THE DETERMINATION OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH), POLYCHLOROBIPHENYLS (PCB) AND ORGANOCHLORINE COMPOUNDS (OC) IN AMBIENT ARCTIC AIR

PART A - SAMPLING EQUIPMENT AND FIELD PROCEDURES

Project No. 441-J3034

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1 INTRODUCTION

In 1991, the Northern Contaminants Research Program was initiated to characterize the air concentration and vapour-particle distribution of organochlorine (OC) and polycyclic aromatic hydrocarbon (PAH) compounds in the northern atmosphere. The Arctic Air Toxics Network consists of four stations:

- Alert, North West Territories (established in January 1992);
- Tagish, Yukon (established in December 1992);
- Dunai, Russia (established in March 1993); and
- Cape Dorset, Baffin Island (established in November 1993).

The objectives of the network are to measure the occurrence of selected organochlorines and polycyclic aromatic hydrocarbon compounds in the Arctic atmosphere over a two year period of time thereby providing insight into seasonal trends, environmental transport, removal, transformation and surface exchange processes as well as data for the development of realistic environmental pathways models (L. Barrie, 1992).

Selection of sites was based upon the following criteria:

1. Regionally representative sites, at least 50 km from major sources of fossil fuel combustion or a town of > 10,000 people; a distance of at least 20 km from a town of > 2,000 people are suitable. Since in the north air pollutants can be trapped in the boundary layer and channelled along river valleys for long distances without dilution, sites at a higher elevation or without prominent orographic features were selected (e.g., Alert, Cape Dorset, Tagish).
2. Locally, sites were at least 5 km from a source of pollution (including mobile sources).
3. Sites were selected in well exposed areas (e.g. a hill was preferable to a valley location).
4. Power, at least, 2 Kw was required at each site. An elevated location for the sampler at least 2 m above ground and an area for the sample change hut were required. A second building was required to store equipment and parkas for changing samples.
5. Sites without persistently high winds due to mesoscale channelling effects and snowfall lower than 1.5 m annually were desirable to allow access.
6. Availability of skilled operators to change samples, document procedures and tend to

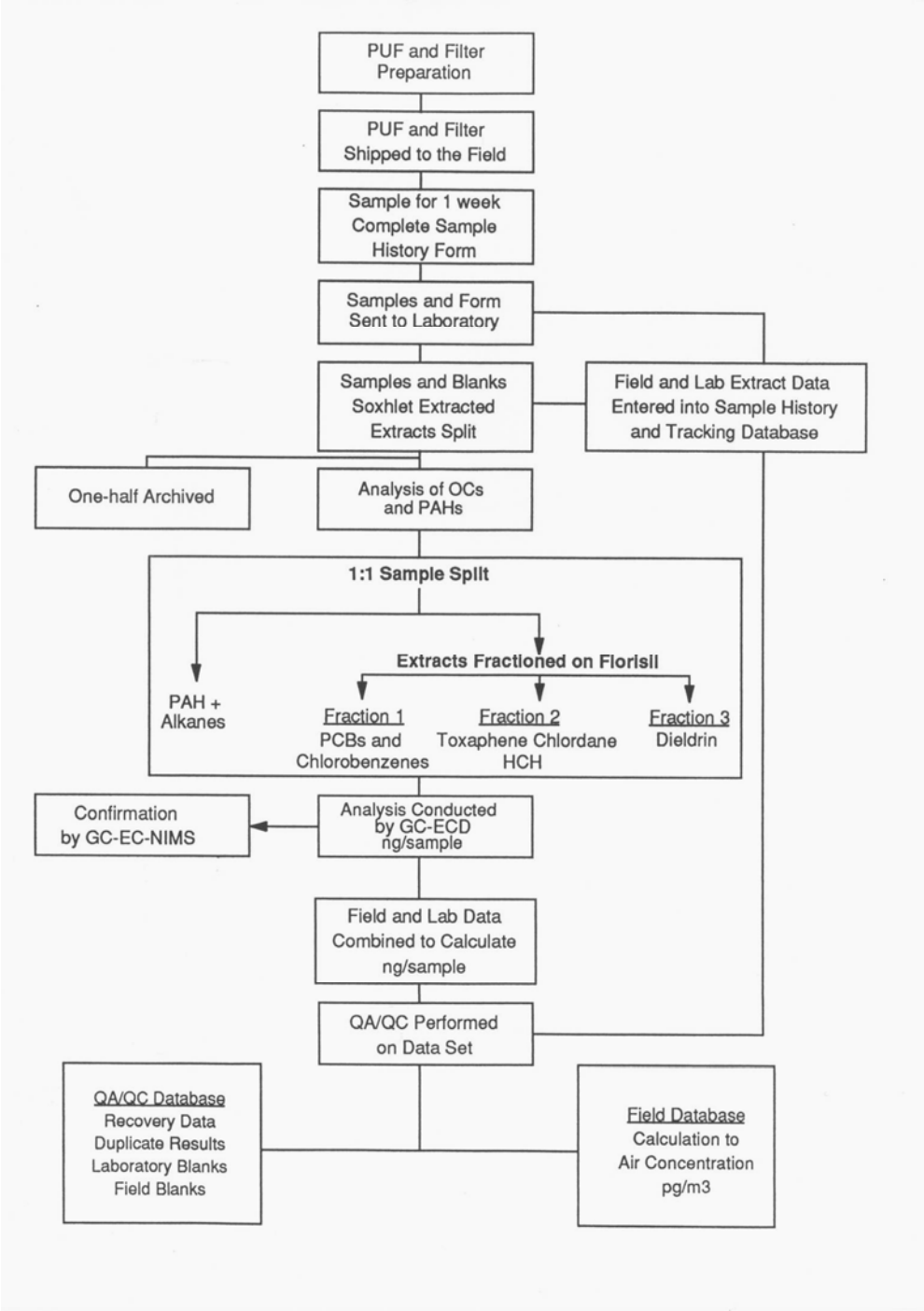
minor instrument problems was considered key for operation of the site.

Weekly samples are collected by means of a high volume sampler with a size-selective inlet, 10 μm aerodynamic diameter, for particles and a collection cartridge consisting of a glass fiber filter (particles < 10 μm) followed by two polyurethane foam (PUF) sorbent plugs (organic vapours). Samples are shipped to the laboratory and extracted with hexane (PUFs) or dichloromethane (filters). Approximately one-half of the extract is used for clean-up and analysis by gas chromatography-electron capture detection (GC-ECD) or low resolution gas chromatography-mass spectrometry detection (GC-MS). Occasionally analytical results are confirmed with high resolution GC/MS or NICI-MS (negative ion chemical ionization-mass spectrometry).

The general procedures for handling of samples, documenting chain of custody and processing of data are summarized in Figure 1-1. Analytical data are reviewed manually and transferred to a spreadsheet. Quality assurance measures include the analysis of laboratory and field blank materials of both types (PUF/filters), replicate analysis (1 in 10 samples), processing of recovery standards, use of internal standard compounds and auditing of field, extraction, analysis and data handling procedures. In this manual are documented the field, laboratory and QA/QC procedures.

Section 2 describes field procedures and includes a detailed description of the air sampling equipment, its components and operating methods. Section 3 describes the data management system. Section 4 describes the network organization. Section 5 contains the references and all backup information is contained in the appendices.

FIGURE 1-1 Sample and Data Collection



2 FIELD OPERATIONS

2.1 GENERAL DESCRIPTION OF THE SAMPLER

Sampling equipment was custom designed and constructed for the Arctic monitoring environment. The equipment consists of a PM_{10} head and housing from Wedding and Associates, Fort Collins, CO. (Wedding and Weigand, 1985). This unit is supplied without oil in the large particle collection reservoir to avoid sample contamination. The machined anodized aluminium sampling cartridge is custom constructed to hold one or two glass fiber filters and two PUF plugs. The cartridge is designed to be fitted in the sampler with quick connect fasteners to make operation in Arctic conditions easier. Volumetric flow control is achieved by means of a critical flow device (CFD), supplied by Wedding and Associates, and thus avoids the use of electronic controllers that might easily fail under harsh Arctic conditions. The flow control device is connected to an external pump by means of a 10 ft length of 2 in. inner diameter (I.D.) cold temperature hose (-40°C specification). The pump is housed in a wooden protective shelter and exhaust air is vented away from the sampler to avoid potential contamination of samples. The pump is a Rotron regenerative blower from EG & G Rotron, Saugerties, N.Y., model 505 CD58 (2.5 hp) or equivalent, modified with low temperature bearings. The maximum vacuum of the blower is 57 inches of water equivalent.

To date the sampler has been deployed at four Arctic sites with few operational problems. The two most persistent difficulties experienced during operation of the sampler are pump failures at the Alert site and occasional plugging of the inlet with ice crystals or blowing snow at Alert and at Dunai. The failures were attributed to a housing that was inadequately ventilated causing overheating and consequent pump failure. The inlet may become plugged under blowing snow conditions that occur from time to time. This is readily rectified by use of sampler cleaning tools. Occasionally, ice crystals can be found on sampling filters due to the presence of ice crystals of less than 10 microns in air that penetrate the size selective inlet.

2.2 COMPONENTS OF THE SAMPLER

The sampler consists of the following components that function as an integral unit to collect airborne particles and semi-volatile organic compounds including:

- the PM_{10} inlet,
- the sampling cartridge and materials,
- the critical flow device, and
- the pump, timer controller and housing.

2.2.1 PM_{10} Sampler Inlet

The sampler inlet is a modified Wedding PM_{10} Inlet as shown in Figure 2-1. Typically, the inlet contains a small quantity of low volatility oil in the large particle capture reservoir (> 10 micron aerodynamic diameter) to enhance the collection of large particles and prevent their re-entrainment in the flow stream. The amount of re-entrainment is low however and since the sampler is being used to collect organic compounds, it was considered important to operate it without oil in the reservoir to avoid potential contamination of samples. Features of the inlet include a simple mechanism for detaching the inlet from the sampler housing (Figure 2-2) to allow rapid access to the sampler cartridge for routine sampler cartridge changes. The inlet also has a maintenance access port to allow cleaning of the inner surfaces. The inlet was designed in the late 1970's and has undergone extensive testing to characterize its performance for sampling of airborne particulate matter. Independent testing by the U.S. EPA led to its designation as a reference method for PM_{10} (RFPS 1087-062, U.S. EPA). The inlet has symmetrical geometry and operates with equal effectiveness in all wind directions up to 25 km/h. The unique "no-bounce surface" has been shown to give consistent collection independent of particle composition and morphology when operated at 40 SCFM (1200 L/min).

2.2.2 Sampler Cartridge

The sampler cartridge is a custom designed holder that fits in the sampler housing between the inlet and the Critical Flow Device. Figure 2-3 is an illustration of the two part cartridge. The first is the support screen and retention ring for the filter. The exposed surface of the screen is 20 cm nominal diameter, round in contrast to the rectangular geometry of standard high volume samplers and provides an exposed surface area of 324 cm^2. A standard 8.5 x 10 inch filter cartridge provides an exposed filter surface of 414 cm^2. The filter element holder is directly coupled to the 8 inch (20 cm) diameter PUF cartridge designed to accommodate two PUF plugs. This size of plug is required to permit the 40 SCFM design flow to be achieved. The cartridge sampler is made of anodized aluminum except for the filter retention gasket which is made of teflon, thus allowing easy cleaning of the system with solvent and minimizing the possibility of corrosion. Filter elements (glass fibre (GFF), teflon or other material) are 8.74 inches in diameter and PUF plugs are 8.5 inch diameter by 1.5 inch in thickness. The PUF plug density is required to be greater than 0.0225 g/cm^3 of white foam material. Both sampling elements are obtained by use of custom constructed dies.

FIGURE 2-1 Sampler Inlet Design

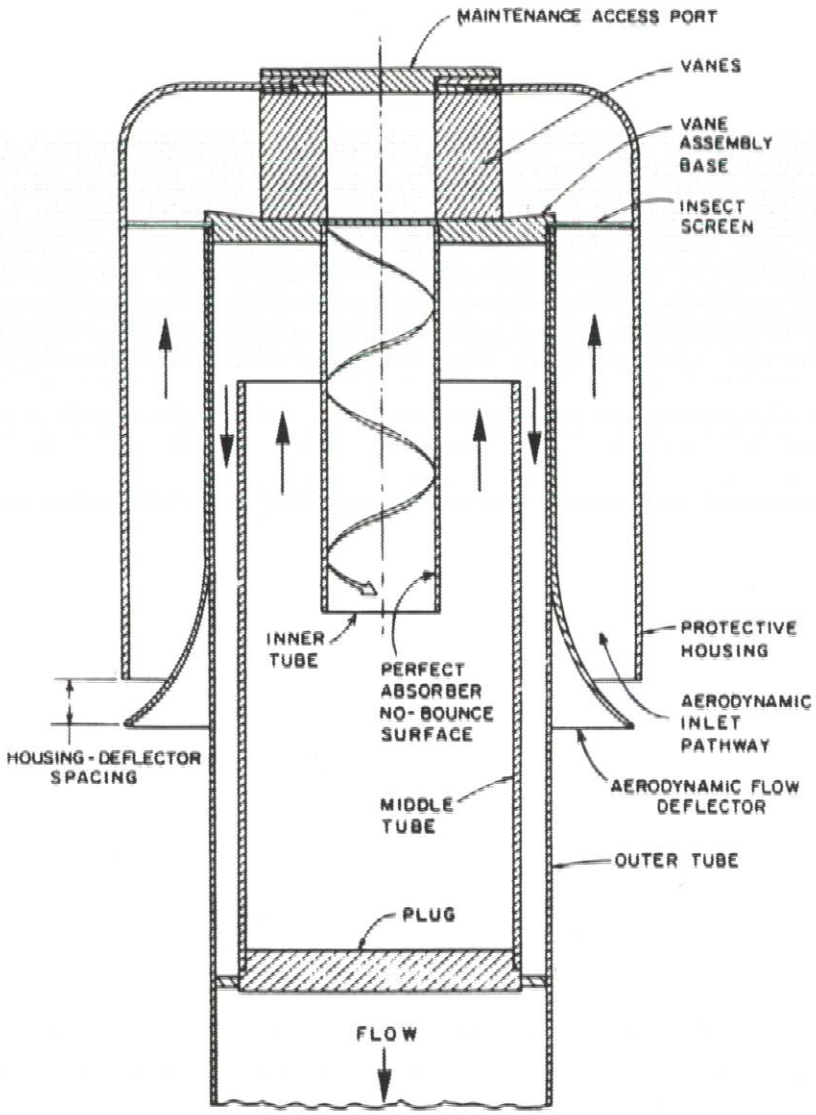
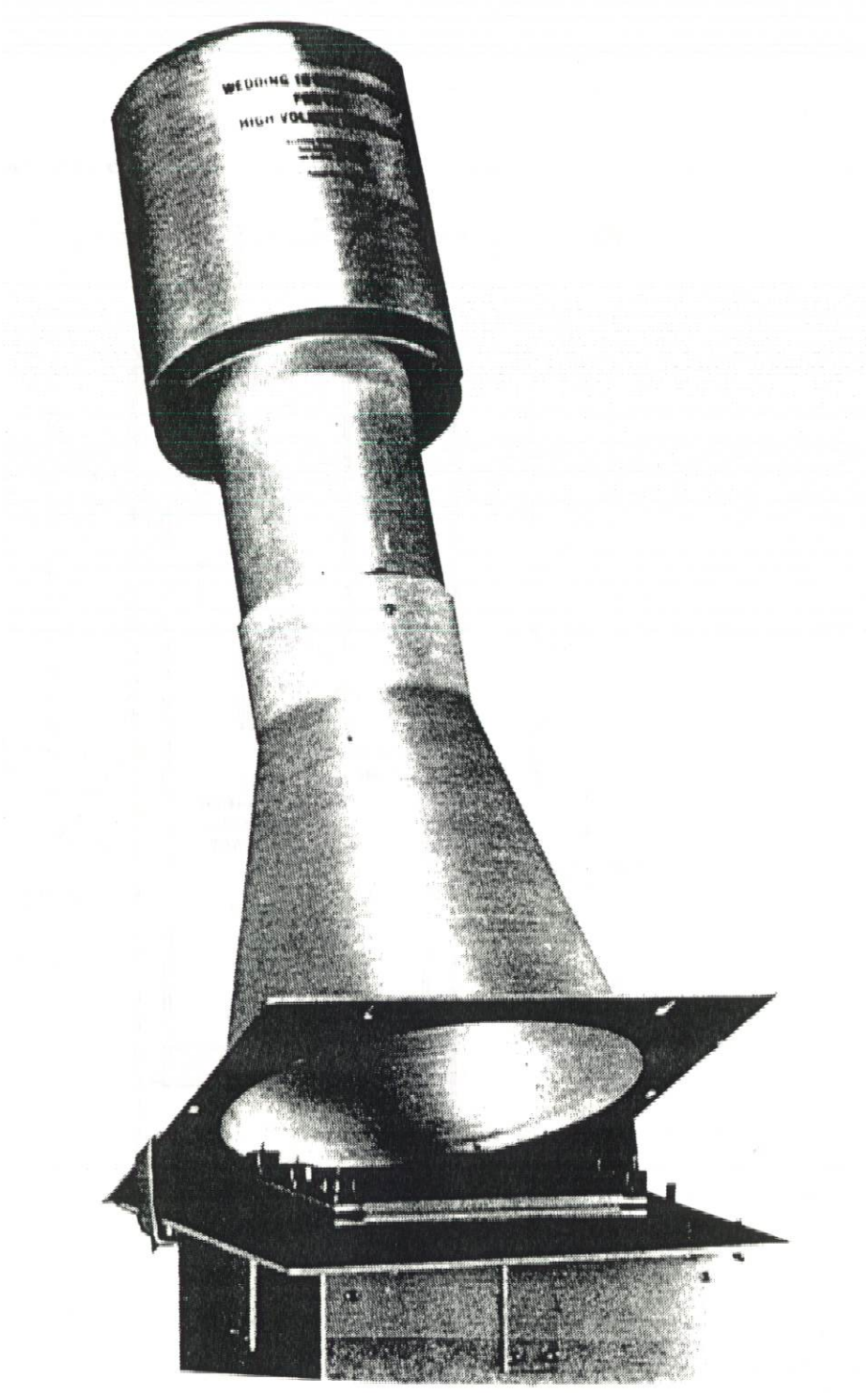
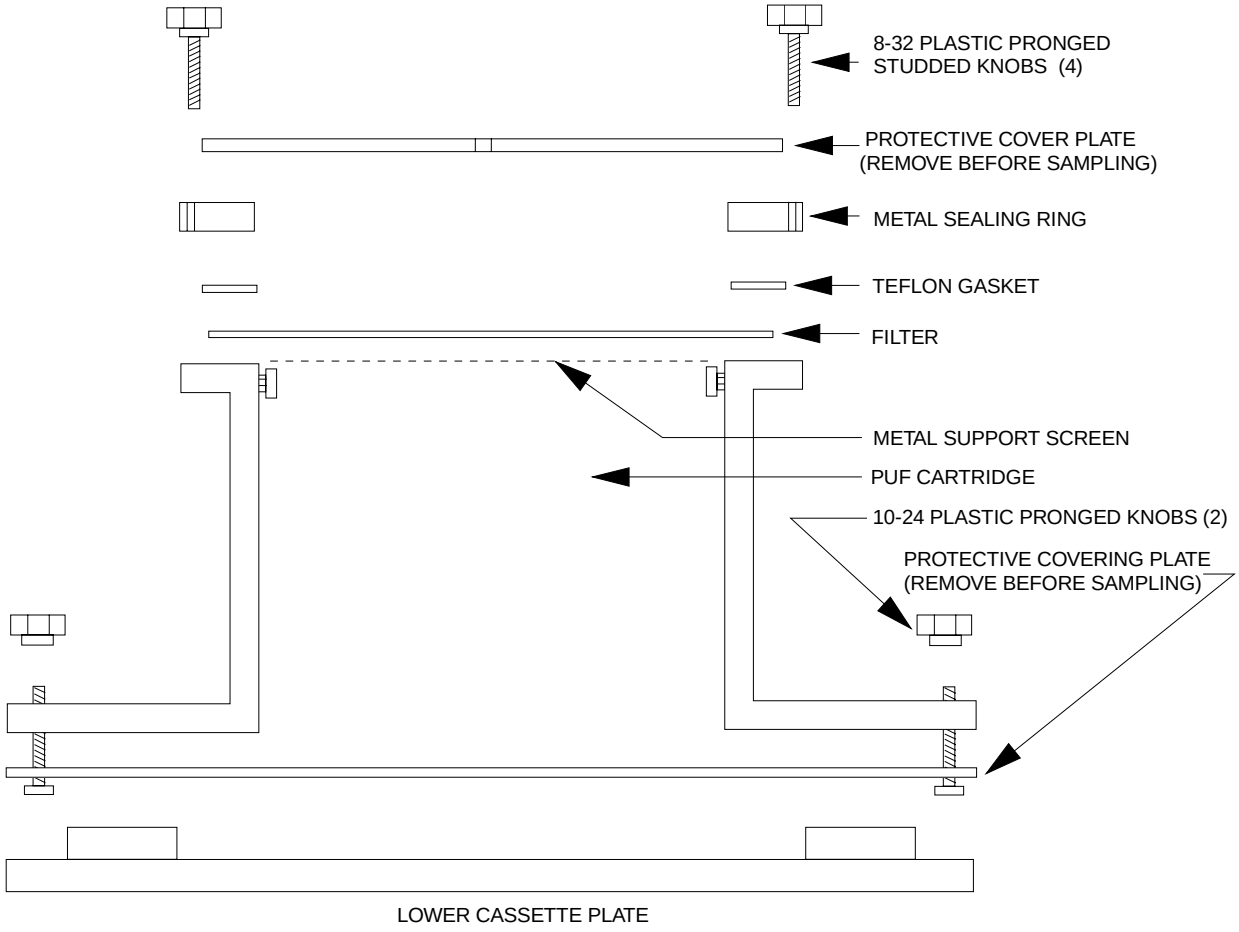


FIGURE 2-2 Sampler Inlet Housing



Note: the sampler cartridge is not as shown in this diagram

FIGURE 2-3 Filter and PUF Cartridge Assembly Schematic

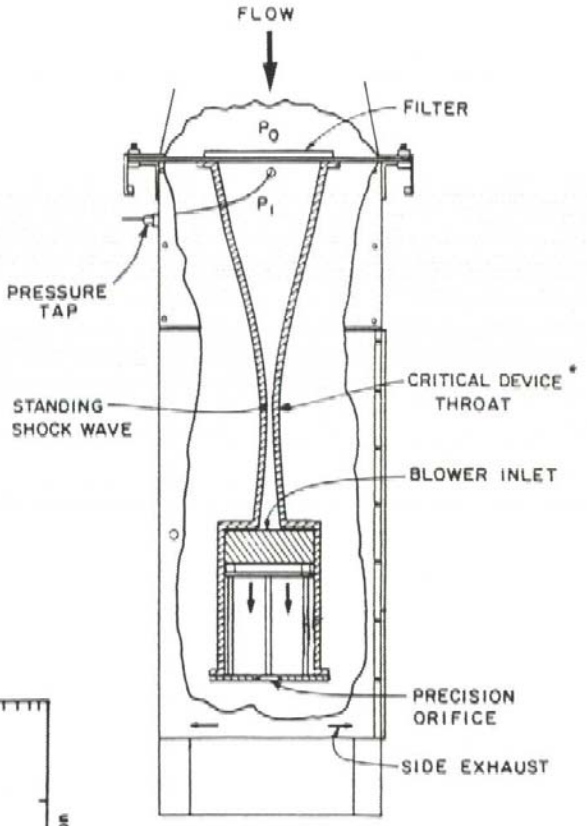


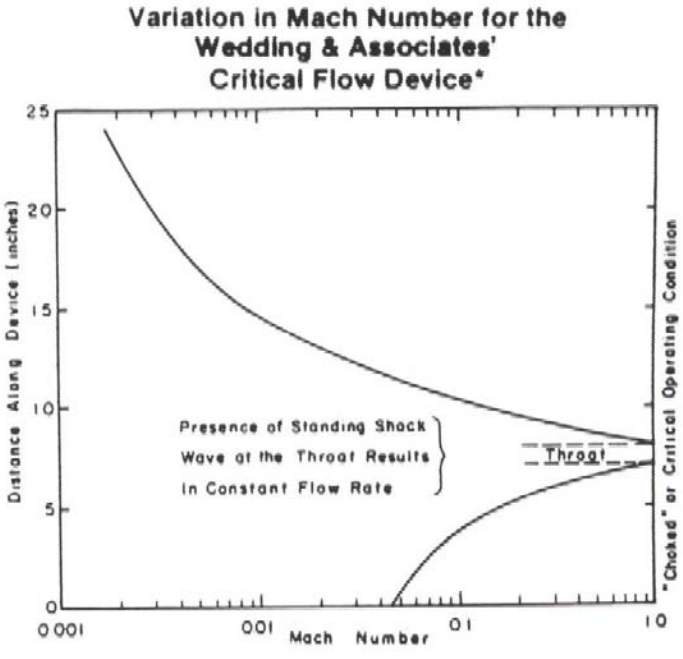
2.2.3 The Critical Flow Device

The Critical Flow Device (CFD) is a proprietary device (Wedding and Associates) that achieves flow control due to a "choking" effect. The CFD, illustrated in Figure 2-4, relies on establishing a critical state which is achieved when the Mach number is unity. The maximum in the relationship between flow rate and area is uniquely related to the choking effect. For a specific area, a subsonic flow exists for a maximum initial Mach number which allows maintenance of a steady flow. (This is analogous to the performance characteristics of a flow limiting orifice.) When this condition exists, a stable shock wave is established and maintained within the throat of the CFD.

A steady state flow condition is maintained by establishing a suitable pressure differential by means of a pumping system. Important features of the CFD that make it attractive for operation in Arctic conditions are the absence of mechanical and electronic components and the steady operation at one-flow. Performance features of the CFD include a maximum variation in flow of ± 1.9 % for a change in temperature of 40°C. Thus, for particle loading values of less than 150 $\mu g/m^3$ over a 24 h sampling period or ca. 25 $\mu g/m^3$ over a 7 day sampling period, the variation in volumetric flow rate is expected to be less than 0.8 %. The CFD has been shown to meet EPA reference method flow criteria as outlined in Fed. Reg. 52, 24665, 40 CFR. Part 50, Appendix J. The lack of moving parts also allows the operation of the sampler without frequent time consuming field calibrations. Checks of flow using a appropriate meter allows verification of performance. For the Arctic sampler the standard CFD requires modification to allow connection to a Rotron pump.

FIGURE 2-4 Critical Flow Device





2.2.4 Blower Pump Assembly

Based on the rigorous field sampling requirements a Rotron regenerative blower was substituted for the pump normally used with the CFD. The CFD was connected to the pump by means of 2 m long by 6 cm diameter tubing. The pump is maintained in a separate housing and the exhaust flow is ducted away from the sampler with 3 m of tubing. To sustain a flow of 40 CFM through the sampler with the high pressure drop caused by the PUF plug, the use of a 2.5 hp blower is specified by EG & G Rotron. Moreover, to reduce the electrical requirements, a 230 VAC motor is specified. The sites where the samplers are deployed have either single phase or three phase power available. Use of three phase power also reduces the operating amperage. The blower specified for the sampler, an EG & G Rotron model DR 505 CD58 part no. 036282 with a TEFC motor enclosure rated at 2.5 hp power, requires 230 VAC, single or three phase, 60/50 Hz electrical circuitry. The maximum vacuum is 57 inches of water equivalent. The motor is brushless and features sealed low temperature bearings for long service life and low maintenance. The low temperature bearings are not a standard feature and must be specified when ordering the blower. Any blower meeting these specifications may be substituted.

2.2.5 Elapsed-Time Indicator

A mechanical elapsed time indicator is wired to operate when the Rotron blower is operating. The instrument automatically and cumulatively registers the elapsed time. Thus, any breakdowns, mechanical or electrical will be recorded with the timer to allow determination of the sampling duration.

2.3 GENERAL OPERATION OF THE SAMPLER

Samples are obtained over one week (10080 min.) intervals at ca. 40 CFM (1.13 m^3/min) thus giving a nominal total flow of 11300 m^3. Actual flows are monitored by measurement of the pressure at the CFD with a micromanometer or Magnahelic gauge at the beginning and end of each sampling interval. Flows are computed from these readings, and corrected to standard temperature by means of look-up tables with flow factors adjusted for average weekly temperature. Each week, on a designated day (eg., Monday at 10 a.m. E.D.T. at Alert) the sampling cartridge on the sampler is removed by the field operator. The operator is required to wear a clean parka and gloves during all sample changes. The cartridge is carried to the sample handling shed, and placed on a clean teflon coated table top. With clean tweezers and using

polyethylene disposable plastic gloves, the PUF plugs are removed from the sampling cartridge and placed in shipping containers. The filter element is placed in a glass jar. The cartridge is then loaded with unexposed sampling materials and installed in the sampler unit. Once every four weeks, two filters are loaded into the sampling cartridge**. (Note: that the use of two filter elements was discontinued in 1996 for cost reasons).** Also, every fourth week, a field blank PUF and filter element are handled in the same manner. Exposed and blank sampling materials are stored on site under ambient conditions for up to four weeks in the sealed containers, and then shipped for processing to Conor Pacific Environmental in Toronto.

2.3.1 Deployment of Sampling Media in the Field

Before loading a new sample, the operator must clean the sampling cartridge, tweezers, protective plates and teflon sheet with acetone while wearing the clean parka and gloves. The sampling cartridge is loaded with one filter and 2 PUF plugs. However, once every four weeks, the cartridge is loaded with 2 filters and 2 PUF plugs. (See the note about the use of two filters – this procedure was discontinued in 1996). The cartridge is placed upside down, and a PUF plug is placed inside using clean tweezers. This procedure is repeated with the second PUF, ensuring that the sides of the PUFs are firmly pushed below the level of the head. The bottom protective plate is attached and the cartridge is turned right side up. The filter is placed on the metal screen, using the metal tweezers followed by the teflon ring, metal ring and upper protective plate. The screw holes are aligned and the knurled nuts are tightened finger tight.

Before loading the cartridge onto the sampler, the sampler inlet is cleaned using the special brush. After cleaning the inlet, the protective plates are removed from the sampling cartridge, which is then mounted onto the sampler and secured with the pressure clamps. The sampler inlet lid is closed and tightened with the six knurled nuts (nuts are tightened finger tight).

The following information is recorded on the sample history form.

- Date and Time when the sampler was turned on
- Pressure Drop (inches of water)
- Mechanical Timer Reading (minutes)
- Sample Number and Type

2.3.2 Removal of the Exposed Sampling Media

Before unloading a sample, the following information is recorded on the sample history form:

- Date and Time when the sampler was turned off
- Pressure Drop Reading (inches of water)
- Mechanical Timer Reading (minutes)
- Sample Number and Type

Using clean disposable gloves, the sampling cartridge is removed from the sampler inlet, and placed on the teflon-covered bench. Using the rinsed stainless steel tweezers, the filter is removed and folded to fit into the 500 mL amber jar. The 2 PUF plugs are placed in two separate 2 L jars and the jars are sealed by wrapping the lids with Teflon tape. The jars are labelled with the sample number, date and time on/off, sample type (sample or blank) and F1 (or F2 if necessary), or P1 or P2 to show the order of placement in the samples cartridge.

The jars are placed into the designated storage locations within the suitcases. Each suitcase is labelled A or B; suitcase B has extra positions for the PUF filter blanks and the extra filter.

Every four weeks, a field blank is prepared by loading one PUF and one filter into the cartridge, and placing the cartridge on the sampler. No air is drawn through the sampler. Then the filter and PUF are unloaded immediately. The field blank allows correction for contaminants that are found on the filters and PUFs or that are contributed by handling procedures.

2.4 SAMPLE HANDLING, IDENTIFICATION AND DOCUMENTATION

A numbering scheme and a system for handling and processing samples has been developed for this network. The PUFs are transported to the sites in cleaned 4 x 10 inch diameter metal containers. The filters are wrapped in methanol-rinsed aluminum foil and shipped in manila envelopes. The sample storage jars are shipped in plastic, airtight, foam-filled suitcases.

In the field, the sampling media and containers are stored in a designated 'clean' room at conditions similar to the sampling conditions (vis a vis - temperature and relative humidity). The samples are loaded and unloaded in this room.

The samples are stored in the prescribed containers at ambient temperatures. Then, the samples

are shipped for processing as soon as possible or within one month whichever is less.

The samples are transported to the laboratory in plastic, air tight foam-filled cases. Each case is locked and contains materials from 2 weeks of sampling.

All samples are uniquely identified with a field code comprised of a series of alphanumeric characters. The key used for creating each field code is presented in Table 2-1.

Loading and unloading procedures and observations are documented for each sample on the sample history forms (Figure 2-5). Information on the history form includes the sample number and description, sample duration, pressure drop, and mechanical timer reading. A commentary is also provided to record unusual events that may have occurred during the sampling period. The history form is made up of 3 copies, one remains at the site and the other two copies are forwarded with the samples to the extraction laboratory.

Itemized sample handling instructions provided to the operator are contained in Appendix I.

TABLE 2-1 Sample Code Key

Code ***AB-CC-DD-EF***

where A = Sample Origin
B = Sample Type
C = Year
D = Week Number
E = Sampling Media Type
F = Sequential Number

A - Sample Origin	A = Alert, NWT Y = Tagish, Yukon D = Dunai, Russia C = Cape Dorset, Baffin Island
B - Sample Type	A = Alert Field Sample Y = Tagish Field Sample D = Dunai Field Sample C = Cape Dorset Field Sample B = Field Blank L = Laboratory Blank R = Recovery Spiked Sample (QC)
CC = Year	92 = 1992 93 = 1993 94 = 1994
DD = Week #	02 = Week number 2 52 = Week number 52
E = Sample Type	F = filter P = PUF J = Jar (Laboratory QC sample) P = PUF sorbent (Laboratory QC sample) F = filter sorbent (Laboratory QC sample) FWI = Solvent and flurosil blanks from FWI
F = Sequential Number	1 = 1st filter or PUF 2 = 2nd filter or PUF

FIGURE 2-5 Northern Contaminants Project - Sample History Form

NORTHERN CONTAMINANTS PROJECT
TOXICS SAMPLE HISTORY FORM

STATION _____ PERIOD COVERED _____ TO _____

DAY MONTH YEAR DAY MONTH YEAR

LOADING	FIELD												UNLOADING	
BOX # _____	S #	FILTER #	FILTER TYPE	ACTIVE SAMPLE PERIOD						PRESSURE " H2O		OPER. INITL.	DATE REC'D AES	
				TIME ON			TIME OFF							
				DAY	MO	HR(GMT)	DAY	MO	HR(GMT)	ON	OFF		TECH'S INITLS.	
LOADING DATE	SAMPLE													
			PUF-FRONT											
			PUF-BACK											
SHIPPING DATE			GFF-FRONT	COMMENTS									DATE REC'D CONTRACTOR	
			GFF-BACK *											
	SAMPLE													
			PUF-FRONT											
			PUF-BACK										DATE UNLOADED	
TECH'S INITL.			GFF-FRONT	COMMENTS										
			GFF-BACK *											
	BLANK												TECH'S INITL.	
			PUF-FRONT											
			GFF-FRONT											

* ONLY WHEN REQUIRED - ONE WEEK IN EVERY FOUR AT SAME TIME AS FIELD BLANK

COMMENTS _____

NOTE: 1. ONE OF THESE LOGSHEETS DESCRIBES THE SAMPLES/BLANKS IN ONE BOX
2. A FIELD BLANK IS TAKEN AND A DOUBLE FILTER INITIATED WHEN CENTRE JAR IS PRESENT IN BOX

COPIES: 1. WHITE - AES; 2. YELLOW - CONTRACTOR; 3. PINK - SAMPLING SITE

3 DATA MANAGEMENT

The general procedure for handling field data, laboratory data, documenting chain of custody and processing the data are presented below.

Two spreadsheets based on Excel have been designed to log field and laboratory data:

1. Toxic Sample History and Tracking System and
2. Toxics Laboratory Database

A detailed description of the Sample History and Tracking System is provided in Appendix II.

All samples and field data forms are shipped to Conor Pacific Environmental in Toronto where they are assigned a field code and logged into the Tracking System, then stored for extraction.

As samples are retrieved and extracted, the field code, date and time are recorded in the Arctic Project Log book. Once the extraction is complete, the extracts are dried and concentrated, then split into two aliquots (gravimetrically). The dates and weights of the split samples are recorded in the tracking system.

The following information is added to the tracking system prior to shipping extracts to the analytical laboratories:

- the date the samples are extracted
- the sample extract weights (archive and analytical sample)
- the date that the sample is sent to analytical laboratory

Extracts of samples and corresponding chain of custody forms (electronic and hard copies) are sent with each batch of samples. Once analyses are complete, data files in Excel are composed containing the following information:

- sample code
- sample type
- date received at analytical laboratory
- date of analysis for OC and PAH
- date data sent to Conor Pacific
- sample vial weight (QC check)
- analytical results in ng/fraction of sample.

The analytical data are merged with the field and laboratory data to allow calculation of air concentration values. A statistical software package (SPSS) is used to calculate the air

concentrations by means of equation 3.1.

$$\frac{Analytical\,data\,(ng/FWI\,sample)\times lab\,volume\,ratio}{sample\,volume(m^3)\times 1000} = pg/m^3 \qquad (3.1)$$

For results that are reported as below the analytical detection limit, two-thirds (2/3) the analytical detection limit is used as the surrogate numeric value to calculate air concentrations in pg/m^3 form. To convert blank (laboratory and field blanks) data to pg/m^3 equivalent results, a nominal air volume of 12,000 m^3 is applied to the laboratory results.

3.1 DATA SCREENING AND VALIDATION

3.1.1 Data Screening

After the field and laboratory data have been entered into the sample history and tracking system, the following checks are performed:

- the sample history forms are reviewed to ensure that the number of samples received is equal to the number of samples analyzed.
- the sample air volume indicators are reviewed and the sampling time is calculated.
- the sample pressure drop is checked for any anomalous readings.
- the sample vial weight at CPE is compared to the sample vial weight at FWI and the percent difference is calculated.

3.1.2 Data Validation

Upon completion of the laboratory analysis, the data are entered into a database, and the following data validation procedures are carried out:

- the PUF 1 data is compared to PUF 2 and any significant breakthrough is noted.
- the ratio of particle content (filter) to vapour phase content (PUF) is calculated and compared with previous samples.
- the field and laboratory blanks are compared to previous average values and anomalies are noted.
- duplicate analysis results are reviewed for any significant difference in values.
- extraction recovery efficiencies are calculated for samples that have been spiked with surrogate compounds.
- solvent blank data are reviewed and compared to average laboratory blank data.
- blank data (laboratory and field blanks) are converted to pg/m^3 by assuming a

nominal air volume value of 12,000 m^3.

- the method detection limit is calculated by taking into account the average sample field blank values and adding 3 times the standard deviation.

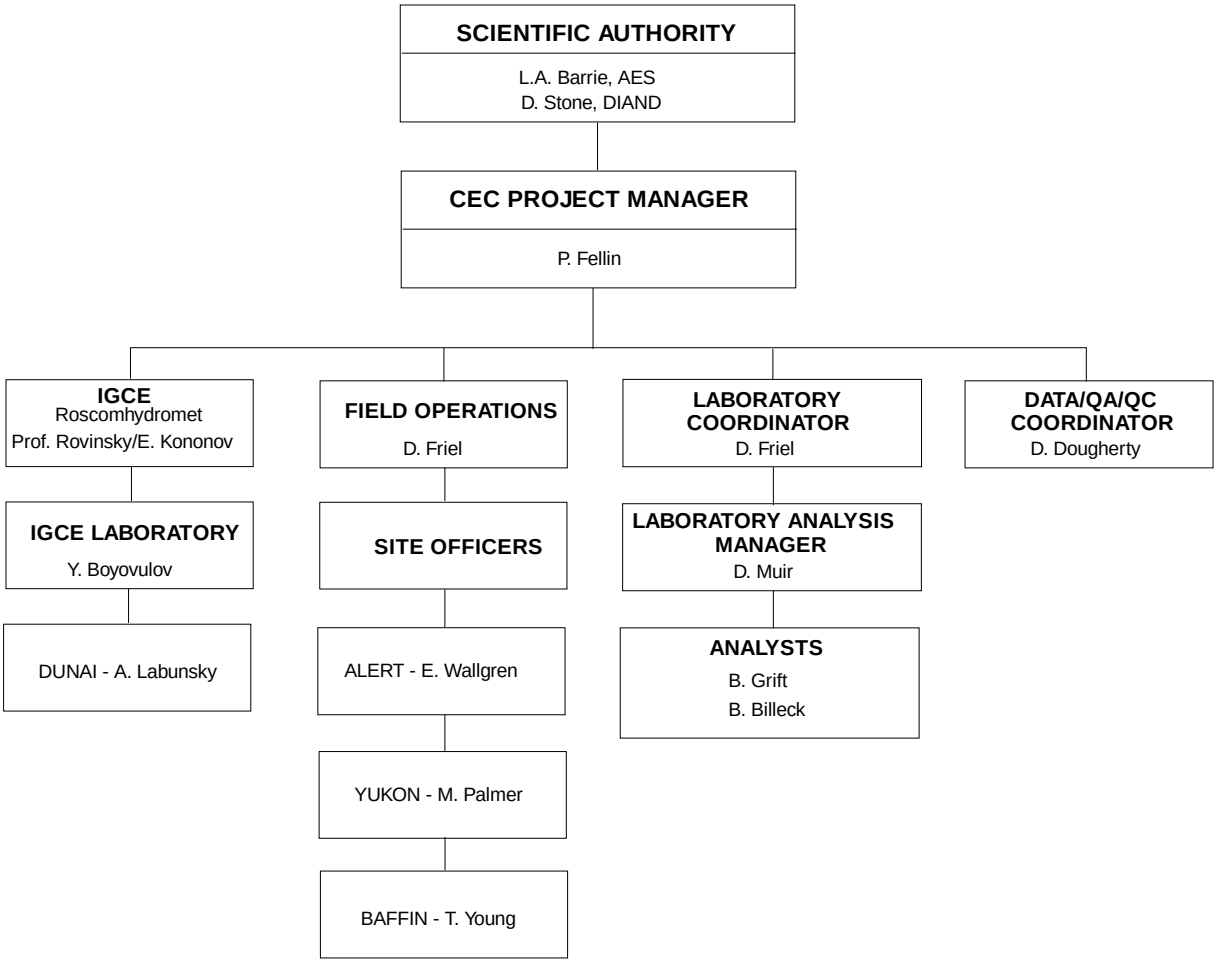
$$MDL = [(\overline{X}_F\,(FIELD\,BLANK\,FILTER) + 3SD_F)\,ng + (\overline{X}_P\,(FIELD\,BLANK\,PUF) + 3SD_P)\,ng] \div \frac{12{,}000}{1{,}000} = pg / m^3 \qquad (3.2)$$

- Sample results are flagged according to a system outlined in Appendix III.

4 NETWORK ORGANIZATION

The network operations and responsibilities of individuals are summarized in Figure 4-1.

FIGURE 4-1 Network Organization



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APPENDIX I

Documentation of
Sample History and Tracking System for Field Operators

NORTHERN CONTAMINANTS PROJECT
TOXICS SAMPLE HISTORY FORM

STATION _____ PERIOD COVERED _____ TO _____
DAY MONTH YEAR DAY MONTH YEAR

LOADING	FIELD												UNLOADING
BOX # _____	S #	FILTER #	FILTER TYPE	ACTIVE SAMPLE PERIOD						PRESSURE " H2O		OPER. INITL.	DATE REC'D AES
				TIME ON			TIME OFF						TECH'S INITLS.
				DAY	MO	HR(GMT)	DAY	MO	HR(GMT)	ON	OFF		
LOADING DATE	SAMPLE												
			PUF-FRONT										
			PUF-BACK										
			GFF-FRONT	COMMENTS									DATE REC'D CONTRACTOR
SHIPPING DATE			GFF-BACK *										
	SAMPLE												
			PUF-FRONT										
			PUF-BACK										DATE UNLOADED
TECH'S INITL.			GFF-FRONT	COMMENTS									
			GFF-BACK *										
	BLANK												TECH'S INITL.
			PUF-FRONT										
			GFF-FRONT										

* ONLY WHEN REQUIRED - ONE WEEK IN EVERY FOUR AT SAME TIME AS FIELD BLANK

COMMENTS _____

NOTE: 1. ONE OF THESE LOGSHEETS DESCRIBES THE SAMPLES/BLANKS IN ONE BOX
2. A FIELD BLANK IS TAKEN AND A DOUBLE FILTER INITIATED WHEN CENTRE JAR IS PRESENT IN BOX

COPIES: 1. WHITE - AES; 2. YELLOW - CONTRACTOR; 3. PINK - SAMPLING SITE

APPENDIX II

Documentation of Toxic Sample History and Tracking System

DOCUMENTATION OF
TOXIC SAMPLE HISTORY AND TRACKING SYSTEM

Column	Title	Description
A	Sample I.D.	AA-BB-CC-DD

AA = Sample Type

AA = Alert Sample
AB = Alert Field Blank
AL = Alert Lab Blank

DD = Dunai Sample
DB = Dunai Field Blank
DL = Dunai Lab Blank

YY = Yukon Sample
YB = Yukon Field Blank
YL = Yukon Lab Blank

CC = Cape Dorset Sample
CB = Cape Dorset Field Blank
CL = Cape Dorset Lab Blank

BB = Year

92 = 1992
93 = 1993

CC = Week #

02 = Week #2 - Starts Jan. 13, 1992 to
52 = Week 52 - Starts Dec. 28, 1992

DD = Sample Type

F1 = Filter #1
F2 = Filter #2

P1 = Puf #1
P2 = Puf #2

J1 = Blank Jar

DOCUMENTATION OF
TOXIC SAMPLE HISTORY AND TRACKING SYSTEM

Column	Title	Description

B	Sample Type	F1 = Field Filter Sample 1
		F2 = Field Filter Sample 2
		
		P1 = Field PUF Sample 1
		P2 = Field PUF Sample 2
		
		BF1 = Field Blank Filter 1
		BF2 = Field Blank Filter 2
		
		BP1 = Field Blank PUF 1
		BP2 = Field Blank PUF 2
		
		BLJn = Blank Lab Jar #n
		BLFn = Blank Lab Filter #n
		BLPn = Blank Lab PUF #n

C	Flag	Field, Laboratory and Data flags To be developed
D	Data On (yy, mm, dd)	Date Sampler turned on: Enter as @ DATE (YY, MM, DD)
E	Time On (hh, mm, ss)	Time Sampler turned on: Enter as @ TIME (HH, MM, SS)
F	Date Off (yy, mm, dd)	Date Sampler turned off: Enter as @ DATE (YY, MM, DD)
G	Time Off (hh, mm, ss)	Time Sampler turned off: Enter as @ TIME (HH, MM, SS)
H	Sample Duration (min)	Sample duration in minutes Date and time off - Date and time on Calculated using formula: $[(F+G)_{off} - (D+E)_{on}] \times 1440$ where 1440 converts days to minutes

DOCUMENTATION OF
TOXIC SAMPLE HISTORY AND TRACKING SYSTEM

Column	Title	Description
I	Pressure Drop in. H_2O	From field data forms pressure reading at start of sampling period
J	Pressure Drop in. H_2O off	From field data forms pressure drop reading at the end of the sampling period
K	Pressure Drop in. H_2O avg (dP)	Average Pressure Drop (in. H_2O) for sampling period Calculated using formula: (I + J)/2
L	Pressure Drop mm Hg avg (dP)	Average Pressure Drop Converts in. H_2O to mm Hg mm Hg = (in. H_2O (K)) x 25.4/13.6 13.6 converts in. H_2O to in. Hg 25.4 converts in. Hg to mm Hg
M	Barometric Pressure mm Hg (P_o)	Barometric pressure of 735.1 mm Hg used for all data calculation (as per L. Barry request)
N	Stagnation Pressure mm Hg (P_1)	Barometric Pressure - Average Pressure Drop. Calculated using formula: M-L
O	Ratio (P_1/P_o)	Ratio of Stagnation pressure to Barometric pressure Calculated using formula: N/M
P	Ambient Temp. deg. C (T_o)	Ambient Air Temperature (T_o) in Degrees Celcius

DOCUMENTATION OF TOXIC SAMPLE HISTORY AND TRACKING SYSTEM

Column	Title	Description
Q	Ambient Temp. deg. K (T_o)	Ambient Air Temperature (T_o) in Degrees Kelvin Converts °C to °K Calculated using formula: P + 273
R	Sample flow rate Q_o (m^3/min)	Actual flowrate obtained from Look-up Tables
S	Sample flow rate Q_{std} (m^3/min)	where: STP = 273°K and 760 mm Hg (as per L. Barry request). Calculated using formula: $\text{Sample Flow Rate (R)} \times \frac{\text{Barometric Pressure (mm Hg) M}}{\text{Ambient Temp. (°K) Q}} \times \frac{273°\text{K}}{760\ \text{mm Hg}}$
T	Sample Volume (m^3)	Volume of air sampled corrected to STP Calculated using formula: $Q_{standard}$ (m^3/min) S x Sample time (min) H
U	Samples Received at CEC	Date samples received at CEC Enter @ DATE (YY, MM, DD)
V	Date Extracted at CEC	Date samples extracted at CEC Enter @ DATE (YY, MM, DD)
W	Extraction Volume Ratio Total/FWI	Ratio of total sample extract weight to weight of extract sent to FWI Calculated by formula: Z ÷ X
X	Total Extract Weight (g)	Weight of sample extract before splitting
Y	Archive Extract Weight (g)	Weight of portion of sample extract stored at CEC
Z	FWI Extract Weight (g)	Weight of portion of sample extract sent to Fresh Water Institute (FWI) for analysis

DOCUMENTATION OF TOXIC SAMPLE HISTORY AND TRACKING SYSTEM

Column	Title	Description
AA	Date Shipped to FWI	Date samples shipped to FWI @ DATE (YY, MM, DD)
AB	Date Received at FWI	Date samples received at FWI @ DATE (YY, MM, DD)
AC	CEC Sample Weight (g)	Weight of (sample extract + vial) prior to shipping to FWI recorded by CEC
AD	FWI Sample Weight (g)	Weight of (sample extract + vial) recorded by FWI upon receipt for analysis
AE	% DIFF Sample Weight	Calculate % difference between CEC weight and FWI weight. Calculated using formula: @ ABS [(AD - AC)/((AD + AC)/2)] x 100
AF	Date of Analyis at FWI (PAH)	@ DATE (YY, MM, DD)
AG	Date of Analysis at FWI (OC)	@ DATE (YY, MM, DD)
AH	Date Analytical Data Sent to CEC	@ DATE (YY, MM, DD)
AI	Comments	

APPENDIX III

Flagging System

FLAGGING SYSTEM

Flagging system was developed to flag the relationship between puff/filter sample concentration and the Dominated Detection Limit (DDL). The flags will help to (i) screen for breakthrough and (ii) qualify best estimate for total gas concentration. Total gas concentration was calculated from:

Total GAS = P1 + P2 + F2

DDL was defined as:

Greater of MDL and ADL,

where

MDL was defined as the sum of mean and 3 times the standard deviation of the field blanks

Flags for Puff

Case	P1 > MDL	P2 > MDL	P2/P1 < 0.333	Flag	Remarks
A	Y	Y	Y	PB1	Both good
A	Y	Y	N	PB2	Considerable breakthrough
B	Y	N	Y	PB3	Both good
B	Y	N	N	PB4	Considerable breakthrough
C	N	N	-	PB5	Both good
D	N	Y	-	PB6	Possible switching

Flags for Filter 2

F2 Exist	F2 > MDL	Flags	Remarks
N	-	FF0	
Y	Y	FF1	
Y	N	FF2	

Programs to Attach Flags

OC	PAH	Function
FBOCMDL.PAD	FBPHMDL.PAD	1. Get field blanks data 2. Separate puff and filter data 3. Create a file for homogeneous period 4. Calculate mean and standard deviation for each homogenous period 5. Create a file with MDL values
OCPARSE.PAD	PAHPARSE.PAD	1. Get field sample data 2. Separate P1, P2 (puff), F1 and F2 (filter) data 3. Reformat the data into P1, P2, F1 and F2 by week number
OCMDL.PAD	PAHMDL.PAD	1. Attached corresponding MDL to the field sample data file created by above
OCADL.PAD	PAHADL.PAD	1. To generate ADL by week number
OCDDL.PAD	PAHDDL.PAD	1. To get the DDL out of MDL and ADL
OCFLG.PAD	PAHFLG.PAD	1. Attach flags to field samples data and calculate total gas concentration