

$$\text{Normality of } Na_2S_2O_3 = \frac{10.0 \times 0.100}{\text{mL of thiosulphate consumed}}$$

f) Stock iodine solution (0.100N) - dissolve 40 g KI in 800 mL distilled water in a 1000 mL volumetric flask, add 12.8 g of iodine and dilute to volume.

g) Standard iodine solution (0.025N) - dilute 125.0 mL of stock solution to 500 mL in a 500 mL volumetric flask with distilled water.

h) Standardize the 0.025N iodine solution against the above standard $Na_2S_2O_3$ solution, as follows:

Pipet 50.0 mL standard iodine solution and 50 mL distilled water into 250 mL Erlenmeyer flasks. Add 50 mL distilled water, 5 mL 1+5 HCl and 1 mL starch solution to both the flasks. Titrate with 0.025N sodium thiosulphate to the disappearance of the blue colour.

$$\text{Normality of iodine solution} = \frac{(a-b) \times N}{50.0}$$

WHERE

N = normality of $Na_2S_2O_3$ solution.

a = mL of $Na_2S_2O_3$ solution consumed by the iodine standard.

b = mL of $Na_2S_2O_3$ solution consumed by the blank.

7. Procedure

a) Sampling

Preparation of hydrogen sulphide candle - impregnate 60 x 5 cm filter paper tapes with zinc acetate/glycerine solution by soaking them for 15 to 20 hours in the acetate solution. Remove the tapes and allow them to dry until they are just slightly damp. Wrap each tape around a jar and tie it with thread. Expose the candle in the field for approximately 4 weeks.

b) Analysis

i) Measure the exposed surface area of the tape in cm^2 before removing it from the jar.

ii) Remove the tape from the jar.

iii) Fold the tape to fit in the bottom of a 600 mL beaker.

iv) Add 150 mL of distilled water thoroughly immersing the tape. Allow it to stand for one hour at room temperature.

v) Add 10.0 mL of 0.025N iodine solution followed by 5 mL of conc. HCl. If after stirring, the brown colour of the solution disappears, immediately add more iodine solution in 10 mL portions until the brown colour persist. Record the mL of iodine solution added.

vi) Titrate with 0.025N sodium thiosulphate solution adding 0.5 mL of starch towards the end point. The end point is reached when the blue colour disappears. Read and record titrations to the nearest 0.10 mL.

vii) Run an iodine blank initially and after every tenth sample.

8. Calculation

$$\text{mg sulphide} = (C - D) \times 0.4 \times \frac{0.025}{N}$$

WHERE

C = mL of $Na_2S_2O_3$ solution used for blank.

D = mL of $Na_2S_2O_3$ solution used for sample.

0.4 = mg of sulphide, equivalent to 1 mL of 0.025N iodine solution.

N = Normality of $Na_2S_2O_3$ solution.

The final result is expressed as:

$$\text{mg } SO_3\text{/day/100 cm}^2 = \frac{\text{mg sulphide} \times 2.497 \times 100}{a \times d}$$

WHERE

$$2.497 = \frac{\text{mol. weight of } SO_3}{\text{mol. weight of sulphide}}$$

a = area of the exposed tape in cm^2

d = no. of days exposed

100 = conversion to 100 cm^2

9. References

a) H.P. Sanderson, R. Thomas and M. Katz, J. Air Pollution Control Association, Volume 16, 1966, p. 328.

b) H.C. Wohlers and M. Feldstein; J. Air Pollution Control Association, Volume 16, 1966, p. 19.

APPENDIX A-5

DETERMINATION OF WATER SOLUBLE FLUORIDES
(STATIC MONITORING)

Method No. 12020
(extracted from "Methods Manual for Chemical
Analysis of Atmospheric Pollutants 1985,"
Third Edition, Alberta Environmental Centre)

FLUORIDE, WATER SOLUBLE
(Specific Ion Electrode)
(METHOD NO. 12020 - OCTOBER 1981)

1. Introduction

During the combustion of coal and processing of phosphate bearing rocks, fluorine compounds such as hydrofluoric acid and silicon tetrafluoride are released.

In the process of industrial operations to produce phosphate fertilizer, iron and steel, glass and ceramics, fluorine compounds are set free as gaseous and/or particulate fluoride.

2. Principle

Fluoride is collected by exposing a filter paper soaked with saturated CaO solution. Fluoride is determined using a fluoride specific ion electrode in conjunction with a standard calomel reference electrode. The potential developed by the presence of fluoride ions is measured by an expanded scale pH/mv meter.

3. Scope

The range is 0.05 mg/L to 2 mg/L fluoride in the test solution.

4. Interference

Polyvalent cations such as Si, Fe and Al interfere. A buffer prevents these interferences.

5. Apparatus

a) pH meter with expanded mv scale.

b) Fluoride electrode (Orion 94-09, or equivalent).

c) Magnetic stirrer and Teflon coated stirring bar.

6. Reagents

a) Saturated CaO solution is distilled water.

b) Total ionic strength adjustment buffer (TISAB) - add 57 mL of glacial acetic acid, 58 g of sodium chloride and 2 g DCTA (1, 2-diamino-cyclohexane-tetra acetic acid) to approximately 500 mL of distilled water. Stir to dissolve and cool to room temperature. Adjust the pH of the solution to between 5.0 and 5.5 with 5N NaOH. Transfer the solution to 1000 mL volumetric flask and dilute to volume with distilled water.

c) Stock fluoride solution (100 mg/L F) - dissolve 0.221 g anhydrous sodium fluoride in distilled water and dilute to 1000 mL.

d) Working Standards - prepare as follows:

mL stock/1000 mL	conc. mg/L F
1.0	0.10
2.5	0.25
5.0	0.50
10.0	1.00
15.0	1.50
20.0	2.00

7. Procedure

a) Sampling

i) Immerse 15 cm diameter Whatman filter paper in a saturated CaO solution for 16 hours.

ii) After 16 hours remove the filter paper and allow to dry to a slightly damp condition.

iii) Expose the fluoride paper in the field for approximately 4 weeks.

b) Analysis

i) Immerse the fluoride paper in 50 mL water + 50 mL buffer overnight.

ii) Remove the filter paper and adjust the volume to exactly 100 mL in a volumetric flask with distilled water. Transfer the buffered sample into a 200 mL beaker.

iii) To 50 mL of each standard in a 200 mL beaker, add 50 mL of buffer solution.

iv) Insert the electrode, stir the solution using a magnetic stirrer for three minutes or longer and record the potential when the reading is stable. The standards and the samples should be at the same temperature.

8. Calculation

Using two cycle semi-log graph paper, prepare a calibration curve by plotting mg/L F on the log scale vs the mv readings on the linear scale. A straight line should be obtained. Read the fluoride concentration from the graph in units of mg/L F.

$$\text{Mg F} = \frac{\text{mg/L F} \times \text{total sample volume in mL}}{1000}$$

The final result is expressed as:

$$\text{mg F/cm}^2\text{/day} = \frac{\text{mg F}}{a \times d}$$

WHERE

a = area of the fluoride paper
b = number of days exposed

Note: Maintenance of Electrodes:

a) The electrodes may be stored in water for short time periods between measurements or may be dried for longer storage. Refer to the electrode manuals.

b) The fluoride electrode, whose response may become sluggish with time, can be restored to working order by brushing the sensing element on the flat tip of the electrode with a fluoride tooth paste and soft brush.

9. References

a) Std. Meth. 14th Ed., p. 391.

b) Orion Application Information Procedure No. 504.

APPENDIX A-6

DETERMINATION OF DUSTFALL
(STATIC MONITORING)

Method No. 32020
(extracted from "Methods Manual for Chemical
Analysis of Atmospheric Pollutants 1985,"
Third Edition, Alberta Environmental Centre)

DUSTFALL, TOTAL AND FIXED
(Gravimetric)
(METHOD NO. 32020 - OCTOBER 1978)

1. Introduction

Dustfall is the settleable fraction of the total particulate matter in air. It is collected in an open jar of a specified size containing water as collecting medium.

Total Dustfall is defined as the amount of material left after evaporation of a sample of dustfall and its subsequent drying. Total Fixed Dustfall is the residue that is left after ignition of the total dustfall sample. The total dustfall includes both suspended and dissolved matters. The loss in weight after ignition is mainly due to combustion of organic matter.

2. Principle

A well-mixed sample is evaporated in a pre-weighed platinum crucible on a water bath and then dried in an oven at 105°C for one hour. The residue left is the total dustfall. The total dustfall is then ignited at 550°C for 30 minutes in order to determine the total fixed dustfall.

3. Scope

The method covers a procedure for the field collection of settleable particulate matter in ambient air and its determination. The detection limit is 10 mg/L total and/or fixed dustfall in the test solution.

4. Interference

A 20 mesh sieve is used to eliminate deposits such as inspections and bird droppings.

5. Apparatus

a) Dustfall collector - the dustfall collector is an open-topped plastic container with flat bottom, 10 cm in diameter and 20 cm high. A holder is to be provided to secure safe positioning of the collector in the field.

b) Sieve - 20 mesh size.

c) Platinum crucibles of 50 mL capacity.

d) Water bath.

e) Laboratory oven.

f) Muffle furnace.

g) Desiccator.

h) Analytical balance of 200 g capacity and a sensitivity of 0.1 mg.

6. Reagents

a) Algicide - Dowicide B (Dow Chemical), $CuSO_4$, or equivalent.

b) Isopropanol.

7. Procedure

a) Sampling

Pour 500 mL distilled water and 5 mL of 1% Dowicide B or 5 mg $CuSO_4$ in the collector in summer. Use 500 mL of 1+1 distilled water-isopropanol in winter. Expose the collector in the field for approximately 4 weeks.

b) Analysis

i) Filter the contents of the collector through a 20 mesh sieve into a 600 mL beaker. Rinse the container with distilled water using a rubber policeman and add the rinse to the filtrate.

ii) Adjust the volume of the filtrate to 300 mL.

iii) Ignite the platinum crucibles in a muffle furnace at 550°C for 30 minutes, cool in a desiccator and weigh.

iv) Thoroughly mix the sample with a magnetic stirrer and pipet 50 mL into a preweighed platinum crucible.

v) Evaporate the sample to a dryness on a water bath.

vi) Dry the residue in an oven set at 105°C ± 2°C for one hour.

vii) Cool in a desiccator, weigh and record the weight.

viii) Ignite the crucible with the residue for 30 minutes at 550°C, cool in a desiccator, weigh and record the weight.

8. Calculation

$$\text{Total dustfall, mg} = \frac{(B - A) \times 300}{\text{vol. of sample used for evaporation}}$$

$$\text{Total fixed dustfall, mg} = \frac{(C - A) \times 300}{\text{vol. of sample used for evaporation}}$$

A = initial weight of empty platinum crucible in mg
B = weight of platinum crucible in mg after evaporation
C = weight of platinum crucible in mg after ignition

The results are expressed as $mg/cm^2/30$ days $= \dfrac{mg \times 30}{a \times d}$

where

a = area of the dustfall collector-opening in cm^2
d = number of days exposed

9. References

ASTM, Part 26, 1977, p. 515

REPEALED - refer to 2016 Air Monitoring Directive, as amended

APPENDIX A-7

SOIL MONITORING GUIDELINES

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

This guide addresses soil monitoring associated with all sulphur recovery or solid sulphur handling operations.

1.1 OBJECTIVES

The pollutant addressed by this program is elemental sulphur. The sulphur originates from solid sulphur handling operations such as blocks, base pads, granulating facilities, prilling towers and loading facilities.

There are three objectives to the soil monitoring program within this AMD. The first is to monitor deposition of elemental sulphur on soils. The second is to evaluate the response of soils to elemental sulphur deposition. The third is to provide a mechanism for industry to inform the licensing agencies of the mitigative measures undertaken to halt or reverse acidifying effects of sulphur deposition. The principal mitigative measure is application of limestone although other measures may be possible.

This guide is not designed to provide operators with a rigid set of step-by-step instructions. Rather, designs and methods are provided as suggestions for the individual operators to develop programs that meet the needs of the regulating agencies. The guidelines have been made more flexible than those in AMD 81-1 by providing exemptions for operators not handling solid sulphur and by allowing each operator to design site specific monitoring plans.

The terms "suggested" and "recommended" used in the guidelines do not imply "required". Rather, they indicate scientific methods which have been designed by government and industry personnel to provide the best monitoring information possible without undue inconvenience to the operator.

1.2 INFORMATION COLLECTED

1.2.1 Site Description

A Site Description should be provided for all operations (details provided in Section 2). This information will provide background characteristics of the site which will aid in the intepretation of specific chemical data collected in later monitoring programs.

1.2.2 First Year Monitoring Program

Operators will collect data on soil pH and sulphur levels at each sample site to help delineate the extent and degree of any existing sulphur deposition and/or establish baseline soil conditions. Measurements of bulk density, electrical conductivity (EC_e), and cation exchange capacity (CEC) are also recommended.

Bulk density is determined to allow conversion of sulphur concentrations (ppm) to a weight basis (e.g., kg/ha). EC_e is used to determine if high natural salt levels are present. It can also be used to indicate if oxidation of sulphur to sulphate is occurring and to monitor potential salt increases caused by liming. CEC is useful for prediction of soil buffering capacity.

1.2.3 Annual Monitoring Program

Operators will collect data on soil pH and sulphur levels. Also recommended are data on EC_e. Further details are provided in Sections 3 and 4.

1.3 CLASSIFICATION OF OPERATIONS

The areal extent of the monitoring program will be determined by the type of operation and expected level of sulphur dusting.

1.3.1 Exempt Operations

Operations with liquid sulphur handling only or those without sulphur blocks and/or solid sulphur handling facilities are normally exempt from the soil monitoring requirements. Operations where sulphur blocks have been removed and where handling of solid sulphur is no longer ongoing can apply for exemption from the monitoring program. Exemption will be granted if the operator provides data showing no existing or potential adverse impacts.

1.3.2 Operations With Prilling Towers

Prilling towers are likely to spread elemental sulphur to a greater distance than sulphur blocks. Therefore, operations with prilling towers are normally expected to monitor a larger area than operations without towers.The suggested sampling area for operations with a prilling tower is an ellipse approximately 2 km long in the dominant wind direction and 1 km in the upwind direction (Figure 1). The ellipse should be focused on the centre of the source (e.g., the block). Where two or more sources are present, the ellipse should be focused on a point equidistant from all sources. Further details on sampling patterns are given in Section 3.

1.3.3 Operations Without Prilling Towers

For operations without a prilling tower, the suggested sampling area is a circle with a radius of approximately 1 km (Figure 1). Operations with granulating facilities fall under this category. Further details are given in Section 3.

1.3.4 Operations With Static Blocks

Operations which have sulphur blocks and/or pads but where physical breakup of the blocks and/or pads is not being conducted at any time in the reporting year will be exempt from monitoring if the operator provides data from previous years showing no existing adverse impacts and no potential for changes in soil pH or sulphur levels. Operations removing sulphur from blocks using only remelt techniques fall under this category. However, operators should monitor periodically (e.g., every 3 to 5 years) to ensure impacts are not occurring.

1.3.5 Operations Initiating Sulphur Handling or Sulphur Block Construction

Operations falling under Sections 1.3.1 or 1.3.4 above which intend to start handling sulphur (including basepad reclamation) should initiate an annual soil monitoring program. A site description should be in hand before any sulphur is processed and a first year monitoring program will normally be coincident with initiation of sulphur storage and/or handling.

1.3.6 New Operations

It is recommended that new operations conduct the Site Description study described in Section 2, even if the operation will be exempt from the monitoring program. This will provide baseline data for future use should the operator need to handle solid sulphur.

1.4 APPROVALS

Operators will develop sampling designs (patterns) for each operation and submit the designs to Alberta Environment, Standards and Approvals Division, for approval. The sampling pattern may change from year to year depending on the results of previous year's sampling. However, operators must provide sound scientific reasons for changes to sampling designs and all such changes will be reviewed with Alberta Environment.

Descriptions of all soil ameliorative measures undertaken by the operator will form part of the Annual Monitoring report. While these plans will not require approval, Alberta Environment may, in consultation with the operator, suggest changes to the amelioration plans. Alberta Environment in conjunction with the ERCB may also request implementation of an amelioration plan if the soils data appear to warrant such an action and no plan has been initiated by the operator.

2. SITE DESCRIPTION

This section outlines the information that should be collected for the Site Description report. The Site Description is meant to provide an overall characterization of the sampling area. This will facilitate interpretation of the sensitivity of the study area and assist with the design of any required sampling programs.

The operator should provide:

A. A description of the plant including name, location, current (and expected) block size, and historical data on volumes of sulphur handled (and handling methods) for the last 5 years.

B. A wind rose diagram or chart for the plant location (or nearest location with similar topography). A few statements should be made on how the winds will affect sulphur dust patterns (spatial and temporal) in the sample area.

C. A topographic map (preferred) or photo mosaic at a scale of 1:20 000[1] or larger of the sampling area around the plant. The map should show the plant site (block, prilling tower), centre of the source(s) (see Section 1.3.2), sampling area, roads, railways, waterbodies, and human settlements.

D. A description of the major soil types in the sample area indicating approximate locations, areal extents and, if possible, the important physical and chemical characteristics. Background values for pH and total sulphur should be determined for the dominant soils to be sampled in the monitoring program. The background levels should not be taken from any areas previously impacted by the operation to be monitored.

E. A description of the land use and dominant vegetation in the sample area.

F. A preliminary design for the First Year Monitoring Program unless exempt (see Sections 1.3.1 or 1.3.4).

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[1] The 1:20 000 scale topography map could be produced by enlargement from a 1:50 000 base map.

2.1 NEW PLANT REQUIREMENTS

New plants should collect Site Description information prior to coming on stream or during the initial portion of the first year of operation. It is preferred that the Site Description study be carried out in time to allow the First Year Monitoring Program to be conducted in the fall of the first operating year.

2.2 EXISTING PLANT REQUIREMENTS

It is likely that most plants currently operating (i.e., onstream as of 1986) will have much of this data collected and may even have submitted much of it in prior reports. It is suggested that each operator discuss the Site Description requirements for their operation with Alberta Environment. If such discussions do not take place the operator will normally be expected to follow the recommendations in Section 2.

3. PROGRAM DESIGN AND SAMPLING

3.1 GENERAL

It is recognized that the potential for sulphur dust emissions and subsequent deposition nearby will vary from operation to operation. The following sampling program is presented for an operation which handles large quantities of solid sulphur where the potential for deposition is significant. Modification of the program for the opposite situation of minimal sulphur dusting will also be presented. As each operator will design his own soil sampling program, it is expected that all final sampling designs will fall somewhere between or at these extremes and will consider the site specific conditions.

The sampling design recommended for routine monitoring is the radial transect design. The reason for this selection is that it can identify if there has been significant sulphur deposition and the general location of the deposition with a minimal number of samples and a high degree of confidence. For those sites showing large amounts of sulphur deposition, a grid sampling design is recommended in the following year to better define the limits and extent of the affected area. A grid design is presented which makes optimal use of soil sampling sites from the transect design.

All radial transect and grid sampling sites are located outside the plant site boundary. Sampling within the plant site is not covered by this guideline but is encouraged. Paired samples are normally not required but operators are encouraged to take replicate samples along the main downwind transect to get some handle on variability and hence some confidence in their results.

3.2 RADIAL TRANSECT SAMPLING DESIGN

Eight radial transects begin at the centre of the main source(s) of sulphur dust and extend outwards in all directions at 45 degree intervals for distances up to two kilometers (Figure 1). Soil sampling sites are selected along these transects at 500 m intervals. An additional site is located along each transect 50 m from the plant boundary. These sites may substitute for nearby 500 m sampling sites. The principal transect is in the predominant wind direction from the plant site. Sites on this transect are recommended at 500, 1000, 1500, and 2000 m. Transects 45 degrees from the principal transect would be 1500 m in length. All remaining transects would be 1000 m in length.

This design can be modified for plants with reduced sulphur dusting hazard (see Section 1.3 and Figure 1 for more details). In addition, the design may vary depending on the wind rose data. A minimal program would consist of six sites as previously used under AMD 81-1.

3.2.1 Sampling Sites

If possible, sampling sites should be representative of dominant soil types, slopes, aspects, drainages, and land use. Also, where possible, avoid wet seep or disturbed areas, and locate 50 to 100 m away from roadways. Sampling of organic soils should be avoided unless they form a dominant soil type in the sampling area. To achieve proper site selection, recommended distance criteria may need to be adjusted.

A record of fertilizer application, where available, along with mention of the crop type (i.e., barley, alfalfa, summerfallow, etc.) during the sampling year, should be submitted with the report for any sites located on agricultural land. Adequate identification of sampling sites in the field and on maps should be maintained as they will be used in subsequent years.

3.2.2 Sampling procedure

For grassland and cultivated soils, a minimum of 15 cores should be taken at random within a 5 m radius of each sampling site to produce a composite sample. The grassland should be sampled from 0 to 5 cm and cultivated soils from 0 to 15 cm (see Appendix I, section 2 for definitions). The litter layer (LFH) of forest soils should be sampled to mineral contact and the thickness of the litter recorded. The top 0 to 5 cm of an organic soil is to be sampled. For forest litter layer and organic soils, 10 cm x 10 cm samples are to be taken at five locations within a 5 m radius to produce a composite sample.

Soils should be sampled each year at about the same time and under similar weather conditions. The period of August to October is considered most appropriate, assuming there is no snow cover. Care should be taken during each sampling to minimize disturbance of the site as future samplings will be undertaken in the same location.

3.3 GRID SAMPLING DESIGN

Areas which have surface soil samples exhibiting one or more of the following conditions should be considered for grid sampling in the next year:

1. a soil pH depression of one unit from baseline conditions;
2. addition of 320 kg/ha of total sulphur above the baseline in litter or 0-5 cm soil samples;
3. addition of 640 kg/ha of total sulphur above the baseline in a 0-15 cm soil sample.

A grid sampling pattern is recommended to provide additional detail in areas of known deposition and to better establish deposition boundaries. A spacing of 350 m between grid points is recommended. This grid size also uses a majority of the original transect sites (Figure 2). Since soils exhibiting these larger amounts of soil acidification and sulphur deposition will probably require liming, the grid sampling pattern will help define the area to be limed. If an operator does not feel liming is required he should be ready to provide reasons for this decision.

3.3.1 Sampling Sites

The grid design will include areas identified by the radial transects as having significant elemental sulphur deposition. However, the grid perimeter should include sampling sites at which sulphur deposition is less than the levels specified in 3.3 above. A modified version of the original radial transect design may be used to continue monitoring low deposition areas within the sampling area. This may result in fewer of the radial transect sites outside the gridded area being used.

3.3.2 Sampling Procedure

Soil samples from the grid sample sites should be obtained in an identical manner to those from the transects with the exception that additional depths are required to identify the extent of acid or salt penetration into the soil. Grassland and organic soils should include an additional sample from 5 to 15 cm. Forest soils should be sampled from 0 to 15 cm in the mineral soil in addition to the LFH sample. Cultivated soils should be sampled from 15 to 30 cm as well as from 0 to 15 cm. For all soils, additional depths of 15 to 30 cm or 30 to 60 cm may be needed in some highly impacted areas.

3.4 SAMPLE TREATMENT

Samples should to be placed in plastic or cloth bags[1], transported to the laboratory and air dried as soon as possible. Electrostatic charges on sample bags and equipment may attract elemental S, therefore care must be taken to ensure all elemental S is removed from the bag surfaces and added to the sample. Because elemental S settles in transit, the entire sample must be thoroughly mixed (homogenized) prior to analysis. The mineral-soil samples should be ground to pass a 2 mm sieve and, if possible, analyzed within 48 hrs. Organic soils and LFH (litter) samples should be air dried and finely chopped in a rotary or flail-type mill to ensure that larger size pieces of organic debris are included and that homogeneity is achieved.

It is important that the drying, grinding and analyses areas are clean (e.g., free of basic and acidic fumes, and calcareous soil dust).

[1] Cloth bags are useful for dry mineral soil samples but not recommended for moist mineral or organic soil samples, as particles of elemental sulphur may adhere to the sides.

4. ANALYTICAL REQUIREMENTS

4.1 RECOMMENDED SOIL ANALYTICAL METHODS

Details of recommended analytical methods are provided in Appendix II for the key soil parameters. While commonly accepted laboratory techniques have been identified in this section, it is recognized that analytical laboratories vary widely in equipment types used and experience for conducting soil analyses. Rather than restricting the methods allowed for a particular soil analysis or approving data only from those laboratories thought to have produced good soils data in the past, a system of quality assurance/quality control (QA/QC) has been implemented.

4.2 QUALITY ASSURANCE/QUALITY CONTROL

The QA/QC program will require the laboratory selected by the operator to include standard soil samples with samples taken from field monitoring activities. The standard samples will have known elemental sulphur concentrations and other properties, which the selected laboratory will have to reproduce within acceptable limits. Standard samples and the acceptable limits will be provided to the operators by Alberta Environment, Soil Protection Branch, Waste and Chemicals Division. The number of standard analyses required will vary with the kind of soil analysis required, phase of the monitoring program and previous experience with the selected laboratory/technique combination (Appendix II, section 2). Where possible, the number of standard soil samples and replicates for analysis should be agreed by the Department and the operators when the proposal for the first year monitoring program is received.

If an operator wishes to check a laboratory's performance prior to sampling, Alberta Environment can issue the operator a set of standard samples and acceptable ranges. These standards will be different than those supplied for the monitoring programs.

Applications for standard soil samples should be made to Soil Protection Branch of the Waste and Chemicals Division, Cousins Building, Lethbridge, Alberta, T1J 4B3 (381-5322).

5. FORMAT OF REPORTS

5.1 SITE DESCRIPTION REPORT

The Site Description Report will present the information collected under Section 2. The report will be presented in sections: (A) Study Area, (B) Soils Descriptions, (C) Wind Rose(s) and Expected Deposition Pattern, and (D) Design of First Year Monitoring Program unless exempt (see Section 1.3.1 or 1.3.4). The Site Description Report should be submitted prior to undertaking the First Year Monitoring Program to allow time for Alberta Environment to approve the sampling program design. A minimum of three (3) months should be allowed between submission time and approval.

5.2 FIRST YEAR MONITORING REPORT

The First Year Monitoring Report will contain all the information in the Annual Monitoring Report (Section 5.3 below). It will also include the initial soils data on pH and sulphur levels for each sampling site. Data on bulk density, EC_e, and CEC are recommended parameters for this report.

5.3 ANNUAL MONITORING REPORT

The Annual Monitoring Report will be submitted to Alberta Environment, Standards and Approvals Division, in the spring of the year following sampling. The latest date for submission is 15 March. The report will contain the following information:

A. A map or air photo at a scale of 1:20 000 or larger showing location of all samples sites, the plant and the sources.

B. A description of all sample sites (as per Appendix I, Table 1).

C. Soil pH and sulphur data for the current year (as per Appendix I, Table 2), previous year and the initial year (as per Appendix I, Tables 3 and 4).

D. Interpretation of the data, including a discussion of observed changes since the previous year and since the initial year.

E. A discussion of any ameliorative program to be undertaken. Where lime is the ameliorative agent the operator will provide data on application rates and show on the map in (A) the area(s) to be limed at each rate. The operator should indicate the soil pH target the liming program is intended to achieve. Where lime is not the ameliorative agent full details on the methodology to be used should be supplied.

F. A discussion of the effects of any ameliorative action taken the previous year. Soil chemistry data should be used to show effects.

G. A review of changes to the soil sampling scheme (location, depths, replications, numbers, timing) with sound scientific reasons for the changes. Note that the new sample sites should be characterized in the next Annual Monitoring Report as per requirements in Section 5.2.

6. GOVERNMENT RESPONSE

Following review of the Annual Report, Alberta Environment will notify the operator in writing that:

A. The report is acceptable as written or that changes are recommended.

B. The operator's interpretation of the need for ameliorative action is acceptable or that discussions with the operator regarding addition of, or changes to, an ameliorative action are suggested.

C. The operator's request for a change to the sampling design is acceptable.

Written notification will be received by the operator no later than 30 June to allow for adequate planning for the next sampling season.

APPENDICIES

I	DATA FORMS
II	ANALYTICAL METHODS

APPENDIX I. DATA FORMS

1. SOIL SAMPLING SITE DOCUMENTATION

This table will provide the documentation required to locate the sites and to interpret the soil chemistry data generated each year.

Note:
1. Plant location to be supplied in LSD format. Same for all tables.
2. Soil type to be described to the same level as in the Site Description Study.
3. Bulk density and CEC are normally measured once in the first sampling year -- not every year. CEC may be reported as me/100g or in SIS units as mol(ion)/kg.
4. Significant features to report include land use, vegetation/crop type, management practices, etc.
5. If no changes to this Table have occurred since the previous year, a photocopy of the Table will be sufficient for the report.
6. An asterisk should be placed beside sample sites not in use for the current reporting year. Sites not used in the most recent five-year period can be removed from the Table.
7. The centre of the source (see Section 1.3.2) should be used to measure distance and direction of sample sites.
8. Report direction as a compass bearing (e.g., N, SW, ESE).

Table 1. Soil sampling site documentation.

PLANT OPERATOR ______________________ PLANT LOCATION____________________

PLANT NAME __________________________ DOMINANT WIND DIRECTION____________

Site Number	Distance to Site	Site Direction	Soil Type	Recommended Data		Significant Features of Site
				Bulk Density (g/cc)	CEC (me/100g)	

2. ANNUAL SOIL SAMPLING DATA

This table will present the soil chemistry data collected in the current reporting year. Only the current year's sites are reported.

<u>Note</u>:

1. Carbonate content and EC_e need only be analysed where heavy dusting or liming has occurred. Sampling can be restricted to the LFH or 0 to 15 cm (cultivated agricultural soil) depths. EC_e may be reported as mS/cm or in SIS units as dS/m.
2. Soil pH and sulphur at the 15 to 30 and 30 to 60 cm depths should be analysed when sulphur levels in the surface layer exceed 320 kg/ha. The same applies for the 0 to 15 cm depth under forest soils.
3. The 0 to 5 cm depth is to be used when reporting data on grassland (uncultivated agricultural) soils. The 0 to 5 cm layer is taken as the surface vegetation mat plus 0 to 5 cm of mineral soil. The vegetation should be clipped to the surface and discarded. Cultivated agricultural soils are reported using the 0 to 15 cm depth. Forest soils are reported using the LFH layer.
4. Depths should be specified as LFH, 0 to 5, 5 to 15, 0 to 15, 15 to 30, or 30 to 60 cm.
5. Type = Forest (F), Grassland (G), Organic (O), or Cultivated Agricultural (A).
6. Indicate whether sulphur is Total (T) or Elemental (E). Sulphur may be reported as ppm or in SIS units as ug/gm.

Table 2. Annual soil sampling data.

PLANT OPERATOR____________________ PLANT LOCATION ____________________

PLANT NAME____________________ MONTH/YEAR ____________________

Site Number	Type	Soil pH		Soil Sulphur		Carbonate Content (%)	EC_e (mS/cm)
		Depth	pH	Depth	ppm		

3. CUMULATIVE SOIL pH DATA

This table presents a summary of the most recent two years' data as well as the initial data. All sites sampled in the two-year period are to be reported.

<u>Note</u>:

1. The soil depths should be reported as LFH, 0 to 5, 5 to 15, 0 to 15, 15 to 30, or 30 to 60 cm.
2. The initial value will be the background levels collected under for the Study Description. For new operations the initial value may be the first years data for each site. For existing operations the initial value will be a mean background value for that soil type collected from undisturbed areas nearby.

Table 3. Cumulative soil pH data.

PLANT OPERATOR ______________________ PLANT LOCATION ____________________

PLANT NAME __________________________

	Previous Year	Current Year			
Site	Initial	19__		19__	
Number	Value/Year	Depth	pH	Depth	pH

4. CUMULATIVE SOIL SULPHUR DATA

This table presents a summary of the most recent two years' data as well as the initial data. All sites sampled in the two-year period are to be reported.

Note:

1. The soil depths should be reported as LFH, 0 to 5, 5 to 15, 0 to 15, 15 to 30, or 30 to 60 cm.
2. Indicate whether sulphur is Total (T) or Elemental (E).
3. The initial value will be the background levels collected under for the Study Description. For new operations the initial value may be the first years data for each site. For existing operations the initial value will be a mean background value for that soil type collected from undisturbed areas nearby.

Table 4. Cumulative soil sulphur data.

PLANT OPERATOR ______________________ PLANT LOCATION ___________________

PLANT NAME __________________________

		Previous Year		Current Year	
Site Number	Initial Value/Year	19__ Depth	ppm	19__ Depth	ppm

APPENDIX II. ANALYTICAL METHODS

1. RECOMMENDED ANALYTICAL METHODS

Recommended analytical methods for selected soil parameters to be evaluated in monitoring programs. The analytical method used should be reported in the Annual Report.

Soil Parameter	Recommended Method	Reference	Comments
1. Soil pH	2:1 (H_2O:soil)	McKeague (1978)	for organic soils and forest litter increase the ratio to 10:1
	2:1 (0.01M$CaCl_2$:Soil)	McKeague (1978) Proc. 3.11	less variable than water pH but less commonly used in Alberta; recommended for any new programs
2. Total Sulphur (S)	Leco oxidation	Leco Furnace Manual	an operating temperature of 1425°C, which is slightly higher than that specified in some Leco manuals, has been found to yield better total results.
3. Elemental Sulphur (S^0)	Acetone/NaCN	Maynard & Addison (1985)	a new method, proven to be effective even on soils high in organic matter content.
4. Electrical Conductivity (EC_e)	Saturated Paste Extract (for interpreting vegetation effects)	McKeague (1978) Proc. 4.13	measurement of the paste pH is not required.

CONCLUDED.

Soil Parameter	Recommended Method	Reference	Comments
5. Sulphate Sulphur (SO_4)	Analysis of Saturated Extract	McKeague (1978) Proc. 3.21	analysis of the extract can be undertaken by automated Technicon systems or other wet chemical development procedures.
6. Calcium Carbonate Equivalent	Gas Pressure Method	McKeague (1978) Proc. 3.43	this method is one of the least complicated and allows a rough separation of dolomite and calcite.
7. Cation Exchange Capacity (CEC)	Ammonium Acetate pH 7.0	McKeague (1978) Proc. 3.32	

References

Leco Corporation. 1980. Instruction Manual: SC-32 Sulphur System, 780-600. Leco Corporation, St. Joseph, Michigan.

Maynard, D.G. and P.A. Addison. 1985. Extraction and colorimetric determination of elemental sulphur in organic horizons of forest soils. Canadian Journal of Soil Science 65:811-813.

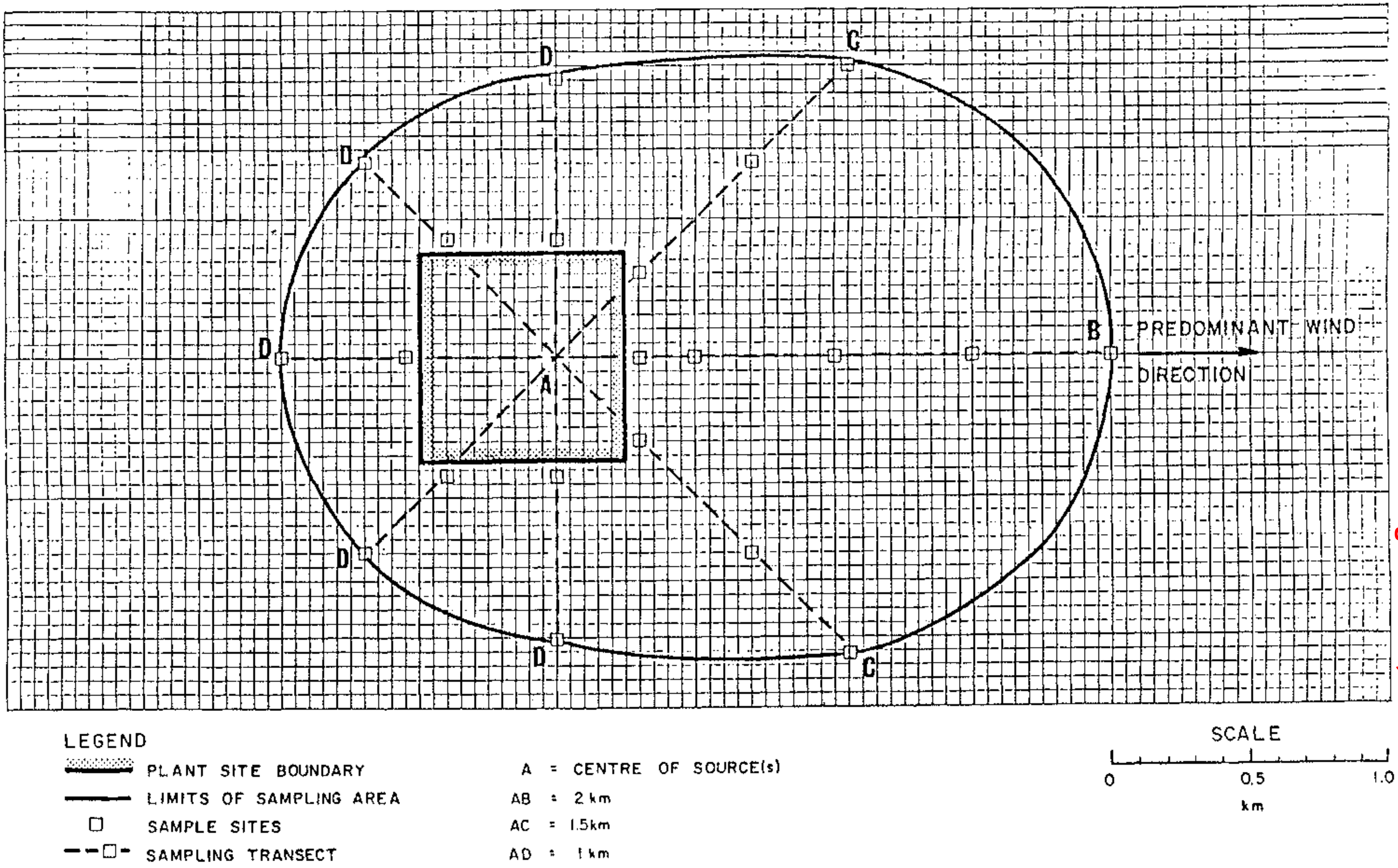
McKeague, J.A. (Editor). Manual on soil sampling and method of analysis. 2nd Edition. 1978. Prep. by the Subcommittee on Methods of Analysis of the Canada Soil Survey Committee. 212 pp.

NOTE: Water:soil extracts at 10:1 should be used to determine EC_e and SO_4 in litter and organic soil samples. 10:1 ratios should also be used for mineral soil samples if the primary objective of the analysis is to determine the actual amount of soluble salt being generated by sulphur and lime additions.

2. SOIL STANDARDS GUIDELINES

Guidelines for inclusion of standard soils with soil analyses involved in monitoring programs.

	Parameter(s) Soil	Number of Standard Soil Analyses	Comments
1.	Soil pH, Total S Elemental S, CEC	3 standard samples for first 50 or less field samples.	standards are to be included with monitoring samples by the operator.
		1 standard sample for each additional 25 or less samples.	
2.	Calcium Carbonate Equivalent, EC_e Sulphate Sulphur (SO_4)	1 standard sample for first 25 or less field samples.	standards are to be included with monitoring samples by the operator
		1 standard sample for each additional 25 or less samples.	



A = CENTRE OF SOURCE(s)
AB = 2 km
AC = 1.5km
AD = 1 km

For plants without prill towers AB and AC are 1 km

Figure 1 RADIAL TRANSECT SAMPLING DESIGN

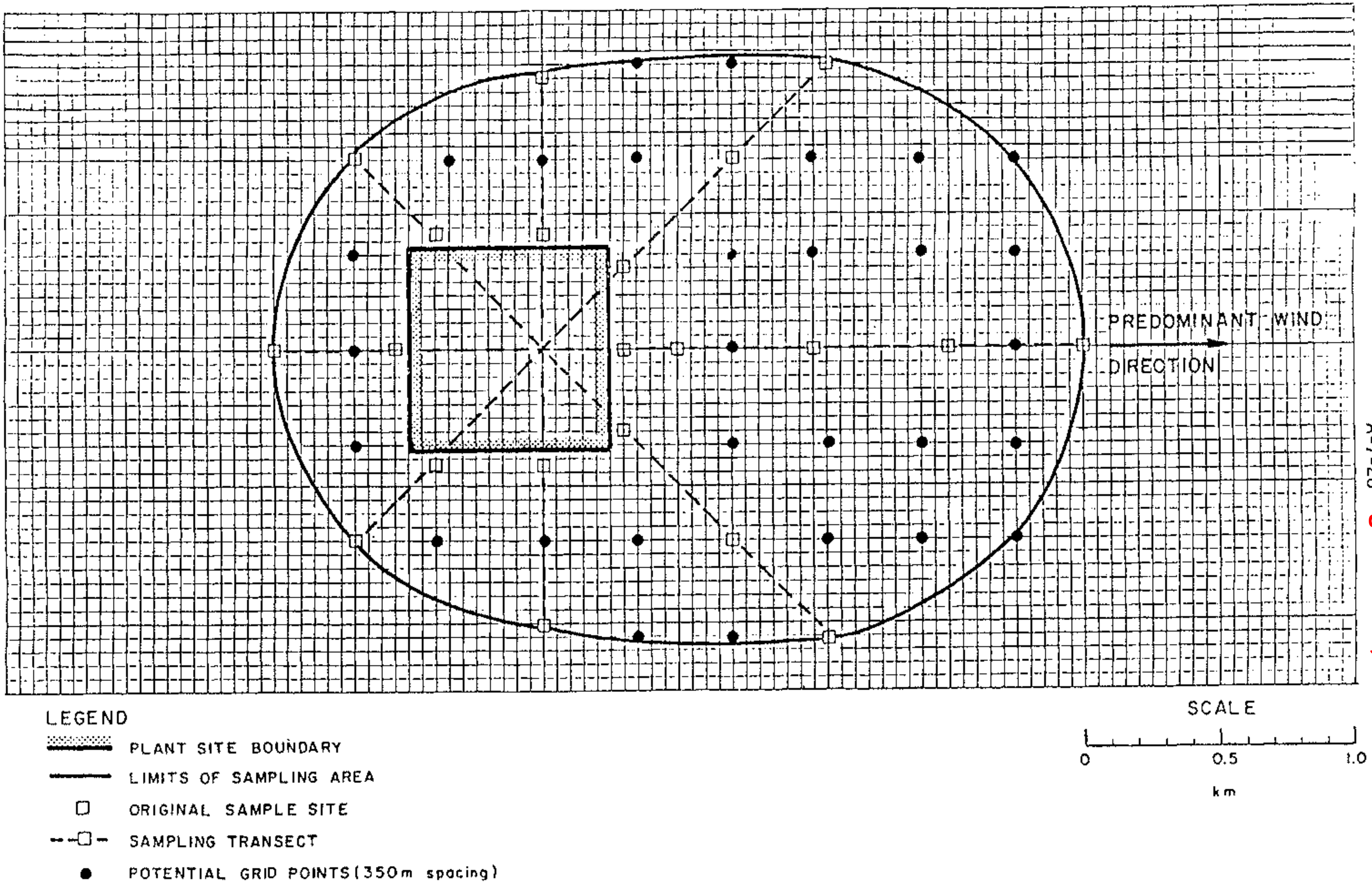


Figure 2 GRID SAMPLING DESIGN

APPENDIX A-8

A. HIGH VOLUME SAMPLING - STANDARD REFERENCE METHOD*

1. FIELD OF APPLICATION

This method is applicable to the measurement of the mass concentration of suspended particulates in ambient air. When the sampler is operated at an average flow rate of 1.06 cubic metres per minute for 24 hours, an adequate sample will be obtained even in an atmosphere having concentrations of suspended particulates as low as 1 microgram per cubic metre. If particulate levels are unusually high, a satisfactory sample may be obtained in 6 to 8 hours time or even less. For the determination of the mean concentrations of suspended particulates in ambient air, a standard sampling period of 24 hours is recommended.

2. PRINCIPLE

Air is drawn into a covered housing and through a filter by means of a high flow rate blower (See Figure 1). This allows suspended particulates having diameters of less than 100 µm, Stokes equivalent, to pass to the filter surface. Particles within the size range of 100 to 0.1 µm are ordinarily collected on glass fibre filters. The mass concentration of suspended particulates in the ambient air, expressed in micrograms per cubic metre, is calculated by measuring the mass of collected particulates and the volume of air sampled.

The weight is determined to the nearest 0.1 milligram, the flow rates are measured to the nearest 0.03 cubic metre per minute, the times are determined to the nearest 2 minutes and the mass concentrations are calculated and recorded to the nearest microgram per cubic metre.

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* Extract from Air Pollution Control Directorate, Environmental Protection Service of Environment Canada Report No. EPS-1-AP-73-2, January 1973.

3. INTERFERENCES

Particulate matter that is oily, such as wood smoke or photochemical smog, may block the filter and cause a rapid decrease in airflow at a nonuniform rate. Dense fog or high humidity can cause the filter to become too wet and severely reduce the airflow through the filter.

Glass fibre filters are comparatively insensitive to changes in relative humidity, but collected particulates can be hygroscopic (10.2).

Wherever the concentration of particulates is abnormally high, there may be loss of particulates, because of the weak adhesion of the particles to the filter.

4. FILTER MEDIA

Glass fibre filters having a collection efficiency of at least 99% for particles of 0.3 μm diameter, as measured by the DOP* test, are suitable for the quantitative measurement of concentrations of suspended particulates, although some other medium, such as paper, may be desirable for certain analyses (10.5). If a more detailed analysis is contemplated, care must be exercised to use filters that contain low background concentrations of the pollutant being measured. Careful quality control is required to determine background levels of these pollutants.

* Based upon the use of monodisperse dioctyl phthalate aerosol as the size calibrating medium.

5. APPARATUS

5.1 Sampling

5.1.1 Sampler. The sampler is composed of three parts: (i) the face plate, gasket and retaining ring, (ii) the filter adapter assembly, and (iii) the motor-fan unit. The sampler must be capable of drawing ambient air through a portion of a clean glass fibre filter, 406.5 square centimeters in area, with an actual flow rate ranging between 0.85 and 1.42 cubic metres per minute. The motor must be able to operate continuously per 24 hour periods with input voltages ranging from 110 to 120 volts, 50 - 60 Hz and must have third wire safety ground. The housing for the motor unit may be of any convenient construction as long as the assembly remains airtight and leak free. The life of the sampler motor can be extended by lowering the voltage by about 10 percent by means of a small "buck or boost" transformer between the sampler and power outlet. These brushes should be replaced before they are worn to the point where motor damage could occur.

5.1.2 Sampler shelters. It is important that the sampler be properly installed in a suitable shelter. The shelter is subjected to extremes of temperature, humidity and all types of air pollutants. For these reasons, the materials of the shelter must be chosen carefully. Properly painted exterior plywood or heavy gauge aluminum serves well. The shelter must be provided with a roof so that the filter is protected from precipitation and debris. The internal arrangement and configuration of a suitable shelter with a gable roof is shown in Figure 1. The area of clearance between the main housing and the roof at its closest point should be 580.5 ± 195.5 square centimetres. The main housing should be rectangular, with dimensions of about 29 x 36 centimetres.

5.1.3 Flow Recorder. The actual airflow through the sampler must be recorded over the entire sampling period. The method, as described in reference 10.6, is acceptable. This method involves the use of an exhaust orifice meter assembly connected through a transducer to a system for continuously recording airflow on a circular chart. The volume of air sampled is calculated by the following equation:

$$V = Q \cdot T$$

where Q = average sampling rate, m^3/min
T = sampling time, in minutes

The average sampling rate, Q, is determined from the recorder chart by estimation, if the flow rate does not vary more than 0.11 cubic metres per minute during the sampling period. If the flow rate does vary more than 0.11 cubic metres per minute during the sampling period, read the flow rate from the chart at two hour intervals and take the average.

5.1.4 Orifice calibration unit. This consists of a metal tube 7.6 cm internal diameter and 15.9 cm in length, provided with a static pressure tap 5.1 cm from one end. See Figure 2. The tube end nearest the pressure tap is flanged to about 10.8 cm in external diameter with a male thread of the same size as the inlet end of the high volume air sampler. A single metal plate, 9.2 cm in diameter and 0.24 cm thick, having a central orifice 2.9 cm in diameter, is held in place at the air inlet end with a female threaded ring. The other end of the tube is flanged to hold a loose female threaded coupling which screws on to the inlet of the sampler. An 18-hole metal plate, an integral part of the unit, is positioned between the orifice and sampler to simulate the resistance of a clean glass fibre filter. An orifice calibration unit is shown in Figure 2.

5.1.5 Differential manometer. Capable of measuring to at least 40 cm of water.

5.1.6 Positive displacement meter. Calibrated in cubic metres or cubic feet, to be used as a primary standard.

5.1.7 Barometer. Capable of measuring atmospheric pressure to the nearest millimetre of mercury.

5.2 Analysis

5.2.1 Filter conditioning equipment. Balance room or desiccator maintained at 20 to 30°C with less than 50% relative humidity.

5.2.2 Analytical balance. Equipped with a weighing chamber designed to handle unfolded filters, in size 20.3 x 25.4 cm. The balance should have a sensitivity of 0.1 milligram.

5.2.3 Light source. A table of the type used to view x-ray films is convenient.

5.2.4 Numbering device. Capable of printing identification number on the edge of the filters.

6. SAMPLING AND SAMPLES

6.1 Filter Preparation

Expose each filter to the light source and inspect for pinholes, particles or other imperfections. Filters having visible defects should not be used. A small brush is useful for removing loose particles. Equilibrate the filters in the filter conditioning environment for 24 hours. Weigh the filters to the nearest milligram and record the tare weight and filter identification number. Do not bend or fold the filter before collection of the sample.

6.2 Sample Collection

Open the shelter, loosen the wing nuts and remove the retaining ring from the filter holder. Install a weighed and numbered glass fibre filter in position with the rough side up, replace the retaining ring without disturbing the filter and fasten securely. The gasket may be sealed to the retaining plate with rubber cement or double sided adhesive tape. Undertightening will allow air leakage, overtightening will damage the sponge rubber gasket. Close the roof on the shelter. During the inclement weather, the filter holder may be removed to a protected area for filter change.

Sample for 24 hours, from midnight to midnight (standard time). Dates for which sampling is required is indicated by the NAPS schedule (see attached). On completion of sampling, record the filter identification number, location or station number, sampling time and date on a manila envelope. Any other factors that may have affected the results, such as meteorological conditions, unusual activity in the area, etc. should also be recorded here. Remove the filter retainer as described above and carefully remove the filter from the holder, touching only the outer edges. Fold the filter lengthwise so that only surfaces with collected particulates are in contact and place in a manila envelope. If the sample is defective, discard it at this time. When the margins of the sample are no longer sharply defined, the sealing gasket should be replaced. In order to obtain a valid sample, the high volume sampler must be operated with the same flow recorder and tubing that were used during its calibration.

6.3 Analysis

Refer to Method No. 25050 - March 1985. A copy of this method is included at the end of Appendix A-8 (page A-8-17).

Alternate analysis methods may be used providing that written approval has first been obtained from the Director of Standards and Approvals.

7. CALIBRATION

Before the orifice calibration unit can be used to calibrate the flow recorder, the orifice calibration unit itself must be calibrated against the positive displacement primary standard.

7.1 Orifice Calibration Unit

Attach the orifice calibration unit to the intake end of the positive displacement primary standard and attach a high volume blower unit to the exhaust end of the primary standard. Connect one end of a differential manometer to the differential pressure tap of the orifice calibration unit and leave the other end open to the atmosphere. Operate the high volume motor-blower unit so that a series of different, but constant airflows, usually six, are obtained for definite time periods. Record the reading of the differential manometer at each airflow. The different constant airflows are obtained by placing a series of load plates, one at a time, between the calibration unit and the primary standard. Placing the orifice before the inlet reduces the pressure at the inlet of the primary standard below atmosphere. A correction must be made, therefore, for the increase in volume caused by this decreased inlet pressure. Attach one end of a second differential manometer to the inlet pressure tap of the primary standard and leave the other end of the manometer open to the atmosphere. During each of the constant airflow measurements made above, measure the true inlet pressure of the primary standard with this second differential manometer. Measure the atmospheric pressure and temperature. Correct the measured air volume to true air volume as directed in Section 8.1.1, then obtain the true airflow rate, Q, as directed in Section 8.1.2. Plot the differential manometer readings of the orifice unit versus Q.

7.2 High Volume Sampler

Assemble a high volume sampler with a clean filter in place and run for at least five minutes. Attach the flow recorder and adjust to obtain a reading of 65 percent of full scale. Seal the adjusting mechanism so that it cannot be changed easily. Shut off the motor, remove the filter and attach the orifice calibration unit in its place. Operate the high volume sampler at a series of different but constant airflows, usually six. Take the readings of the differential manometer from the orifice calibration unit and record the readings of the flow recorder for each flow rate. Measure the pressure and temperature of the ambient atmosphere. Convert the differential manometer readings to cubic metres per minute, Q, then plot flow recorder readings against Q.

8. CALCULATIONS

8.1 Calibration of Orifice

8.1.1 True air volume. Calculate the air volume measured by the positive displacement primary standard, thus:

$$V_a = \frac{(P_a \quad P_m)}{P_a} \cdot V_M$$

where V_a = true volume of air at atmospheric temperature, in cubic metres

P_a = barometric pressure, in millimetres of mercury

P_m = drop in pressure at inlet to reference orifice, in millimetres of mercury

V_M = volume measured using the standard orifice, in cubic metres

Conversion factors

Inches of mercury x 25.4 = millimetres of mercury

Inches of water x 73.48×10^{-3} = inches of mercury

Cubic feet of air x 0.0283 = cubic metres of air.

8.1.2 True flow rate.

$$Q = \frac{V_a}{T}$$

where Q = flow rate of air, in cubic metres per minute
T = duration of sampling, in minutes

8.2 Sample Volume

8.2.1 Volume of air sampled. The volume of air sampled is calculated by the following equation:

$$V = Q \cdot T$$

where V = air volume sampled, m^3
Q = average sampling rate, m^3/min
T = sampling time, min.

The average sampling rate, Q is determined from the recorder chart by estimation, if the flow does not vary more than 0.11 m^3/min during the sampling period. If the flow rate does vary more than 0.11 m^3/min during the sampling period, read the flow rate from the chart at 2 hour intervals and take the average.

8.2.2 Corrections for pressure or temperature. If the pressure or temperature, during calibration or high volume sampler, is substantially different from the pressure or temperature during orifice calibration, a correction of the flow rate, Q, may be required. If the pressures differ by no more than 15 percent and the temperatures, in °C, differ by no more than 100 percent, the error in the uncorrected flow rate will be no more than 15 percent. If necessary, obtain the corrected flow rate as directed below. This correction applies only to orifice meters having a constant overflow coefficient. The coefficient for the calibrating orifice described in 5.1.4 has been shown experimentally to be constant over an operating range of 0.6 to 2.2 cubic metres per minute. Calculate corrected flow rate according to the formula:

$$Q_2 = Q_1 \left[\frac{T_2 \; P_1}{T_1 \; P_2}\right]^{1/2}$$

where Q_2 = corrected flow rate, m^3/min

Q_1 = flow rate during high volume calibration, m^3/min

T_1 = absolute temperature during orifice unit calibration, °K or °R

P_1 = barometric pressure during orifice unit calibration, in mm Hg

T_2 = absolute temperature during high volume calibration, °K or °R

P_2 = barometric pressure during high volume calibration, in mm Hg

8.3 Calculation of Mass Concentration of Suspended Particulates

$$S.P. = \frac{(W_2 - W_1)}{V} \cdot 10^6$$

where S.P. = mass concentration of suspended particulates, $\mu g/m^3$

W_1 = initial weight of filter, grams

W_2 = final weight of filter, grams

V = air volume sampled, cubic metres

10^6 = conversion factor from grams to micrograms.

Weights are determined to the nearest 0.1 milligram, airflow rates are determined to the nearest 0.03 cubic metres per minute, times are recorded to the nearest two minutes, and mass concentrations are reported to the nearest microgram per cubic metre.

9. PRECISION, ACCURACY AND STABILITY

Based upon collaborative testing, the relative standard deviation for single analyst variation, or repeatability of the method, is 3.0 percent. The corresponding value for multilaboratory variation, or reproducibility of the method, is 3.7 percent (10.3).

The accuracy with which the sampler measures the true average concentration depends upon the constancy of the rate of airflow through the sampler. The airflow rate is affected by the concentration and the nature of the dust in the atmosphere. Under these conditions, the error in the measured average concentration may be in excess of ± 50 percent of the true average concentration, depending upon the amount of reduction of airflow rate and on the variation of the mass concentration of dust with time during the 24-hour sampling period (10.4).

10. REFERENCES

10.1 Robson, C.D., and Foster, K.E. "Evaluation of Air Particulate Sampling Equipment." _Am. Ind. Hyg. Assoc. J._ 24, 404 (1962).

10.2 Tierney, G.P., and Conner, W.D. "Hygroscopic Effects on Weight Determinations of Particulates Collected on Glass-Fibre Filter". _Am. Ind. Hyg. Assoc. J._ 28, 363 (1967).

10.3 Unpublished data based on a collaborative test involving 12 participants, conducted under the direction of the Methods Standardization Services Section of the National Air Pollution Control Administration. October (1970).

10.4 Harrison, W.K., Nader, J.S., and Fugman, F.S. "Constant Flow Regulators for High-Volume Air Sampler". Am. Ind. Hyg. Assoc. J. 21, 114 - 120 (1960).

10.5 Pate, J.B., and Tabor, E.C. "Analytical Aspects of the Use of Glass-Fibre Filters for the Collection and Analysis of Atmospheric Particulate Matter." Am. Ind. Hyg. Assoc. J. 23, 144 -150 (1962).

10.6 Henderson, J.S. Eighth Conference on Methods in Air Pollution and Industrial Hygiene Studies. Oakland, California (1967).

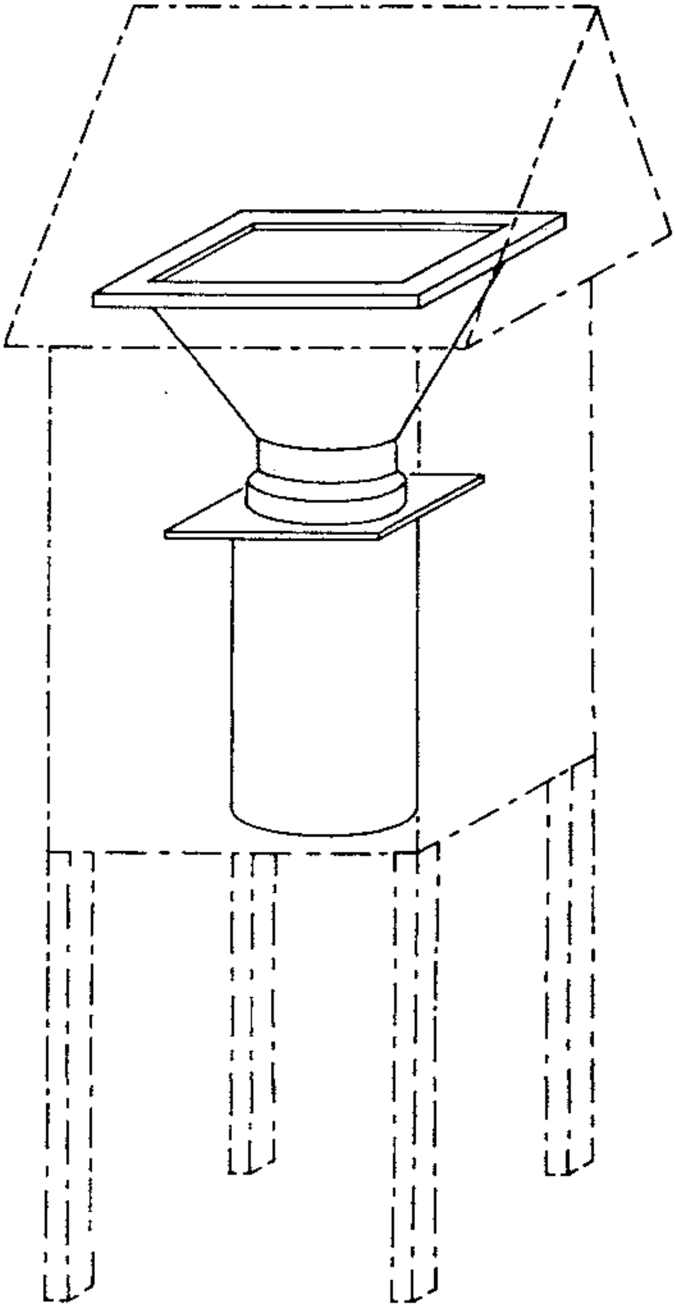

FIG. I SAMPLER AND SHELTER

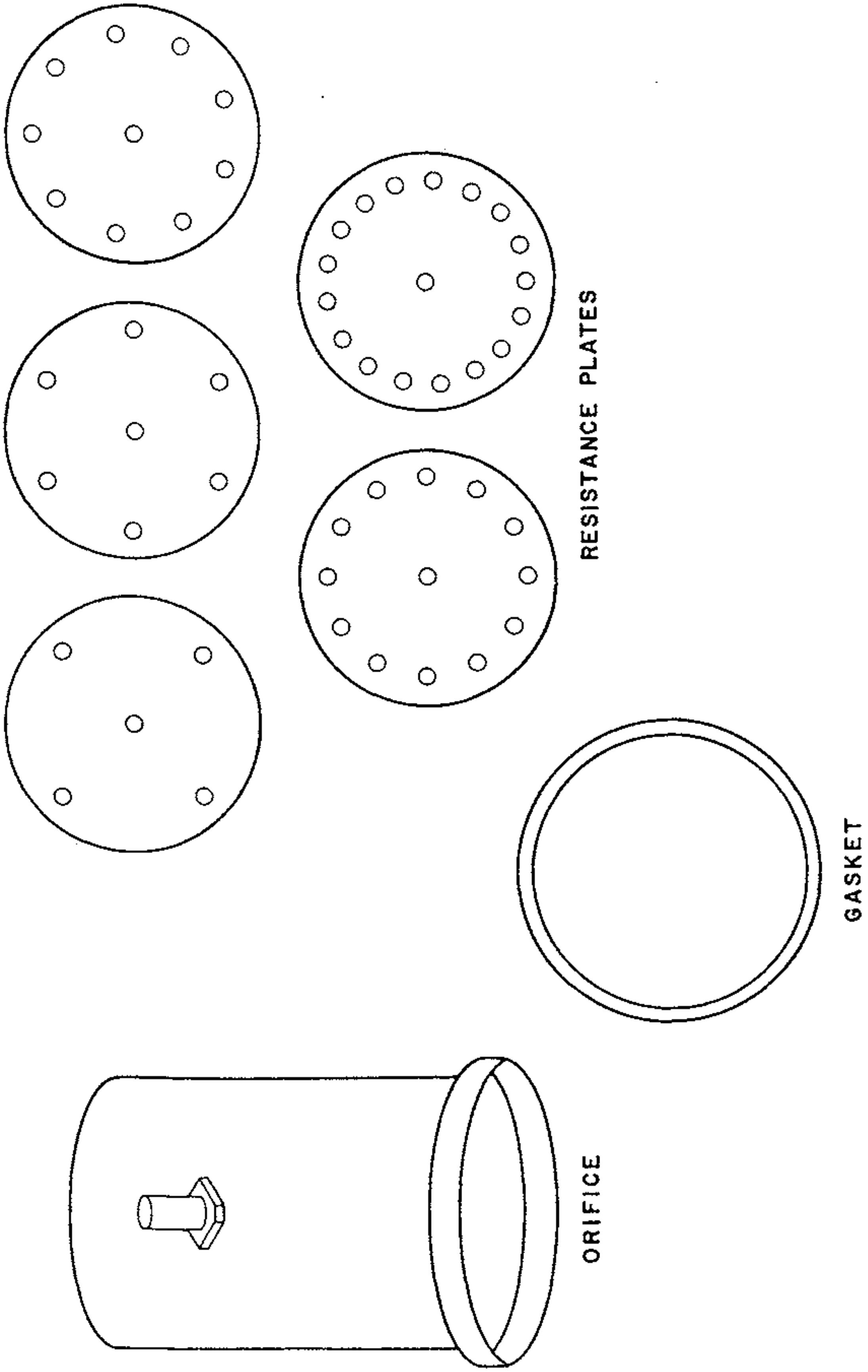

FIG. 2 ORIFICE CALIBRATION UNIT

1989 HIGH-VOLUME SAMPLING SCHEDULE
NATIONAL AIR POLLUTION SAMPLING NETWORK

SAMPLE #	DAY	SAMPLE	DAY
1	WED., JAN. 4	31	MON., JULY 3
2	TUES., JAN. 10	32	SUN., JULY 9
3	MON., JAN. 15	33	SAT., JULY 15
4	SUN., JAN. 22	34	FRI., JULY 21
5	SAT., JAN. 28	35	THUR., JULY 27
6	FRI., FEB. 3	36	WED., AUG. 1
7	THUR., FEB. 9	37	TUES., AUG. 8
8	WED., FEB. 15	38	MON., AUG. 14
9	TUES., FEB. 21	39	SUN., AUG. 20
10	MON., FEB. 27	40	SAT., AUG. 26
11	SUN., MAR. 5	41	FRI., SEP. 1
12	SAT., MAR. 11	42	THUR., SEP. 7
13	FRI., MAR. 17	43	WED., SEP. 13
14	THUR., MAR. 23	44	TUES., SEP. 19
15	WED., MAR. 29	45	MON., SEP. 25
16	TUES., APR. 4	46	SUN., OCT. 1
17	MON., APR. 10	47	SAT., OCT. 7
18	SUN., APR. 16	48	FRI., OCT. 13
19	SAT., APR. 22	49	THUR., OCT. 19
20	FRI., APR. 28	50	WED., OCT. 25
21	THUR., MAY 4	51	TUES., OCT. 31
22	WED., MAY 4	52	MON., NOV. 6
23	TUES., MAY 16	53	SUN., NOV. 12
24	MON., MAY 22	54	SAT., NOV. 18
25	SUN., MAY 28	55	FRI., NOV. 24
26	SAT., JUNE 3	56	THUR., NOV. 30
27	FRI., JUNE 9	57	WED., DEC. 6
28	THUR., JUNE 15	58	TUES., DEC. 12
29	WED., JUNE 21	59	MON., DEC. 18
30	TUES., JUNE 27	60	SUN., DEC. 24
		61	SAT., DEC. 30

B. PARTICULATE MATTER, TOTAL SUSPENDED

(Gravimetric)

(METHOD NO. 25050 - MARCH 1985)

(extracted from "Methods Manual for Chemical
Analysis of Atmospheric Pollutants 1985,"
Third Edition, Alberta Environmental Centre)

1. Introduction

Suspended particulate matter consists of inorganic and organic compounds that range in size from 0.01 µ to about 100 µ. They originate from car exhaust, burning of coal and refuse and from various industrial activities.

2. Principle

Measured volumes of air are drawn through a previously dried and weighed Teflon filter. A high volume sampler is used for this purpose. The filter is a 20 x 25 cm Teflon sheet reinforced with glass fibre which is supported on a metallic screen in the sampler. The flow rate is generally between 1.1 - 1.7 m^3/min (40 - 60 cfm). After the sampling period of 24 hours the filter is dried at room temperature and weighed. The weight of suspended particulate matter is expressed as micrograms per m^3 of air.

3. Scope

The method is applicable for the measurement of solid and liquid particulates. The detection limit is 1 µg/m^3 of air.

4. Interference

No known interferences.

5. Apparatus

a) High volume sampler (Hoskin Scientific Ltd., Montreal, or equivalent).

b) Flow chart paper and ink.

c) Analytical balance, sensitivity of 0.1 mg.

d) Teflon filter reinforced with glass fibre 20 x 25 cm (Pallflex, TM).

6. Reagents

No reagents are required.

7. Procedure

a) Sampling

i) Condition the filter overnight at room temperature and 40% humidity or dry it in a desiccator for 24 hours.

ii) Weigh the filter and record the weight on a data sheet.

iii) Place the filter on a high volume sampler. Fix a flow chart for recording air flow and sampling time. Set the timing for 24 hours sampling.

b) Analysis

i) Read the average flow rate and the time of sampling from the flow chart and record these data on the data sheet.

ii) Dry the filter at room temperature and 40% humidity or dry it in a desiccator for 24 hours.

iii) Weight the filter and record the final weight in grams.

8. Calculation

a) Calculate the total volume of air in m^3 from the flow rate and the sampling time.

b) Determine the weight of total suspended particulate matter in grams collected on the filter.

c) Calculate the concentration of suspended particulate matter as:

$$\mu g/m^3 = \frac{(W_2 - W_1) \times 10^6}{V}$$

WHERE

W_2 = final weight of the filter in grams.

W_1 = initial weight of the filter in grams.

10^6 = conversion factor to change grams to micrograms.

V = volume of air sample in m^3 = ($F \times T$).

WHERE

F = average flow rate in m^3/min.

T = sampling time in minutes.

(0.0283 = conversion factor to change ft^3 to m^3, if necessary).

9. Reference

J.L. Monkman, et.al., International J. of Environ. Anal. Chem., Vol. 2, 1972, p. 63.

C. COAL PARTICLES

(Gravimetric)

(METHOD NO. 22525 - MARCH 1985)

(extracted from "Methods Manual for Chemical
Analysis of Atmospheric Pollutants 1985,"
Third Edition, Alberta Environmental Centre)

1. Introduction

Coal particles are present in ambient air as suspended particulates matter mainly in the vicinity of coal mines.

2. Principle

The sample is collected on a glass fibre filter using a high volume sampler. The filter is dried at room temperature and weighed. A portion of the filter is heated at 500°C in a muffler furnace to a constant weight. The amount of coal particles is calculated from the difference of weights and expressed as microgram per m^3 of air.

3. Scope

The detection limit is 1 $\mu g/m^3$ of air.

4. Interference

Organic compounds interfere. A correction factor is used to eliminate this interference.

5. Apparatus

1. High volume sampler (Haskin Scientific Ltd., Montreal, or equivalent).
2. Flow-chart paper and ink.
3. Glass fibre filter, 20 x 25 cm (Gelman type A, or equivalent).

4. Circular metal punch, 46 mm diameter.
5. Analytical balance, sensitivity 0.1 mg.
6. Muffle furnace.
7. Platinum crucible.

6. Reagents

No reagents are required.

7. Procedure

a) Sampling:

1. Condition the filter overnight at room temperature and 40% humidity or dry it in a desiccator for 24 hours.

2. Weigh the filter and record the weight on a data sheet.

3. Place the filter on a high volume sampler. Fix a flow chart for recording air flow and sampling time. Set the timing for 24 hours sampling.

b) Analysis:

1. Read the average flow rate and the time of sampling from the flow chart and record this data on the data sheet.

2. Dry the filter at room temperature and 40% humidity or dry it in a desiccator for 24 hours.

3. Weigh the filter and record the weight in grams.

4. Cut 5 discs, 20%, from the filter with the metallic punch and place them in a platinum crucible.

5. Weigh the platinum crucible with the discs.

6. Heat the platinum crucible with the filter at 500° ± 10°C to a constant weight.

8. Calculation

1. Calculate the total volume of air in m^3 from the flow rate and sampling time.

2. Determine the weight of total suspended particulate matter collected on the filter paper.

3. The concentration of coal particles is expressed as

$$\mu g/m^3 = \frac{5.5\ (W_1 - W_2) \times 10^6}{V}$$

where

10^6 = conversion factor to change gram to microgram

V = volume of air in m^3 = (F x T)

where

F = average flow rate in m^3/min

T = sampling time in minutes

0.0283 = (conversion factor to change ft^3 to m^3, if necessary)

W_1 = weight of 5 discs + platinum crucible in grams

W_2 = weight of the residue left after heating at 500°C + platinum crucible in grams

The factor 5.5 refers to

1. 100% of filter (20% taken for analysis).
2. 13% of the total combustible as inorganic ash - to be added.
3. 3% of the total combustible as organics - to be deducted.

NOTE: A number of experiments at the Alberta Environmental Centre with different types of coals and high volume coal samples showed that the average inorganic residue in coal is approximately 13% of the coal-combustible, and free atmospheric organics, not associated with coal, is approximately 3% of the total combustible materials on the filter.

9. Reference

1. D.W. Koppenaal and S.E. Monahan, Environ. Sc. & Technol., Vol. 10, 1976, p. 1104.

2. ASTM, Part 26, 1977, p. 373.

APPENDIX A-9

VEGETATION FLUORIDE ANALYSIS

INTRODUCTION

Vegetation fluoride analysis is performed by Technicon AutoAnalyzer II Industrial Method #206-72A with the following modifications* as described. Method #206-72A is described on pages A-9-2 to A-9-8.

MODIFICATIONS TO METHOD #206-72A VEGETATION FLUORIDE

STEPS 3 THRU 8

A 10 gram quantity of vegetation sample is fixed with 0.5 grams of lime in the field. A separate sample is taken for moisture content. The fixed vegetation sample is transferred with deionized water to a large nickel crucible and dried overnight at 105°C. The sample is then put into a cold furnace and brought slowly up to 600°C and ashed for two hours. During the ashing the crucibles are intermittently removed from the furnace and the samples are ground in the crucible.

After ashing the samples are fused at 600°C with 8 grams of NaOH for 7 to 10 minutes.

STEP 9

After the crucibles are removed form the furnace a small amount (10 - 15 mls) of deionized water is added to the crucible to soften the mixture. After the crucibles have cooled down to room temperature the contents are transferred to a 200 ml volumetric flask and diluted to 200 mls with deionized water.

STEP 12

A 3.0 ppm standard is recommended for instrument calibration.

OPERATING NOTES

STEP 2

The fluoride content is based on ppm dry fluoride:

$$\text{ppm F dry} = 100/(100 - \%\ \text{moisture}) \times \text{ppm F wet}$$

*Alberta Research Council - Industrial Services Laboratory

TECHNICON AUTOANALYZER^{TM} II | METHOD
SAMPLER IV

Industrial Method No. 206-72A | Revised August, 1978

FLUORIDE IN PLANT TISSUES

RANGE: 0.06 - 3.0 µg/ml

GENERAL DESCRIPTION

This automated procedure for the determination of fluoride in manually prepared plant tissue samples is based upon the distillation of hydrogen fluoride and subsequent reaction of the distillate with alizarin fluorine blue-lanthanum reagent to form a lilac-blue complex which is measured colorimetrically at 620 mm[1].

Silicate, chloride, nitrate and sulfate ions in high concentrations can be distilled with fluoride ion and will interfere with the analysis by bleaching the alizarin fluorine blue-lanthanum reagent.

PERFORMANCE AT 30 SAMPLES PER HOUR

Sensitivity at 3.0 µg/ml	0.21
Coefficient of Variation at 2.4 µg/ml	± 0.68%

REAGENTS

Unless otherwise specified, all chemicals should be of ACS grade or equivalent.

LIST OF RAW MATERIALS

Sulfuric Acid, Concentrated (H_2SO_4)
Brij-35, 30% Solution * (Technicon No. T21-0110)
Sodium Acetate ($NaC_2H_3O_2.3H_2O$)
Glacial Acetic Acid (CH_3COOH)
Ammonium Hydroxide (NH_4OH)
Alizarin Fluorine Complexone
[$C_{14}H_7O_4.CH_2N(CH_2COOH)_2$]**
Lanthanum Nitrate [$La(NO_3)_3.6H_2O$]
Acetone, Analytical Grade (CH_3COCH_3)
t-Butyl Alcohol [$(CH_3)_3COH$]
Tetrasodium Ethylenediaminetetraacetate [$(NaOCOCH_2)_2N(CH_2)_2$-$N(CH_2OCONa)_2$]
Sodium Fluoride (NaF)
Sodium Hydroxide (NaOH)
Perchloric Acid, Concentrated ($HClO_4$)

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[1] Tentative Method of Analysis for Fluoride Content of the Atmosphere and Plant Tissue (Semiautomated Method), Health Lab. Sci., Vol. 6, No. 2.

* Registered trademark of Atlas Chemical Industries, Inc.

** A suitable grade was obtained from K & K Labs, 121 Express St., Plainview, N.Y. 11803 (Catalogue No. 3429).

REAGENT MAKE-UP

SULFURIC ACID, CARRYING SOLUTION

Concentrated Sulfuric Acid	500	ml
Distilled water	500	ml

Preparation

Carefully add 500 ml of concentrated sulfuric acid to 500 ml of distilled water. Mix and cool to room temperature before use.

DILUENT

Stock standard, 100 µg/ml (Preparation for this reagent given under STANDARDS)	3.0	ml
Brij-35*	0.5	ml
Distilled water	1000	ml

Preparation

Add 3.0 ml of stock standard and 0.5 ml of Brij-35 to one litre of distilled water and mix.

ACETATE BUFFER

Sodium Acetate	60	g
Glacial Acetic Acid	100	ml
Distilled Water	1000	ml

Preparation

Dissolve 60 g of sodium acetate in 500 ml of distilled water. Add 100 ml of glacial acetic acid and dilute to one litre with distilled water.

ALIZARIN FLUORINE COMPLEXONE STOCK SOLUTION, .01 M

Alizarin Fluorine Complexone	0.96	g
Concentrated Ammonium Hydroxide	2	ml
Glacial Acetic Acid	2	ml
Distilled Water, q.s.	250	ml

Preparation

Suspend 0.96 g of alizarin fluorine complexone in 100 ml of distilled water. Add 2 ml of concentrated ammonium hydroxide and shake until the dye has completely dissolved. Add 2 ml of glacial acetic acid and dilute to 250 ml with distilled water. Store in an amber bottle at 4°C.

LANTHANUM NITRATE STOCK SOLUTION

Lanthanum Nitrate	1.08	g
Distilled Water, q.s.	250	ml

Preparation

Dissolve 1.08 g of lanthanum nitrate in 100 ml of distilled water. Dilute to 250 ml with distilled water. Store at 4°C.

ALIZARIN REAGENT

Acetate Buffer	300	ml
Acetone	150	ml
Tertiary Butyl Alcohol	50	ml
Alizarin Fluorine Complexone Stock	36	ml
Lanthanum Nitrate Stock	40	ml
Brij-35	2	ml
Distilled Water, q.s.	1000	ml

Preparation

Mix in the following order: 300 ml of acetate buffer, 150 ml of acetone, 50 ml of tertiary butyl alcohol, 36 ml of alizarin fluorine complexone, 40 ml of lanthanum nitrate and 2 ml of Brij-35. Dilute to one litre with distilled water. De-gas the reagent by placing under vacuum (10 psi) for two minutes. Prepare fresh daily.

EDTA REAGENT, 1% w/v

Tetrasodium Ethylenediaminetetraacetate	10.0	g
Distilled Water, q.s.	1000	ml

Preparation

Dissolve 10.0 g of tetrasodium ethylenediaminetetraacetate in distilled water and dilute to one litre. Take to pH 10 with EDTA.

STANDARDS

STOCK STANDARD, 100 ug F/ml

Sodium Fluoride	0.221 g
Distilled Water, q.s.	1000 ml

Preparation

Dissolve 0.221 g of sodium fluoride in distilled water and dilute to one litre. Store in a polyethylene bottle and refrigerate.

SAMPLE PREPARATION

1. If it is desirable to determine only fluoride which has been absorbed by plant tissues, freshly harvested tissues should be washed to remove surface contamination. The plant tissues are washed in a solution of 0.05% Alconox*** and 0.05% tetrasodium ehtylenediaminetetraacetate (Na_4EDTA) in a polyethylene container for 30 seconds with gentle agitation. The tissue is removed and allowed to drain for a few seconds and is then rinsed for 10 seconds in each of three beakers of deionized water.

2. Dry fresh plant tissues in a forced-draft oven at 80°C for 24 - 48 hours.

3. Grind dried tissues in a semi-micro Wiley mill to pass a 40-mesh sieve. Place ground tissues in clean bottles and cap.

4. Mix the dried samples thoroughly and carefully weigh from 0.1 to 2.0 g of plant tissues, depending on the fluoride content, into clean crucibles (nickel, inconel or platinum, 40 ml capacity).

5. Add (100 ± 10) mg of calcium oxide, sufficient distilled water to make a loose slurry and 2 drops of phenolphthalein. Mix thoroughly with a polyethylene policeman. The final mixture will be a uniform red color and will remain red during evaporation to dryness.

6. Place crucibles on a hot plate and under infrared lamps (do not turn on hot plate) until all liquid is evaporated. Turn on hot plate and char samples for 1 hour.

7. Transfer crucibles to a muffle furnace at 600°C and ash for 2 hours.

   CAUTION: TO AVOID FLAMING, PLACE CRUCIBLES AT FRONT OF MUFFLE FURNACE WITH DOOR OPEN FOR ABOUT 5 MINUTES TO FURTHER CHAR SAMPLES. CRUCIBLES MAY THEN BE POSITIONED IN THE FURNACE.

8. After ashing, remove crucibles (not more than eight at one time). Add (3.0 ± 0.1) g of sodium hydroxide pellets, and replace in the furnace with door closed for 3 minutes.

   CAUTION: WATCH OUT FOR "CREEPING" OF THE MOLTEN NaOH.

   Remove crucibles one at a time and swirl to suspend all particulate matter until the metal is partially solidified. Allow crucibles to cool until addition of a small amount of water does not cause spattering. Wash down inner walls of crucibles with 10 - 15 ml of distilled water.

9. After crucibles have cooled to room temperature, suspend the melts with a polyethylene policeman and transfer to plastic tubes graduated at 50.0 ml with distilled water. Rinse crucibles with 20.0 ml of 50% v/v perchloric acid solution and add to the tubes. Dilute samples to 50.0 ml with distilled water.

10. Cleaning of crucibles: crucibles should be cleaned as soon as possible after use. Inconel crucibles are boiled in 10% w/v sodium hydroxide solution for 1 hour. Follow by washing with hot water and detergent and rinse throughly with distilled water. Crucibles which held samples containing more than 100 µg of fluoride should be immersed in 4N HCl for 45 minutes before boiling in NaOH.

OPERATING NOTES

1. Since the air which is swept through the micro-distillation unit is taken from ambient atmosphere, airborne contaminants in the laboratory may contaminate samples. If this is a problem, a small drying bulb filled with calcium carbonate can be attached to the air inlet tube of the micro-distillation unit.

2. The fluoride content of the sample in µg/ml is as follows:

$$F_T = \frac{F_S V_S D}{W_S}$$

Where

F_T = µg/ml of fluoride in sample.

F_S = µg of fluoride/ml of unknown sample as taken from calibration curve.

V_S = volume in ml of the unknown sample (usually 50 ml).

D = dilution factor used when fluoride in unknown sample exceeds the standard curve.

W_S = weight of sample taken for analysis in grams.

3. It is necessary to maintain a continuous flow of cooling water to the condensers. Tap water is usually adequate. The use of a pressure regulator is recommended.

4. Adjust the vacuum gauge to read 10 inches Hg.

5. When shutting down the system, the following operations should be carried out in the order listed:

   a) Place the sulfuric acid line in deionzied water.
   b) Place the alizarin fluorine complexone-lanathanum reagent line in 0.01% tetrasodium EDTA solution for 1 minute. Transfer the line to distilled water and allow water to pass through the analytical system for 5 minutes.
   c) After use with samples containing particulate matter, the Teflon distillation coil should be cleaned out by connecting a length of standard transmission tubing from the air inlet of the micro-distillation device to a 0.01% tetrasodium EDTA solution. When all particulate matter is removed form the coil, wash briefly with distilled water.

6. Very large amounts of solid matter in the prepared sample will retard distillation. Accordingly, the smallest sample of vegetation consistent with obtaining a suitable amount of fluoride should be used.

7. If samples exceed the standard curve, dilutions should be made using a solution continuing 20 ml of concentrated perchloric acid and 6 g of sodium hydroxide per 100 ml.

8. Occasionally, recovery of fluoride added to samples should be determined. Low values indicate a loss of fluoride possibly during pretreatment; high values indicate contamination.

9. Two blank determinations (beginning with sample preparation) should be made with every batch of samples analyzed (approx. two for every forty samples determined). Blank values over 5 µg of fluoride are considered evidence of contamination, from equipment used in sample preparation.

10. Different amounts, 0.1 - 2.0 g of plant sample continuing 50 - 65 µg/ml of fluoride should be analyzed occasionally. A linear relationship should exist between the fluoride found and the amount of tissue taken. A non-linear relationship may indicate that some component of the tissue is retarding distillation or interfering with color development.

11. Absorbence of reagent baseline with respect to water is 0.30.

12. The use of multiple working standards is only to establish linearity. For day-to-day operation, the 1.8 µg/ml standard is recommended for instrument calibration.

13. All connections in the vacuum distillation apparatus should be as tight as possible, as leaks will cause noisy system performance. Make sleeves of 1/8 x 1/4 acidflex and place them at the bases of the plastic hypodermic needles. They will seal the needles against the plastic connectors. allowing for a good vacuum.

14. A phasing problem may occur at the A10 fitting where the alizarin reagent is added. If the segmenting air bubble is directly over the A10 side arm at the time a Pump III roller releases from the platen, a small extraneous bubble may be injected. This can result in a 5-6% noise level. Insert a small length of 0.073" transmission tubing in front of the A10 to shift the time at which the bubble pauses.

15. The quality of alizarin fluorine complexone is crucial to good performance. It may be necessary to check several suppliers to find an acceptable grade of reagent.

APPENDIX A-10

QUALITY ASSURANCE OF CONTINUOUS
AMBIENT MONITORING SYSTEMS

QUALITY ASSURANCE OF CONTINUOUS AMBIENT MONITORING SYSTEMS

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QUALITY ASSURANCE OF CONTINUOUS AMBIENT MONITORING SYSTEMS

1. AMBIENT AIR MONITORING

1.1 Methods for the Measurement of Ambient Air Pollutants

The typical methods used for the measurement of ambient air pollutants are summarized in Table 1.

1.2 Acceptable Performance Specifications for Monitors

The typical performance specifications for air monitors are tabulated in Table 2. The performance parameters are defined below:

Minimum Detection Limit - the lowest concentration that can be detected with confidence. It is typically defined as two times the noise level.

Precision - the degree of agreement between repeated measurements of the same pollutant concentration by an instrument, expressed as a standard deviation about the mean over a period of seven or more days. (This can be determined by statistically reviewing span check data over a period of seven or more days.)

Linearity - the maximum deviation within the measurement range, usually expressed as a percentage of full scale.

Zero Drift - the maximum deviation of the response to zero air, usually over a 24 hour period.

Span Drift - the percentage change in response to an up-scale pollutant concentration in a continuous, unadjusted operation, usually over a 24 hour period.

Table 1

METHODS FOR THE MEASUREMENT OF AMBIENT AIR POLLUTANTS

Pollutant	Principle of Measurement
Sulphur dioxide (SO_2)	1. pulsed fluorescence 2. coulometric titration 3. flame photometry
Hydrogen sulphide (H_2S)	1. fluorescence after thermal oxidation 2. coulometric titration 3. flame photometry
Nitric oxide (NO)	chemiluminescence
Nitrogen dioxide (NO_2)	chemiluminescence after conversion to NO
Ozone (O_3)	1. chemiluminescence 2. ultraviolet (UV) photometry
Carbon monoxide (CO)	1. nondispersive infrared spectroscopy 2. gas-filter correlation
Total hydrocarbons (organics)	flame ionization
Ammonia (NH_3)	catalytic thermal oxidation followed by NO measurement
Suspended particulates	1. high volume air sampling 2. sample collection by dichotomous sampler
Smoke, haze	light transmission of filter paper soiled by fine suspended particulates (coefficient of haze)

Table 2

TYPICAL PERFORMANCE SPECIFICATIONS FOR AIR MONITORS[1]

PERFORMANCE PARAMETER	POLLUTANT						
	Carbon Monoxide	Total Hydrocarbons	Ozone	Oxides of Nitrogen	Sulphur Dioxide	Hydrogen Sulphide	Ammonia
Minimum Detectable Limit	0.1 ppm	0.1 ppm	0.002 ppm	0.005 ppm	0.002 ppm	0.0025 ppm[5]	0.01 ppm
Precision[2]	± 0.1 ppm	± 2% F. S.	± 0.002 ppm	± 0.002 ppm	±0.001 ppm	± 0.001 ppm	± 0.01 ppm
Linearity	1% F. S.	1% F. S.	± 0.001 ppm	1% F. S.	1% F. S.	1% F. S.	1% F. S.
Zero Drift[3]	± 0.2 ppm	± 1% F. S.	<0.5% F. S. per month	± 0.002 ppm	± 0.003 ppm	± 0.003 ppm	± 0.002 ppm
Span Drift[3]	± 1% F. S.	± 1% F. S.	± 1% F. S. per month	± 1% F. S.	± 1% F. S.	± 1% F. S.	± 1% F. S.
Interference Equivalent	200,000:1[4]	<0.01 ppm			<0.012 ppm	<0.012 ppm	
Noise	± 0.05 ppm	±0.5% F. S.	± 0.001 ppm	± 0.002 ppm	± 0.001 ppm	± 0.001 ppm	± 0.002 ppm
Operating Temperature Range	10° - 40°C	10° - 40°C	10° - 40°C	10° - 40°C	10° - 40°C	10° - 40°C	10° - 40°C
Ranges	50 ppm	10 ppm 20 ppm 50 ppm	0.5 ppm 1.0 ppm 2.0 ppm 5.0 ppm 10.0 ppm	0.5 ppm 1.0 ppm 5.0 ppm	0.5 ppm 1.0 ppm 5.0 ppm	0.1 ppm 0.5 ppm 1.0 ppm 5.0 ppm	1.0 ppm 2.0 ppm 5.0 ppm 10.0 ppm

[1] concentration measured at STP (25°C, 750 mm Hg)
[2] F.S. = full scale
[3] per 24 hours unless otherwise specified
[4] rejection ratio for carbon dioxide and water
[5] a minimum detection limit of 0.001 ppm is achievable with some H_2S

Interference Equivalent - positive or negative response caused by a substance or substances (the sum of which is sometimes taken) other than the one being measured, at a concentration substantially higher than that normally found in the ambient air.

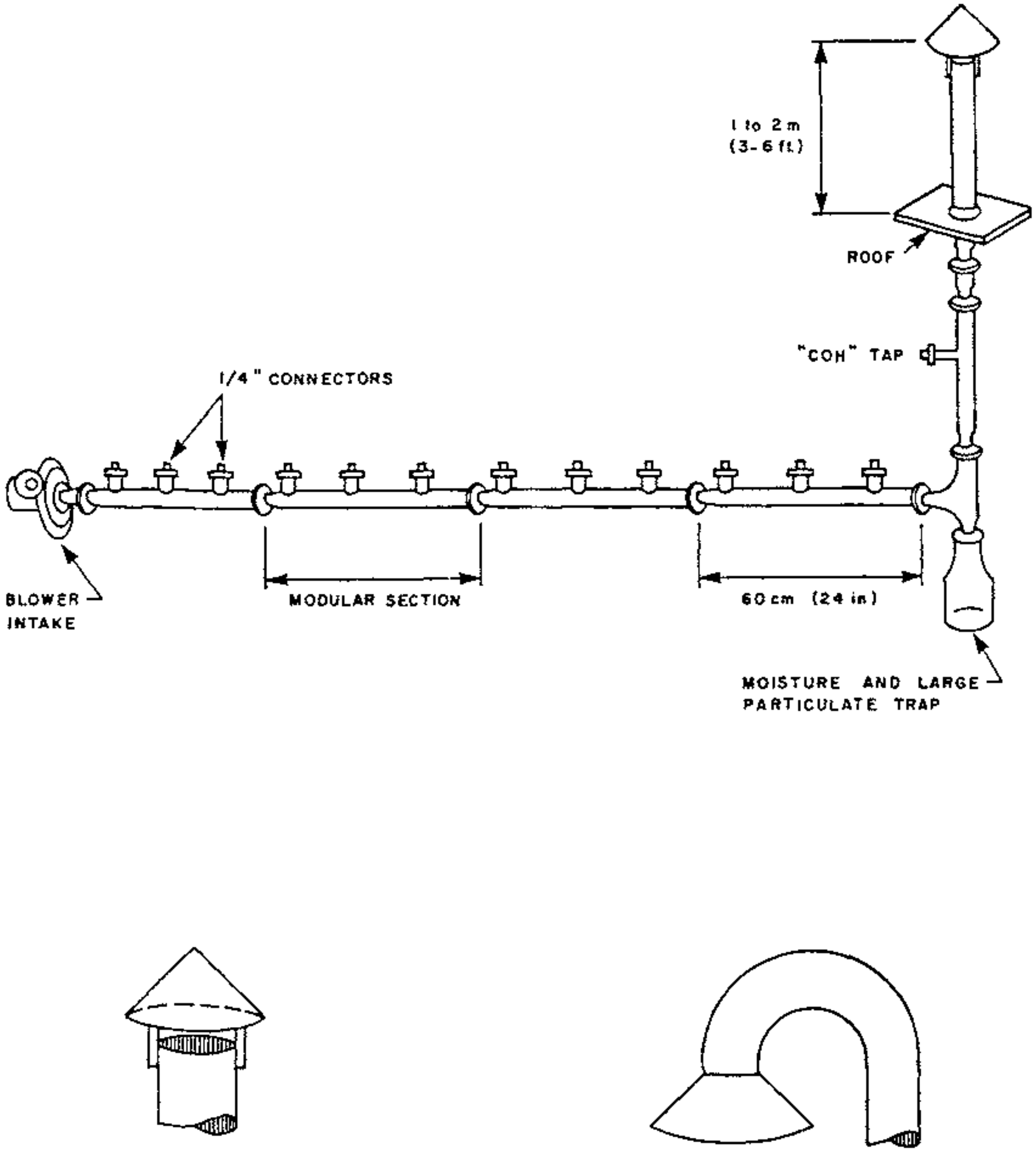
Noise - the spontaneous, short duration deviations in output from the mean response, which is independent of the input concentration, determined as the standard deviation about the mean.

Operating Temperature Range - the ambient temperature range within which the analyzer is capable of producing quality data.

Ranges - the available ranges which correspond to the full scale output of the instrument.

1.3 Typical Design of a Manifold

A typical design of a manifold is illustrated in Figure 1



VERTICAL INLET

INVERTED "U" BEND INLET

BOTH VERTICAL AND INVERTED "U" BEND SAMPLING INLETS ARE ACCEPTABLE.

Figure 1 TYPICAL DESIGN OF A MANIFOLD

1.4 Acceptable materials for Sampling

The acceptable materials for the construction of sampling lines and/or manifolds are tabulated in Table 3.

Table 3

POLLUTANT	MATERIAL							
	PVC	Nylon	Teflon	Glass	Aluminium	Brass	Copper	316 Stainless
H_2S			X	X				X
SO_2			X	X				X
CO	X	X	X	X	X	X	X	X
THC	X	X	X	X	X	X	X	X
$NO-NO_x-NO_2$			X	X				X
O_3			X	X				X
NH_3			X	X				X[1]
HCl			X	X				
COH	X	X	X	X				

[1] heat traced to minimize adsorption

X-acceptable

1.5 Flow Measurements and Corrections

One of the largest sources of error in any dilution calibration stems from improperly calibrated or improperly corrected flow measuring systems. All flow measurements must be corrected to Standard Temperature and Pressure. This is normally referred to as STP.

Standard Temperature = + 25°C

Standard pressure = 760 mm Hg

1.5.1. Bubble Flowmeter

The bubble flowmeter technique is an absolute method of measuring the mass flow of gases. In order to measure mass flow in standard cubic centimeters per minute, the volume flow must be corrected for temperature, atmospheric pressure, and the vapour pressure of water.

Correction is made using the following equation:

$$\text{Mass Flow (Standard cc/min)} = \frac{\text{Vol (cc)}}{\text{Time (min)}} \times \frac{(P - Pv)}{760} \times \frac{298}{(273 + T)}$$

WHERE

P = atmospheric pressure (mm of Hg)

Pv = vapour pressure of water (mm of Hg) at T°C, see table included

T = temperature of gas (°C)

TABLE OF VAPOUR PRESSURE OF WATER (P_V)

°C	Inches Hg	mm Hg	°C	Inches Hg	mm Hg
15	.50	12.79	24	.88	22.38
16	.54	13.63	25	.94	23.76
17	.57	14.53	26	.99	25.21
18	.61	15.48	27	1.05	26.74
19	.65	16.48	28	1.12	28.35
20	.69	17.54	29	1.18	30.04
21	.73	18.65	30	1.25	31.82
22	.78	19.83	31	1.33	33.70
23	.83	21.07	32	1.40	35.66

1.5.2 Linear Mass Flowmeters

Although linear mass flowmeters are generally very stable, it is desirable that calibration checks be performed periodically. The unit should be checked at several points over its full range using a bubble flowmeter. Particulates carried into the flowmeter by the gas stream will result in inaccuracy or at worst, clogging of the sensor, therefore the best method of ensuring that the flowmeter remains stable and accurate is to provide good flow filtration.

1.5.3 Rotameter

In order to measure mass flow using a rotameter, the volumetric flow must be corrected for both temperature and atmospheric pressure. Equation for correction of volumetric to mass flow is:

$$F_{STP} = F_{AMB} \times \frac{P_A}{760} \times \frac{298}{T_A}^{1/2}$$

WHERE:

F_{STP} = mass flow at STP, which is ambient volumetric flow corrected for temperature and pressure.

F_{AMB} = flow, for a given float ball position, as read from the manufacturer's curve.

P_A = ambient barometric pressure. (mm of Hg)

T_A = ambient temperature (°K).

The rotameter is a moderately accurate, rugged, field portable measuring device. Since air density will affect the accuracy of the unit, it is essential that STP corrections be applied to all flow measurements.

Accuracy is affected by build-up of contaminants on both the walls of the tube and the indicator ball. Therefore, some effort should be made to eliminate particles from the air stream. Rotameters can be cleaned be running methanol through the unit. Rotameters should be cross-checked using a bubble flowmeter or mass flowmeter approximately every 6 months.

1.5.4 <u>Capillary and Orifice Systems</u>

Capillary and orifice based calibration systems use a set of flow restrictors and a corresponding set of pressure differential versus flow curves to give a predetermined flow. Because of the high sensitivity to the diameter of the restrictor (proportional to the 4th power), and variances in the repeatability of pressure guages, the accuracy of these systems generally leaves much to be desired. Therefore, flows should be cross-checked more frequently than any other system. If this system is used to generate a calibration standard, the flow system should be used only to maintain a constant flow. The flow measurement should be done with either a bubble flowmeter or a mass flowmeter.

1.6 Calibration Procedures, Calculations and Acceptance Limits

1.6.1 Purpose of Calibration

The purpose of a calibration is two-fold; first to standardize the data that will be gathered in the month following the calibration, and second, to act as a reference relative to the previous monthly calibration.

1.6.2 Calibration Procedure - General (Figure 2)

The calibration should be performed in the following manner:

1. Calibration gas is introduced to the analyzer through the sample port. The sample inlet filter is changed before the calibration is performed.

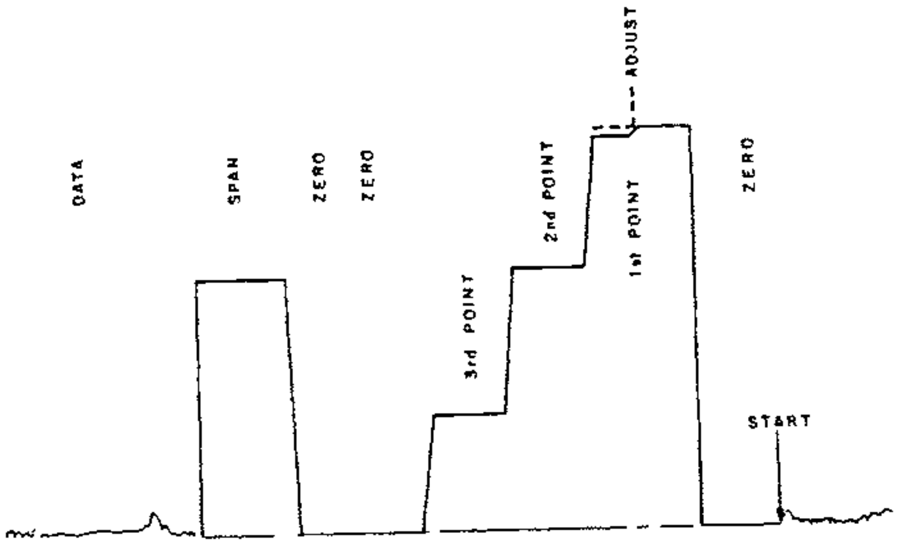
2. Zero the instrument using calibrator zero air, allow sufficient settling time. Adjust if necessary. Each measurement (response) must demonstrate at least 20 minutes of stable response.

3. Set the calibrator for the highest point to be calibrated. Observe the response, note change from the previous calibration on the report. Adjust the analyzer to the correct reading, since this is the point of maximum relative accuracy. Note, after the initial settling time, demonstrate the stable response for 20 minutes. Do not make any SPAN changes after the first calibration point.

4. Set the calibrator for the second point; demonstrate the stable response for 20 minutes, record data.

5. Set the calibrator for the lowest point, follow the same procedure as before.

FIGURE 2 ILLUSTRATION OF CALIBRATION STEPS



6. Zero the instrument on calibrator zero air. This should result in the same value as step 2.

7. Zero the instrument on Zero-Span source zero air.

8. Span the instrument using the Zero-Span source. This will standardize the span gas concentration.

All flows must be corrected to STP conditions which are 760 mm Hg and 25°C.

1.6.3 Primary Standard Gases

Primary standard gases which are of unquestionable accuracy are standards certified by the National Bureau of Standards in Washington, D. C. Primary standards are available from NBS. The primary standard is usually an order of magnitude more accurate than a secondary standard which is normally used for routine calibration. In all cases, it is the responsibility of the user to ensure that standard gases are accurate and uncontaminated.

1.6.4. Secondary Standard Gases

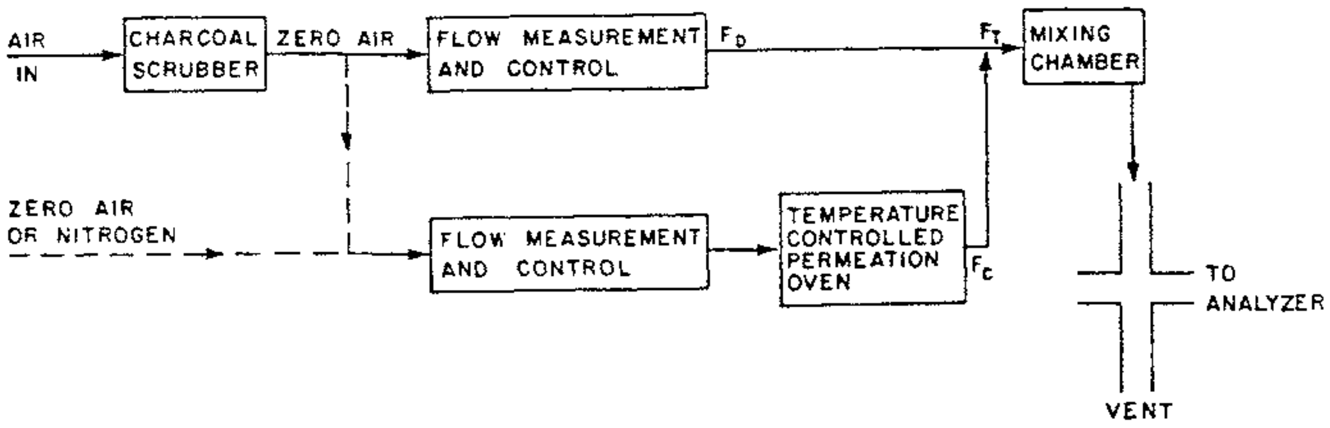
Secondary standards must be traceable back to a proven primary standard. It is the responsibility of the user to ensure the accuracy of all standards used. Commercial secondary standards should be cross-checked in order to verify certification and long-term stability.

A secondary standard certification can be derived for a permeation device by cross-comparison to a NBS standard or by gravimetric determination.

1.6.5 Dynamic Calibration Using a Permeation Device (Figure 3)

A permeation device is a sealed ampule, whose walls are permeable to the vapour of the chemical compound it contains. The compound is held in liquid/vapour phase equilibrium, inside the ampule.

FIGURE 3 PERMEATION TUBE CALIBRATION SYSTEM



At a given temperature, the device provides a constant flow of its compound into the carrier gas stream. The permeation rate of the device is highly temperature dependent, and requires temperature control in the order of ± 0.05°C at 30°C.

For this reason a calibrator being moved from location to location must be kept operational in transit. This can be accomplished by using an inverter. Another option is to let the calibrator stablize at the site where the calibration will take place. Stablilization time should be in the order of several hours, and the calibrator should be purged at all times to eliminate accumulation of permeated gases in the oven chamber.

The accuracy of a calibration using a permeation device is dependent upon control of the following parameters:

1. Permeation rate must be a known quantity.
2. Oven temperature.
3. Quality of dilution air.
4. Dilution flow must be accurately measured and corrected to STP conditions.

The degree to which each parameter is controlled will have a direct bearing on the accuracy of the calibration. The permeation rate of a device can be determined using the following methods:

1. Gravimetric determination - measuring weight loss of a device per unit time.
2. Comparison to a known standard.
3. Wet chemical analysis.
4. Using manufacturers stated permeation rate on certified devices.

1.6.5.1. Calculation

Permeation rate in nanograms/minute is calculated using the following expression:

$$P_T = \frac{FC}{Km}$$

WHERE

P_T = permeation rate in nanograms/minute at T°C

F = flow rate in cc/min. at STP

C = concentration in PPM (Vol.)

$Km = \text{molar constant} = \frac{24.46}{\text{Mol. Wt.}}$

WHERE 24.46 is the ideal gas molar volume in litres at STP.

Km can also be expressed as

$$Km = \frac{1}{\text{molecular density}}$$

$$\text{where molecular density} = \frac{\text{molecular weight}}{\text{molecular volume}}$$

with a known permeation rate:

Concentration in ppm = $(P_T \times K_m)/F$

TABLE OF MOLECULAR WEIGHTS AND CONSTANTS AT STP

GAS	FORMULA	MOL. WT.	Km
Ammonia	NH_3	17.03	1.439
Carbon Disulphide	CS_2	76.13	0.322
Carbonyl Sulphide	COS	60.07	0.408
Chlorine	Cl_2	70.91	0.346
Hydrogen Sulphide	H_2S	34.08	0.719
Methyl Mercaptan	CH_3SH	48.10	0.509
Nitrogen Dioxide	NO_2	46.01	0.532
Sulphur Dioxide	SO_2	64.07	0.382

1.6.5.2. Procedure

Perform flow checks, electronic calibration, or converter temperature checks before proceeding. Change sample inlet filter.

1. Calculate points to be introduced to the analyzer with a fixed permeation rate, as follows:

   1st point 50 to 80% or more of full scale
   2nd point 25 to 40% of full scale
   3rd point 10 to 20% of full scale

   The above values are suggested values and are not mandatory.

2. Follow the calibration procedure outlined for dilution calibrations (Section 3.6).

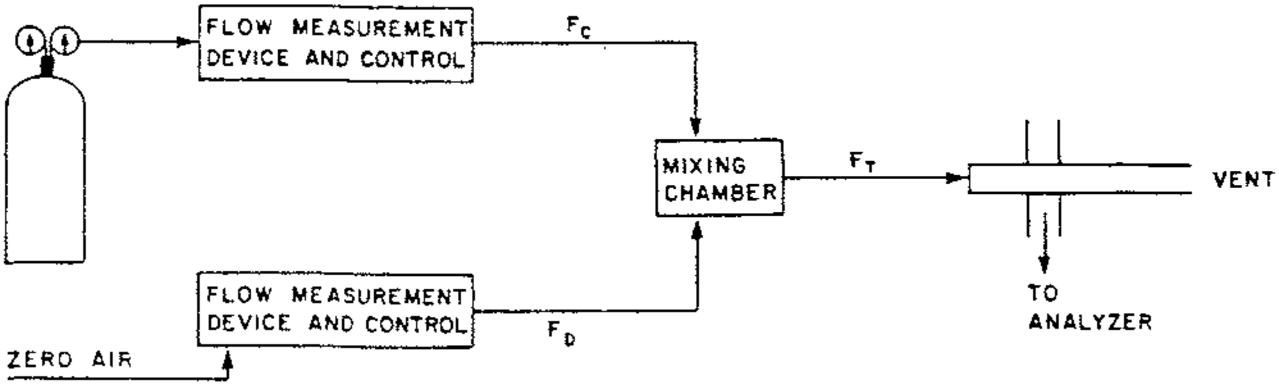
1.6.6 Dilution Calibration (Figure 4)

This section deals with calibrations where the calibration gas is derived from a compressed gas cylinder. Concentrations of compressed gases generally fall in the 5 ppm to 200 ppm range. This method is capable of providing accurate calibrations with dilution ratios from 100 to 1500. Dilution ratios larger than 1500 are better achieved with a two stage dilution system. The accuracy of the calibration is directly dependent upon the accuracy of flow measurements and corrections applied to those flows.

Flow measurement devices should be the best available, either bubble flowmeter, mass flowmeter, rotameter or orifice with pressure chart. All must be corrected to STP conditions.

The accuracy of the system outlined if Figure 3 is dependent upon the quality and stability of the pollutant gas and the accuracy of flow measurements. Also, all materials used in the system should be compatible with the gas type being diluted. (See Section 1.4)

FIGURE 4 DILUTION SYSTEM FOR COMPRESSED GASES (ppm concentration)



1.6.6.1 Calculation

In order to determine the concentration of calibration gas after dilution, the following relationship is used:

$$C_F = \frac{Fc}{Ft} \times Cs$$

WHERE

C_F = Output concentration (PPM)

Cs = Concentration of compressed gas being diluted (PPM)

Fc = Flow of compressed gas corrected to STP

F_D = Flow of zero gas (Dilution Air) corrected to STP

Ft = Total flow (Fc + F_D)

1.6.6.2 Procedure

1. Introduce zero gas from the calibrator to the analyzer. Allow sufficient time for the analyzer to stabilize. Correct the instrument zero and record any changes on the calibration record.

   Twenty minutes of stable response is required for a calibration point.

2. Introduce the highest of the three upscale points, 50 to 80% upscale, allow sufficient time to stabilize. Record the reading on the calibration record. This is the point of maximum relative accuracy, therefore the span correction should be done at this point. No other span change should be performed after this point.

3. Run the second and third upscale points and record the data. The second upscale point should be 25 to 40% of full scale, and the third (lowest) point should be 10 to 20% full scale.

   The purpose of the second and third points is to demonstrate the downrange capability and linearity of the instrument.

   Points should not demonstrate a non-linearity greater than ±5%. If the 5% limit is exceeded, servicing of the instrument or calibrator may be indicated.

4. Zero the instrument once again to ensure that no baseline change has occurred. If the baseline has changed more than 2% of full scale the calibration should be rechecked. Since some instruments exhibit a degree of interaction between zero and span adjustments, it is advisable to recheck the response to zero gas after a span adjustment before proceeding to the next step.

5. Plot all calibration points to produce a graph of the calibration. Maximum deviation of any point from the standard slope of the graph should be less than 5%.

6. Put the instrument into the zero-span mode and allow the unit to go through the cycle. This standardizes the daily span point, which will be used to assess instrument performance on a daily basis between calibrations. Record the span concentration on the calibration record.

The monthly calibration report should include the calibration data sheet, graph and a copy of the chart recording or data logger output. When a data logger is used, the maximum interval between printouts shall be no greater than 30 seconds.

The calibration data sheet must include all parameters relevant to the calibration.

1.6.6.3 Hydrocarbons Calibration by Dilution Method

When calibrating reactive hydrocarbon or total hydrocarbon analyzers, calibration gases used are to be expressed as a "Methane Equivalent". This is obtained from the following expression:

$$\text{Methane Equivalent} = \frac{\text{Molecular Wt of Hydrocarbon Gas}}{\text{Molecular Wt of Methane}}$$

EXAMPLE: Calibration gas is propane (C_3H_8) 1.40 ppm and methane (CH_4) 5.00 ppm mixture with balance being zero air.
NOTE: Mixture in nitrogen balance will give erroneous readings as FID detector sensitivity is different for different carrier gases.

Total Hydrocarbon content is:

$$CH_4 \text{ Equivalent} = \frac{\text{mol. wt. of } C_3H_8}{\text{mol. wt. of } CH_4} \times 1.40 \text{ ppm}) + (5.00 \text{ ppm})$$

$$= \frac{(3 \times 12.01) + (8 \times 1.008)}{12.0 + (4 \times 1.008)} \times 1.40 + 5.00 \text{ ppm}$$

$$= \frac{44.09}{16.04} \times 1.40 + 5.00 \text{ ppm}$$

$$= (2.75 \times 1.40) + 5.00 \text{ ppm}$$

$$= 3.85 + 5.00 = 8.85 \text{ ppm}$$

Reactive hydrocarbons are described as non-methane hydrocarbons lumped collectively. Hydrocarbons is a term used loosely to include all organic compounds which give response to the Flame Ionization Detector.

1.6.7 Gas Phase Titration (Figure 5)

Gas phase titration may be used as a method of generating primary standards for nitrogen dioxide and ozone. The reaction which takes place when O_3 is added to a concentration of NO is:

$$O_3 + NO = NO_2 + O_2$$

The relationship is 1:1 in theory, but in practice the perfect stoichiometry is never achieved. However, since the GPT method does yield better than 99% conversion, it is very useful for :

1. calibration of NO - NO_X - NO_2 monitors
2. calibration of O_3 monitors
3. verification of O_3 generators
4. verification of gas standards
5. determination of NO_2 - NO converter efficiency

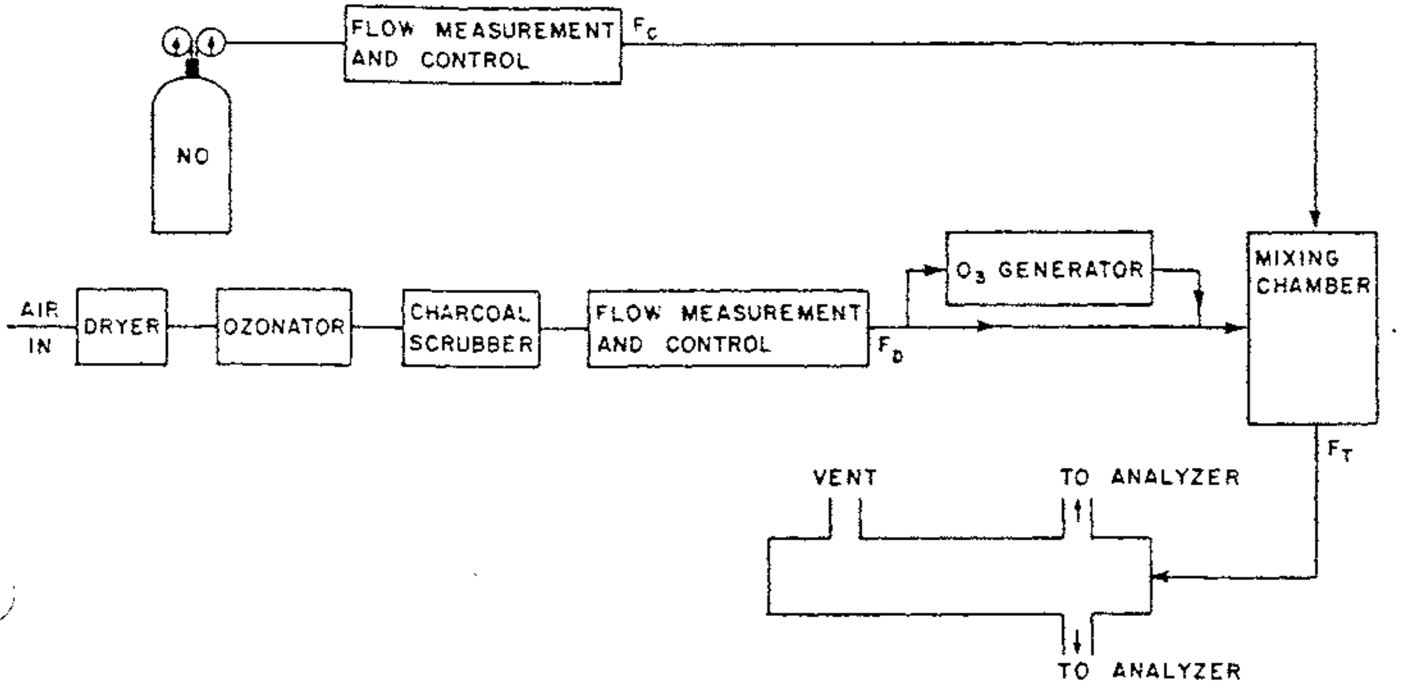
The calibration system used for Gas Phase Titration is essentially the same as the dilution system previously outlined, but incorporates an ozone generator to the dilution side of the flow system.

The accuracy of the calibration is directly related to the following parameters:

1. Quality of dilution zero air
2. Accuracy of compressed NO gas standard
3. Accuracy of flow measurements and stability of flows.
4. Stability of ozone generator and stability of flow through the ozone generator chamber.
5. Compatibility of materials used in the construction of the calibration system.
6. Condition of analyzers being calibrated or used as a reference.

All of the above items can significantly affect the accuracy, linearity and repeatability of the calibration.

FIGURE 5 GAS PHASE TITRATION CALIBRATION SYSTEM



1.6.7.1. Calculations

For determination of NO concentration:

$$C_F = \frac{Fc \times Cs}{F_T}$$

WHERE

C_F = Output concentration (PPM)

Cs = NO concentration of compressed gas (PPM)

Fc = NO flow at STP

F_D = Dilution flow at STP

F_T = Total flow ($Fc + F_D$) at STP

For determination of O_3 concentration:

$NO_I - NO_{II} = O_3$

WHERE

NO_I = NO concentration before introduction of O_3

NO_{II} = NO concentration after introduction of O_3

For determination of NO_2 concentration when O_3 is known:

$NO_I - NO_{II} = NO_2$, or

$O_3 = NO_2$

Since the NO_x converter in all instruments is never 100% efficient, a calculation of converter efficiency must be performed.

$$\text{Converter Efficiency} = \frac{NO_2 \text{ increase} \times 100\%}{NO \text{ decrease}}$$

1.6.7.2 Procedure

Preform flow checks and electronic alignment checks on the instrument before proceeding. Change sample inlet filter.

A. NO/NO_x Calibration

Use the procedure outlined for dilution calibration.

B. NO_2/NO_x Calibration

1. Introduce zero gas and allow NO_2 output to stabilize.

2. Reintroduce the highest NO concentration which was generated in the NO portion of the calibration. Allow sufficient time for the analyzer to stabilize. NO and NO_x channels should be at exactly the same level and NO_2 should be zero. No adjustments should be made to the analyzer.

3. Introduce O_3 to convert 10 to 15% of the NO to NO_2, allow the instrument to stabilize.

   Record $NO/NO_x/NO_2$ readings, and ozone generator flows and settings.

4. Increase O_3 to convert 30 to 40% of the NO to NO_2, allow the instrument to stabilize. Record the $NO/NO_x/NO_2$ readings, and O_3 generator flows and settings.

5. Increase O_3 to convert 60 to 70% of the NO to NO_2, allow the instrument to stabilize. Record the $NO/NO_x/NO_2$ readings, and O_3 generator flows and settings.

6. Plot "NO_2 increase" versus "NO decrease" to produce a calibration curve. Maximum deviation of any point from the slope of the graph should not exceed 5%.

7. Calculate average convertor efficiency.

8. Enter all data relevant to the calibration on the calibration record.

C. Ozone Calibration

Method 1 - Varying Dilution Gas Flow

An ozone analyzer can be calibrated by using a fixed UV generator setting along with a fixed flow through the O_3 generator chamber. The O_3 concentration is then varied by changing the dilution flow.

Method 2 - Varying UV Lamp Power

An ozone calibration may also be performed using fixed flows and varying the ozone lamp setting. However, some inaccuracy may result due to lamp variation from one calibration to another.

Method 3 - Direct Gas Phase Titration

A previously calibrated $NO/NO_x/NO_2$ analyzer is required to perform this type of calibration, or this calibration can be performed in conjunction with the calibration described for NO_2.

1. Introduce zero gas from the calibrator to the analyzer, allow sufficient time for the analyzer to stabilize. Record the reading, adjust if necessary, record any changes.

2. Introduce NO to the calibration system and measure NO with a calibrated NO analyzer, allow instrument to stabilize. The NO concentration should be equivalent to approximately 100% deflection of the O_3 analyzer's range. The NO_x analyzer is normally operated on the 1.0 ppm range and the O_3 analyzer on the 0.5 ppm range.

3. Introduce O_3 to convert 60 to 70% of the NO to NO_2. The O_3 analyzer should still be reading about zero. Once the $NO/NO_x/NO_2$ analyzer has stabilized, calculate the amount of O_3 in the system:

$$NO_I - NO_{II} = O_3$$

Remove the NO from the dilution stream. Once the NO has been flushed, the O_3 analyzer should rise to the calculated value (60 to 70% of full scale). After a stable output is obtained, adjust the analyzer to the correct reading. Record the output reading and adjustments. No further adjustments should be made after this point.

4. With NO reintroduced to the system, decrease O_3 to convert 30 to 40% of NO to NO_2, allow settling time. Remove NO from the dilution system. The O_3 analyzer should rise to the calculated O_3 value. Record the reading, O_3 calculations and calibrator settings.

5. With NO reintroduced to the system, decrease O_3 to convert 10 to 15 % of NO to NO_2, allow settling time. Remove NO from the dilution system. The O_3 analyzer should rise to the calculated O_3 value. Record reading, O_3 calculations and calibrator settings. In steps 3, 4, and 5, the O_3 reading should be equal to the NO decrease.

6. Re-zero the instrument to ensure that the baseline has not shifted.

1.6.8 Calibration Acceptance Limits

Correction factor is the ratio of calculated concentration to indicated concentration for the highest calibration point. Span corrections are made in order to adjust the correction factor to 1.0. The same ratio for each point must be within the range of 0.95 to 1.05; that is within ± 5% of the correction factor, before it is acceptable as a calibration point. If the criterion cannot be met, corrective action must be taken.

1.7 Examples of Calibration Reports

A calibration report includes:

1. Identification of instrument calibrated, its location and date
2. Identification of calibration standard
3. Conditions under which calibration is performed
4. Calibration results
5. Calculation of correction factor
6. Changes of correction factor from the previous calibration (comparison between the correction factor before span adjustment and that of the last calibration)
7. Calibration curve
8. Recorder trace or numerical printouts every 30 seconds for the entire calibration
9. Identification of person who performed the calibration

Examples of calibration reports are shown in the following pages.

ALBERTA ENVIRONMENT
SO_2 CALIBRATION

Station: ______ Date: Feb. 17, 1987

Make & Model of Instrument: ______ AMU: #946

Calibration: Routine x Audit ___ CM ___

Calibration Method: Permeation Device B.P. 27.68

Calibration Equipment: ______ Temp. 23°C

Permeation Tube No.: 24-29519 Permeation Tube Rate: 1600 ng/min

Instrument Settings Before Calibration

Zero pot: 160

Span pot: 432

Inlet flow: 500 cc/min

Monitoring Range: 0-0.5 ppm

After Calibration:

Zero pot: 160

Span pot: 432

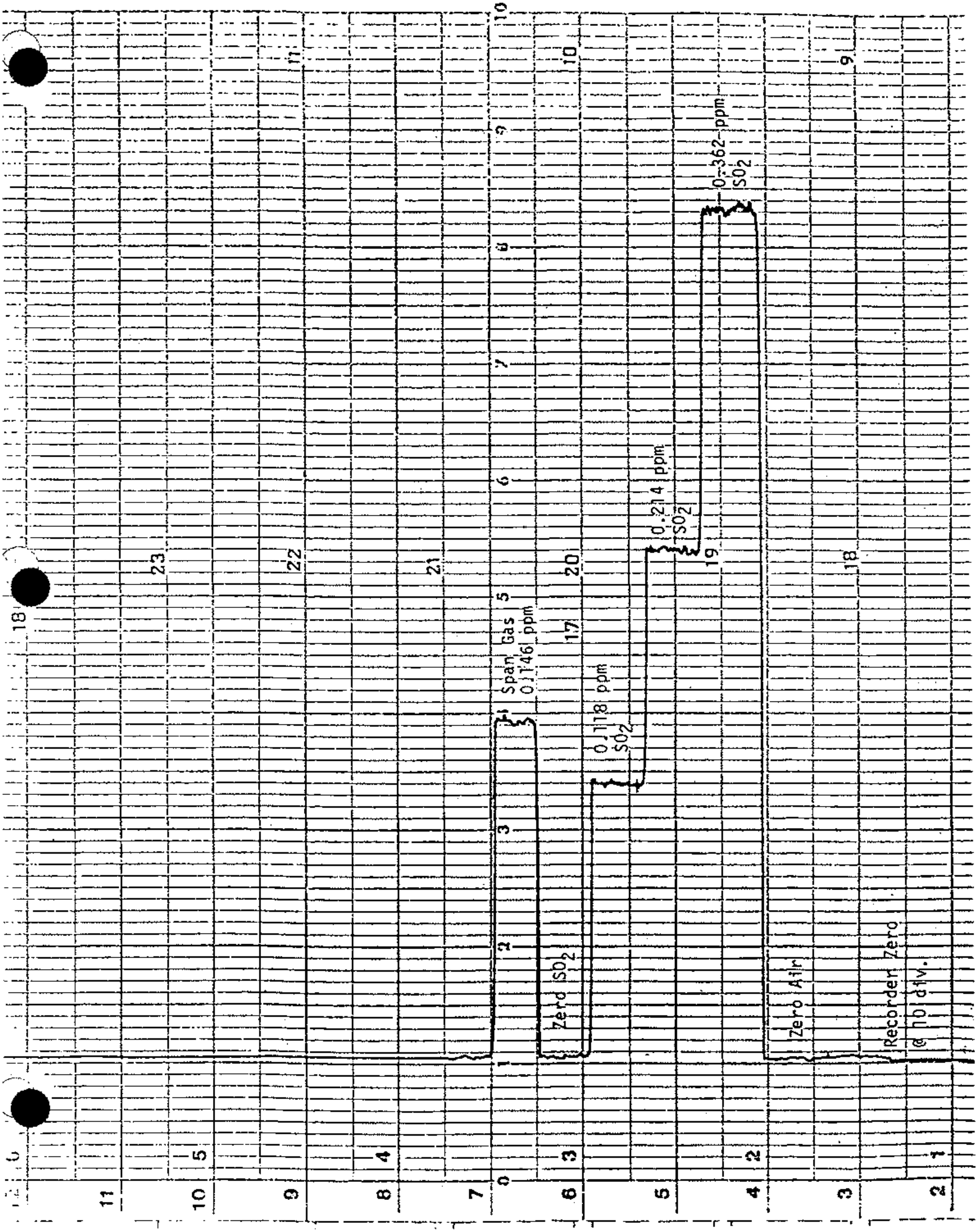
Other Details:

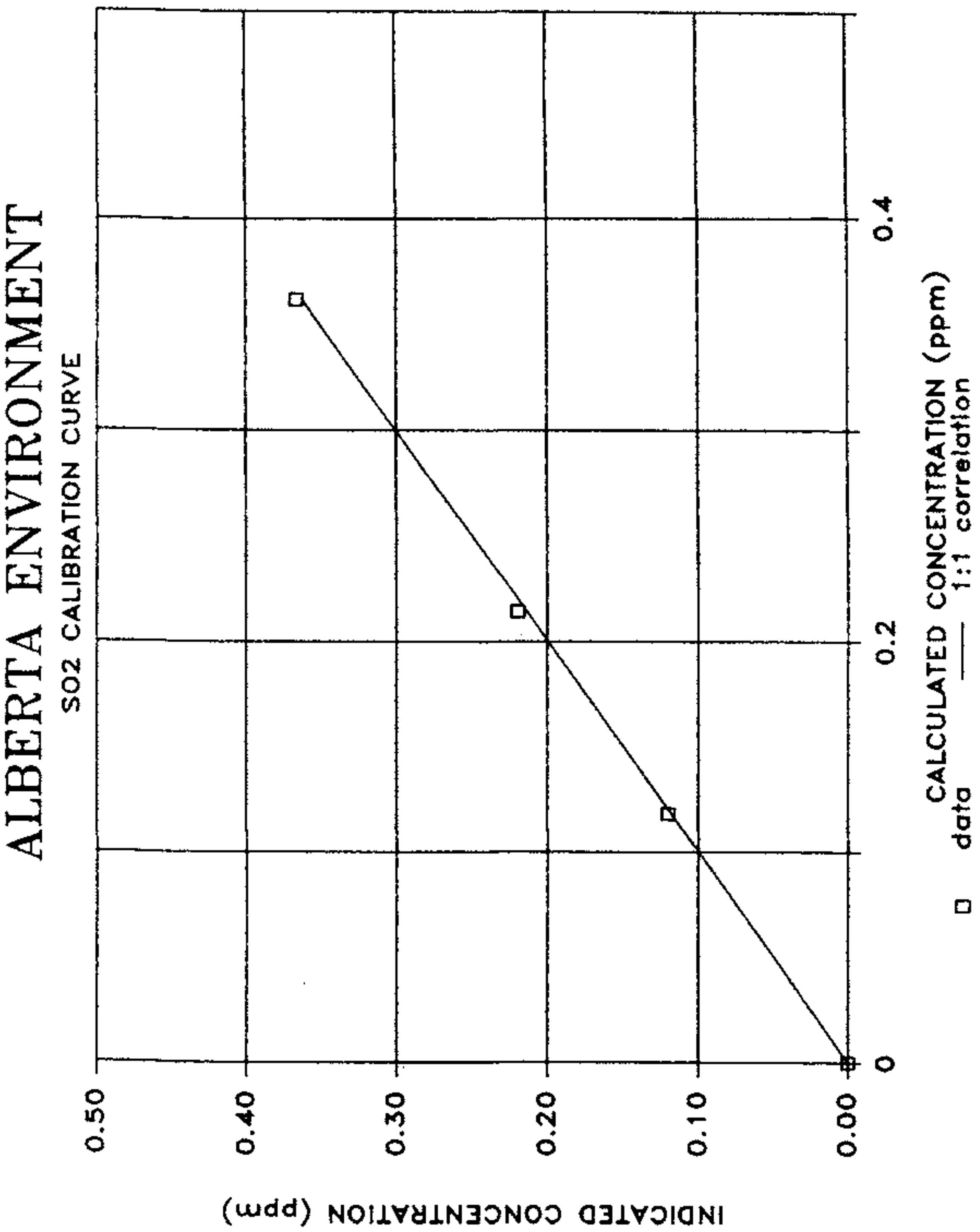
- * Changes in correction factor from previous calibration (before adjustment) = 1.7 %
- * Date of last Calibration: Jan. 14/87

Calibration System Flowrate sccm	Calculated Conc.(C_c) ppm	Indicated Conc.(C_i) ppm	Correction(C_o/C_i) Factor
Zero Air	0.000	0.000	
1688.4	0.362	0.366	0.989
2856.1	0.214	0.220	0.973
5179.7	0.118	0.120	0.983
		Correction Factor:	0.989

Station Operator ______

Calibrator ______


Span Gas
0.1146 ppm
Zero SO$_2$
0.1118 ppm
SO$_2$
0.214 ppm
SO$_2$
0.362 ppm
SO$_2$
Zero Air
Recorder Zero
@ 10 div.


ALBERTA ENVIRONMENT
SO2 CALIBRATION CURVE
INDICATED CONCENTRATION (ppm)
0.50
0.40
0.30
0.20
0.10
0.00
0
0.2
0.4
CALCULATED CONCENTRATION (ppm)
□ data
1:1 correlation

ALBERTA ENVIRONMENT

H_2S CALIBRATION

Station: ____ Date: Feb. 11, 1987

Make & Model of Instrument: ____ AMU: #954

Calibration: Routine x Audit ____ CM ____

Calibration Method: Permeation Device B.P. 27.60

Calibration Equipment: ____ Temp. 23°C

Permeation Tube No.: 86-29542 Permeation Tube Rate: 145 ng/min

Instrument Settings Before Calibration

Zero pot: 420

Span pot: 610

Inlet flow: 550 cc/min

Monitoring Range: 0-100 ppb

After Calibration:

Zero pot: 420

Span pot: 610

Other Details:

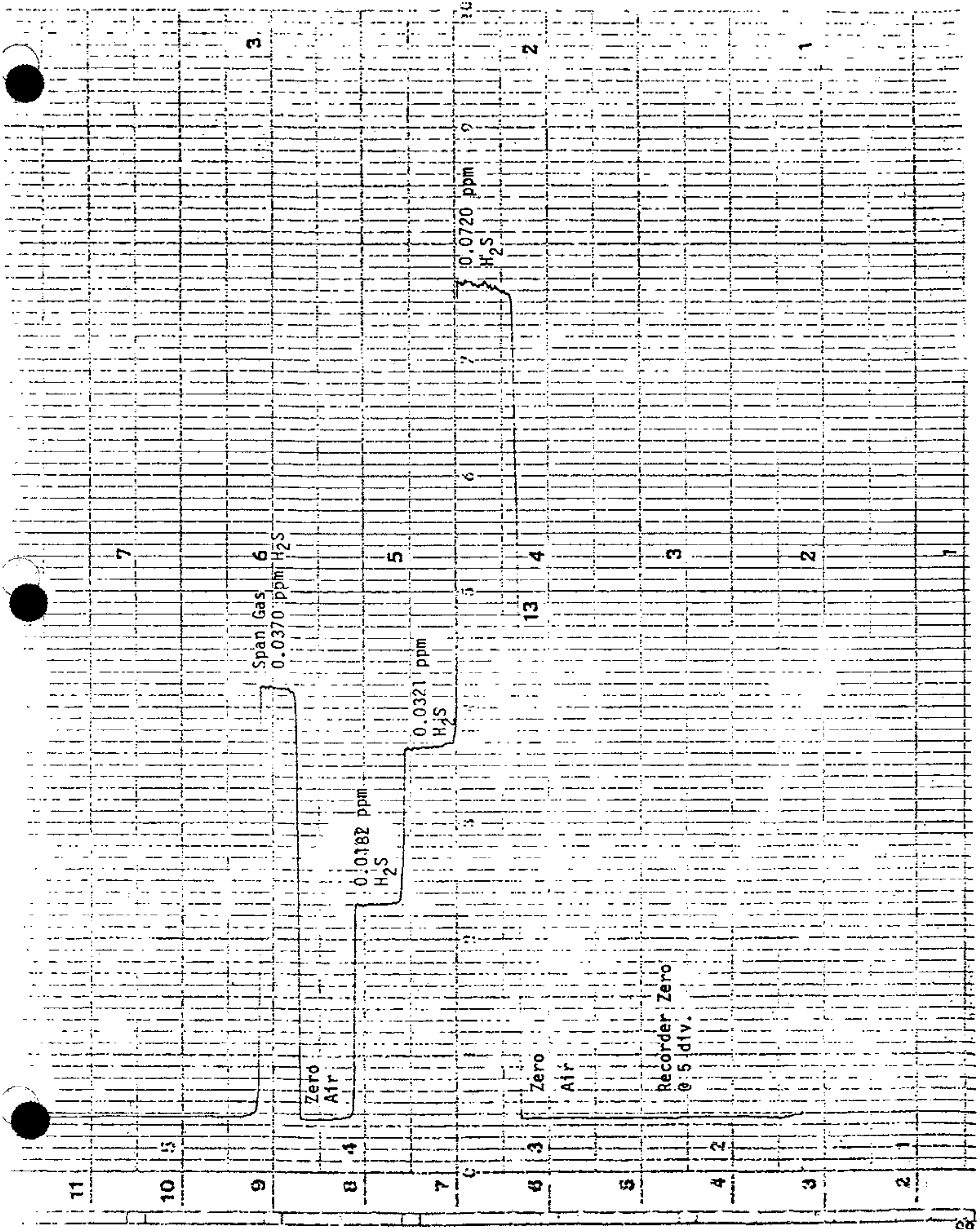
* Changes in correction factor from previous calibration (before adjustment) = 1.0%

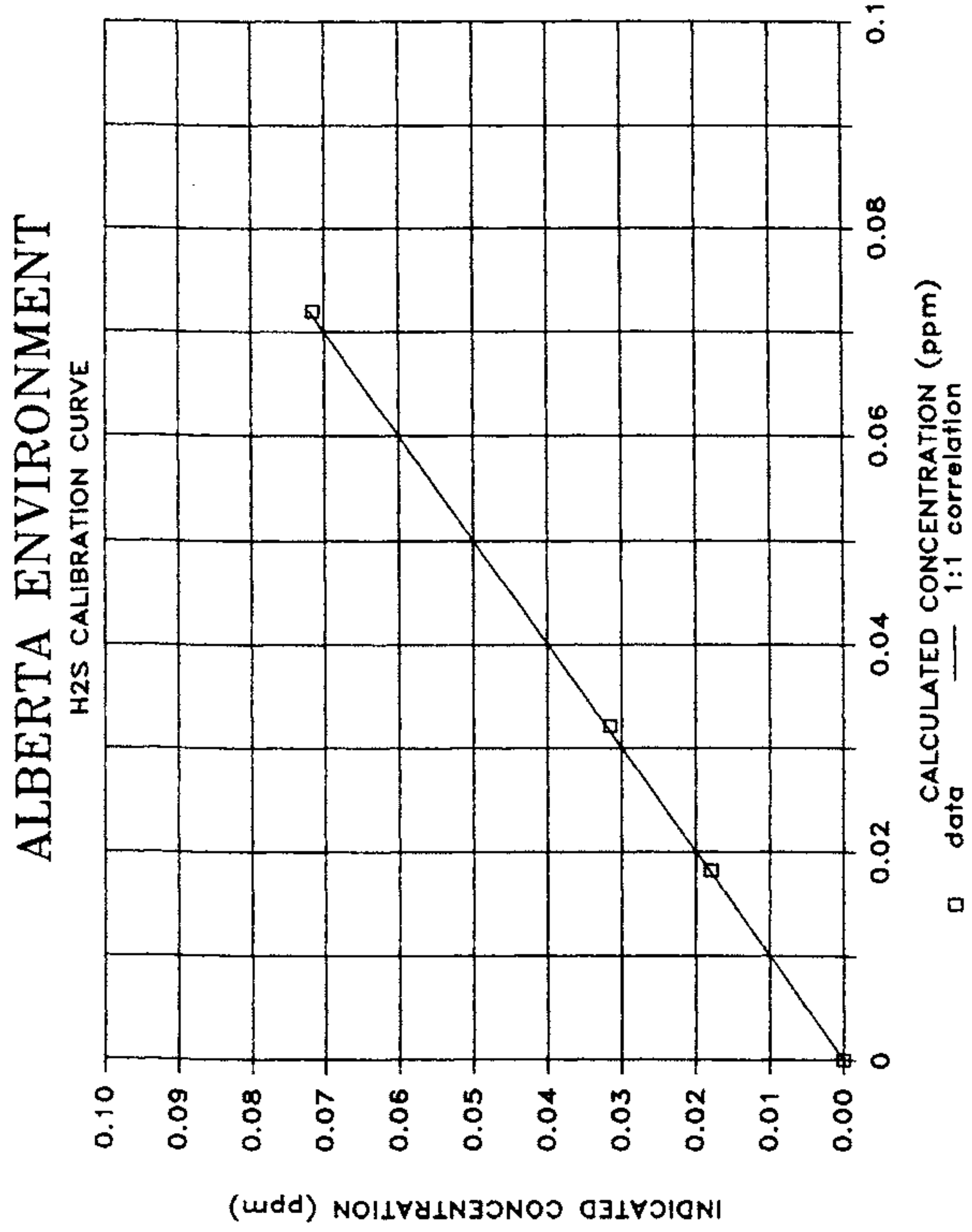
* Date of last Calibration: Jan. 7/87

Calibration System Flowrate sccm	Calculated Conc.(C_c) ppm	Indicated Conc.(C_i) ppm	Correction(C_o/C_i) Factor
Zero Air	0.0	0.0	-
1448.0	0.0720	0.0715	1.007
3247.8	0.0321	0.0316	1.016
5728.3	0.0182	0.0180	1.011
		Correction Factor:	1.007

Station Operator ____

Calibrator ____


Span Gas
0.0370 ppm H$_2$S
Zero
Air
0.0182 ppm
H$_2$S
0.0321 ppm
H$_2$S
0.0720 ppm
H$_2$S
13
Zero
Air
Recorder Zero
@ 5 div.


ALBERTA ENVIRONMENT
H2S CALIBRATION CURVE
INDICATED CONCENTRATION (ppm)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
CALCULATED CONCENTRATION (ppm)
0
0.02
0.04
0.06
0.08
0.1
□ data
—— 1:1 correlation

ALBERTA ENVIRONMENT

NO - NO_2 - NO_x CALIBRATION AND CONVERTER EFFICIENCY

Station: ________ Date: Feb. 17, 1987

Analyzer: ________ AMU: 1111

Calibration: Routine x Audit ___ CM ___

Calibration Method: Dilution: Gas Phase Titration B.P. 27.62

Calibration Equipment: ________ Temp. 23°C

NO/N_2 Cylinder No.: Bal 3590 No Concentration: 94.7 ppm

Instrument Settings Before Calibration:

Zero pot: 280

Span pot: NO-624 NO_x-636

Inlet flow: 800 cc/min

Monitoring Range: 0 - 1.0

Previous Span: 0.456 ppm New Span: 0.452 ppm*

After Calibration:

Zero pot: 280

Span pot: NO-624 NO_x-636

Other Details:

* Changes in correction factor from previous calibration (before adjustment) = NO 1.1% NO_x 1.5%

Date of last calibration : Jan 8, 1987

PART I NO - NO_x CALIBRATION

Dilution Flow	NO Flow	Calculated Conc.	NO Response	CF	NO_x Response	CF
Zero Air	-	0.0	0.000	-	0.000	-
1750.7	13.3	0.714	0.713	1.001	0.706	1.011
2817.1	13.3	0.445	0.443	1.005	0.439	1.014
5024.7	13.3	0.250	0.248	1.008	0.247	1.012
			Corr. Factor	1.001	Corr. Factor	1.011

PART II NO_2 CALIBRATION AND CONVERTER EFFICIENCY

Air Setting

Gas Setting

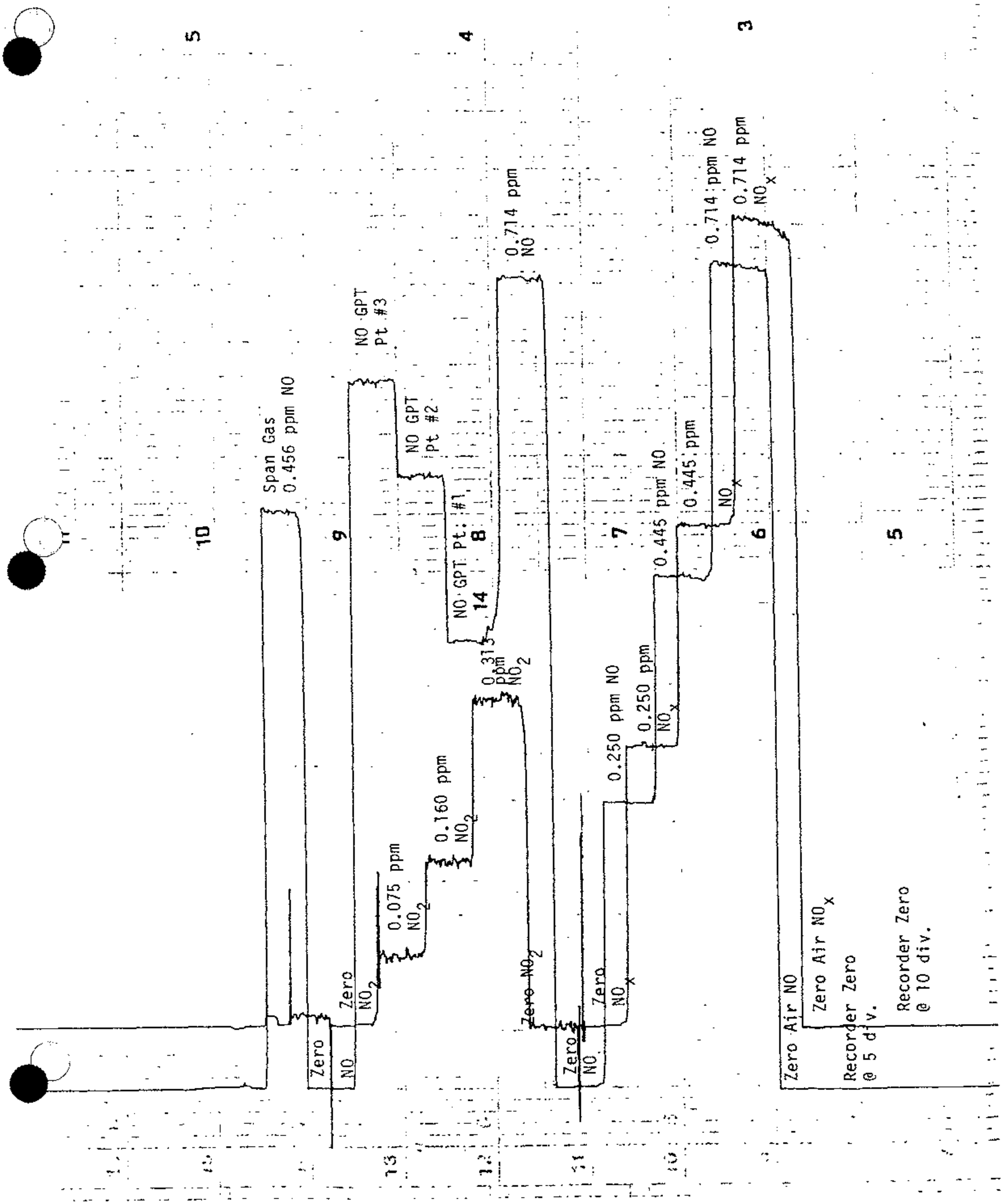
O_3 Setting	Set Point	NO Concentration ppm	NO Decrease ppm	NO_2 Increase ppm	CF
-	-	0.714	-	-	
200	5.0	0.714	0.313	0.291	1.076
200	3.0	0.714	0.160	0.150	1.067
100	3.0	0.714	0.075	0.070	1.071

Correction Factor: 1.076

Station Operator ________

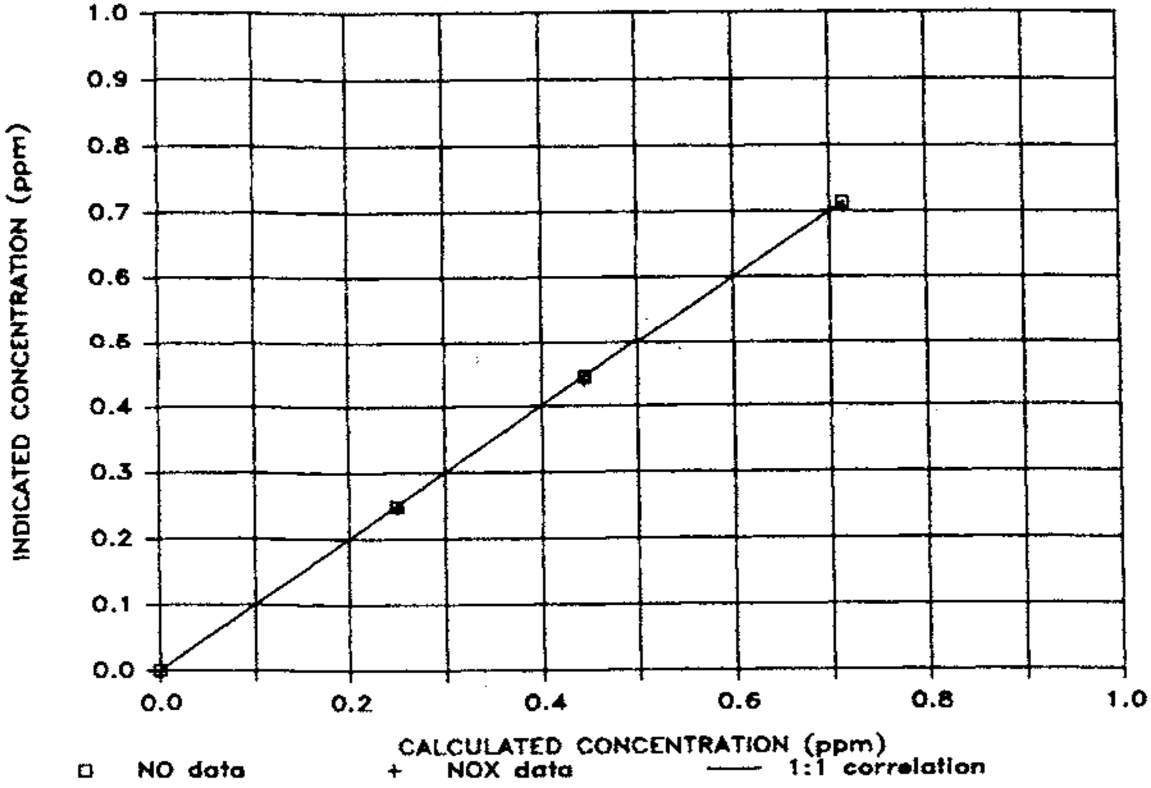
Calibrator ________

Converter Efficiency (NO_2/NO x 100) 93.4%


Span Gas
0.456 ppm NO
Zero
NO
Zero
NO2
0.075 ppm
NO2
0.160 ppm
NO2
NO GPT
Pt #3
NO GPT
Pt #2
NO GPT Pt. #1
0.313
ppm
NO2
0.714 ppm
NO
Zero NO2
Zero
NO
Zero
NO
0.250 ppm NO
0.250 ppm
NOx
0.445 ppm NO
0.445 ppm
NOx
0.714 ppm NO
0.714 ppm
NOx
Zero Air NO
Zero Air NOx
Recorder Zero
@ 5 div.
Recorder Zero
@ 10 div.
5
4
3
10
9
8
7
6
5
14
13
12
11
10

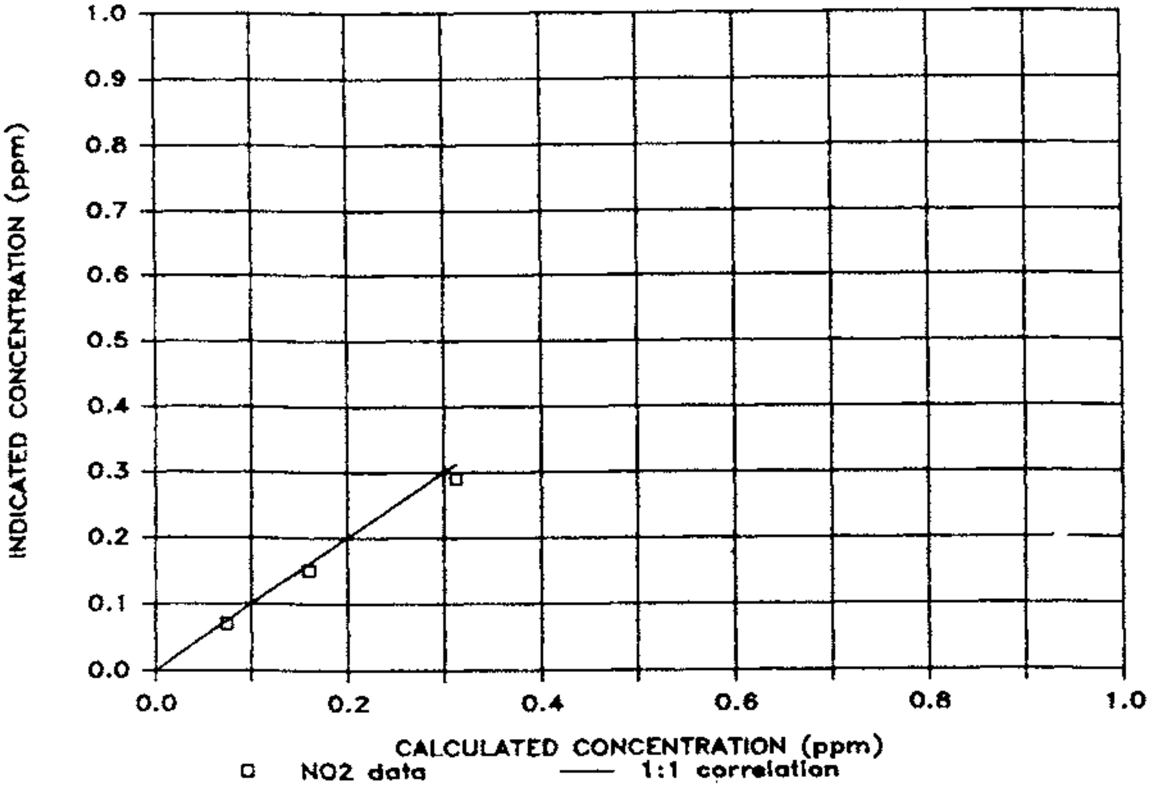
ALBERTA ENVIRONMENT

NO–NOX CALIBRATION CURVES



ALBERTA ENVIRONMENT

NO2 CALIBRATION CURVE



OZONE CALIBRATIONS

Station: ______________________

Date: Jan. 22, 1987

Make & Model of Instrument ______________________

AMU: #630

Calibration: Routine x Audit ____ CM ____

Calibration Method: Ozone from Gas Phase Titration

B.P. 27.68

Calibration Equipment: ______________________

Temp. 24°C

NO/N_2 Cylinder No.: BAL 3592

No Concentration: 98.2 ppm NO

Instrument Settings Before Calibration

Zero pot: 050

Span pot: 432

Inlet flow: 900 cc/min

Monitoring Range: 0 - 0.5 ppm

After Calibration: New Span:

Zero pot: 050

Span pot: 432

Other Details:

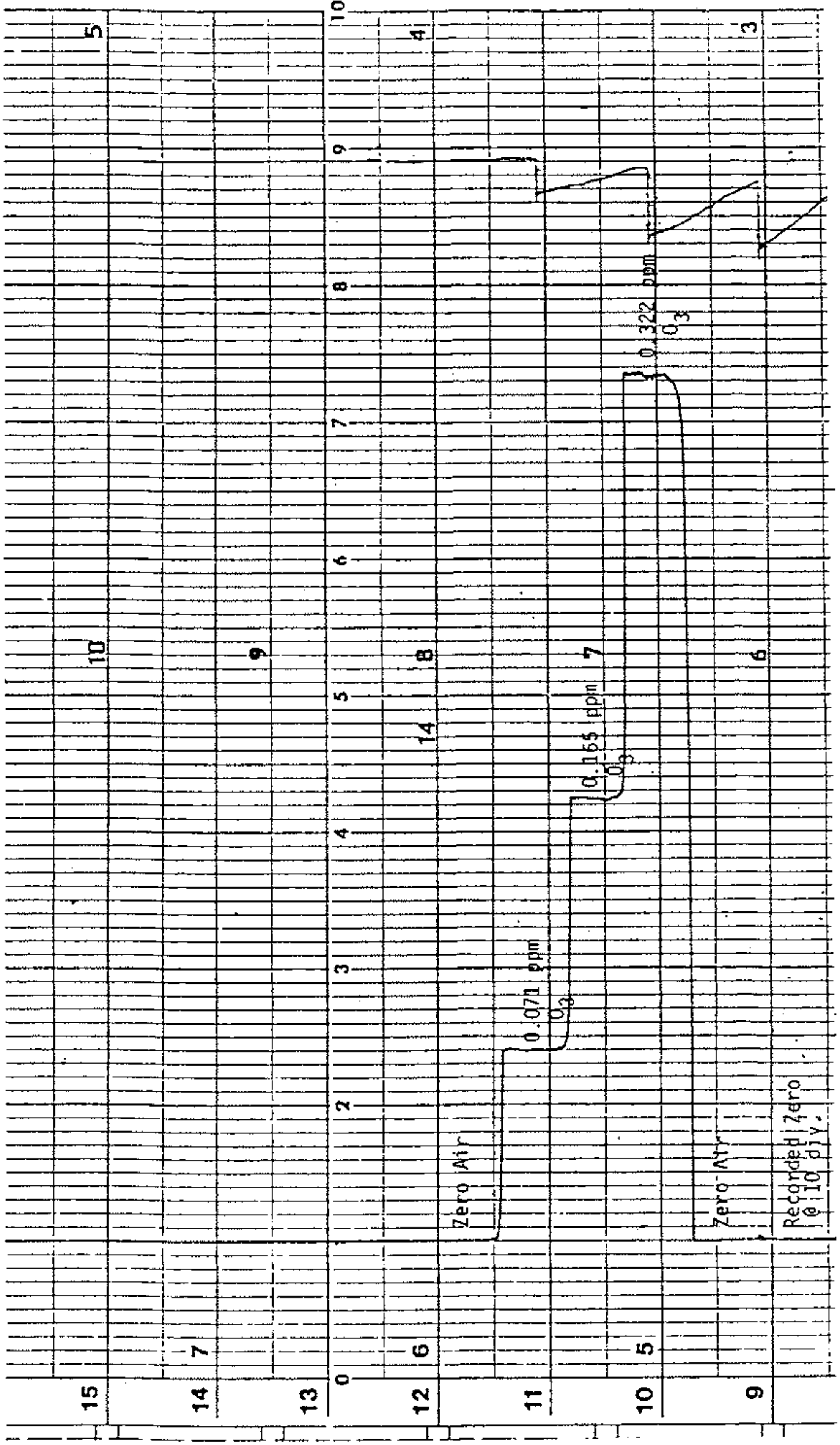
* Changes in correction factor from previous calibration (before adjustment) = 1.6 %

* Date of last calibration: Dec. 19, 1986

Air Flow sccm	O3 Setting	Set Point	NO Decrease or Ozone Output, ppm (C_c)	Ozone Response ppm (C_i)	C_c/C_i Ratio
Zero Air	-	-	0.0	0.0	-
1620	500	3.0	0.322	0.317	1.016
1620	200	5.0	0.165	0.162	1.019
1620	100	5.0	0.071	0.070	1.014
			Correction Factor:		1.016

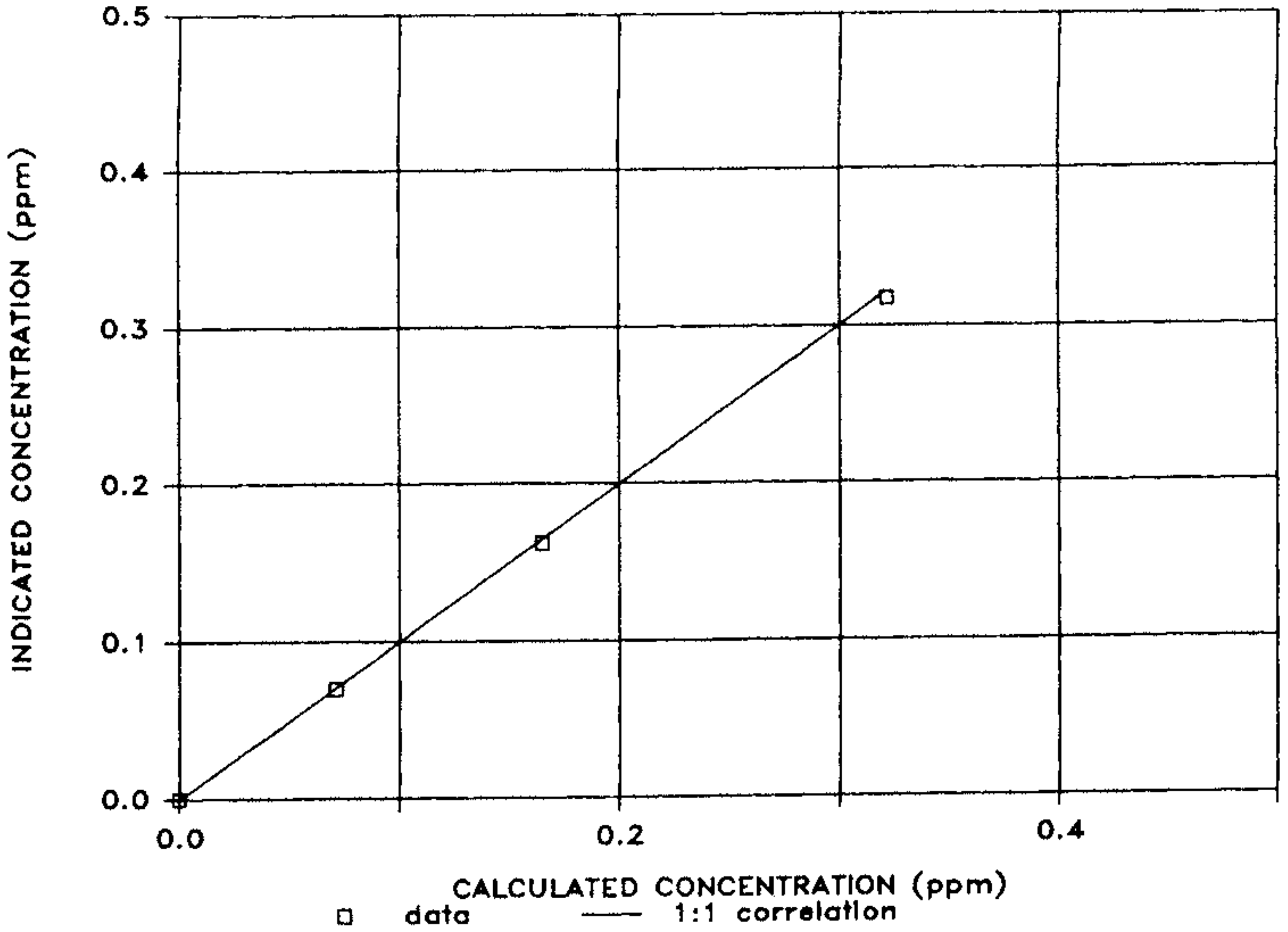
Station Operator ______________________

Calibrator ______________________


Zero Air
0.071 ppm O3
0.165 ppm O3
0.322 ppm O3
Zero Air
Recorded Zero @ 10 div.

ALBERTA ENVIRONMENT

O_3 CALIBRATION CURVE



ALBERTA ENVIRONMENT

NH_3 CALIBRATION

Station:
Date: January 14, 1986
Make & Model of Instrument: AMU #1087, 1088
Calibration: Routine x Audit ___ CM ___

Calibration Method: Permeation Device
B.P. 27.78
Calibration Equipment:
Temp. 22°C
Permeation Tube No.: 28-24118; 28-24121
Permeation Tube Rate: 1310; 1340 ng/min

Instrument Settings Before Calibration

Zero pot: 220
Span pot: NO - 0.462 NO_x - 0.474
Inlet flow: 800 cc/min
Monitoring Range: 0 - 5.0 ppm

After Calibration:

Zero pot: 220
Span pot: NO-0.462; NO_x - 0.474

Other Details:

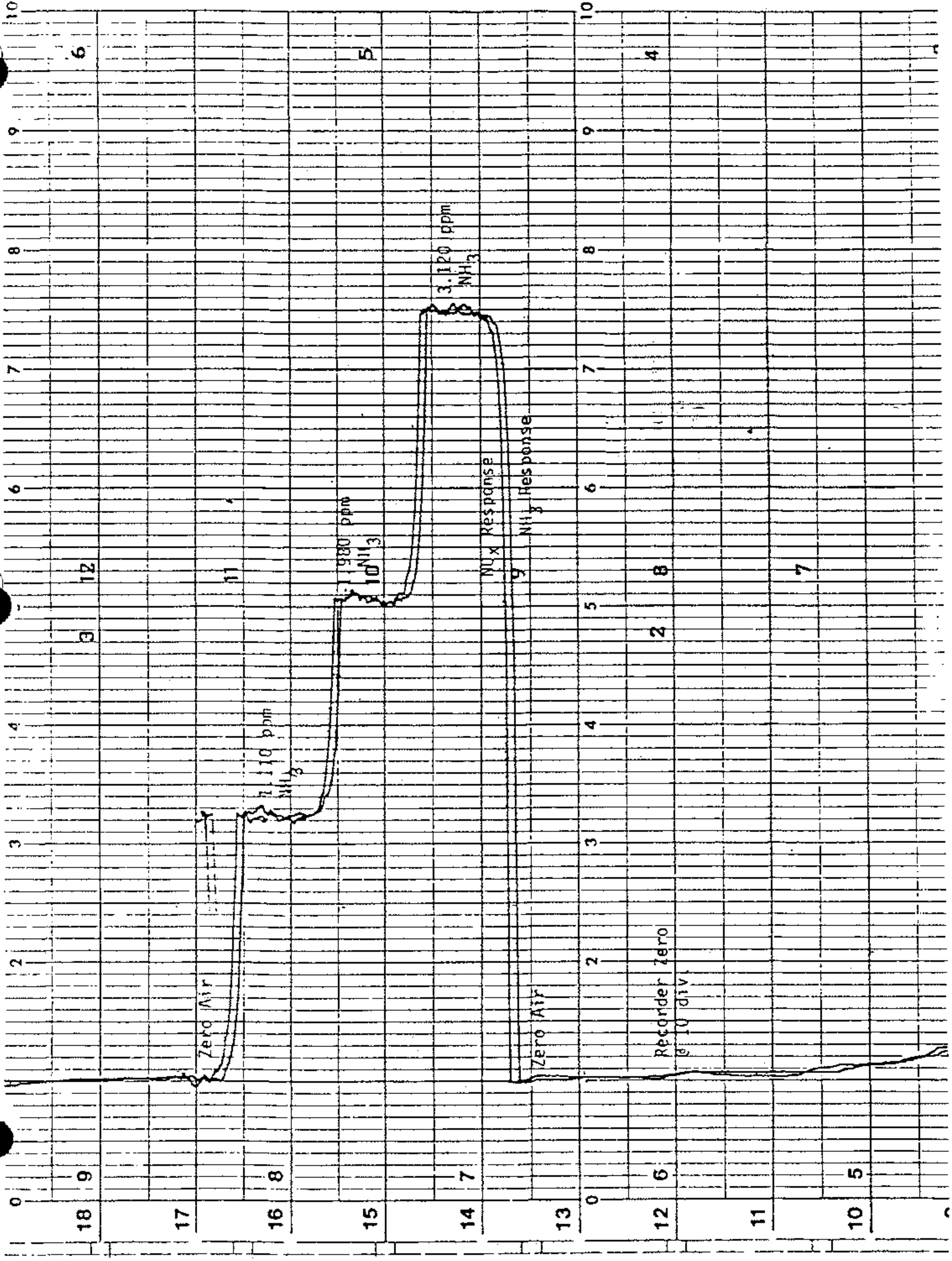
- * Changes in correction factor from previous calibration (before adjustment) = 3.5 %
- * Date of last calibration: Dec. 18/85

Calibration System Flowrate sccm	Calculated Conc. (C_c) ppm	Indicated Conc. (C_i) ppm	C_c/C_i Ratio
Zero Air	0.0	0.000	
1222.2	3.120	3.250	0.960
1925.9	1.980	2.040	0.971
3435.5	1.110	1.150	0.965
		Correction Factor:	0.960

Station Operator __________

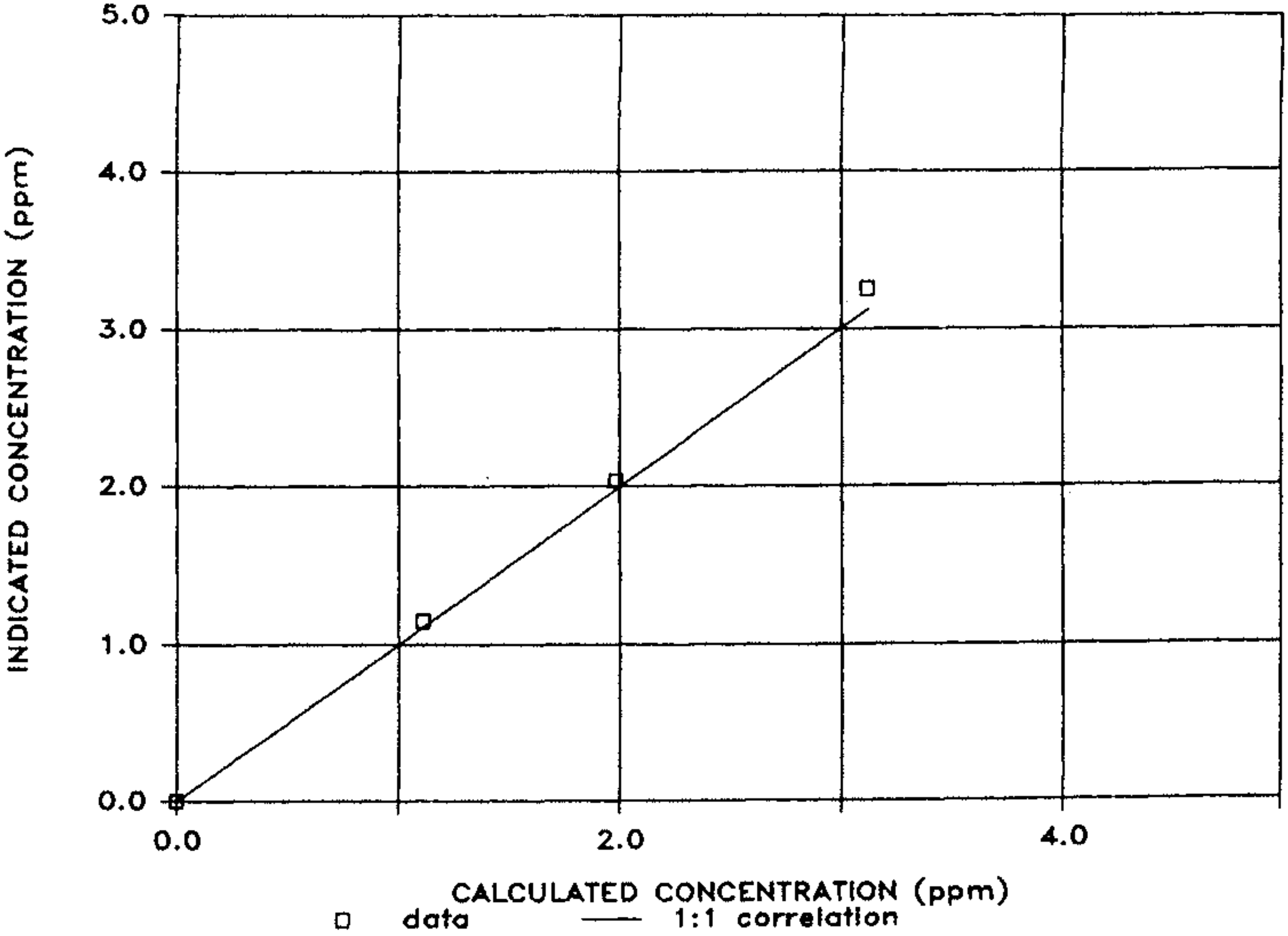
Calibrator __________

REPEALED - refer to 2016 Air Monitoring Directive, as amended



ALBERTA ENVIRONMENT

NH3 CALIBRATION CURVE



REPEALED - refer to 2016 Air Monitoring Directive, as amended

ALBERTA ENVIRONMENT

CO CALIBRATION

Station: ______ Date: Feb. 10, 1987
Make & Model of Instrument: ______ AMU: #694
Calibration: Routine x Audit ____ CM ____

Calibration Method: Dilution B.P. 27.68
Calibration Equipment: ______ Temp. 23°C
CO Cylinder No. RAL 3545 CO Concentration: 5070 ppm

Instrument Settings Before Calibration
Zero pot: 452
Span pot: 620
Inlet flow: 800 cc/min
Monitoring Range: 0-50

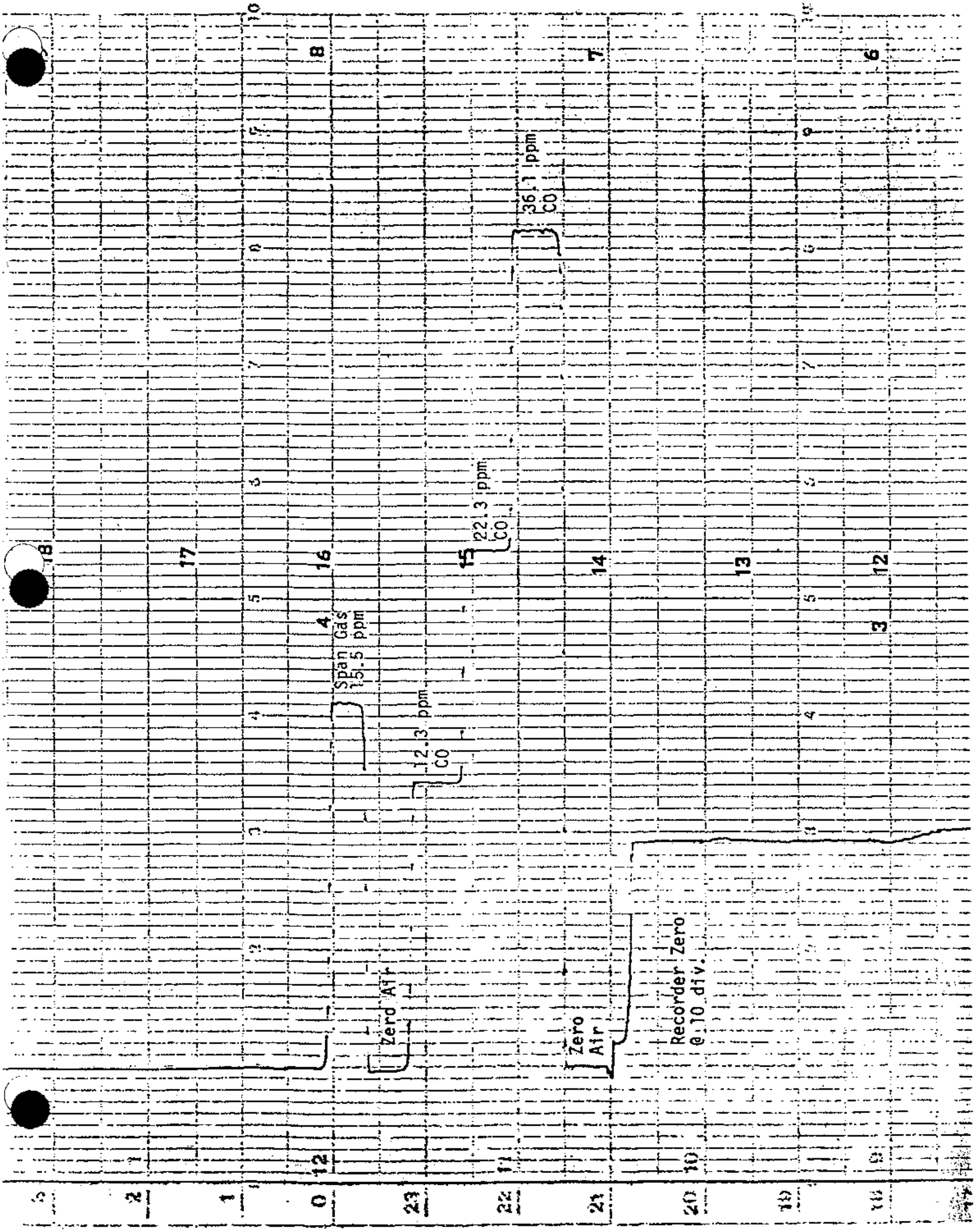
After Calibration:
Zero pot: 452
Span pot: 620
Other Details:

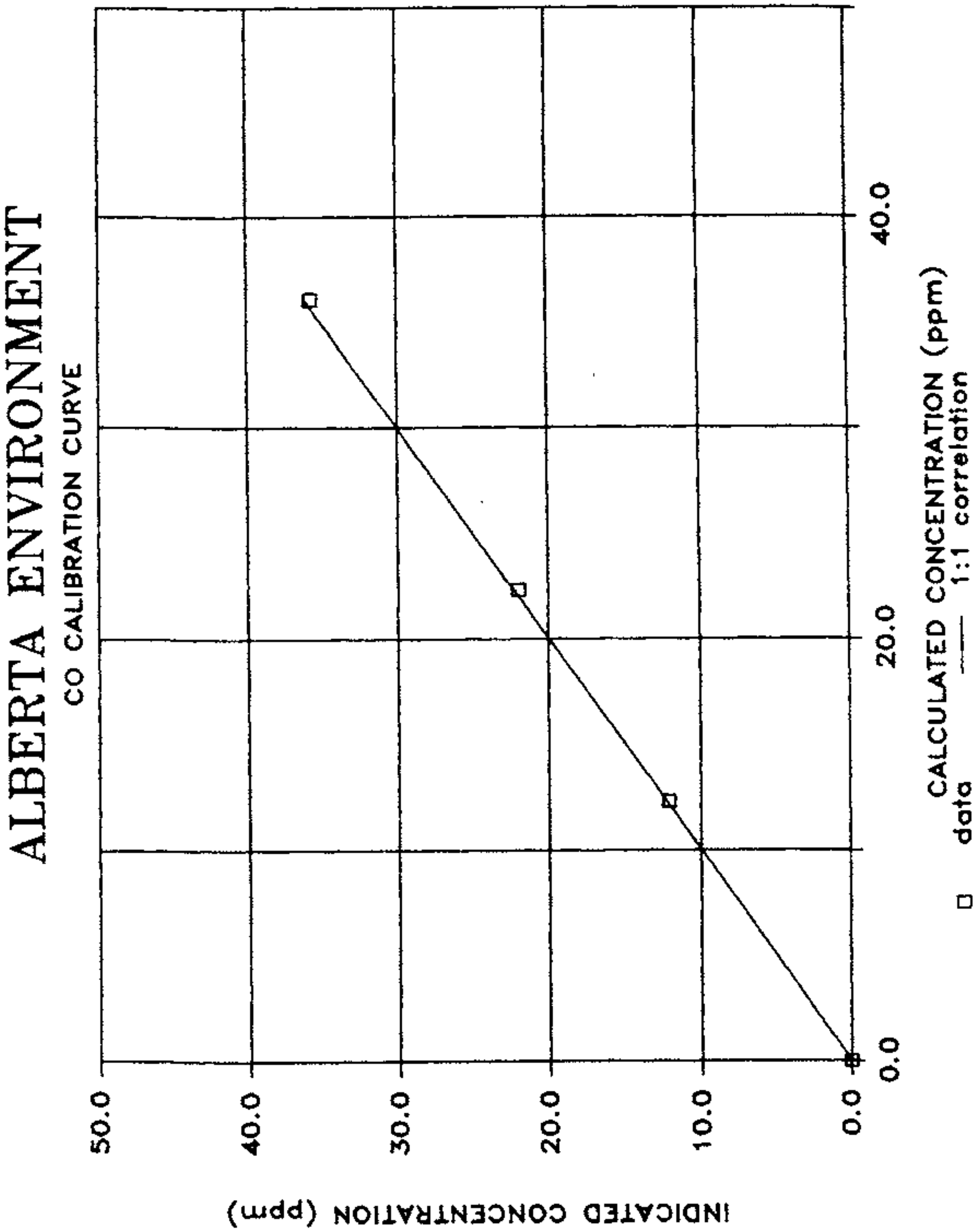
* Changes in correction factor from previous calibration (before adjustment) = 1.3 %

* Date of last calibration: Jan. 8/87

Calibration System Flowrate sccm	Calculated Conc(C_c) ppm	Indicated Conc.(C_i) ppm	Correction (C_c/C_i) Factor
Zero Air	0.0	0.0	-
1729.1; 12.4	36.1	35.7	1.011
2806.8; 12.4	22.3	22.0	1.014
5098.8; 12.4	12.3	12.1	1.017
		Correction Factor:	1.011

Station Operator ______
Calibrator ______


36.1 ppm
CO
22.3 ppm
CO
12.3 ppm
CO
Span Gas
15.5 ppm
Zero Air
Zero
Air
Recorder Zero
@ 10 div.
8
7
6
18
17
16
15
14
13
12
4
3
12
11
10
9
3
2
1
0
23
22
21
20
19
18


ALBERTA ENVIRONMENT
CO CALIBRATION CURVE
INDICATED CONCENTRATION (ppm)
0.0
10.0
20.0
30.0
40.0
50.0
CALCULATED CONCENTRATION (ppm)
0.0
20.0
40.0
□ data
—— 1:1 correlation

1.8 Audit: Assessment Criteria

To assess the performance (response and linearity) of the analyzer, the linear regression method may be used on the audit calibration results. The calculations are summarized as follows:

set X_i = calculated concentration for audit

Y_i = indicated concentration from analyzer

n = number of points in audit calibration

Then, slope = change in indicated conc./change in calculated conc.

$$= \frac{n\Sigma X_iY_i - \Sigma X_i\Sigma Y_i}{n\Sigma X_i^2 - (\Sigma X_i)^2}$$

~1/correction factor for response

intercept = indicated concentration when calculated concentration is zero

$$= \frac{\Sigma X_i^2\Sigma Y_i - \Sigma X_i\Sigma X_iY_i}{n\Sigma X_i^2 - (\Sigma X_i)^2}$$

~zero drift correction

correlation coefficient

= indication of linearity of analyzer response

$$= \frac{n\Sigma X_iY_i - \Sigma X_i\Sigma Y_i}{[(n\Sigma X_i^2 - \Sigma(X_i)^2)(n\Sigma Y_i^2 - (\Sigma Y_i)^2]1/2}$$

Simple computer programs are available for performing such calculations. An example is shown at the end of this section with an audit report.

The "slope" is the parameter used for assessing the accuracy of the analyzer response. Evaluation is also made based on the "intercept" and "correlation coefficient".

The assessment criteria used are summarized below.

Slope

Excellent: $0.95 \leq \text{slope} \leq 1.05$

Satisfactory: $0.85 \leq \text{slope} < 0.95$ or $1.05 < \text{slope} \leq 1.15$

Unsatisfactory: $\text{slope} < 0.85$ or $\text{slope} > 1.15$

Intercept

Satisfactory: intercept $\leq$ 3% full range of analyzer

Unsatisfactory: intercept $>$ 3% full range of analyzer

Correlation Coefficient

Linear: correlation coefficient ≥ 0.9950
(maximum = 1.0000)

Non-Linear: correlation coefficient < 0.9950

Analyzers rated as "unsatisfactory" or "non-linear" are subjected to appropriate corrective action.

AUDIT REPORT

Date: July 10, 1985

Station: ____________ Operator: ____________

Instrument Model & Serial No.: ____________

Audit Parameter: NO - NO_2 - NO_x

Audit Method: Dilution, Gas Phase Titration

Permeation Device#/Bottle#: Bottle X

Permeation Rate/Concentration: 93.0 ppm

Last Calibration:				
	Parameter			
	Correction Factor			
	Date			

Audit Parameter	Range (ppm)	Audit Concentration (ppm) C_c	Indicated Concentration (ppm) C_i	C_c/C_i Ratio	1/(slope) from LSQ	Regression of Ind. Conc. on Calc. Conc.		
						slope	Intercept	Correlation Coefficient
NO	0-1.0	0.0	0.0	-	0.981	1.020	-0.0073	0.9994
		0.215	0.205	1.049				
		0.377	0.369	1.022				
		0.592	0.604	0.980				
NO_x	0-1.0	0.0	0.0	-	0.974	1.026	-0.0071	0.9995
		0.215	0.207	1.039				
		0.377	0.372	1.013				
		0.592	0.608	0.974				
NO_2	0-1.0	0.0	0.0	-	1.028	0.972	-0.0004	0.999
		0.279	0.272	1.026				
		0.143	0.136	1.052	converter	efficiency = 97%		
		0.058	0.057	1.018				

COMMENTS: ____________

AUDITOR:

AUDIT REPORT

Criteria for Performance Assessment

(based on linear regression slope, intercept & correlation coefficient)

Slope

Excellent : $0.95 \leq \text{slope} \leq 1.05$
Satisfactory: $0.85 \leq \text{slope} < 0.95$ or $1.05 < \text{slope} \leq 1.15$
Unsatisfactory: $\text{slope} < 0.85$ or $\text{slope} > 1.15$

Intercept

Satisfactory: intercept $\leqslant 3\%$ full range of analyzer
Unsatisfactory: intercept $> 3\%$ full range of analyzer

Correlation Coefficient

Linear: correlation coefficient $\geqslant 0.9950$
(maximum = 1.0000)
Non-linear: correlation coefficient < 0.9950

Comments: (from system audit)

Audit Results: From data acquisition

Parameter	Slope	Intercept	Correlation Coefficient
NO	Excellent	Satisfactory	Linear
NO_x	Excellent	Satisfactory	Linear
NO_2	Excellent	Satisfactory	Linear

Auditor

LEAST SQUARE PROGRAM (FORTRAN)

```
C     LINEAR REGRESSION (LEAST SQUARE) - "AUDIT"
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
C                   INPUT
C     1. STATION, ST - (A4)
C     2. PARAMETER, PARAM - (A4)
C     3. NUMBER OF POINTS, N - (I1)
C     4. VALUES OF X AND Y, - (2F10.0),  ONE LINE PER PAIR
C        ( COL. 1 - 10 : CALC. CONC. ; COL. 11 - 20 : INDICATED CONC.)
C     5. GO TO 1 FOR ANOTHER DATA SET
C     6. ST = STOP (TERMINATION)
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      DIMENSION X(20),Y(20)
      CHARACTER*4 ST,STOP,PARAM
      DATA STOP/'STOP'/
 500  READ(5,5) ST
 5    FORMAT(A4)
      IF(ST.EQ.STOP) STOP
      READ(5,10) PARAM
 10   FORMAT(A4)
      READ(5,15) N
 15   FORMAT(I1)
      WRITE(6,20) ST,PARAM
 20   FORMAT('0 STATION :  ',A4,6X,'PARAMETER AUDITED :  ',A4,/)
      WRITE(6,25)
 25   FORMAT('0 N',6X,'CALCULATED CONC.',4X,'INDICATED CONC.')
      DO 100 I=1,N
      READ(5,30) X(I),Y(I)
 30   FORMAT (2F10.0)
      WRITE(6,35) I,X(I),Y(I)
 35   FORMAT (1X,1I2,6X,F10.4,10X,F10.4)
 100  CONTINUE
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      CALL LSQ(N,X,Y,20,SLOPE,CEPT,SE,COR)
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      CF=1.0/SLOPE
      WRITE(6,40) SLOPE,CF
 40   FORMAT ('0SLOPE :  ',15X,' CORRECTION FACTOR(1/SLOPE) :  '/ 1F7.3,17
     1X,1F7.3)
      WRITE(6,45) CEPT
 45   FORMAT ('0INTERCEPT :  '/ 1F8.4)
      WRITE(6,50) COR
 50   FORMAT ('0CORRELATION COEFFICIENT :'/ 1F8.4,////)
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      GO TO 500
      END
```

cont'd. -- least square program

```
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
C          SUBROUTINE FOR LEAST SQUARE ANALYSIS
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      SUBROUTINE LSQ(N,X,Y,J,SLOPE,CEPT,SE,COR)
      REAL X(J),Y(J)
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      PX=0.0
      PY=0.0
      PXX=0.0
      PXY=0.0
      PYY=0.0
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      DO 11 I=1,N
      SX=PX+X(I)
      PX=SX
      SY=PY+Y(I)
      PY=SY
      SXX=PXX+X(I)*X(I)
      PXX=SXX
      SXY=PXY+X(I)*Y(I)
      PXY=SXY
      SYY=PYY+Y(I)*Y(I)
      PYY=SYY
 11   CONTINUE
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      C=(N*SXX)-(SX*SX)
      CC=(N*SYY)-(SY*SY)
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      SLOPE=((N*SXY)-(SX*SY))/C
      CEPT=((SXX*SY)-(SX*SXY))/C
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      PR=0.0
      DO 22 I=1,N
      D=Y(I)-SLOPE*X(I)-CEPT
      RR=PR+D*D
      PR=RR
 22   CONTINUE
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      SE2=RR/(N-2)
      SE=SQRT(SE2)
      SES=SE2*(N/C)
      SEC=SE2*(SXX/C)
      XS=SQRT(SES)
      XC=SQRT(SEC)
      COR=SQRT(SLOPE*SLOPE*C/CC)
C     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
      RETURN
      END
```

INPUT

```
xxxx
NO
4
0.0          0.0
0.215        0.205
0.377        0.369
0.592        0.604
xxxx
NOX
4
0.0          0.0
0.215        0.207
0.377        0.372
0.592        0.608
xxxx
NO2
4
0.0          0.0
0.279        0.272
0.143        0.136
0.058        0.057
STOP
```

OUTPUT

```
STATION : xxxx        PARAMETER AUDITED : NO


N        CALCULATED CONC.     INDICATED CONC.
1             .0000                .0000
2             .2150                .2050
3             .3770                .3690
4             .5920                .6040

SLOPE :                      CORRECTION FACTOR(1/SLOPE) :
 1.020                         .981

INTERCEPT :
 -.0073

CORRELATION COEFFICIENT :
  .9994
```

```
STATION : xxxx        PARAMETER AUDITED : NOX


N        CALCULATED CONC.     INDICATED CONC.
1             .0000                .0000
2             .2150                .2070
3             .3770                .3720
4             .5920                .6080

SLOPE :                      CORRECTION FACTOR(1/SLOPE) :
 1.026                         .974

INTERCEPT :
 -.0071

CORRELATION COEFFICIENT :
  .9995
```

```
STATION : xxxx        PARAMETER AUDITED : NO2


N        CALCULATED CONC.     INDICATED CONC.
1             .0000                .0000
2             .2790                .2720
3             .1430                .1360
4             .0580                .0570

SLOPE :                      CORRECTION FACTOR(1/SLOPE) :
  .972                        1.028

INTERCEPT :
 -.0004

CORRELATION COEFFICIENT :
  .9999
```

2. Wind Monitoring

2.1 Instrument Selection

Wind speed sensors may be any of the following types: vertical shaft rotational (cups), horizontal shaft rotational (propeller), hot film, or sonic. The transducer which converts rotation to an electrical signal may be either an interrupted light beam (photochopper) or a D.C. generator. The wind speed measuring system must meet the following specifications:

starting threshold: 1.5 km/h (0.4 m/s)
accuracy : ± 1%
distance constant: < 3 m
range: 0-100 km/h (0-30 m/s)

Wind directions may be sensed directly by means of a flat plate vane or indirectly by measuring two horizontal wind components (propellers, hot film or sonic) and combining them vectorially. In converting the angular position of the vane to an electrical signal (say by potentiometer) the discontinuity that occurs at North must not cause confusion in the recording system. The wind direction measuring system must meet the following specifications:

starting threshold: 1.5 km/h (0.4 m/s)
accuracy: ± 5°

If a flat plate vane is used, then these additional specifications must be met:

damping ratio: 0.4-0.6
delay distance: < 3 m
physical separation from speed sensor: < 0.6 m

2.2 Wind Instrument Orientation by the Local Apparent Noon Method

Solar orientation is by far the most accurate method of determining true north and is therefore recommended over other methods. It is necessary to choose a day when the sun casts a detectable shadow.

Determine from a map or other source the longitude of the station and calculate the difference between it and the standard meridian for Mountain Standard Time, 105°W. Multiply this difference in degrees and minutes by 4 to find the time difference in minutes between standard time and local mean time.

Because the station will be west of the standard meridian, the sun will cross the station later than it will cross the standard meridian and Local Mean Noon will occur later than twelve o'clock standard time.

From Table 4 determine the Local Mean Time at Local Apparent Noon on the standard meridian.

From the Local Mean Time on the standard meridian, calculate the standard time at the station by adding the time difference found above (the difference between the station longitude and the standard meridian multiplied by 4).

Example: Date March 7

Station Longitude	113°30' West	
Station Meridian	105°00' West	
Difference	8°30'	
Multiply by 4	4	(Note: There are 60 minutes to a degree)
Time difference	34 minutes.	

From Table 4, Local Mean Time on the standard meridian is 12:11 on March 7 at Local Apparent Noon. Standard Time of Local Apparent Noon at the station is therefore 12:45 (12:11 plus 34 min).

At local apparent noon the operator should stand north of the anemometer tower so that the shadow of the tower is at his feet. A stake or marker is planted on the shadow at the appropriate time. From then on the marker is True North for that location and may be used at any time for anemometer alignment.

Table 4
LOCAL MEAN TIME AT LOCAL APPARENT NOON ON THE MERIDIAN

Date of Month	January	February	March	April	May	June
	h m	h m	h m	h m	h m	h m
1	12 03 1/2	12 14	12 12 1/2	12 04	11 57	11 57 1/2
4	12 05	12 14	12 12	12 03	11 56 1/2	11 58
7	12 06 1/2	12 14 1/2	12 11	12 02	11 56 1/2	11 58 1/2
10	12 07 1/2	12 14 1/2	12 10 1/2	12 01	11 56	11 59
13	12 09	12 14 1/2	12 09 1/2	12 00 1/2	11 56	12 00
16	12 10	12 14 1/2	12 08 1/2	11 59 1/2	11 56	12 00 1/2
19	12 11	12 14	12 08	11 59	11 56 1/2	12 01
22	12 11 1/2	12 14	12 07	11 58 1/2	11 56 1/2	12 02
25	12 12 1/2	12 13 1/2	12 06	11 58	11 56 1/2	12 02 1/2
28	12 13	12 13	12 05	11 57 1/2	11 57	12 03
31	12 13 1/2	.....	12 04	.....	11 57 1/2	.....

Date of Month	July	August	September	October	November	December
	h m	h m	h m	h m	h m	h m
1	12 03 1/2	12 06	11 59 1/2	11 49 1/2	11 43 1/2	11 49 1/2
4	12 04	12 06	11 58 1/2	11 48 1/2	11 43 1/2	11 50 1/2
7	12 04 1/2	12 05 1/2	11 57 1/2	11 47 1/2	11 44	11 52
10	12 05	12 05	11 56 1/2	11 47	11 44	11 53
13	12 05 1/2	12 04 1/2	11 55 1/2	11 46	11 44 1/2	11 54 1/2
16	12 06	12 04	11 54 1/2	11 45 1/2	11 45	11 56
19	12 06	12 03 1/2	11 53 1/2	11 45	11 45 1/2	11 57 1/2
22	12 06	12 02 1/2	11 52 1/2	11 44 1/2	11 46 1/2	11 59
25	12 06	12 02	11 51 1/2	11 44	11 47 1/2	12 00 1/2
28	12 06	12 01	11 50 1/2	11 44	11 48 1/2	12 02
31	12 06	12 00	.....	11 43 1/2	.....	12 03 1/2

At....................., longitude........., Local Mean Time is.......minutes later than Standard Time. To find the Mountain Standard Time of local apparent noon you may simply add....... minutes to the appropriate value in the table.
(Enter data from your station for future reference).

APPENDIX A-11

HEAVY METALS ANALYSIS

PETROLEUM REFINING

Heavy metal analyses are to be conducted on representative samples of petroleum feedstock and particulate matter which are discharged to the atmosphere at the frequency stated in the plant licence (or as may be required by the Department).

The samples of discharged particulate matter shall be obtained from atmosphere samples downstream of the pollution control equipment.

Analysis is for the heavy metals listed below:

- Arsenic (As)
- Beryllium (Be)
- Boron (B)
- Cadmium (Cd)
- Chromium (Cr)
- Cobalt (Co)
- Copper (Cu)
- Iron (Fe)
- Lead (Pb)
- Magnesium (Mg)
- Manganese (Mn)
- Mercury (Hg)
- Molybdenum (Mo)
- Nickel (Ni)
- Selenium (Se)
- Silver (Ag)
- Tin (Sn)
- Vanadium (V)
- Zinc (Zn)

NOTE: For approved analytical procedures, refer to "Methods Manual for Chemical Analysis of Atmospheric Pollutants" published by Alberta Environmental Centre.

LIST OF ELEMENTS TO BE
ANALYZED FROM STACK PARTICULATE SAMPLES
FOR THE OIL SANDS INDUSTRY

Aluminum	Al
Iron	Fe
Vanadium	V
Calcium	Ca
Titanium	Ti
Nickel	Ni
Magnesium	Mg
Molybdenum	Mo
Manganese	Mn
Copper	Cu
Zinc	Zn
Lead	Pb
Chromium	Cr
Cobalt	Co
Sodium	Na
Arsenic	As
Strontium	Sr
Beryllium	Be
Cadmium	Cd
Silver	Ag
Antimony	Sb
Tin	Sn
Tellurium	Te

Mercury and Selenium, because of their volatility, should be analyzed from a bitumen sample.

NOTE: For approved analytical procedures, refer to "Methods Manual for Chemical Analysis of Atmospheric Pollutants" published by Alberta Environmental Centre.

REPEALED - refer to 2016 Air Monitoring Directive, as amended

APPENDIX A-12

DETERMINATION OF NITROGEN DIOXIDE

(Static Monitoring)

Method No. 13536
(extracted from "Methods Manual for Chemical
Analysis of Atmospheric Pollutants 1985,"
Third Edition, Alberta Environmental Centre)

NITROGEN DIOXIDE

(Triethanolamine Exposure Method)

1. Introduction

Nitrogen dioxide in ambient air originates from combustion systems such as motor vehicles, furnaces and industrial processes. Nitrogen dioxide is only toxic to living organisms, but also plays an important role in photochemical smog-forming reactions.

2. Principle

The triethanolamine exposure method is based on the accumulation of NO_2 over a certain period of time, providing an average NO_2 concentration in ambient air. Nitrogen dioxide is absorbed on triethanolamine-impregnated paper which is exposed in the field for approximately four weeks. The filter paper is expected with Saltzman reagent and the intensity of colour is measured at 550 nm.

3. Scope

The detection limit is 2 mg/L NO_2 in the test solution.

4. Interference

Nitric oxide and ozone do not interfere. Sulphur dioxide interferes to some extent; by the addition of 1% acetone to the Saltzman reagent. However, any interference from SO_2 is avoid.

5. Apparatus

1. Whatman #1 filter paper.
2. Huey plates.
3. O-rings.
4. Spectrophotometer, 1 cm cells.

6. Reagents

1. Triethanolamine solution - dissolve 25 g triethanolamine and 4 g glycerol in 50 mL acetone and dilute the solution to 100 mL with distilled water.

2. N-(1-napthyl)-ethylenediamine dihydrochloride (0.1%) - dissolve 100 mg of the reagent in 100 mL of distilled water. Preserve the solution in a brown bottle in a refrigerator.

3. Saltzman reagent - dissolve 5.0 g of anhydrous sulphanilic acid, $NH_2C_6H_4SO_3H$, in a solution of 140 mL glacial acetic acid and 800 mL distilled water. Heat gently if necessary for complete solution. To the cooled solution, add 20 mL of the 0.1% solution of N-(1-napthyl)-ethylenediamine dihydrochloride, 10 mL acetone and dilute the solution to one litre with distilled water. The solution is preserved in a well-stoppered brown bottle in a refrigerator.

4. Stock sodium nitrite solution (2.160 g/L $NaNO_2$) - dissolve 2.160 g sodium nitrite in distilled water in a 1000 mL volumetric flask and dilute to volume with distilled water. Store the stock solution in a refrigerator.

5. Standard sodium nitrite solution (0.0216 g/L $NaNO_2$) - dilute 10.0 mL of the stock solution to 1000 mL with distilled water. One mL of this standard solution of sodium nitrite produces a colour equivalent to that of 20 µg of NO_2 in the test solution.

6. Working standards - prepare working standards by diluting the standard solution to 25 mL with Saltzman reagent as follows:

mL Standard Solution/25 mL	Concentration μg NO_2
0.10	2
0.25	5
0.50	10
0.75	15
1.00	20

NOTE: Absorbance of standards must be read within 15 minutes of preparation.

7. Procedure

a) Sampling:

1. Preparation of plates - soak Whatman #1 filter paper discs (45 mm diameter) in the triethanolamine solution for 1/2 hour. Dry them in an oven at 50°C for two hours and store in a dessicator.

2. Place one disc in a Huey plate and hold it in position with a rubber O-ring. Expose it in the field for a period of approximately four weeks.

b) Analysis:

1. Measure the area of the exposed disc in cm^2.

2. Remove the exposed disc from the Huey plate and extract it with 200 mL of Saltzman reagent for 60 minutes at room temperature.

3. Dilute a 10 mL aliquot of this solution to 25 mL with additional Saltzman reagent. Allow 15 minutes to complete the colour development.

4. Transfer a portion of the sample to a stoppered cell and read the absorbance in a spectrophotometer at 550 nm using unexposed reagent as reference.

5. Prepare working standards as described under reagents.

6. Allow 15 minutes for complete colour development and read absorbance at 550 nm.

8. Calculation

Prepare a calibration curve by plotting the absorbances vs µg NO_2. Read the concentration of sample from the graph in units of µg NO_2.

$$\mu g\ NO_2 = \frac{\mu g\ NO_2 \text{ in the aliquot x total sample volume in mL}}{\text{aliquot volume in mL}}$$

The final result is expressed as

$$\mu g\ NO_2/cm^2/day = \frac{\mu g\ NO_2}{a \times d}$$

where

a = area of the disc in cm^2
d = number of days exposed

9. Reference

1. ASTM, Part 26, 1977, p. 492.

2. S.C. Barton and H.G. McAdie "A Cumulative Survey Technique for Atmospheric Nitrogen Dioxide": Ontario Research Foundation, Sheridan Park, Ontario, Canada, presented at the 67th Annual Meeting of the Air Pollution Control Association, Denver, Colorado, June 9-13, 1974.

REPEALED - refer to 2016 Air Monitoring Directive, as amended

APPEDIX B
REPORTING

APPEDIX B-1-1

SAMPLE MONTHLY REPORT FORMAT

REPEALED - refer to 2016 Air Monitoring Directive, as amended

CEMENT MANUFACTURING
MONTHLY AIR MONITORING SUMMARY

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

STACK OPACITY MEASUREMENT

STACK TYPE	NO. HOURS READING 40%	PEAK DAILY AVERAGE	MONTHLY AVERAGE	% TIME MONITOR OPERATIONAL

STATIC AND INTERMITTENT AMBIENT MONITORING

PARAMETER	NO. OF STNS IN NETWORK	NO OF SAMPLES	PEAK READING	AVG. READING FOR NET WORK	NO. OF STNS/ SAMPLES > GUIDELINE
T. D.					
F. D					▨
H V 1					
H V 2					

STACK SURVEY RESULTS

SOURCE	DATE	POLLUTANT	LICENCE LIMIT	SURVEY RESULTS

SIGNATURE OF COMPANY REPRESENTATIVE

FOR ALBERTA ENVIRONMENT USE ONLY

Annotation for the "Monthly Report Summary"
For Cement Manufacturing

1. Only those portions of the form which are applicable to your Clean Air Licence and plant operations are required to be filled in.

2. Licence number refers to the number of the current Clean Air Licence issued by Alberta Environment.

3. Report date refers to the month and year for which data is being submitted.

4. Stack Opacity Measurement:

   (a) Stack Type: refers to the stacks that have continuous stack emission monitors.

   (b) No. of Hours Readings > 40%: is the total number of hours of opacity readings > 40%.

   (c) Peak Daily Average: refers to the highest daily average reading.

   (d) Monthly Average : is the arithmetic average of the daily average readings for the month.

   (e) % Time Monitor Operational: The % time for which the CEM was operational during the month should be shown. In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

5. Static and Intermittent Ambient Monitoring:

   (a) Parameter Identifiers:

   TD - total dustfall
   FD - fixed dustfall
   HV1 - High Volume - total suspended particulates - sampler no. 1
   HV2 - High Volume - total suspended particulates - sampler no. 2

   (b) No. of Stations

   Refers to the total number of stations in the network.

   (c) No. of Samples:

   Refers to the total number of samples collected in the month for the dustfall network and for each given high volume sampler.

   (d) Peak Reading:

   Is the highest value of all data collected.

(e) Average Reading for Network:

Is the arithmetic average of all readings collected in the month for each given parameter.

(f) No. of Stations/Samples > Guidelines:

The number of readings during the month that exceed the maximum permissible levels for the given parameter should be listed in this column.

6\. Stacks Survey Results: Average values for each parameter measured is to be reported under the survey results heading. Licence limits for each parameter measured are also to be reported. For the months that no stack survey is performed, Not Applicable (N.A.) should be filled in on the summary.

The Clean Air (Maximum Levels) Regulation references these levels as follows:

Part 1 - Section 7 (b):	Suspended particulates in the ambient air shall not exceed an average maximum permissible concentration of 100 micrograms per cubic meter as a 24-hour concentration.
Part 1 - Section 8 (b):	Total dustfall readings in the ambient air, making due allowance for normal background levels, shall not exceed 158 milligrams per 100 square centimeters per 30 days in commercial and industrial areas.

REPEALED - refer to 2016 Air Monitoring Directive, as amended

CEMENT MANUFACTURING INDUSTRY
PRODUCTION AND CONTINUOUS STACK MONITORING

PLANT ______________________ MONTH ______________

DATE	PRODUCTION (TONNES)				OPACITY (%)										ESTIMATED PARTICULATE EMISSION (g/kg)									
					STACK										STACK									
	KILN NO.																							
					AVE	MAX	AVE	MAX	AVE	MAX	AVE	MAX	AVE	MAX	AVE	MAX	AVE	MAX	AVE	MAX	AVE	MAX	AVE	MAX
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
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23																								
24																								
25																								
26																								
27																								
28																								
29																								
30																								
31																								
TOTAL																								
AVE																								

CEMENT MANUFACTURING INDUSTRY

AMBIENT MONITORING

PLANT ______________________ MONTH OF ______________________

DUSTFALL

STATION NO.	DUSTFALL (mg/100 sq cm/30 days)	
	TOTAL	CALCIUM
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

HIGH VOLUME SAMPLERS

SAMPLE DATE	SUSPENDED PARTICULATE $\mu g/m^3$	
	STATION 1	STATION 2

Certified by: ______________________

CHEMICAL INDUSTRY

MONTHLY REPORT SUMMARY

PLANT NAME/LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

SOURCE SUMMARY

POLLUTANT	STACK	AVG CONCENTRATION	NO READING >LICENCE LIMIT

STATIC AMBIENT MONITORING

PARAMETER	STN NO	PEAK READING	AVG OF NETWORK	NUMBER OF STATIONS OVER GUIDELINES

CONTINUOUS AMBIENT MONITORING

PARAMETER	STN NO	% TIME OPERATIONAL	MAX. 1 HOUR CONCENTRATION (PPM)	MAX 24 HOURS CONCENTRATION (PPM)	NO READINGS > 1 HOUR	NO READINGS >24 HOURS

SIGNATURE OF COMPANY REPRESENTATIVE

FOR ALBERTA ENVIRONMENT USE ONLY

Alberta
ENVIRONMENT

ANNOTATION FOR THE MONTHLY REPORT SUMMARY
FOR: CHEMICAL INDUSTRY

1. Only those portions of the form which are applicable to your Clean Air Act Licence and plant operations are required to be filled in.

2. Licence Number refers to the number of the current Clean Air Licence issued by Alberta Environment.

3. Report date refers to the month and year for which data is being submitted.

4. Source Summary: The pollutant measured and the identifying stack should be recorded with the average concentration and number of readings greater than the licence limits shown.

5. Static Ambient Monitoring: The pollutant measured is to be shown in the first column followed by the station number. The peak reading is the highest reading for the month at that station. The average concentration for that month is the arithmetic average of all the readings for the month. The number of stations over the guidelines is to be shown.

6. In the continuous ambient monitoring section, the specific parameter monitored along with trailer number is to be recorded, followed by the % operational time for the month for this instrument. The maximum 1-hour, 8-hour and 24-hour averages are to be provided. All readings recorded for that parameter which exceed the Clean Air (Maximum Levels) Regulation for 1-hour, 8-hour and 24-hours are to be recorded in the respective columns under "No. Readings > Regulation".

   Note: The "8-hour average" columns apply to those pollutants for which an 8-hour maximum permissible concentration is specified for in the Clean Air (Maximum Levels) Regulation.

COAL PROCESSING INDUSTRY
MONTHLY AIR MONITORING SUMMARY

PLANT NAME/ LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO
AL		

STATIC AND INTERMITTENT AMBIENT MONITORING					
PARAMETER	NO OF STNS IN NETWORK	NO OF SAMPLES	PEAK READING	AVG READING FOR NETWORK	NO. OF STNS/ SAMPLES > GUIDELINE
T D					
F D					■
H V 1					
H V 2					
C C 1					■
C C 2					■

SIGNATURE OF COMPANY REPRESENTATIVE

FOR ALBERTA ENVIRONMENT USE ONLY

Alberta
ENVIRONMENT

Annotation for the "Monthly Report Summary"

Coal Processing Industry

1. Parameter Identifiers:

TD - total dustfall
FD - fixed dustfall
HV1 - High Volume - total suspended particulates - sampler no. 1
HV2 - High Volume - total suspended particulates - sampler no. 2
CC1 - coal content in suspended particulates - sampler no. 1
CC2 - coal content in suspended particulates - sampler no. 2

2. No. of Stations

Refers to the total number of stations in the network.

3. No. of Samples:

Refers to the total number of samples collected in the month for the dustfall network and for each given high volume sampler.

4. Peak Reading:

Is the highest value of all data collected.

5. Average Reading for Network:

Is the arithmetic average of all readings collected in the month for each given parameter.

6. No. of Stns/Samples > Guidelines:

The number of readings during the month that exceed the maximum permissible levels for the given parameter should be listed in this column.

The Clean Air (Maximum Levels) Regulation references these levels as follows:

Part 1 - Section 7 (b): Suspended particulates in the ambient air shall not exceed an average maximum permissible concentration of 100 micrograms per cubic meter as a 24 hour concentration.

Part 1 - Section 8 (b): Total dustfall readings in the ambient air, making due allowance for normal background levels, shall not exceed 158 milligrams per 100 square centimeters per 30 days in commercial and industrial areas.

REPEALED - refer to 2016 Air Monitoring Directive, as amended

FERTILIZER INDUSTRY
MONTHLY REPORT SUMMARY

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE YR.	REPORT DATE MO.
AL		

TOTAL EMISSIONS FOR MONTH (In tonnes)		
POLLUTANT	SULPHURIC ACID STACK	NITRIC ACID STACK
SO_2		
NO_x		

POLLUTANT	STACK TYPE	NUMBER OF HOURS READINGS EXCEEDED STACK LICENCED LIMITS (CEM): 1 HOUR AVG. CONCENTRATION (PPM)	1 HOUR AVG. MASS EMISSION (kg)	24 HOUR AVG. MASS EMISSION (tonnes)	1 HOUR AVG. CONCENTRATION (kg/t)	24 HOUR AVG. CONCENTRATION (kg/t)	% TIME STACK MONITOR OPERATIONAL
SO_2	Sulphuric Acid						
NO_x	Nitric Acid						

STATIC AMBIENT MONITORING				
PARAMETER	NO OF STATIONS	PEAK READING	AVG OF NETWORK	NUMBER OF STATIONS OVER GUIDELINES
TOTAL SULPHATION				
FLUORIDE				

CONTINUOUS AMBIENT MONITORING						
			ONE – HOUR AVERAGE		24 – HOUR AVERAGE	
PARAMETER	STN. NO.	% TIME MONITOR OPERATIONAL	MAXIMUM CONCENTRATION (PPM)	NO. READINGS > STANDARD	MAXIMUM CONCENTRATION (PPM)	NO. READINGS > REGULATION

SIGNATURE OF COMPANY REPRESENTATIVE

FOR ALBERTA ENVIRONMENT USE ONLY

Alberta

REPEALED - refer to 2016 Air Monitoring Directive, as amended

FERTILIZER INDUSTRY
MONTHLY PRODUCTION SUMMARY
CONFIDENTIAL

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

PLANT PRODUCTION	(monthly total in tonnes)
H_2SO_4 (100%)	
HNO_3 (100%)	
NH_3	
P_2O_5 (100%)	
UREA	
AMMO PHOS.	
AMMO NIT.	

DATE	DAILY PLANT PRODUCTION (tonnes)	
	SULPHURIC ACID PLANT	NITRIC ACID PLANT
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
TOTAL		
AVG.		

SIGNATURE OF COMPANY REPRESENTATIVE

FOR ALBERTA ENVIRONMENT USE ONLY

Alberta
ENVIRONMENT

Annotation for the "Monthly Report Summary"

For Fertilizer

1. "Licence Number" refers to the number of the current Clean Air Licence issued by Alberta Environment.

2. "Month and Year" refers to the month and year of the report submitted.

3. "Total emissions for month" refers to the total number of tonnes of SO_2 and/or NO_x (as equivalent NO_2) that was emitted from the sulphuric acid and/or the nitric acid stack(s) for the report month.

4. "Number of Hours Readings Exceeded Stack Licenced Limits (CEM)" refers to the number of hours of excess emission from the sulphuric acid and/or the nitric acid plant stack as compared to maximum emission requirements listed in the Licence-to-Operate. These readings are based on continuous emission monitors (CEMS). Where the Licence-to-Operate does not specify a limit for a particular reading (i.e. 1-hour concentration) then Not Applicable (N.A.) should be filled in on the summary.

5. In calculating percentage operational times for each CEM, calibration periods (includes span checks) are not to be considered downtime.

6. For Static Ambient Monitoring, "Peak Reading" refers to the reading for the station in the network with the highest monthly exposure level.

7. "Average of network" refers to the arithmetic average of readings obtained for the exposure station network for the report month. Only those stations for which readings are available should be used in the average.

8. Continuous Ambient Monitoring Section.

a) "Parameter" refers to the individual monitoring instrument (i.e. SO_2, NO_2, NH_3, Wind).

b) "Maximum concentration" refers to the peak 1-hour or 24-hour average obtained during the month.

c) "No. readings > standard (Or regulation)" refers to the total number of 1-hour (or 24-hour) average readings in excess of the standard (or regulation) (i.e. - SO_2 - maximum 1-hour standard = 0.17 ppmv over a 1-hour period; NH_3 - maximum 1-hour guideline of 2.0 ppmv over a 1-hour time period).

REPEALED - refer to 2016 Air Monitoring Directive, as amended

FERTILIZER INDUSTRY
CONTINUOUS STACK EMISSION MONITORING RESULTS
(sulphuric & nitric acid stacks)

COMPANY ____________________ PLANT LOCATION ____________________ MONTH OF ____________________

DATE	SULPHUR DIOXIDE				OXIDES OF NITROGEN (as eq. NO_2)			
	ppm		kg/day		ppm		kg/day	
	DAILY AVG.	DAILY * MAX	DAILY AVG.	DAILY * MAX	DAILY AVG.	DAILY * MAX	DAILY AVG.	DAILY * MAX.
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
TOTAL	▨	▨		▨	▨	▨		▨
AVG.		▨		▨		▨		▨

* DAILY MAXIMUM CALCULATED ON CLOCK HOUR TIME

STATIC MONITORING RESULTS

FERTILIZER PLANT OPERATOR ______________________ PLANT LOCATION ______________________

MONTH ______________________ PERIOD OF EXPOSURE ______________________

STATION NUMBER	TOTAL SULPHATION	FLUORIDES	STATION NUMBER	TOTAL SULPHATION	FLUORIDES
1			21		
2			22		
3			23		
4			24		
5			25		
6			26		
7			27		
8			28		
9			29		
10			30		
11			31		
12			32		
13			33		
14			34		
15			35		
16			36		
17			37		
18			38		
19			39		
20			40		

COMMENTS: ______________________

NOTE: UNITS FOR TOTAL SULPHATION: SO_3 eq. mg/day/100 cm^2

UNITS FOR FLUORIDES: ug F/100 cm^2/30 days

LABORATORY RESPONSIBLE ______________________

SIGNATURE OF SUPERVISOR

Alberta
ENVIRONMENT

REPEALED - refer to 2016 Air Monitoring Directive, as amended

HEAVY OIL INSITU OPERATIONS
MONTHLY REPORT SUMMARY

PLANT NAME/ LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE YR.	REPORT DATE MO.
AL		

TOTAL EMISSIONS FOR MONTH (in tonnes)

POLLUTANT	POWER HOUSE AND BOILER STACKS	INCINERATOR STACK	FLARE	MISCELLANEOUS
SO_2				

		HOURS OF EXCEEDED STACK LICENCED LIMITS				
POLLUTANT	STACK TYPE	1 HOUR AVG. CONCENTRATION	1 HOUR AVG MASS EMISSION	24 HOUR MASS EMISSION	MIN. STACK TOP TEMP.	% TIME STACK MONITOR OPERATIONAL
SO_2						

STATIC AMBIENT MONITORING

PARAMETER	NO. OF STATIONS	PEAK READING	AVG OF NETWORK	NUMBER OF STATIONS OVER GUIDELINES
T S				
H_2S				

CONTINUOUS AMBIENT MONITORING

			1 HOUR AVERAGE		8 HOUR AVERAGE		24 HOUR AVERAGE	
PARAMETER	STN. NO	% TIME OPERATIONAL	MAXIMUM CONCENTRATION (PPM)	NO. READINGS > REGULATION	MAXIMUM CONCENTRATION (PPM)	NO. READINGS > REGULATION	MAXIMUM CONCENTRATION (PPM)	NO. READINGS > REGULATION

SIGNATURE OF COMPANY REPRESENTATIVE

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Annotation for the "Monthly Report Summary"

for Heavy Oil

1. Only those portions of the form which are applicable to your Clean Air Licence and plant operations are required to be filled in.

2. Licence number refers to the number of the current Clean Air Licence issued by Alberta Environment.

3. Report date refers to the month and year for which data is being submitted.

4. Regarding the "Total Emission for Month" section, it is noted that emissions identified be based on sulphur dioxide (SO_2) in tonnes.

5. The section pertaining to "Hours of Exceeded Stack Licenced Limits", applies to all stacks for which daily emission calculations are required, as well as to those that have continuous stack emission monitors (CEM). The % time in which the CEM was operational for the month should be shown. In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

6. For the "Static Ambient Monitoring Section", note that T.S. refers to "total sulphation" and H_2S refers to "hydrogen sulphide" exposure. In the column "No. of stations", the actual number of stations for which results for that month were obtained is to be indicated. The highest reading recorded in the network for that month is to be provided in the column "Peak Reading" for both T.S. and H_2S. The average of the readings of all stations for both T.S. and H_2S is to be shown in the column "Average of Network". As well, the number of T.S. and H_2S stations exceeding the 0.5 and 0.1 SO_3 equivalent mg/day/ 100 sq. cm., respectively is to be recorded.

7. In the "Continuous Ambient Monitoring Section", the specific parameter monitored (i.e. SO_2, H_2S, wind, etc.) along with trailer number is to be recorded, followed by the % operational time for the month for this instrument. The maximum 1-hour, 8-hour and 24-hour averages are to be provided. All readings recorded for that parameter which exceeds the Clean Air (Maximum Levels) Regulation for 1-hour, 8-hour and 24-hour are to be recorded in the respective columns under "No. Readings > Regulation".

Note: 1. The "8-hour average" columns apply only to those pollutants for which an 8-hour maximum permissible concentration is specified for in the Clean Air (Maximum Levels) Regulations.

2. "No. Readings > Regulations" for the 24 hour average H_2S readings need not be included on "Summary Sheet".

CONFIDENTIAL

OIL SANDS INDUSTRY
MONTHLY AIR MONITORING REPORT SUMMARY - PRODUCTION / CONSUMPTION

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

MONTHLY FUEL CONSUMPTION / PRODUCTION TOTALS

BITUMEN		COKE		SYNTHETIC CRUDE OIL PRODUCED (m^3)
PROCESSED (m^3)	% S CONTENT	PROCESSED (tonnes)	% S CONTENT	

SIGNATURE OF COMPANY REPRESENTATIVE

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ENVIRONMENT

ANNOTATION FOR THE MONTHLY REPORT SUMMARY

FOR: OIL SANDS

1. Licence Number refers to the number of the current Clean Air Licence issued by Alberta Environment.

2. Report date refers to the month and year for which data is being submitted.

3. Regarding the "Total Emission for Month" section, it is noted that emissions identified be based on sulphur dioxide (SO_2) in tonnes.

4. In the section pertaining to "Hours of Exceeded Stack Licenced Limits", the total number of hours, in which each of the licenced stack limits was exceeded during the month, is to be recorded. Under stack type, indicate whether it is the power house and boiler stack, incinerator or flare stack. The 24 hours SO_2 mass emission column is to be filled in. For facilities licenced with a minimum stack top limit, only the total time period below the limit needs to be reported. The % time continuous stack emission monitor (CEM) was operational for the month is to be shown. In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

5. For the "Static Ambient Monitoring Section", note that T.S. refers to "total sulphation" and H_2S refers to "hydrogen sulphide" exposure. In the column "No. of stations", the actual number of stations for which results for that month were obtained is to be indicated. The highest reading recorded in the network for that month is to be provided in the column "Peak Reading" for both T.S. and H_2S. The average of the readings of all stations for both T.S. and H_2S is to be shown in the column "Average of Network". As well, the number of T.S. and H_2S stations exceeding the 0.5 and 0.1 SO_3 equivalent mg/d/100 sq. cm., respectively is to be recorded.

6. Stack Opacity Measurement: The stack type and the number of hours of opacity readings greater than 40% is to be shown, along with the peak daily average, and monthly average. The % time the continuous emission monitor (CEM) was operational for the month is to be shown. In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

7. In the continuous ambient monitoring section, the specific parameter monitored (i.e. SO_2, H_2S, wind, etc.) along with trailer number (i.e. 1, 2, 3, etc.) is to be recorded followed by the % operational time for the month for this instrument. The maximum 1-hour and 24-hour average readings are to be noted. All readings recorded for that parameter which exceed the Clean Air (Maximum Levels) Regulation for both 1-hour and 24-hours are to be recorded in the respective columns under "No. Readings > Regulation".

Note: The maximum 24-hour readings for H_2S need not be included on the "Summary form".

8. Monthly Fuel Consumption/Production Totals: The total amount of Bitumen processed should be shown. This is followed by the % sulphur content from the analysis for that bitumen processed. The amount of coke processed and the % sulphur content from the analysis for that coke is to be shown. The amount of synthetic oil produced is shown in the last column. Note that the analyses reported should be the "as received" determination.

OIL SANDS INDUSTRIES
MONTHLY AIR MONITORING SUMMARY

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE YR.	REPORT DATE MO.
AL		

TOTAL EMISSIONS FOR MONTH (in tonnes)				
POLLUTANT	POWER HOUSE AND BOILER STACKS	INCINERATOR STACK	FLARE	SOUR WATER STRIPPER / DIVERTER
SO_2				

		NUMBER OF HOURS READINGS EXCEEDED STACK LICENCED LIMITS (CEM)				
PARAMETER	STACK TYPE	1 HOUR AVG CONCENTRATION	1 HOUR AVG. MASS EMISSION	24 HOUR MASS EMISSION	15 min AVG. STACK TOP TEMP.	% TIME STACK MONITOR OPERATIONAL

STATIC AMBIENT MONITORING				
PARAM	NO STNS IN NETWORK	PEAK READING	AVG READING FOR NETWORK	NO. READINGS > GUIDELINE
T. S				
H_2S				

STACK OPACITY MEASUREMENT				
STACK TYPE	NO HOURS READING > 40 %	PEAK DAILY AVERAGE	MONTHLY AVERAGE	% TIME MONITOR OPERATIONAL

CONTINUOUS AMBIENT MONITORING						
PARAMETER	STN NO	% TIME MONITOR OPERATIONAL	ONE - HOUR AVERAGE		24 - HOUR AVERAGE	
			MAXIMUM CONCENTRATION (PPM)	NO READINGS > REGULATION	MAXIMUM CONCENTRATION (PPM)	NO READINGS > REGULATION

SIGNATURE OF COMPANY REPRESENTATIVE

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ENVIRONMENT

POWER GENERATING INDUSTRY MONTHLY REPORT SUMMARY

PLANT NAME/LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

OPERATIONAL DATA

GENERATING UNIT		
UNIT NO.	NOMINAL CAPACITY (MW)	MONTHLY GROSS GENERATION (GWH)

COAL				
CONSUMPTION (tonnes)	QUALITY ANALYSIS AVG. FOR MONTH			
	% SULPHUR	% ASH	% MOISTURE	GROSS CAL. VALUE (kJ/kg)

SOURCE EMISSIONS

STACK NO.	UNIT NO'S SERVED BY STACK	STACK EMISSIONS (in tonnes) TOTAL FOR MONTH			% OF TIME CONTINUOUS STACK EMISSION MONITORS OPERATIONAL		
		SO_2	NO_2	PARTICULATE MATTER	SO_2	NO_x/NO_2	OPACITY

STACK NO.	UNIT NO'S SERVED BY STACK	NUMBER OF STACK READINGS IN EXCESS OF LIMITS OR REGULATIONS						
		SO_2			OPACITY	OXIDES OF NITROGEN EXPRESSED AS NO_2		
		MASS EMISSIONS		CONC.		MASS EMISSIONS		CONC.
		1 HOUR LIMIT	24 HOUR LIMIT	1 HOUR LIMIT		1 HOUR LIMIT	24 HOUR LIMIT	1 HOUR LIMIT

Alberta
ENVIRONMENT

POWER GENERATING INDUSTRY
MONTHLY REPORT SUMMARY

PLANT NAME/LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

AMBIENT MONITORING

A. CONTINUOUS AMBIENT MONITORING

			ONE – HOUR AVERAGE		24 – HOUR AVERAGE	
PARAMETER ie. SO_2, NO_2, WIND, etc.	STN. NO.	% TIME MONITOR OPERATIONAL	MAXIMUM CONCENTRATION (PPM)	NO. READINGS >REGULATION	MAXIMUM CONCENTRATION (PPM)	NO. READINGS >REGULATION

B STATIC AND INTERMITTENT AMBIENT MONITORING

PARAMETER	NO OF STNS IN NETWORK	NO. OF SAMPLES	PEAK READING	AVG. READING FOR NETWORK	NO. OF READINGS > CRITERIA
TOTAL DUSTFALL					
FIXED DUSTFALL					
TOTAL SUSP. PART.					
TOTAL SULPH.					

SIGNATURE OF COMPANY REPRESENTATIVE

FOR ALBERTA ENVIRONMENT USE ONLY

Alberta ENVIRONMENT

for Power Generating Plants

1. Only those portions of the form which are applicable to your Clean Air Licence and plant operations are required to be filled in.

2. Licence number refers to the number of the current Clean Air Licence issued by Alberta Environment.

3. Report date refers to the month and year for which data is being submitted.

4. In the section pertaining to "Generating Unit", each of the plants power generating units should be listed in the column headed "Unit No.". The corresponding nominal capacity rating and that months gross power generation should be listed in the 2 following columns.

5. In the "Coal" section, the total consumption of coal for that month should be listed in the first column. This is followed by the average quality analyses of that coal consumed. The average % sulphur, % ash, % moisture and gross calorific value should all be listed under the appropriate headings. Note that the analyses reported should be the "as received" determination.

6. The section pertaining to "Source Emissions" applies only to operations that have continuous stack emission monitors. Each stack and the power generating units served by that stack should be listed under the appropriate heading. The months total SO_2, NO_2 and particulate emissions should be listed in the next three columns.

   The percent time in which the CEM was operational for the month should be reported under the appropriate headings. In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

7. In the section pertaining to "Number of Stack Readings in Excess of Limits or Regulations", the total number of readings in which each of the licenced stack limits were exceeded during the month is to be recorded.

8. In the "Continuous Ambient Monitoring" section, the specific parameter (ie. SO_2, NO_2, wind, etc.) along with the station number is to be recorded under the appropriate headings. This is to be followed by the % time that the instrument was operational for that month. The maximum 1-hour and 24-hour average readings are to be recorded. <u>All</u> readings recorded for that parameter which exceed the Clean Air (Maximum Levels) Regulation for both 1-hour and 24-hour readings are to be recorded in the respective columns.

9. For the "Static and Intermittent Ambient Monitoring" section, the number of stations required by licence in the network is to be reported. This is followed by the actual number of stations for which results were obtained for that month. The highest reading recorded in each network for that month is to be recorded under the "Peak Reading" heading, followed by the arithmetic average reading for each network. All readings recorded in excess of the Clean Air (Maximum Levels) Regulations for each parameter should be recorded in the final column.

SUMMARY OF READINGS IN EXCESS OF STACK LICENCE LIMITS (HOURS)

Month	SO_2 conc. ppm	SO_2 Tonnes/hr	NO_x Conc. (ppm)	NO_x tonnes/hr	% Opacity	Cause
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						
TOTAL						

REPEALED - refer to 2016 Air Monitoring Directive, as amended

COMPANY [illegible]: ______________________
CLEAN AIR LICENCE NO. ______________________
LICENCE LIMIT ______________________

LOCATION ______________________
AVERAGING PERIOD & UNITS ______________________
MONITOR MAKE/MODEL ______________________

SOURCE ______________________
DATA ADJUSTED TO* ______________________
% UPTIME ______________________

DAY	HOURS																								MEAN
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
8																									
10																									
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25																									
26																									
27																									
28																									
29																									
30																									
31																									

MAX FOR THE MONTH ______________ OCCURRED ON DAY ______________ HOUR __________

*PLEASE PROVIDE RAW DATA ON THIS PAGE AND THE ADJUSTED TO LICENCE CONDITION DATA ON THE SECOND SIMILAR PAGE

INDICATE REASONS FOR NO DATA AVAILABILITY: AM = ANALYZER MALFUNCTION; CM = COMPUTER MALFUNCTION;
PM = PREVENTIVE MAINTENANCE; CM = CORRECTIVE MAINTENANCE; OC = OUT OF CONTROL DATA STATUS; OR = OTHER REASON

REPEALED - refer to 2016 Air Monitoring Directive, as amended

CONTINUOUS OPACITY MONITORING DATA FOR ________ 19___

COMPANY NAME: ____________________ LOCATION: ____________

CLEAN AIR LICENCE NO. ____________ SOURCE: ____________

MONITOR MAKE & MODEL ____________ % UPTIME: ____________

FREQUENCY DISTRIBUTION OF ALL SIX-MINUTE AVERAGE READINGS*

DATE	TOTAL NO. OF READINGS	% READING BETWEEN					NO. OF INDICATED EXCEEDENCES**	
		0-10	11-20	21-30	31-40	> 40	TOTAL	REPORTABLE
1								
2								
3								
4								
5								
6								
7								
8								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
AVERAGE								
TOTAL								

MAXIMUM OPACITY READING FOR MONTH ________ DATE & TIME OF OCCURRENCE ____________

* Reading means a six minutes average opacity.

** Notwithstanding section 10(2) of the Clean Air (Maximum Levels) Regulations, where a Clean Air Licence has an opacity limit less than 40%, one reading in excess of the limit but not greater than 40% is allowed in an hour.

ek/2344m

CONTINUOUS OPACITY MONITORING DATA FOR ________ 19__

COMPANY NAME: ______________________ LOCATION: __________

CLEAN AIR LICENCE NO. ______________ SOURCE: __________

MONITOR MAKE & MODEL ______________ % UPTIME: __________

FREQUENCY DISTRIBUTION OF ALL SIX-MINUTE AVERAGE READINGS*

DATE	TOTAL NO. OF READINGS	% READING BETWEEN					NO. OF INDICATED EXCEEDENCES**	
		0-10	11-20	21-30	31-40	> 40	TOTAL	REPORTABLE
1								
2								
3								
4								
5								
6								
7								
8								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
AVERAGE								
TOTAL								

MAXIMUM OPACITY READING FOR MONTH ________ DATE & TIME OF OCCURRENCE __________

* Reading means a six minutes average opacity.

** Notwithstanding section 10(2) of the Clean Air (Maximum Levels) Regulations, where a Clean Air Licence has an opacity limit less than 40%, one reading in excess of the limit but not greater than 40% is allowed in an hour.

ek/2344m

CONTINUOUS OPACITY MONITORING DATA FOR ________ 19__

COMPANY NAME: ______________________ LOCATION: __________

CLEAN AIR LICENCE NO. ______________ SOURCE: __________

MONITOR MAKE & MODEL ______________ % UPTIME: __________

FREQUENCY DISTRIBUTION OF ALL SIX-MINUTE AVERAGE READINGS*

DATE	TOTAL NO. OF READINGS	% READING BETWEEN					NO. OF INDICATED EXCEEDENCES**	
		0-10	11-20	21-30	31-40	> 40	TOTAL	REPORTABLE
1								
2								
3								
4								
5								
6								
7								
8								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
AVERAGE								
TOTAL								

MAXIMUM OPACITY READING FOR MONTH ________ DATE & TIME OF OCCURRENCE __________

* Reading means a six minutes average opacity.

** Notwithstanding section 10(2) of the Clean Air (Maximum Levels) Regulations, where a Clean Air Licence has an opacity limit less than 40%, one reading in excess of the limit but not greater than 40% is allowed in an hour.

ek/2344m

PULP AND PAPER INDUSTRY
MONTHLY REPORT SUMMARY

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE YR.	REPORT DATE MO.
AL		

TOTAL EMISSIONS FOR MONTH (in tonnes)

POLLUTANT	POWER HOUSE AND BOILER STACKS	MISCELLANEOUS

OPACITY MEASUREMENT (CEM)

STACK	NO. OF HOURS >20 %	NO. OF HOURS >40 %	PEAK DAILY AVERAGE	MONTHLY AVERAGE	% TIME OPERATIONAL

		NUMBER OF HOURS READINGS EXCEEDED STACK LICENCED LIMITS (CEM)			
POLLUTANT	STACK TYPE	4 HOUR AVG. STACK EMISSION (tonnes)	4 HOUR AVG. CONCENTRATION (PPM)	STACK TOP TEMPERATURE	% TIME STACK MONITOR OPERATIONAL

CONTINUOUS AMBIENT MONITORING

PARAMETER	STN NO	% TIME OPERATIONAL	MAX 1 HOUR CONCENTRATION (PPM)	MAX 24 HOURS CONCENTRATION (PPM)	NO READINGS > 1 HOUR	NO. READINGS > 24 HOURS

STATIC AMBIENT MONITORING

PARAMETER	NO OF STNS.	NO OF SAMP.	PEAK READING	AVG. OF NETWORK	NUMBER OF STATIONS OVER GUIDELINES
T.S.					
H_2S					

POLLUTANT	NO. OF ACCIDENTAL RELEASES	TOTAL HOURS OF RELEASES

SIGNATURE OF COMPANY REPRESENTATIVE

FOR ALBERTA ENVIRONMENT USE ONLY

REPEALED - refer to 2016 Air Monitoring Directive, as amended

PULP AND PAPER INDUSTRY
MONTHLY PRODUCTION REPORT SUMMARY
CONFIDENTIAL

PLANT NAME/ LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE YR.	REPORT DATE MO.
AL		

WOOD PRODUCTS MILL PRODUCTION

PULP AIR DRIED TONNES

SIGNATURE OF COMPANY REPRESENTATIVE

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ENVIRONMENT

ANNOTATION FOR THE MONTHLY REPORT SUMMARY
FOR: PULP AND PAPER

1. Licence Number refers to the number of the current Clean Air Licence issued by Alberta Environment.

2. Report date refers to the month and year for which data is being submitted.

3. Total Emissions for Month (tonnes): refers to the total number of tonnes of SO_2 that was emitted from the boiler stacks for the report month.

4. Opacity Measurements (CEM):

   (a) Stack: refers to the stacks that have continuous stack emission monitors.

   (b) No. of Hours > 20%: based on the hourly average, this is the total number of hours of opacity readings > 20%.

   No. of Hours > 40%: based on the hourly average, this is the total number of hours of opacity readings > 40%.

   (c) Peak Daily Average: refers to the highest daily average reading in %.

   (d) Monthly Average: is the arithmetic average of the daily average readings for the month in %

   (e) % Time Operational: the % time for which the CEM was operational during the month should be shown. In calculating of operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

5. Number of Hours Reading Exceeded Stack Licenced Limits (CEM): The total number of hours (based on a 4-hour average) in which each of the licenced stack limits were exceeded during the month is to be recorded.

6. % Time Stack Monitor Operational (CEM): The % time for which the CEM was operational during the month should be shown. In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

7. In the continuous ambient monitoring section, the specific parameter monitored (i.e. SO_2, H_2S, wind, etc.) along with trailer number (i.e. 1, 2, 3, etc.) is to be recorded followed by the % operational time for the month for this instrument. The maximum 1-hour and 24-hour average readings are to be noted. All readings recorded for that parameter which exceed the Clean Air (Maximum Levels) Regulation for both 1-hour and 24-hours are to be recorded in the respective columns under "No. Readings > Regulation".

   Note: The maximum 24-hour readings for H_2S need not be included on the "Summary form".

8. For the "Static Ambient Monitoring Section", note that T.S. refers to "total sulphation" and H_2S refers to "hydrogen sulphide" exposure. In the column "No. of stations", the actual number of stations for which results for that month were obtained is to be indicated. The highest reading recorded in the network for that month is to be provided in the column "Peak Reading" for both T.S. and H_2S. The average of the readings of all stations for both T.S. and H_2S is to be shown in the column "Average of Network". As well, the number of T.S. and H_2S stations exceeding the 0.5 and 0.1 SO_3 equivalent mg/d/100 sq. cm., respectively is to be recorded.

9. Number of Accidental Releases: The pollutant released, the number of occurrences and the total number of hours of releases is to be recorded.

sc/0745R

REPEALED - refer to 2016 Air Monitoring Directive, as amended

PETROLEUM REFINING INDUSTRY
MONTHLY REPORT SUMMARY
CONFIDENTIAL

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE YR.	REPORT DATE MO.
AL		

CRUDE OIL PROCESSED		
MONTHLY TOTALS (m^3)	DAILY AVERAGE (m^3)	AVERAGE SULPHUR CONTENT (%)

SIGNATURE OF COMPANY REPRESENTATIVE

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PETROLEUM REFINING INDUSTRY MONTHLY REPORT SUMMARY

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

TOTAL EMISSIONS FOR MONTH (in tonnes)				
POLLUTANT	CO BOILER STACKS	INCINERATOR STACK	FLARE	MISCELLANEOUS

		NUMBER OF HOURS READINGS EXCEEDED STACK LICENCED LIMITS (CEM)				
POLLUTANT	STACK TYPE	1 HOUR AVG. CONCENTRATION (PPM)	1 HOUR AVG. STACK EMISSION (tonnes)	24 HOUR AVG. MASS EMISSION (tonnes)	MIN. STACK TOP TEMPERATURE 15 MIN. AVG.	% TIME STACK MONITOR OPERATIONAL

STATIC AMBIENT MONITORING					
PARAMETER	NO OF STNS.	NO OF SAMP.	PEAK READING	AVG. OF NETWORK	NUMBER OF STATIONS OVER GUIDELINES

OPACITY MEASUREMENT (CEM)					
STACK	NO. OF HOURS		PEAK DAILY AVERAGE	MONTHLY AVERAGE	% TIME OPERATIONAL
	20 %	40 %			

CONTINUOUS AMBIENT MONITORING						
PARAMETER	STN. NO.	% TIME MONITOR OPERATIONAL	ONE - HOUR AVERAGE		24 - HOUR AVERAGE	
			MAXIMUM CONCENTRATION (PPM)	NO. READINGS > REGULATION	MAXIMUM CONCENTRATION (PPM)	NO READINGS > REGULATION

SIGNATURE OF COMPANY REPRESENTATIVE

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ENVIRONMENT

ANNOTATIONS FOR THE MONTHLY REPORT SUMMARY
FOR: REFINERIES

1. Only those portions of the form which are applicable to your Clean Air Licence and plant operations are required to be filled in.

2. Licence Number refers to the number of the current Clean Air Licence issued by Alberta Environment.

3. Report date refers to the month and year for which data is being submitted.

4. Total Emissions for Month: Note that emissions are to be based on sulphur dioxide (SO_2) in tonnes.

5. The section pertaining to "Hours of Exceeded Stack Licenced Limits", applies to all stacks for which daily emission calculations are required, as well as to those that have continuous stack emission monitors (CEM). The % time for which the CEM was operational for the month should be shown. In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

6. For the "Static Ambient Monitoring Section", note that T.S. refers to "total sulphation" and H_2S refers to "hydrogen sulphide" exposure. In the column "No. of stations", the actual number of stations for which results for that month were obtained is to be indicated. The highest reading recorded in the network for that month is to be provided in the column "Peak Reading" for both T.S. and H_2S. The average of the readings of all stations for both T.S. and H_2S is to be shown in the column "Average of Network". As well, the number of T.S. and H_2S stations exceeding the 0.5 and 0.1 SO_3 equivalent mg/d/100 sq. cm., respectively is to be recorded.

7. Opacity Measurement (CEM):

   (a) Stack refers to stacks that have continuous stack emission monitors.

   (b) No. of Hours > 20%: based on the hourly average, this is the total numbers of hours of opacity readings > 20%.

   No. of Hours > 40%: based on the hourly average, this is the numbers of hours of opacity readings > 40%.

   (c) Peak Daily Average: refers to the highest daily average reading in %.

   (d) Monthly Average is the arithmetic average of the daily average readings for the month in %.

   (e) % Time Operational: the % time for which the CEM was operational for the month should be shown. In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

8. In the continuous ambient monitoring section, the specific parameter monitored (i.e. SO_2, H_2S, wind, etc.) along with trailer number (i.e. 1, 2, 3, etc.) is to be recorded followed by the % operational time for the month for this instrument. The maximum 1-hour and 24-hour average readings are to be noted. All readings recorded for that parameter which exceed the Clean Air (Maximum Levels) Regulation for both 1-hour and 24-hours are to be recorded in the respective columns under "No. Readings > Regulation".

   Note: The maximum 24-hour readings for H_2S need not be included on "Summary form".

9. Confidential Report Summary: The monthly totals and the daily average of crude oil processed in m^3 should be reported. The average sulphur content in % is also to be shown.

SOUR GAS PROCESSING INDUSTRY
MONTHLY REPORT SUMMARY

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

TOTAL EMISSIONS FOR MONTH (in tonnes)			
POLLUTANT	INCINERATOR STACK	FLARE	MISCELLANEOUS
SO_2			

		'HOURS' OF EXCEEDED STACK LICENCED LIMITS				
POLLUTANT	STACK TYPE	1 HOUR AVG. CONCENTRATION	1 HOUR AVG. MASS EMISSION	24 HOUR MASS EMISSION	STACK TOP TEMP.	% TIME STACK MONITOR OPERATIONAL
SO_2						

STATIC AMBIENT MONITORING				
PARAMETER	NO. OF STATIONS	PEAK READING	AVG. OF NETWORK	NUMBER OF STATIONS OVER GUIDELINES
T. S				
H_2S				

CONTINUOUS AMBIENT MONITORING						
			ONE - HOUR AVERAGE		24 - HOUR AVERAGE	
PARAMETER	STN NO	% TIME OPERATIONAL	MAXIMUM CONCENTRATION (PPM)	NO. READINGS > REGULATION	MAXIMUM CONCENTRATION (PPM)	NO. READINGS > REGULATION

SIGNATURE OF COMPANY REPRESENTATIVE

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Alberta
ENVIRONMENT

Annotation for the "Monthly Report Summary"

for Sour Gas

1. Only those portions of the form which are applicable to your Clean Air Licence and plant operations are required to be filled in.

2. Licence number refers to the number of the current Clean Air Licence issued by Alberta Environment.

3. Month and year refer to the month and year of the report submitted.

4. Regarding the "Total Emission for the Month" section, it is noted that emissions identified in this section be based on SO_2 in tonnes. As well gas plants that vent SO_2 through point sources other than an incinerator stack and/or flare stack are to list their SO_2 emissions under heading "Miscellaneous" on the monthly report summary sheet.

5. In the section pertaining to "Hours of Exceeded Stack Licenced Limits", the total number of hours, in which each of the licenced stack limits was exceeded during the month, is to be recorded. Under stack type, indicate whether it is the incinerator or flare stack. Flaring plants are licenced for 24 hours SO_2 mass emission and this column is to be filled in. For facilities licenced with a minimum stack top limit, only the total time period below the limit needs to be reported. The % time continuous stack emission monitor (CEM) was operational for the month is to be shown. (This only applies to sulphur recovery plants which utilize CEM instrumentation on their incinerator stacks). In calculating % operational times for each CEM, calibration periods (including span checks) are not to be considered downtime.

6. For the static ambient monitoring section, note that T.S. refers to "total sulphation" and H_2S refers to "hydrogen sulphide"

exposures. In the column "No. of Stations", the actual number of stations in which results for that month were obtained is to be indicated. The highest reading recorded in the network for that month is to be recorded in the column under "Peak Reading" for both T.S. and H_2S. The average of the readings of all stations for both T.S. and H_2S is to be shown in the column under "Average of Network". As well, the number of T.S. and H_2S stations exceeding the 0.5 and 0.1 SO_3 equivalent mg/day/100 sq. cm. respectively, is to be recorded.

7. In the continuous ambient monitoring section, the specific parameter monitored (ie. SO_2, H_2S, wind, etc.) along with trailer number (ie. 1, 2, 3, etc.) is to be recorded followed by the % operational time for the month for this instrument. The maximum 1-hour and 24-hour average readings are to be noted. All readings recorded for that parameter which exceeds the Clean Air (Maximum Levels) Regulation for both 1-hour and 24-hours are to be recorded in the respective columns under "No. Readings > Regulation".

Note: The maximum 24 hour readings for H_2S need not be included on "Summary form".

SOUR GAS INDUSTRY
CONTINUOUS STACK EMISSION MONITORING RESULTS

PLANT OPERATOR ______________________ PLANT LOCATION ______________________

LICENCE LIMITS:

________ ppm / hr. ________ tonnes / hr. ________ tonnes / day ________ °C

DATE	SULPHUR DIOXIDE IN THE INCINERATOR FLUE GAS (ppm)	SULPHUR DIOXIDE (mass emission rate as tonnes) FROM THE INCINERATOR STACK		INCINERATOR STACK TEMPERATURE (°C)	SULPHUR DIOXIDE (mass emissions rate in tonnes) FROM THE FLARE STACK
	MAXIMUM 1-HOUR READING	DAILY TOTAL	MAXIMUM 1- HOUR	DAILY MINIMUM	DAILY TOTAL
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

WOOD PRODUCTS INDUSTRY

MONTHLY REPORT SUMMARY

PLANT NAME / LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE YR.	REPORT DATE MO.
AL		

BURNER TEMPERATURE	
MINIMUM REQUIRED OPERATING TEMPERATURE	% TIME BELOW REQUIRED TEMP

STATIC AND INTERMITTENT AMBIENT MONITORING

PARAMETER	NO. OF STNS IN NETWORK	NO. OF SAMPLES	PEAK READING	AVG. READING FOR NET WORK	NO. OF STNS/ SAMPLES > GUIDELINE
T. D.					
F. D.					▨
H V 1					
H V 2					

STACK SURVEY RESULTS

SOURCE	DATE	POLLUTANT	LICENCE LIMIT	SURVEY RESULTS

SIGNATURE OF COMPANY REPRESENTATIVE

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WOOD PRODUCTS INDUSTRY
MONTHLY REPORT SUMMARY
CONFIDENTIAL

PLANT NAME/LOCATION

COMPANY

LICENCE NUMBER	REPORT DATE	
	YR.	MO.
AL		

WOOD PRODUCTS MILL PRODUCTION

SIGNATURE OF COMPANY REPRESENTATIVE

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REPEALED - refer to 2016 Air Monitoring Directive, as amended

Annotation for the "Monthly Report Summary" For the Wood Products Industry

1. Only those portions of the form which are applicable to your Clean Air Licence and plant operations are required to be filled in.

2. Licence number refers to the number of the current Clean Air Licence issued by Alberta Environment.

3. Report date refers to the month and year for which data is being submitted.

4. Burner Temperatures:

   (a) Minimum Required Operating Temperature: refers to the minimum operating burner temperature as specified in the Clean Air Licence to Operate.

   (b) % Time Below Required Temperature: The amount of time that the burner operated below the minimum required temperature is to be shown in %.

5. Static and Intermittent Ambient Monitoring:

   (a) Parameter Identifiers:

   TD - total dustfall
   FD - fixed dustfall
   HV1 - High Volume - total suspended particulates - sampler no. 1
   HV2 - High Volume - total suspended particulates - sampler no. 2

   (b) No. of Stations

   Refers to the total number of stations in the network.

   (c) No. of Samples:

   Refers to the total number of samples collected in the month for the dustfall network and for each given high volume sampler.

   (d) Peak Reading:

   Is the highest value of all data collected.

   (e) Average Reading for Network:

   Is the arithmetic average of all readings collected in the month for each given parameter.

   (f) No. of Stations/Samples > Guidelines:

   The number of readings during the month that exceed the maximum permissible levels for the given parameter should be listed in this column.

6. Stacks Survey Results: Average values for each parameter measured is to be reported under the survey results heading. Licence limits for each parameter measured are also to be reported. For the months that no stack survey is performed, Not Applicable (N.A.) should be filled in on the summary.

7. Confidential Report Summary: The wood products mill production should be reported with the units of measure shown.

The Clean Air (Maximum Levels) Regulation references these levels as follows:

Part 1 - Section 7 (b):	Suspended particulates in the ambient air shall not exceed an average maximum permissible concentration of 100 micrograms per cubic meter as a 24-hour concentration.
Part 1 - Section 8 (b):	Total dustfall readings in the ambient air, making due allowance for normal background levels, shall not exceed 158 milligrams per 100 square centimeters per 30 days in commercial and industrial areas.

MONTHLY REPORT WOOD PRODUCTS INDUSTRY

WOOD WASTE BURNER PERFORMANCE SUMMARY

COMPANY: ______________________ LOCATION: ______________________

MONTH: ______________________ LICENCE NO.: ______________________

MINIMUM REQUIRED OPERATING TEMPERATURE (BY LICENCE): ______________________

Date	Production Rate (x 100 fbm)	Burner Operating Temperature		Minimum Daily Operating Temperature
		Hrs/Day	Hrs/Day Below Licenced Limit	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				

NOTES: 1. Hours of burner operation below licenced limit does not include start-up and shut-down.

2. An explanation is required if burner temperature is below licenced limit.

Alberta
ENVIRONMENT

REPEALED - refer to 2016 Air Monitoring Directive, as amended

WOOD PRODUCTS

AMBIENT MONITORING

PLANT ____________________ MONTH OF ____________________

DUSTFALL

STATION NO.	DUSTFALL (mg/100 sq. cm/30 days)	
	TOTAL	CALCIUM
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

HIGH VOLUME SAMPLERS

SAMPLE DATE	SUSPENDED PARTICULATE $\mu g/m^3$	
	STATION 1	STATION 2

Certified by: ____________________

REPEALED - refer to 2016 Air Monitoring Directive, as amended

APPENDIX B-2

SOURCE EMISSION SURVEY REPORT FORMAT

SOURCE EMISSION SURVEY REPORT FORMAT

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Page

I. Introduction

The stack emission survey reports must be tabulated, summarized, and forwarded to the Director of Standards and Approvals of Alberta Environment either as an attachment to the company monthly report or as a separate stack survey report.

This report format applies to stack surveys required by the Energy Resources Conservation Board (E.R.C.B.) unless indicated otherwise by the E.R.C.B. Stack survey reports for the sour gas industry shall be submitted to the E.R.C.B.

II. Stack Emission Survey Reporting Requirements

A. General

1. All stack emission survey reports required by Alberta Environment, not included with monthly air monitoring reports, shall be addressed as follows:

   Director, Division of Standards and Approvals
   Alberta Environment
   4th Floor, Oxbridge Place
   9820 - 106 Street
   Edmonton, Alberta
   T5K 2J6

2. All reports shall be clearly legible and contain the necessary detail as specified in this report format.

3. All stack emission survey reports shall include all the information requested in this directive, unless prior

agreement has been obtained from the Air Quality Branch of the Division of Standards and Approvals.

4. In a covering letter with the report, the licencee shall include:

    a) the actual operating rate during the survey,
    b) the percentage of licenced process operating rate during the survey,
    c) the emission limits for each pollutant as stated in the Licence to Operate,
    d) whether the process is in compliance with the emission limits stated in the Licence to Operate,
    e) the chart data from the continuous emission monitor for the corresponding stack survey period and also for the six hour periods prior to and immediately after the stack survey period (applies only to stacks equipped with continuous emission monitors).

99B. Report Format

1. Title page

a) The heading of the title page shall make reference to the plant name, plant location, and the date of the survey.

b) The title page shall also contain the name of the sampling firm and the author of the report.

2. Summary

The summary of the source emission survey shall contain:

a) The identity of the stack(s) sampled during the survey.

b) The identity of the pollutant(s) collected.

c) A summary of emission results.

d) Reasons for any omission of any results (i.e., inconsistencies in findings, problems with analytical procedures, problems with sampling procedures, etc.)

3. Table of Contents

The source emission survey report shall include a table of contents.

4. Test Methods

a) A brief outline of the methods and equipment used to collect and analyze the samples shall be contained in this section.

b) This section must also explain in detail any deviation from the Alberta Environment Source Sampling Code (Publication SSC-1/76) or any other reference methods.

c) The most recent calibration dates for pitot tubes, dry gas meter and orifice shall be included.

d) For stacks equipped with continuous emission monitors the most recent calibration date(s) for the continuous emission monitor(s).

5. Results

The section on results shall contain:

a) A table to include the stack(s) surveyed, test number, name of pollutant(s), concentration of pollutant(s) expressed as kilograms per thousand kilograms of flue gas (pounds per thousand pounds of flue gas), or parts per million for gaseous pollutants, and mass emission rates of pollutant(s) expressed as kilograms per hour (pounds per hour) or as required by the conditions stated in the Licence to Operate. This table should also include the average concentration and mass emission rate for each pollutant surveyed.

b) The mean isokinetic variations for each particulate test shall be included in a table.

c) A table to include an approximate particulate weight distribution where particulates are being sampled, based on percentage of particulate catch in the front half and back half of the sampling train.

d) For stacks equipped with continuous emission monitors. (CEM'S) (except opacity monitors), a table shall be included with the following information.

- The stack(s) surveyed, test numbers, date.
- Name of pollutant.
- Concentration of pollutant effluent flow rate, and mass emission of pollutant as determined by the stack survey.
- Corresponding CEM readings for the compliance survey period.
- Percentage deviation from stack survey.
- Any problem noted with the CEM and a possible explanation for the difference between stack survey and CEM results when this difference is significant (i.e. >10%).

6. Discussion

A discussion of the survey shall indicate:

a) Problems encountered with sampling equipment (if any).

b) Problems encountered during sample analysis (if any).

c) Problems encountered due to inadequate sampling facilities (if any).

d) Sampling problems associated with plant operations (if any), (i.e., process rate changes in plant operating parameters, etc.).

7. Appendices

a) An appendix shall be included in the report giving the computer output or equivalent for each test. This should contain:

    i) Barometric pressure in inches of mercury (or millimeters of mercury).
    ii) Stack static pressure in inches of mercury (or millimeters of mercury).
    iii) Average stack temperature in degrees Fahrenheit(or degrees celsius).
    iv) Average orifice pressure in inches of water (millimeters of water) or equivalent data.
    v) Pitot correction factor.
    vi) Stack diameter in feet (or meters).
    vii) Volume (weight) of condensate collected in millimeters (or grams).
    viii) Volume of flue gas sampled at meter conditions in cubic feet (or cubic meters).

    ix) Average flue gas velocity in feet per second (or meters per second).
    x) Effluent flowrate at reference conditions in cubic feet per second (or cubic meters per second).
    xi) Average flue gas composition.
    xii) Pollutant emission results expressed as concentration and mass emission rate.

b) An appendix shall be supplied giving a point by point isokinetic variation for each particulate test.

c) An appendix shall be included showing the velocity profile for each traverse.

d) An appendix shall be included supplying the original or a legible photocopy of the original raw field data for each test unless prior agreement with Air Quality Branch for deletion of field data has been obtained.

e) An appendix shall be included showing all calculations used for the survey results that do not appear in the Stack Sampling Code (SSC-176) (i.e. excess air calculations, concentration to mass emission calculations, etc.).

f) For stacks equipped with continuous emission monitors, an appendix shall be included containing:

    i) The original or legible photocopy of the continuous emission monitor chart data for the time period in which the compliance test was conducted as well as for the six hour periods before and after the stack survey period.

ii) The most recent calibration date on the continuous emission monitor.

iii) The method of calibration used for the continuous emission monitor.

III. SAMPLE REPORT

Source Emission Survey
Name of Industry
Location of Industry
Month, Year

Sampled by:
Written by:

SUMMARY

Alberta Environment conducted a source emission survey on the kiln stack at Super Company, Anywhere, Alberta on November 26 and 27, 1985.

This survey was conducted to determine the concentrations and mass emission rates of sulphur dioxide and particulates. The sulphur dioxide mass emission rates ranged from 9.3 to 17.0 kilograms per hour with a corresponding concentration range of 94.2 to 124.9 parts per million. The particulate concentrations ranged from 0.11 to 0.15 kilograms of particulate per thousand kilograms of stack effluent with a corresponding particulate mass emission range of 5.2 to 6.5 kilograms per hour.

Results for particulate concentrations and mass emission rates are based on the sample collected in the front half of the sampling train only. The back half particulate catch was not used for determination of particulate emission levels due to formation of pseudo particulates in the sampling process.

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TEST METHODS

The test methods and equipment used to collect the samples were an integration of the equipment and procedures described in Methods 4 and 5 of the Alberta Environment Source Sampling Code (Publication SSC-1/76) for the testing of particulates and sulphur dioxide. The samples were collected isokinetically through a sampling system consisting of the following components. A button-hook type nozzle was connected to a five foot long, glass lined probe, which, in turn, was connected to a glass fibre filter. The sample was then pulled through a series of impingers and through the pump, meter and orifice. The first two impingers each contained 150 mls of 3% hydrogen peroxide, the third impinger was dry and the fourth contained 500 grams of a drying agent.

The particulate catch collected in the back half of the sampling train was not included in the particulate emission results as pseudo particulates were formed in the impinger solutions from sulphates in the stack effluent. The most recent calibration of the pitot tube, dry gas meter and orifice used in the survey, occurred on March 15, 1985.

The most recent calibrations of the sulphur dioxide and opacity continuous emission monitors located on this stack were carried out on May 17, 1985 and August 23, 1985 respectively.

RESULTS

The sulphur dioxide concentrations and mass emission rates calculated for this survey are summarized in Table 1. Particulate concentrations and mass emission rates are shown in Table 2, as well as the mean isokinetic sampling variation for each test. Table 3 indicates the approximate particulate catch distribution. A comparison of the stack survey data to the continuous emission monitoring data is shown in Table #4.

Table 1

SULPHUR DIOXIDE CONCENTRATIONS AND MASS EMISSION RATES

Super Company
Kiln Stack

Test No.	Date	Time	SO_2 Concentration (ppmv)	SO_2 Mass Emission Rate (kg/hr)
1	Nov. 26/85	1550-1655	94.2	9.7
2	Nov. 26/85	1700-1805	124.9	12.0
3	Nov. 27/85	0900-1010	96.9	9.3
		Avg.	105.3	10.3

Table 2

PARTICULATE CONCENTRATIONS AND
MASS EMISSION RATES

Super Company
Kiln Stack

Test No.	Date	Time	Particulate Concentration (kg/1000 kg)	Particulate Mass Emission (kg/hr)	Mean Isokinetic Variation (%)
1	Nov. 26/85	1550-1655	0.11	5.2	98.29
2	Nov. 26/85	1700-1805	0.15	6.5	105.70
3	Nov. 27/85	0900-1010	0.14	6.2	102.57
		Avg.	0.13	6.0	

Table 3

PARTICULATE CATCH DISTRIBUTION

Super Company
Kiln Stack

Test No.	Front Half (%)	Back Half (%)
1	100.0	0.0*
2	100.0	0.0
3	100.0	0.0

* For this survey, the back half was not analyzed for particulate loading (see Test Method Section for details).

Table 4

COMPARISON OF STACK SURVEY AND CONTINUOUS EMISSION MONITOR DATA

Super Company
Kiln Stack

Parameter Measured	Test 1, Nov. 26/85, 1550–1655 hrs			Test 2, Nov. 26/85 1700–1805 hrs			Test 3, Nov. 27/85, 0900–1010 hrs		
	Stack Survey	CEM	% Deviation	Stack Survey	CEM	% Deviation	Stack Survey	CEM	% Deviation
SO_2 conc. (ppm)	94.2	93.1	-1.2	124.9	130.3	+4.3	96.9	99.5	+2.7
Effluent flowrate (m^3/s)	10.7	10.9	+1.9	10.1	10.5	+4.0	10.0	5.1	-49.8*
SO_2 Emission Rate (kg/hr)	9.7	9.6	-1.0	12.0	13.1	+9.2	9.3	6.0	-36.8*

* The CEM effluent flowrate and mass emission rate data from Test 3 was low due to a leak in the system. The problem was found and rectified.

DISCUSSION

There were no major problems encountered while conducting the source emission survey or in the analysis of the samples collected. One minor problem that occurred was that the sampling rate for the first point on test 2 was set slightly higher than desired, resulting in an isokinetic sampling rate of 110.37%. Also, some problems were encountered in obtaining an acceptable leakage rate at the beginning of the first test due to ice buildup on the glassware connections. This resulted in a late start for this survey as can be seen by a start time of 1550 hours for Test 1. Although lights were available, the third test of this survey was conducted the next day due to concerns for personnel safety. The third test was carried out without any problems.

The plant operated in a steady state manner throughout the testing period. Plant production rates are provided in the covering letter to this report.

The results obtained from this survey are considered representative of the stack emissions at the time of the survey was conducted.

APPENDIX A

DATA OUTPUT

```
ALBERTA ENVIRONMENT,AIR QUALITY CONTROL BRANCH

 SUPER COMPANY ,KILN STACK,TEST 1
 NOV.26 ,1985

            OBSERVATIONS AND RESULTS
BAROMETRIC PRESSURE                           IN HG        26.50(673.1 MM HG)
STACK PRESSURE,STATIC                         IN HG         0.01( 0.28 MM HG)
AVERAGE STACK TEMPERATURE                     DEG F       181.70( 83.2 DEG C)
AVERAGE ORIFICE PRESSURE                     IN H2O         0.80( 20.3 MM H2O
PITOT CORRECTION FACTOR                                    0.840
STACK DIAMETER                                 FEET         4.50(1.37 METERS)
VOLUME OF CONDENSATE COLLECTED                   ML         2.
VOLUME OF FLUE GAS SAMPLED,METER COND         CU FT        31.31( 0.89 CU M)
AVERAGE FLUE GAS VELOCITY                       FPS        32.63(  9.9 M/S)
EFFLUENT FLOWRATE,REFERENCE COND.               CFS       379.7(  10.7CU M/S

      SAMPLE COLLECTION PERIOD  1550 1655

          AVERAGE FLUE GAS COMPOSITION

                         WET BASIS          DRY BASIS
CONSTITUENT             MOLE PERCENT       MOLE PERCENT
    CO2                    0.0                0.0
    O2                    20.928             21.000
    N2                    78.729             79.000
    H2O                    0.343
MOLECULAR WT              28.80 (28.80)      28.84 (28.84)

           POLLUTANT EMISSION RESULTS

**********************************************************************
SULFUR DIOXIDE
---------------

EMISSION RATE OF SULFUR DIOXIDE          LB/HR        21.3 (      9.7KG/HR)
FLOWRATE OF SULFUR DIOXIDE                SCFS       0.036  ( 0.0010CU M/S
CONCENTRATION OF SULFUR DIOXIDE,WET       PPMV        94.2
OVERALL MAXIMUM GROUND-LEVEL CONCENTRATION=0.024 PPM AS A 1.00 HOUR AVG.
                    DISTANCE OF OCCURRENCE=     158. M
              CRITICAL TEN-METRE WINDSPEED=       9.0 M/S

******************************************************************** *

ASSUMPTIONS USED WHILE CALCULATING THE MGLC FOR THE ABOVE POLLUTANTS
STACK HEIGHT =    40.  FT  (    12.   M )  AMBIENT TEMPERATURE =     8. DEG   (
FLAT AND ROUGH TERRAIN
DIFFUSION WITHIN A MIXING LAYER BENEATH AN ELEVATED INVERSION
INVERSION BASE AT LEVEL OF HIGHEST PLUME OR 100. M WHICHEVER IS LARGER
TEN-METRE WINDSPEEDS BETWEEN 1 AND 20 M/S, INCREMENTS 0.5 M/S ARE EXAMINEI

**********************************************************************
PARTICULATES FROM THE FRONT-HALF OF TRAIN
------------------------------------------

EMISSION RATE OF PARTICULATES             LB/HR        11.4    (    5.2KG/HR)
CONCENTRATION OF PARTICULATES         LB/1000 LB      0.11(0.11 KG/1000 KG)

**********************************************************************
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ALBERTA ENVIRONMENT,AIR QUALITY CONTROL BRANCH

 SUPER COMPANY,KILN STACK, TEST 2
 NOV.26 ,1985


            OBSERVATIONS AND RESULTS
BAROMETRIC PRESSURE                               IN HG       26.50(673.1 MM HG)
STACK PRESSURE,STATIC                             IN HG        0.01( 0.32 MM HG)
AVERAGE STACK TEMPERATURE                         DEG F      181.25( 82.9 DEG C)
AVERAGE ORIFICE PRESSURE                         IN H2O        0.85( 21.6 MM H2O
PITOT CORRECTION FACTOR                                       0.830
STACK DIAMETER                                     FEET        4.50(1.37 METERS)
VOLUME OF CONDENSATE COLLECTED                       ML        5.
VCLUME OF FLUE GAS SAMPLED,METER COND             CU FT       32.38( 0.92 CU M)
AVERAGE FLUE GAS VELOCITY                           FPS       30.51(  9.3 M/S)
EFFLUENT FLOWRATE,REFERENCE COND.                   CFS       355.3(  10.1CU M/S

      SAMPLE COLLECTION PERIOD  1700 1805

          AVERAGE FLUE GAS COMPOSITION

                          WET BASIS          DRY BASIS
CONSTITUENT              MOLE PERCENT       MOLE PERCENT
    CO2                     0.0                0.0
    O2                     20.821             21.000
    N2                     78.326             79.000
    H2O                     0.853
MOLECULAR WT               28.75 (28.75)      28.84 (28.84)

           POLLUTANT EMISSION RESULTS

*************************************************************************
SULFUR DIOXIDE
--------------

EMISSION RATE OF SULFUR DIOXIDE             LB/HR        26.4 (     12.0KG/HR)
FLOWRATE OF SULFUR DIOXIDE                   SCFS       0.044   ( 0.0013CU M/S
CONCENTRATION OF SULFUR DIOXIDE,WET          PPMV       124.9
OVERALL MAXIMUM GROUND-LEVEL CONCENTRATION=0.031 PPM AS A 1.00 HOUR AVG.
                    DISTANCE OF OCCURRENCE=     158. M
              CRITICAL TEN-METRE WINDSPEED=      8.5 M/S

*************************************************************************

ASSUMPTIONS USED WHILE CALCULATING THE MGLC FOR THE ABOVE POLLUTANTS
STACK HEIGHT =    40.   FT  (   12.   M )  AMBIENT TEMPERATURE =     8. DEGS
FLAT AND ROUGH TERRAIN
DIFFUSION WITHIN A MIXING LAYER BENEATH AN ELEVATED INVERSION
INVERSION BASE AT LEVEL OF HIGHEST PLUME OR 100. M WHICHEVER IS LARGER
TEN-METRE WINDSPEEDS BETWEEN 1 AND 20 M/S, INCREMENTS 0.5 M/S ARE EXAMINE

*************************************************************************
PARTICULATES FROM THE FRONT-HALF OF TRAIN
-------------------------------------------

EMISSION RATE OF PARTICULATES             LB/HR        14.2    (    6.5KG/HR)
CONCENTRATION OF PARTICULATES         LB/1000 LB      0.15(0.15 KG/1000 KG)

*************************************************************************
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ALBERTA ENVIRONMENT,AIR QUALITY CONTROL BRANCH

 SUPER COMPANY,KILN STACK, TEST 3
 NOV. 27,1985


            OBSERVATIONS AND RESULTS
BAROMETRIC PRESSURE                          IN HG     26.60(675.6 MM HG)
STACK PRESSURE,STATIC                        IN HG      0.01( 0.32 MM HG)
AVERAGE STACK TEMPERATURE                    DEG F    187.25( 86.2 DEG C)
AVERAGE ORIFICE PRESSURE                    IN H2O      0.87( 22.1 MM H2O
PITOT CORRECTION FACTOR                                0.840
STACK DIAMETER                                FEET      4.50(1.37 METERS)
VOLUME OF CONDENSATE COLLECTED                  ML      2.
VOLUME OF FLUE GAS SAMPLED,METER COND        CU FT     30.05( 0.85 CU M)
AVERAGE FLUE GAS VELOCITY                      FPS     30.56(  9.3 M/S)
EFFLUENT FLOWRATE,REFERENCE COND.              CFS     353.9(  10.0CU M/S

      SAMPLE COLLECTION PERIOD   900 1010

          AVERAGE FLUE GAS COMPOSITION

                         WET BASIS          DRY BASIS
CONSTITUENT             MOLE PERCENT       MOLE PERCENT
    CO2                    0.0                0.0
    O2                    20.926             21.000
    N2                    78.721             79.000
    H2O                    0.353
MOLECULAR WT              28.80 (28.80)      28.84 (28.84)

           POLLUTANT EMISSION RESULTS

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SULFUR DIOXIDE
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EMISSION RATE OF SULFUR DIOXIDE            LB/HR         20.4 (      9.3KG/HR)
FLOWRATE OF SULFUR DIOXIDE                  SCFS        0.034  ( 0.0010CU M/S
CONCENTRATION OF SULFUR DIOXIDE,WET         PPMV         96.9
OVERALL MAXIMUM GROUND-LEVEL CONCENTRATION=0.023 PPM AS A 1.00 HOUR AVG.
                    DISTANCE OF OCCURRENCE=    158. M
              CRITICAL TEN-METRE WINDSPEED=     8.5 M/S

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ASSUMPTIONS USED WHILE CALCULATING THE MGLC FOR THE ABOVE POLLUTANTS
STACK HEIGHT =    40.   FT  (    12.   M )  AMBIENT TEMPERATURE =     6. DEGS
FLAT AND ROUGH TERRAIN
DIFFUSION WITHIN A MIXING LAYER BENEATH AN ELEVATED INVERSION
INVERSION BASE AT LEVEL OF HIGHEST PLUME OR 100. M WHICHEVER IS LARGER
TEN-METRE WINDSPEEDS BETWEEN 1 AND 20 M/S, INCREMENTS 0.5 M/S ARE EXAMINE

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PARTICULATES FROM THE FRONT-HALF OF TRAIN
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EMISSION RATE OF PARTICULATES               LB/HR         13.6    (    6.2KG/HR)
CONCENTRATION OF PARTICULATES          LB/1000 LB       0.14(0.14 KG/1000 KG)

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APPENDIX B

ISOKINETIC VARIATIONS

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                 ALBERTA ENVIRONMENT,AIR QUALITY CONTROL BRANCH
                           PERCENT ISOKINETIC RESULTS

  SUPER COMPANY ,KILN STACK,TEST 1

POINT #   STACK TEMP   VEL PRES   ORIFICE   VOLUME   TIME   TEMP IN   TEMP OUT
             DEG R     IN. H2O    IN. H2O   CU FT    MIN    DEG R      DEG R
   1        650.00      0.170      0.540    1.310    3.00   525.00     524.00
   2        649.00      0.240      0.780    1.540    3.00   526.00     526.00
   3        644.00      0.250      0.800    1.600    3.00   527.00     527.00
   4        642.00      0.260      0.840    1.580    3.00   527.00     529.00
   5        642.00      0.270      0.860    1.620    3.00   528.00     529.00
   6        642.00      0.270      0.860    1.620    3.00   529.00     530.00
   7        641.00      0.270      0.860    1.630    3.00   530.00     532.00
   8        640.00      0.270      0.860    1.610    3.00   531.00     533.00
   9        640.00      0.250      0.800    1.560    3.00   533.00     534.00
  10        640.00      0.220      0.700    1.480    3.00   533.00     534.00
  11        641.00      0.200      0.650    1.380    3.00   533.00     535.00
  12        640.00      0.220      0.700    1.500    3.00   534.00     535.00
  13        640.00      0.250      0.800    1.570    3.00   535.00     537.00
  14        640.00      0.250      0.800    1.570    3.00   537.00     539.00
  15        640.00      0.260      0.840    1.630    3.00   539.00     541.00
  16        640.00      0.260      0.840    1.620    3.00   540.00     542.00
  17        640.00      0.260      0.840    1.640    3.00   540.00     543.00
  18        641.00      0.260      0.840    1.640    3.00   540.00     544.00
  19        641.00      0.250      0.800    1.610    3.00   541.00     545.00
  20        641.00      0.250      0.800    1.600    3.00   543.00     546.00

                       POINT #   VELOCITY   % ISO
                          1        27.31   101.33
                          2        32.43    99.96
                          3        32.97   101.18
                          4        33.57    97.64
                          5        34.21    98.16
                          6        34.21    97.97
                          7        34.18    98.22
                          8        34.16    96.76
                          9        32.87    97.14
                         10        30.83    98.22
                         11        29.42    96.02
                         12        30.83    99.36
                         13        32.87    97.31
                         14        32.87    96.95
                         15        33.52    98.34
                         16        33.52    97.56
                         17        33.52    98.67
                         18        33.55    98.66
                         19        32.89    98.58
                         20        32.89    97.70
                           ARITHMETIC AVG   98.29
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                  ALBERTA ENVIRONMENT,AIR QUALITY CONTROL BRANCH
                         PERCENT ISOKINETIC RESULTS

 SUPER COMPANY,KILN STACK, TEST 2

POINT #   STACK TEMP   VEL PRES   ORIFICE   VOLUME   TIME   TEMP IN   TEMP OUT
            DEG R      IN. H2O    IN. H2O   CU FT    MIN    DEG R      DEG R
   1       643.00      0.080      0.260     1.020    3.00   552.00     552.00
   2       643.00      0.200      0.720     1.520    3.00   552.00     552.00
   3       642.00      0.200      0.720     1.600    3.00   552.00     552.00
   4       642.00      0.200      0.720     1.560    3.00   551.00     552.00
   5       642.00      0.200      0.720     1.580    3.00   552.00     552.00
   6       642.00      0.200      0.720     1.550    3.00   552.00     552.00
   7       642.00      0.200      0.720     1.560    3.00   552.00     552.00
   8       640.00      0.200      0.720     1.540    3.00   552.00     552.00
   9       641.00      0.210      0.750     1.600    3.00   551.00     551.00
  10       641.00      0.230      0.830     1.640    3.00   552.00     552.00
  11       641.00      0.150      0.540     1.370    3.00   552.00     554.00
  12       640.00      0.180      0.650     1.470    3.00   552.00     554.00
  13       640.00      0.270      0.960     1.720    3.00   552.00     554.00
  14       640.00      0.270      0.960     1.760    3.00   552.00     556.00
  15       641.00      0.280      1.000     1.810    3.00   552.00     556.00
  16       641.00      0.280      1.000     1.820    3.00   552.00     556.00
  17       641.00      0.280      1.000     1.810    3.00   552.00     556.00
  18       641.00      0.280      1.000     1.810    3.00   552.00     556.00
  19       641.00      0.280      1.000     1.810    3.00   552.00     556.00
  20       641.00      0.280      1.000     1.810    3.00   552.00     556.00

                          POINT #   VELOCITY   % ISO
                             1       18.43    110.37
                             2       29.14    104.16
                             3       29.12    109.56
                             4       29.12    106.91
                             5       29.12    108.19
                             6       29.12    106.13
                             7       29.12    106.82
                             8       29.08    105.28
                             9       29.82    107.03
                            10       31.20    104.67
                            11       25.20    107.98
                            12       27.58    105.72
                            13       33.78    101.09
                            14       33.78    103.25
                            15       34.43    104.37
                            16       34.43    104.94
                            17       34.43    104.37
                            18       34.43    104.37
                            19       34.43    104.37
                            20       34.43    104.37
                              ARITHMETIC AVG  105.70
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                    ALBERTA ENVIRONMENT,AIR QUALITY CONTROL BRANCH
                              PERCENT ISOKINETIC RESULTS

 SUPER COMPANY,KILN STACK, TEST 3

POINT #   STACK TEMP   VEL PRES   ORIFICE   VOLUME   TIME   TEMP IN   TEMP OUT
             DEG R      IN. H2O   IN. H2O   CU FT     MIN    DEG R     DEG R
   1        663.00      0.150     0.500     1.260    3.00   518.00    515.00
   2        661.00      0.200     0.670     1.450    3.00   518.00    515.00
   3        660.00      0.250     0.850     1.620    3.00   518.00    515.00
   4        660.00      0.250     0.850     1.610    3.00   518.00    515.00
   5        657.00      0.250     0.850     1.610    3.00   523.00    520.00
   6        653.00      0.250     0.850     1.610    3.00   523.00    522.00
   7        651.00      0.270     0.900     1.650    3.00   523.00    524.00
   8        650.00      0.230     0.790     1.560    3.00   524.00    526.00
   9        645.00      0.200     0.670     1.470    3.00   524.00    526.00
  10        645.00      0.200     0.670     1.450    3.00   524.00    537.00
  11        645.00      0.170     0.560     1.360    3.00   531.00    537.00
  12        641.00      0.200     0.670     1.460    3.00   531.00    537.00
  13        640.00      0.200     0.670     1.420    3.00   534.00    537.00
  14        640.00      0.230     0.790     1.550    3.00   534.00    539.00
  15        640.00      0.230     0.790     1.540    3.00   534.00    539.00
  16        640.00      0.230     0.790     1.540    3.00   534.00    540.00
  17        639.00      0.200     0.670     1.480    3.00   535.00    542.00
  18        639.00      0.200     0.670     1.470    3.00   537.00    546.00
  19        638.00      0.200     0.670     1.470    3.00   539.00    546.00
  20        638.00      0.200     0.670     1.470    3.00   542.00    546.00

                   POINT #   VELOCITY   % ISO
                      1        25.86    106.61
                      2        29.82    106.14
                      3        33.34    106.03
                      4        33.31    105.38
                      5        33.24    104.13
                      6        33.14    103.61
                      7        34.38    101.84
                      8        31.71    103.92
                      9        29.46    104.57
                     10        29.46    102.08
                     11        27.16    103.13
                     12        29.37    101.79
                     13        29.34     98.65
                     14        31.47    100.26
                     15        31.47     99.61
                     16        31.47     99.52
                     17        29.32    102.16
                     18        29.32    100.91
                     19        29.30    100.64
                     20        29.30    100.37
                      ARITHMETIC AVG    102.57
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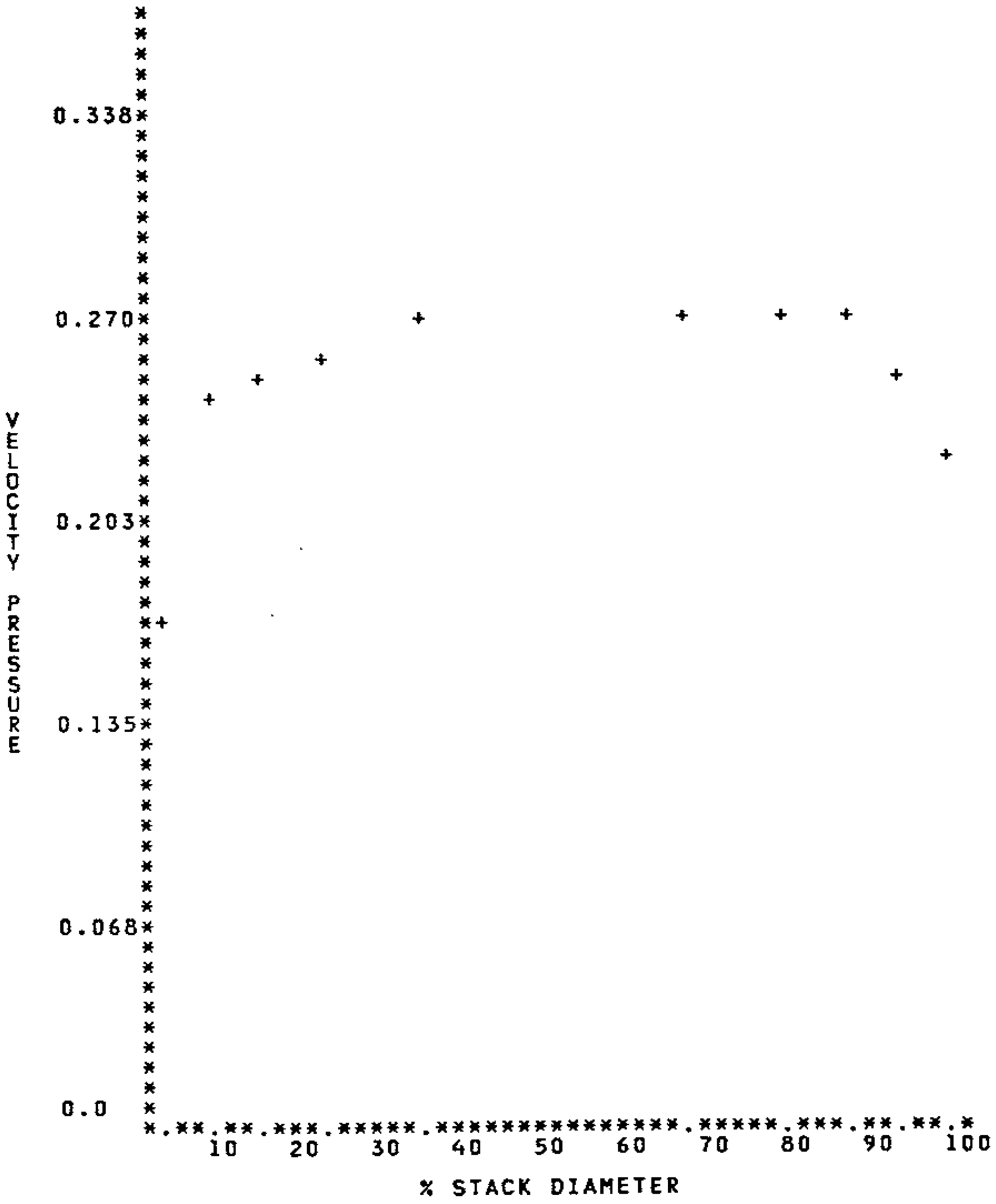
APPENDIX C

VELOCITY PROFILES

ALBERTA ENVIRONMENT, AIR QUALITY CONTROL BRANCH

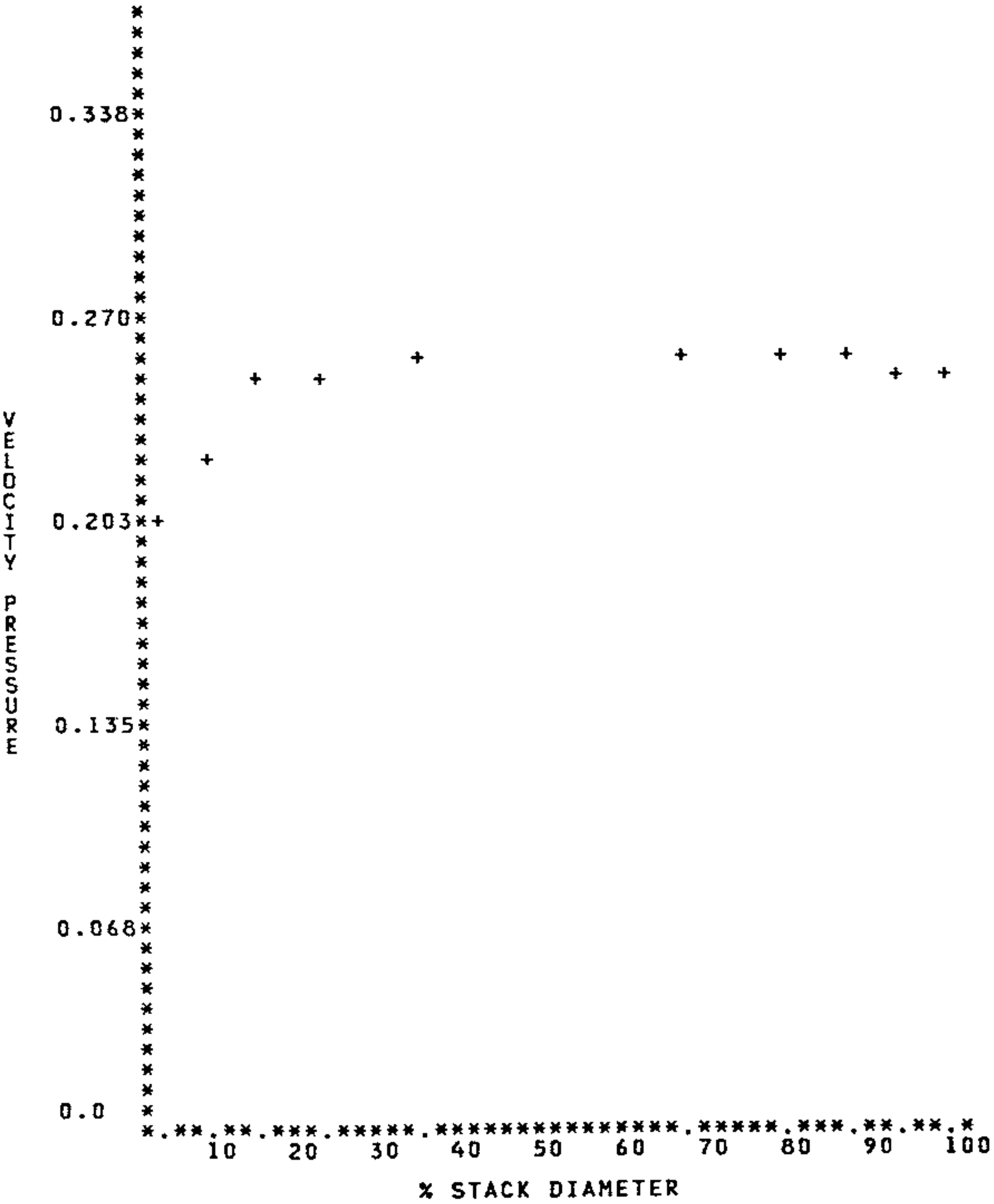
VELOCITY PROFILE
SUPER COMPANY ,KILN STACK,TEST 1
VELOCITY PRESSURE VS. % STACK DIAMETER
NOV.26 ,1985 , EAST PORT



NOTE: VELOCITY PRESSURE IN INCHES OF WATER
DOTS ON X-AXIS INDICATE SAMPLING POINT LOCATION

ALBERTA ENVIRONMENT, AIR QUALITY CONTROL BRANCH

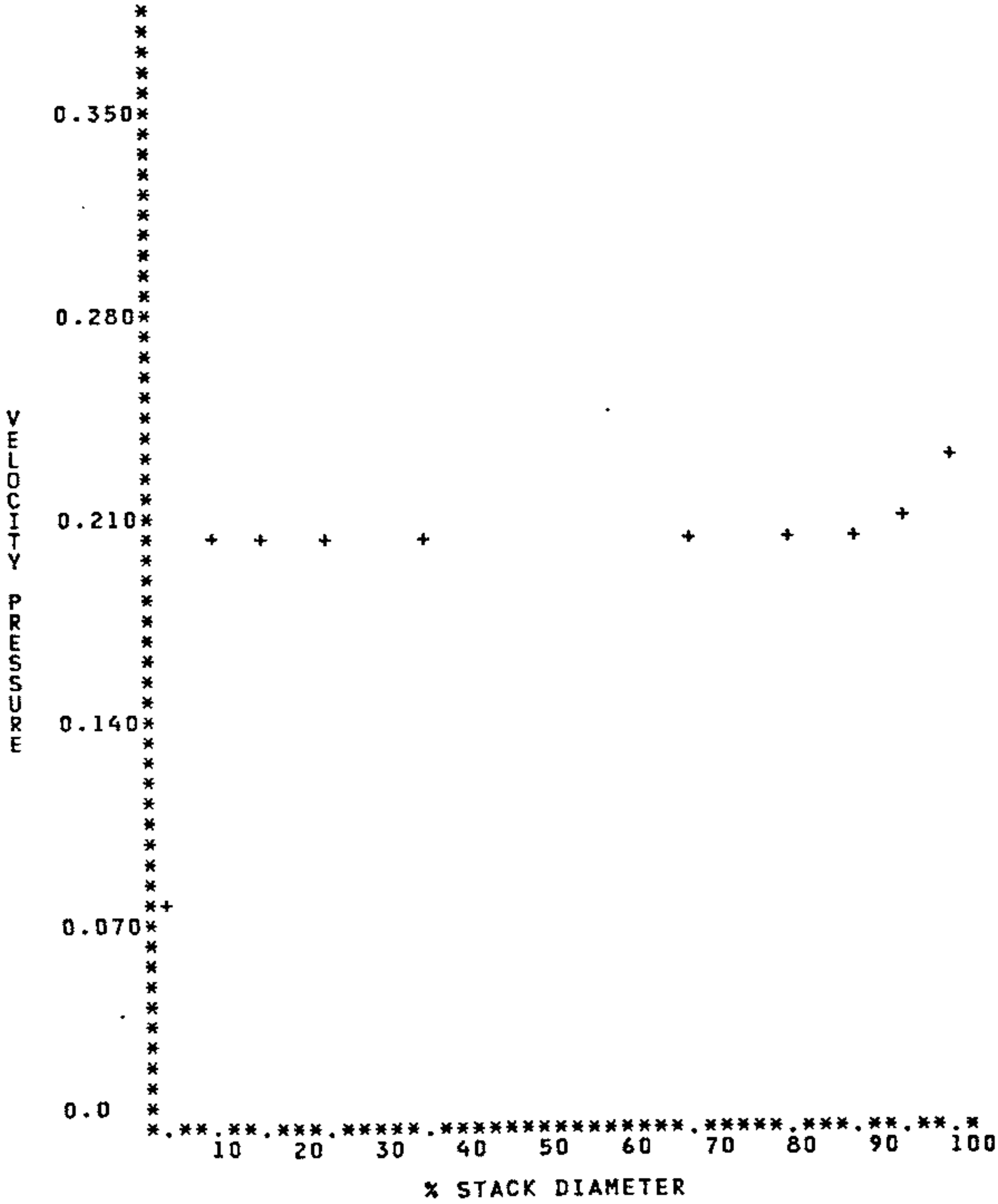
VELOCITY PROFILE
SUPER COMPANY ,KILN STACK,TEST 1
VELOCITY PRESSURE VS. % STACK DIAMETER
NOV.26 ,1985 , SOUTH PORT



NOTE: VELOCITY PRESSURE IN INCHES OF WATER
DOTS ON X-AXIS INDICATE SAMPLING POINT LOCATION

ALBERTA ENVIRONMENT, AIR QUALITY CONTROL BRANCH

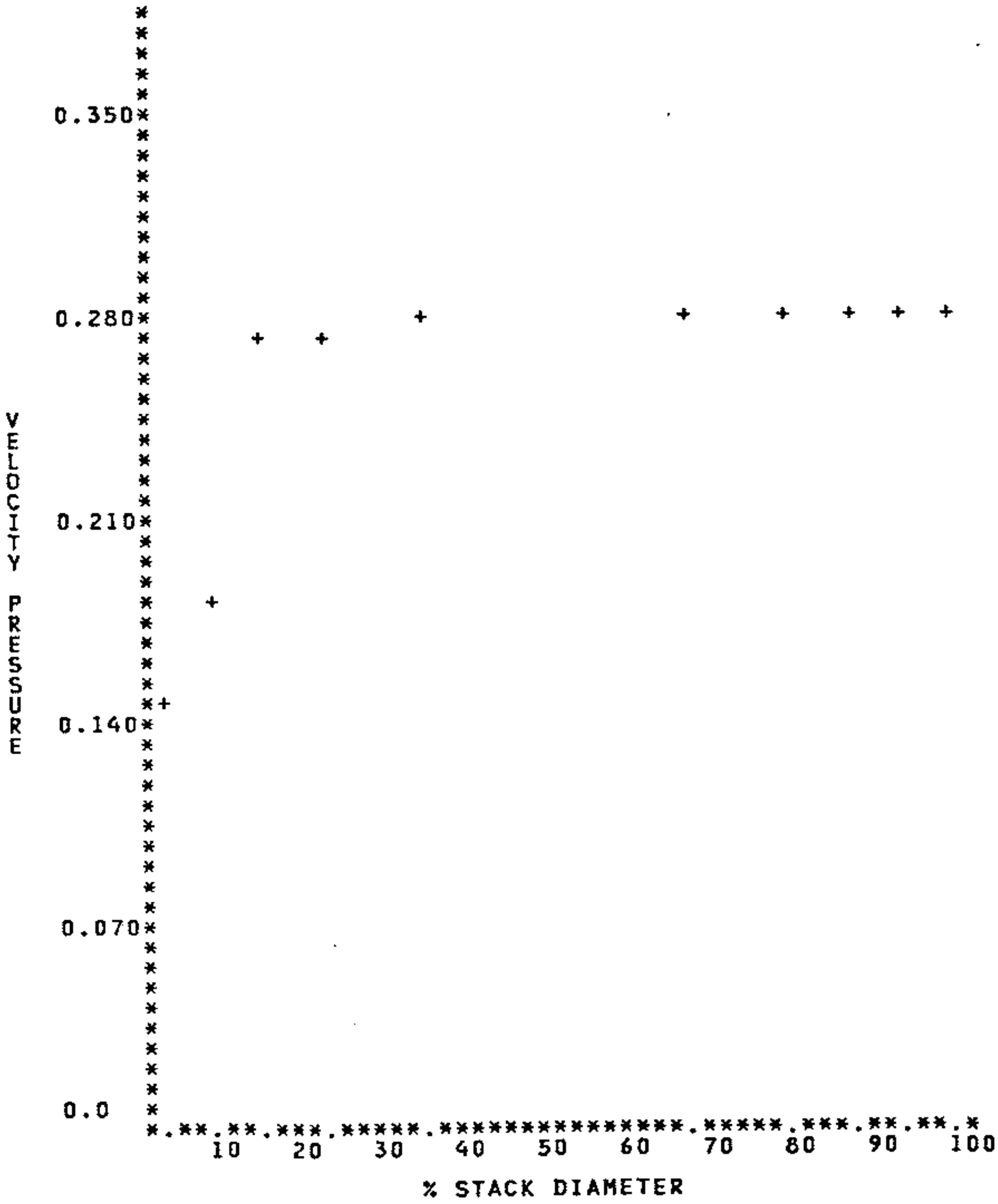
VELOCITY PROFILE
SUPER COMPANY,KILN STACK, TEST 2
VELOCITY PRESSURE VS. % STACK DIAMETER
NOV.26 ,1985 , EAST PORT



NOTE: VELOCITY PRESSURE IN INCHES OF WATER
DOTS ON X-AXIS INDICATE SAMPLING POINT LOCATION

ALBERTA ENVIRONMENT, AIR QUALITY CONTROL BRANCH

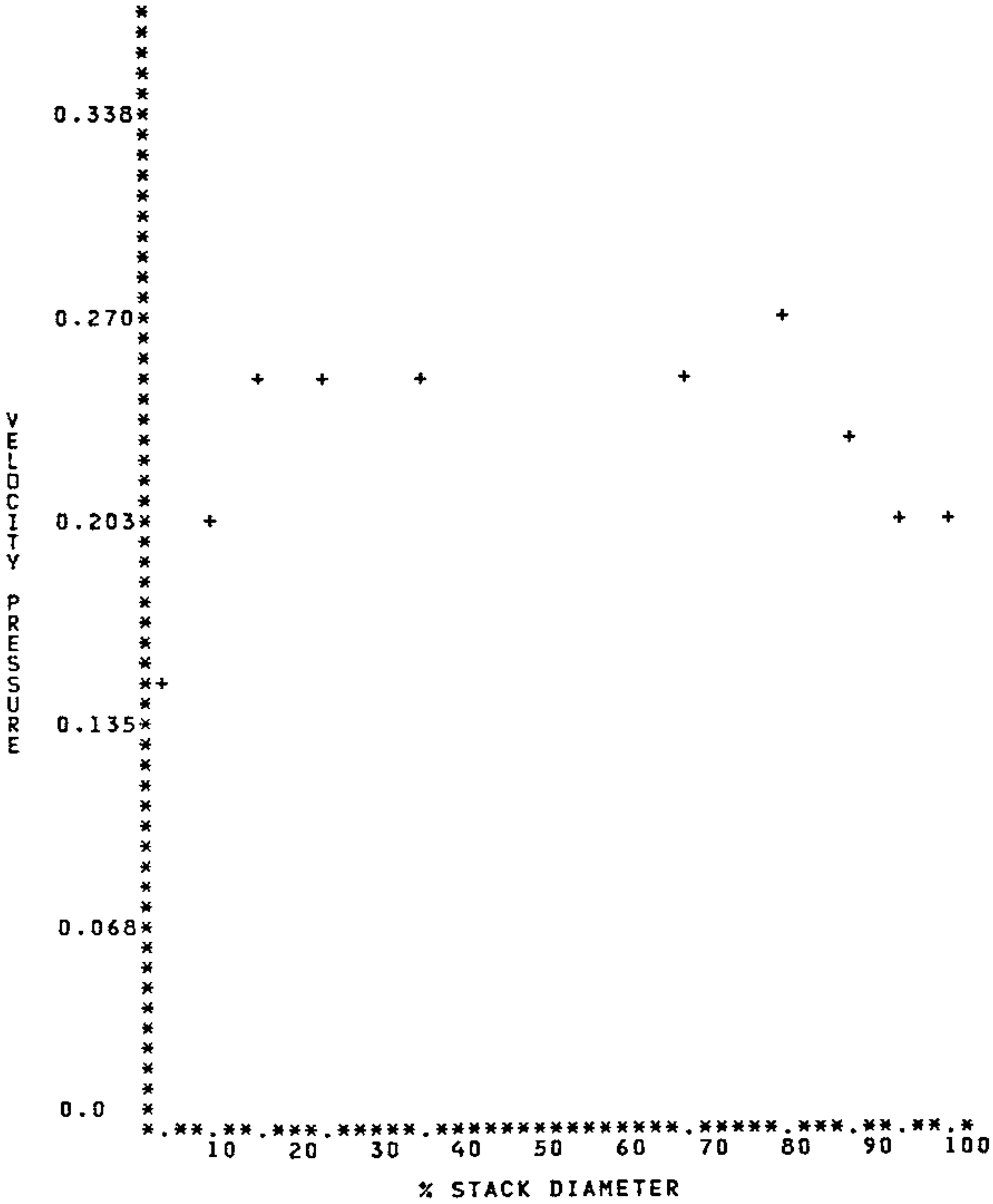
VELOCITY PROFILE
SUPER COMPANY,KILN STACK, TEST 2
VELOCITY PRESSURE VS. % STACK DIAMETER
NOV.26 ,1985 , SOUTH PORT



NOTE: VELOCITY PRESSURE IN INCHES OF WATER
DOTS ON X-AXIS INDICATE SAMPLING POINT LOCATION

ALBERTA ENVIRONMENT, AIR QUALITY CONTROL BRANCH

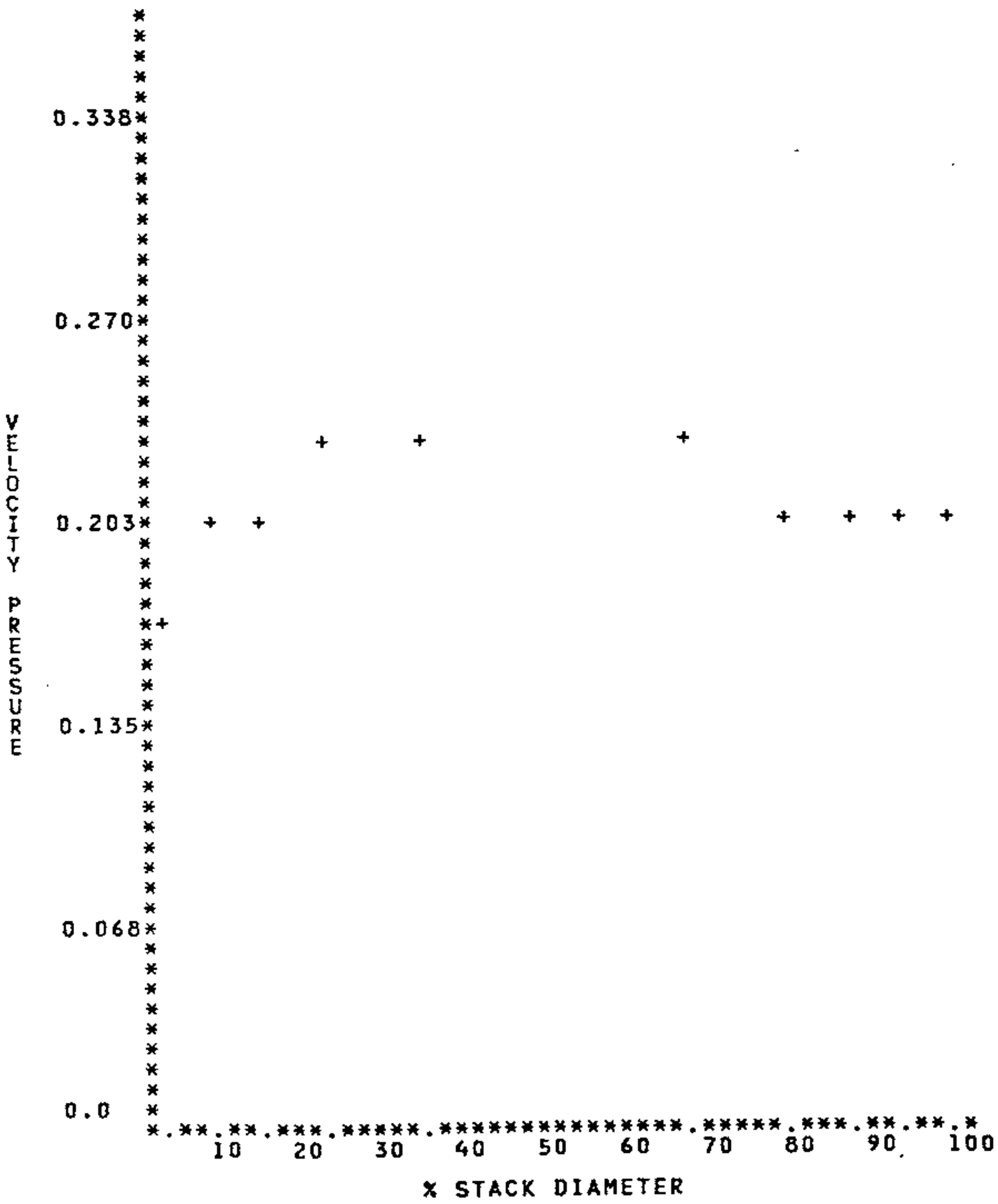
VELOCITY PROFILE
SUPER COMPANY,KILN STACK, TEST 3
VELOCITY PRESSURE VS. % STACK DIAMETER
NOV. 27 ,1985 , SOUTH PORT



NOTE: VELOCITY PRESSURE IN INCHES OF WATER
DOTS ON X-AXIS INDICATE SAMPLING POINT LOCATION

ALBERTA ENVIRONMENT, AIR QUALITY CONTROL BRANCH

VELOCITY PROFILE
SUPER COMPANY,KILN STACK, TEST 3
VELOCITY PRESSURE VS. % STACK DIAMETER
NOV. 27 ,1985 , EAST PORT



NOTE: VELOCITY PRESSURE IN INCHES OF WATER
DOTS ON X-AXIS INDICATE SAMPLING POINT LOCATION

APPENDIX D

FIELD DATA SHEETS

ISOKINETIC TEST DATA

COMPANY NAME	Super Co.	TEST DATE	Nov 27/88	PITOT FACTOR	0.84
PLANT LOCATION	Alberta	TEST START/STOP	0900/1010	TIME/POINT	3 min.
SOURCE TESTED	Kiln Stack	TEST NUMBER	3	H_2O ESTIMATED/ % ACTUAL	1.% 0.8%
OPERATOR	Alberta Env	BAROMETRIC PRESSURE	26.60 in Hg	H2O CONDENSED	2 mls
STATIC IN H2O	+ 14	AMBIENT TEMPERATURE	6° C	NOZZLE I.D. in.	0.245

FILTER NUMBER	3C	CYCLONIC	YES/ [✓ NO]	ANGLE	N/A
PLANT LOAD	X tph	% CO2	0 /	0 / 0	
STACK DIMENSIONS	4.50'	PRESSURE CHECK	BEFORE	AFTER	
%O2	21 / 21 / 21	Qm	[✓ YES]/NO	[✓ YES]/NO	

SP	PITOT dP in H_2O	ORIFICE dH in H_2O	VOLUME	VOLUME/PT	TEMPERATURE F					
					STACK	Tmin	Tmout	VAC		
			66.35							
1	0.15	0.50	67.61	1.26	203	58	55	3.0		
2	0.20	0.67	69.06	1.45	201	58	55	3 0		
3	0.25	0.85	70.68	1.62	200	58	55	3.0		
4	0.25	0.85	72.29	1.61	200	58	55	3.0		
5	0.25	0.85	73.90	1.61	197	63	60	3.0		
6	0.25	0.35	75.51	1.61	193	63	62	3 5		
7	0.27	0.90	77.16	1.65	191	63	64	3 5		
8	0.23	0.79	78.72	1.56	190	64	66	3 5		
9	0.20	0.67	80.19	1.47	185	64	66	3 5		
10	0.20	0.67	81.64	1.45	185	64	67	3.5		
11	0.17	0.56	83.00	1.36	185	71	77	3 5		
12	0.20	0.67	84.46	1.46	181	71	77	3.5		
13	0.20	0.67	85.88	1.42	180	74	77	3.5		
14	0.23	0.79	57.43	1.55	180	74	79	3.5		
15	0.23	0.79	88.97	1.54	180	74	79	4.0		
16	0.23	0.79	90.51	1.54	180	74	80	4.0		
17	0.20	0.67	91.99	1.48	179	75	72	4.0		
18	0.20	0.67	93.46	1.47	179	77	86	4.0		
19	0.20	0.67	94.93	1.47	178	79	86	4.0		
20	0.20	0.67	96.40	1.47	178	82	86	4.0		

ISOKINETIC TEST DATA

COMPANY NAME	Super Comp.	TEST DATE	Nov. 26/85	PITOT FACTOR	0 84
PLANT LOCATION	Alberta	TEST START/STOP	1700, 1810	TIME/POINT	3 min
SOURCE TESTED	Kiln stack	TEST NUMBER	2	H_2O ESTIMATED/ % ACTUAL	1% 0.4%
OPERATOR	Alta. Environment	BAROMETRIC PRESSURE	26.50 in Hg	H2O CONDENSED	5 mls
STATIC IN H2O	+0.14 "	AMBIENT TEMPERATURE	8° C	NOZZLE I.D. in.	0.245

FILTER NUMBER	2B	CYCLONIC	YES [✓ NO]	ANGLE N/A
PLANT LOAD	x tph	% CO2	0.0 / 0.0 / 0.5	
STACK DIMENSIONS	4.50 '	PRESSURE CHECK	BEFORE	AFTER
%O2	21.0 / 20.5 / 21.0	Qm	[✓ YES] NO	[✓ YES] NO

SP	PITOT dP in H_2O	ORIFICE dH in H_2O	VOLUME	VOLUME/PT	TEMPERATURE F					
					STACK	Tmin	Tmout	VAC		
			32.50							
1	0.08	0.26	33.52	1.02	183	92	92	3.0		
2	0.20	0.72	35.04	1.52	183	92	92	3.0		
3	0.20	0.72	36.64	1.60	182	92	92	3.0		
4	0.20	0.72	38.20	1.56	182	91	92	3.0		
5	0.20	0.72	39.78	1.58	182	92	92	3.5		
6	0.20	0.72	41.33	1.55	182	92	92	3.5		
7	0.20	0.72	42.89	1.56	182	92	92	3.5		
8	0.20	0.72	44.43	1.54	180	92	92	3.5		
9	0.21	0.75	46.03	1.60	181	91	91	3.5		
10	0.23	0.83	47.67	1.64	181	92	92	4.0		
11	0.15	0.54	49.04	1.37	181	92	94	4.0		
12	0.18	0.65	50.51	1.47	180	92	94	4.0		
13	0 27	0.96	52.23	1 72	180	92	94	4.0		
14	0.27	0.96	53.99	1.76	180	92	96	4.0		
15	0.28	1.00	55.80	1.81	181	92	96	4.0		
16	0.28	1.00	57.62	1.82	181	92	96	4.5		
17	0.28	1.00	59.43	1.81	181	92	96	4.5		
18	0.28	1.00	61.24	1.81	181	92	96	4.5		
19	0 28	1.00	63.05	1.81	181	92	96	4.5		
20	0.28	1.00	64.86	1.81	181	92	96	4.5		

ISOKINETIC TEST DATA

COMPANY NAME	Super Company	TEST DATE	Nov 26, 1985	PITOT FACTOR	0.84
PLANT LOCATION	Alberta	TEST START/STOP	15:50/16:55	TIME/POINT	3 min
SOURCE TESTED	Kiln stack	TEST NUMBER	1	H_2O ESTIMATED/ % ACTUAL	1%
OPERATOR	Alta Env	BAROMETRIC PRESSURE	26.50 in Hg	H20 CONDENSED	2 mls
STATIC IN H20	+ 0.14"	AMBIENT TEMPERATURE	8° C	NOZZLE I.D. in.	0.245

FILTER NUMBER	1 A	CYCLONIC	YES [✓ NO]	ANGLE N/A
PLANT LOAD	X tph	% CO2	0.0 / 0.5 / 0.0	
STACK DIMENSIONS	4 50'	PRESSURE CHECK	BEFORE	AFTER
%02	21.0 / 20.5 / 21.0	Qm	[✓ YES] NO	[✓ YES] NO

SP	PITOT dP in H_2O	ORIFICE dH in H_2O	VOLUME	VOLUME/PT	TEMPERATURE F					
					STACK	Tmin	Tmout	VAC		
			0.00							
1	0.17	0.54	1.31	1.31	190	65	64	4.0		
2	0.24	0.78	2.85	1.54	189	66	66	4.0		
3	0.25	0.80	4.45	1.60	184	67	67	4.0		
4	0.26	0.84	6.03	1.58	182	67	69	4.0		
5	0.27	0.86	7.65	1.62	182	68	69	4.0		
6	0.27	0.86	9.27	1.62	182	69	70	4.5		
7	0.27	0.86	10.90	1.63	181	70	72	4.5		
8	0.27	0.86	12.51	1.61	180	71	73	4.5		
9	0.25	0.80	14.07	1.56	180	73	74	4.5		
10	0.22	0.70	15.55	1.48	180	73	74	4.5		
11	0.20	0.65	16.93	1.38	181	73	75	4.5		
12	0.22	0.70	18.43	1.50	180	74	75	4.5		
13	0.25	0.80	20.00	1.57	180	75	77	4.5		
14	0.25	0.80	21.57	1.57	180	77	79	5.0		
15	0.26	0.84	23.20	1.63	180	79	81	5.0		
16	0.26	0.84	24.82	1.62	180	80	82	5.0		
17	0.26	0.84	26.46	1.64	180	80	83	5.0		
18	0.26	0.84	28.10	1.64	181	80	84	5.0		
19	0.25	0.80	29.71	1.61	181	81	85	5.0		
20	0.25	0.80	31.31	1.60	181	83	86	5.0		

APPENDIX E

CALCULATIONS

Note: This appendix would show any calculations used to determine pollutant concentrations and/or mass emission values that do not appear in the Stack Sampling Code

APPENDIX F

CONTINUOUS EMISSION MONITOR DATA

NOTE: This appendix would include:

i) The original or legible photocopy of the continuous emission monitor chart data for the time period in which the compliance test was conducted as well as for the six-hour periods before and after the stack survey period.

ii) The most recent calibration date on the continuous emission monitor.

iii) The method of calibration used for the continuous emission monitor.

APPENDIX B-3

ANNUAL REPORT - SAMPLE FORMAT

EXPOSURE CYLINDER DATA 198___

Plant: ______________________ Company: ______________________

Station Number:		1	2	3	4	5	6	7	8	9	10	Average
January	TS											
	H_2S											
February	TS											
	H_2S											
March	TS											
	H_2S											
April	TS											
	H_2S											
May	TS											
	H_2S											
June	TS											
	H_2S											
July	TS											
	H_2S											
August	TS											
	H_2S											
September	TS											
	H_2S											
October	TS											
	H_2S											
November	TS											
	H_2S											
December	TS											
	H_2S											
AVERAGE	TS											
	H_2S											

REPEALED - refer to 2016 Air Monitoring Directive, as amended

SUMMARY OF READINGS IN EXCESS OF STACK LICENCE LIMITS

Month	SO_2 conc. ppm	SO_2 Tonnes/hr	SO_2 Tonnes/Day	Stack Top Temp °C	Cause
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
TOTAL					

REPEALED - refer to 2016 Air Monitoring Directive, as amended

SUMMARY OF READINGS IN EXCESS OF STACK LICENCE LIMITS

Month	SO_2 conc. ppm	SO_2 Tonnes/hr	NO_x Conc. (ppm)	NO_x tonnes/hr	% Opacity	Cause
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						
TOTAL						

APPENDIX B-4

FREQUENCY DISTRIBUTION CHARTS

WIND SPEED AND DIRECTION

B-4-1

PERCENTAGE FREQUENCY DISTRIBUTION OF WIND

STATION IDENTIFICATION: ____________________ YEAR: __________

	WIND SPEED (km/h)						
DIRECTION	1 - 5	6 - 11	12 - 19	20 - 28	29 - 38	39 +	TOTAL
N	1.52	2.64	2.22	2.08	0.13	0.00	8.59
NE	1.95	0.42	0.00	0.00	0.00	0.00	2.36
E	2.08	0.83	0.56	0.13	0.00	0.00	3.60
SE	2.64	6.81	4.17	0.56	0.00	0.00	14.18
S	4.31	8.61	0.97	0.00	0.00	0.00	13.89
SW	3.61	13.19	5.14	0.00	0.00	0.00	21.94
W	0.69	6.39	8.75	0.69	0.00	0.00	16.52
NW	0.97	2.08	4.86	5.14	5.14	0.28	18.47
TOTAL	17.76	40.97	26.67	8.60	5.27	0.28	99.55
Calm 0.54%							

SO_2 MONTHLY AVERAGES AND FREQUENCY DISTRIBUTIONS OF 1 HOUR READINGS

PLANT OPERATOR ______________ PLANT LOCATION ______________ STATION ______________

MONTH	NUMBER OF READINGS	% READINGS IN CONCENTRATION RANGE (ppm SO_2)						SO_2 ppm MONTHLY AVERAGE
		≤ 0.02	$0.02 < C \leq 0.06$	$0.06 < C \leq 0.11$	$0.11 < C \leq 0.17$	$0.17 < C \leq 0.34$	> 0.34	
JAN								
FEB								
MAR								
APR								
MAY								
JUNE								
JULY								
AUG								
SEPT								
OCT								
NOV								
DEC								
							ANNUAL AVERAGE	

C — CONCENTRATION

NO$_2$ MONTHLY AVERAGES AND FREQUENCY DISTRIBUTIONS OF 1 HOUR READINGS

PLANT OPERATOR ____________ PLANT LOCATION ____________ STATION ____________

MONTH	NUMBER OF READINGS	% READINGS IN CONCENTRATION RANGE (ppm NO$_2$)				NO$_2$ ppm MONTHLY AVERAGE
		0 – 0.05	$0.05 < C \leq 0.11$	$0.11 < C \leq 0.21$	> . 0.21	
JAN						
FEB						
MAR						
APR						
MAY						
JUNE						
JULY						
AUG						
SEPT						
OCT						
NOV						
DEC						
					ANNUAL AVERAGE	

C – CONCENTRATION

H_2S MONTHLY AVERAGES AND FREQUENCY DISTRIBUTIONS OF 1 HOUR READINGS

PLANT OPERATOR ____________ PLANT LOCATION ____________ STATION ____________

MONTH	NUMBER OF READINGS	% READINGS IN CONCENTRATION RANGE (ppb H_2S)				H_2S ppb MONTHLY AVERAGE
		≤ 3	$3 < C \leq 10$	$10 < C \leq 50$	> 50	
JAN						
FEB						
MAR						
APR						
MAY						
JUNE						
JULY						
AUG						
SEPT						
OCT						
NOV						
DEC						
					ANNUAL AVERAGE	

C – CONCENTRATION

NH_3 MONTHLY AVERAGES AND FREQUENCY DISTRIBUTIONS OF 1 HOUR READINGS

PLANT OPERATOR ______ PLANT LOCATION ______ STATION ______

MONTH	NUMBER OF READINGS	% READINGS IN CONCENTRATION RANGE (ppm NH_3)			NH_3 ppm MONTHLY AVERAGE
		≤ 1.0	$1.0 < C \leq 2.0$	> 2.0	
JAN					
FEB					
MAR					
APR					
MAY					
JUNE					
JULY					
AUG					
SEPT					
OCT					
NOV					
DEC					
				ANNUAL AVERAGE	

C – CONCENTRATION