BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

HAT CREEK PROJECT

Environmental Research and Technology Inc. - Air Quality and Climatic Effects of the Proposed Hat Creek Project Report - Appendix H - Aerometric Monitoring - April 1978

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Prepared for
British Columbia Hydro and Power Authority

Air quality and climatic effects of the proposed Hat Creek project

Appendix H
Aerometric monitoring

Prepared by
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APPENDIX H

H1.0 INTRODUCTION

As part of the detailed environmental studies for the proposed Hat Creek Project, British Columbia Hydro and Power Authority (B.C. Hydro) has instituted an ambient air quality and extended meteorological monitoring program. Western Research and Development Ltd. (WR&D) has been retained to engineer and construct a multiple-station network for permanent installation in the vicinity of the Hat Creek Project. Environmental Research & Technology, Inc. (ERT) was given the responsibility of assisting, through overall air quality studies, in the design of the monitoring system. This Appendix to the ERT report, Air Quality and Climatic Effects of the Proposed Hat Creek Project, is an overview of the monitoring net-work built by WR&D. It includes a WR&D report describing the system in detail, Volume I of "Hat Creek Environmental Studies, Meteorological and Air Quality Monitoring Equipment," November 1976.

H1.1 MONITORING PLANS

The Hat Creek Project is being planned for construction and operation in an area where only limited local air quality or meteorological data are available. Since the project's air quality effects on the surrounding regions must be evaluated, it is necessary to understand the local meteorology and existing air quality. While a monitoring system can be designed solely to measure existing (i.e., baseline or background) conditions, it is extremely beneficial to also plan it for measurements during operation of the project. Although the power plant may not be in full operation for as much as ten years, the possibility of having continuous data at the same site or sites before and after construction and operation of the project is attractive enough to justify careful planning of the monitoring program. Planning for air quality and extended meteorological monitoring program began in mid-1976. At that

time, WR&D, ERT and other contractors of B.C. Hydro were just beginning the detailed environmental studies of the Hat Creek Project. B.C. Hydro and its contractors, however, had been measuring meteorological parameters in and near the valley for several years prior to that. A considerable body of data had thus been developed. The data are described in Appendix A of this ERT report. Those data were made available to ERT for preliminary analysis, and used as input to the design of the proposed monitoring program. While WR&D explored the monitoring alternatives, ERT performed some preliminary modeling studies to identify areas where the greatest air quality effects of the project might be expected.

The objectives of the monitoring network, as described in Volume I of the WR&D report, were:

- to obtain accurate information on background air quality levels prior to plant start-up;
- to collect meteorological data in sufficient detail to allow evaluation and design of a meteorological control program for the proposed thermal generating plant should that method of air quality control be adopted;
- to collect pertinent meteorological and atmospheric turbulence data for the evaluation and design of cooling towers; and
- to collect meteorological data which will add to the knowledge of the effects of irregular terrain on contaminant dispersion in the vicinity of the proposed plant.

To these were added, as the work progressed, additional objectives:

- to obtain air quality and meteorological data in areas of expected maximum contaminant concentrations;
- to collect data from sites potentially influenced by all three principal air contaminant sources of the project: the power plant stack, the cooling towers and the coal mine;
- to represent the major receptors of interest (especially human populations); and
- to obtain sites that were as permanent as possible.

H1.2 MONITORING SITES

To meet all these objectives of the program to an equal degree would require an unreasonable number of monitoring sites. It was the task of WR&D and ERT to recommend a group of sites that best met the objectives and the constraints of practicability. Initially, the entire area in the vicinity of the proposed facilities was considered; no sites were precluded by B.C. Hydro.

Following consultations among WR&D, ERT and B.C. Hydro, the monitoring plan presented in Volume I of the WR&D report was recommended. Table H1-1 lists the objectives of the monitoring program and the sites that satisfy each criterion. Figure H1-1 shows the station locations.

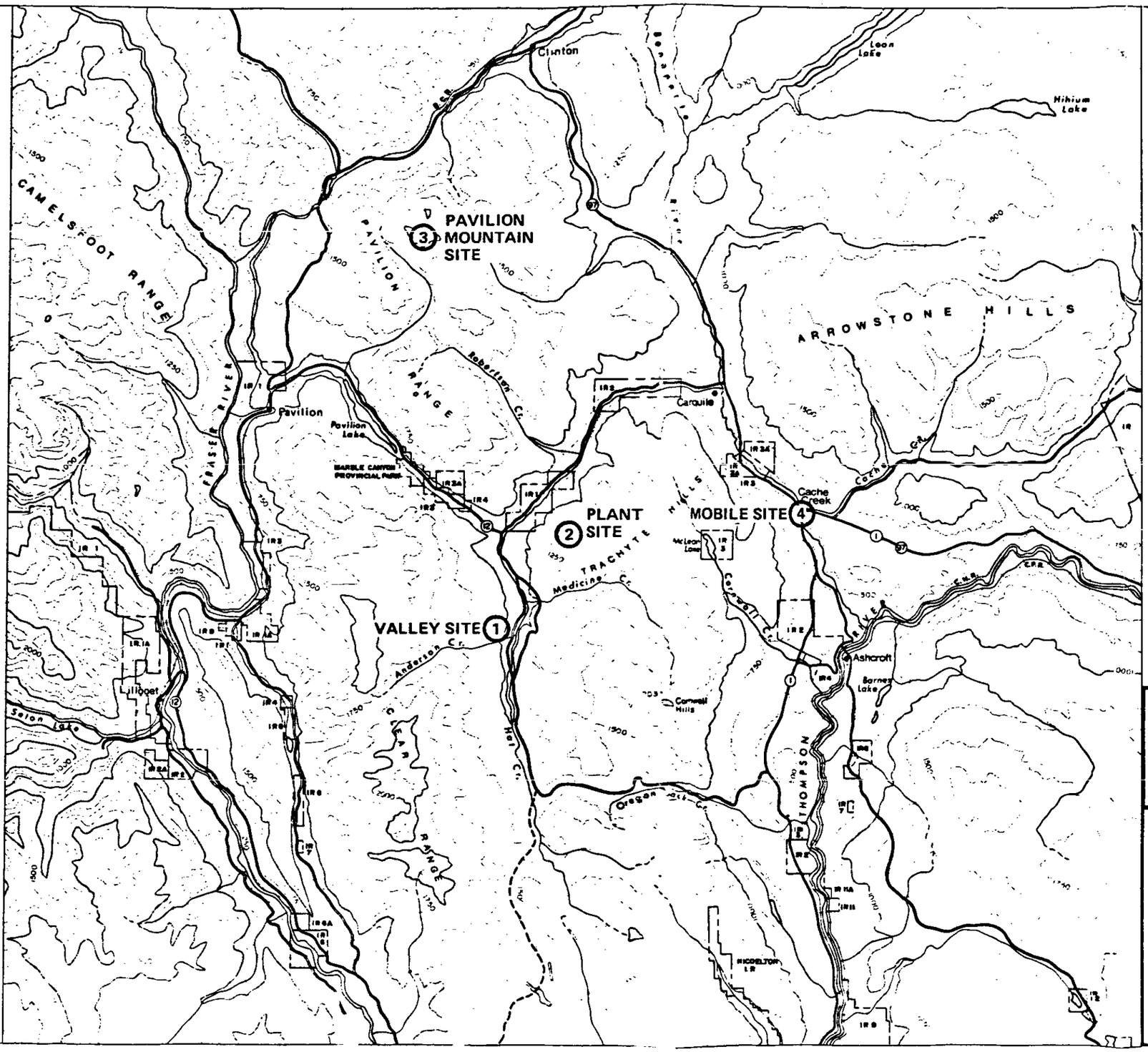
In the text of the report to which this document is an Appendix, the detailed ERT air quality modeling results are presented. The areas of expected maximum contaminant concentrations are shown to be the nearby high terrain, that is the Cornwall Hills, the peaks of the Clear Range and Pavilion Mountain. The first recommendation had been to locate an air quality station at the peak of Cornwall Hills, but this was determined to be impractical due to the lack of electrical power anywhere near the site and the access difficulty expected. The same difficulties precluded establishment of a monitoring station in the Clear Range. A meteorological station was installed by B.C. Hydro on Cornwall Mountain in late 1974. B.C. Hydro is currently considering a meteorological monitoring station in the Clear Range, which could be operated for several years prior to plant operation.

Appendix C, Alternate Methods of Air Quality Control, and Appendix D, Assessment of Atmospheric Effects and Drift Deposition Due to Alternate Cooling Tower Designs, companion appendices to this one, show the degree of analyses possible without the newly collected data. Design parameter optimization will be possible with the meteorological data collected at the plant site.

TABLE H1-1

MONITORING PROGRAM OBJECTIVES SATISFIED
BY RECOMMENDED SITES

Objective	Site			
	Valley	Plant	Mountain	Mobile
Background Air Quality	X	X	X	X
Meteorological Control Design		X	X	
Cooling Tower Design	X	X		
Dispersion in Irregular Terrain	X	X	X	X
Maximum Concentrations				
Power Plant			X	
Cooling Tower		X		
Mine	X			
Receptors of Interest	X			X
Permanent Sites	X	X	X	



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT

DETAILED ENVIRONMENTAL STUDIES

Figure H1-1 Proposed Meteorological and Air Quality Monitoring Stations

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H1.3 MONITORING PARAMETERS

An important part of the monitoring network design was the choice of instrumentation for each site. Table H1-2 lists the meteorological and air quality variables to be measured at each location. Note the following summary comments on the selection of measured quantities among the sampling sites.

- The principal meteorological monitoring location is at the plant site. A 100-meter tower has been installed to obtain vertical profiles of temperature, wind and humidity. At the top of the tower, turbulence data will be collected from a tri-axial anemometer (measuring wind speed in three dimensions). A bi-vane (measuring wind direction in the horizontal and vertical) will be installed at the 10-meter elevation. Both instruments provide information on averages and fluctuations of the wind away from the surface.
- The plant site also is the location for the only evaporation and pressure measurements, expected to be indicative of the entire region.
- Wind speed and direction, temperature, humidity (dew point) and precipitation are monitored at all four sites to provide a regional climatology.
- The mobile station, now at Cache Creek, may be moved to other sites, and thus contains a nearly complete set of instruments. This station will measure all variables except those requiring upper-level, tower-based equipment and those that are not expected to vary appreciably over the area.
- Optical characteristics of the atmosphere are monitored by three measurements: light intensity (solar radiation reaching the ground), visibility and fog (reduction of visibility by ground-based clouds).
- The five common air contaminants for which extensive health related research have been conducted and for which ambient guidelines are or may be established in various jurisdictions (sulfur dioxide, nitrogen dioxide, oxidants, carbon monoxide and suspended particulates) are monitored at the mobile site and, except for carbon monoxide, at the valley site. For the gaseous contaminants, no significant differences of background concentrations are expected at the plant and mountain sites as compared to the valley site.
- Other measures of contaminant concentrations (dustfall, sulfation, corrosion) not utilizing continuously recording instruments are at all four sites.

HAT CREEK ENVIRONMENTAL STUDIES

METEOROLOGICAL AND AIR QUALITY MONITORING EQUIPMENT

VOLUME 1

Prepared for:
British Columbia Hydro and Power Authority

Prepared by:
Western Research & Development Ltd.

November 1976

TABLE H1-2

VARIABLES TO BE MEASURED AT RECOMMENDED MONITORING SITES

Parameter	Site				
	Valley	Plant		Mountain	Mobile
		Tower Base	Tower Top		
Meteorological					
Temperature	X	X	X	X	X
Dew Point Temperature	X	X	X		X
Differential Temperature		X	X		
Precipitation	X	X		X	X
Evaporation		X			
Barometric Pressure		X			
Wind Speed and Direction	X	X	X	X	X
U-V-W- Anemometer			X		
Bi-Vane		X			
Light Intensity	X				
Visibility	X				X
Fog Visiometer	X				
Air Quality					
Sulfur Dioxide	X				X
Nitrogen Oxides	X				X
Ozone	X				X
Carbon Monoxide					X
Suspended Particulates	X	X			X
Dustfall	X	X		X	X
Sulfation	X	X		X	X
Corrosion	X	X		X	X

H1.4 CURRENT STATUS

As of the date of this report, all four sites have been instrumented and all monitoring equipment except that on the meteorological tower is operational and collecting data. The first data report was forwarded by WR&D to B.C. Hydro on April 5, 1978. The data are, therefore, not available for use in this report.

WR&D continues to develop a digital data acquisition system, described in two other reports, "Data Acquisition System for Meteorological and Air Quality Monitoring Equipment" (May 1977), and "Specification of Data Acquisition System for Meteorological and Air Quality Monitoring Equipment" (August 1977).

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I INTRODUCTION

As part of the Hat Creek Environmental Studies, British Columbia Hydro and Power Authority is planning to undertake an extensive program to gather meteorological and background air quality information. B.C. Hydro engaged Western Research & Development Ltd. of Calgary, Alberta, to make recommendations for such a program and to assist in the design, purchase and the initial operation of the monitoring stations.

To gather weather information prior to the proposed program, B.C. Hydro initiated a preliminary meteorological program in November, 1974. This program was to supplement the existing Hat Creek Climate Station data base, which has been developed since the early 1960's.

The main purpose of the present report is to recommend a detailed, long-term data gathering program. The specific objectives are:

- To obtain accurate information on the background air quality levels prior to plant start-up;
- To collect meteorological data in sufficient detail to further evaluate and design a meteorological-control program for the proposed thermal generating plant.
- To collect pertinent meteorological and atmospheric turbulence data for the evaluation and design of cooling towers.
- To collect meteorological data which will add to the knowledge of the effects of irregular terrain on contaminant dispersion in the vicinity of the proposed plant.

Although this monitoring program will be a long-term undertaking, the design discussed in this report is not intended to represent the complete and ultimate monitoring network. It is expected that as all-weather roads and power transmission lines become available in the area, as design of the facilities is finalized, and as the construction of the plant proceeds, the monitoring network will be altered accordingly.

Western Research's participation in this project is only part of a large study. There has been considerable input from Environmental Research and Technology Inc. and from B.C. Hydro personnel regarding specifications and final selection of instruments. There was also significant input from the Coordinating Management Consultant, Envirosphere Company.

In the following sections of the report, there will be a brief discussion of the potential sources of emissions and the contaminants that may be of some concern. Recommendations are made for specific instrumentation to be placed in the individual monitoring stations.

As one of the considerations in the development of this project, Western Research was requested by B.C. Hydro to utilize local resources wherever possible. B.C. Hydro also specified that quotations be obtained from at least three independent suppliers for each instrument or service to be purchased. The method Western Research used for selecting the ultimate supplier and the criteria used in the selection of the individual equipment is discussed in the report.

II EMISSION SOURCES

For the purposes of this report it is assumed that there will be three significant atmospheric emission sources associated with the proposed development:

- The thermal power plant tall stack. Primary contaminants in the plume which could effect air quality are expected to be sulphur dioxide, oxides of nitrogen, carbon monoxide and particulate matter.

- The thermal power plant cooling towers. The cooling tower plume will contain water vapor, water droplets and particulate matter, depending on atmospheric conditions.

- The coal mining operations. Emissions of particulates, carbon monoxide, hydrocarbons and oxides of nitrogen will result.

The air quality and meteorological monitoring program described herein is for the purpose of evaluating these sources, the design, construction, and operation of the Hat Creek project, in terms of existing background air quality. Reports by other consultants will include the detailed rationale for the monitoring program.

III EXISTING METEOROLOGICAL MONITORING PROGRAM

B.C. Hydro initiated a meteorological program in November 1974 for the purpose of collecting data on the air flow patterns over the irregular terrain surrounding the proposed thermal plant. Data were collected from ground-based stations, from instrumented balloons and from aircraft.

Ground-Based Program There are presently eight mechanical weather stations operating in the Hat Creek area. These stations were installed in November and December 1974 to measure wind run, wind direction, temperature and relative humidity at 10 m above the ground. Data from these stations was supplemented during the winter of 1975 by information from four hygrothermographs located on the eastern slopes of the Upper Hat Creek Valley. Data from the weather stations and hygrothermographs is routinely reduced to hourly values for computer analysis and evaluation.

In addition to wind information obtained from the mechanical weather stations, there is also wind data available from a wind sensor which has operated since July 1961 at the junction of the Upper and Lower Hat Creek Valleys with Marble Canyon.

Climatological data pertaining to dry bulb and wet bulb temperatures, relative humidity and precipitation have been collected in the Upper Hat Creek Valley since November 1960.

Upper-Level Studies Minisonde studies were conducted in the Hat Creek Valley during the winter and summer seasons of 1975 and 1976. These studies investigated thermal structures and wind fields occurring in the lower atmosphere.

During the summer of 1975 and the spring of 1976, additional information was obtained from observations of constant-volume balloon flights.

Atmospheric diffusion characteristics and plume trajectories at elevations greater than plume heights have also been studied through the use of smoke and gas tracers. These studies were conducted in the winter, spring and summer of 1976.

These programs of data collection and analysis are the subjects of separate reports. They will also be consolidated into an overall air quality and meteorological summary report by Environmental Research and Technology, Inc., as the Hat Creek Environmental Studies continue.

IV RECOMMENDATIONS FOR MAJOR MONITORING SITES

To achieve the objectives of the project, Western Research recommends that permanent monitoring stations be established in the general Hat Creek area at the following sites (refer to Figure 1.):

Site	Location
1	In the Hat Creek Valley near the mine site
2	At the proposed plant site
3	On Pavilion Mountain
4	In the vicinity of the town of Cache Creek

The Hat Creek Valley site should be situated near the location of the proposed mine. It would be used to monitor background air quality levels to evaluate the potential effects of contaminants which will result from the power plant and mining activities.

The monitoring station at the proposed plant site would be used primarily for collecting meteorological data. This data would be used to model and evaluate the potential environmental and/or air quality influences of cooling tower plumes and for other engineering/environmental measurements.

The proposed mountain site is 14 miles northwest of the plant, on top of Pavilion Mountain. The elevation is about 6800 feet. This location presently has year-round access and is equipped with an instrument shelter and electric power. Information collected at this site should be representative of air quality and meteorological conditions existing at higher elevations within the region of the proposed plant.

A mobile monitoring unit should be maintained in the Cache Creek area. Cache Creek is located approximately 10 miles east of the proposed power plant site. Most of the ground traffic to Hat Creek will pass through Cache Creek. This site is located in a valley about 3000 feet below the proposed plant base and is situated in a growing population centre. Air quality will be of increasing concern to this populated area.

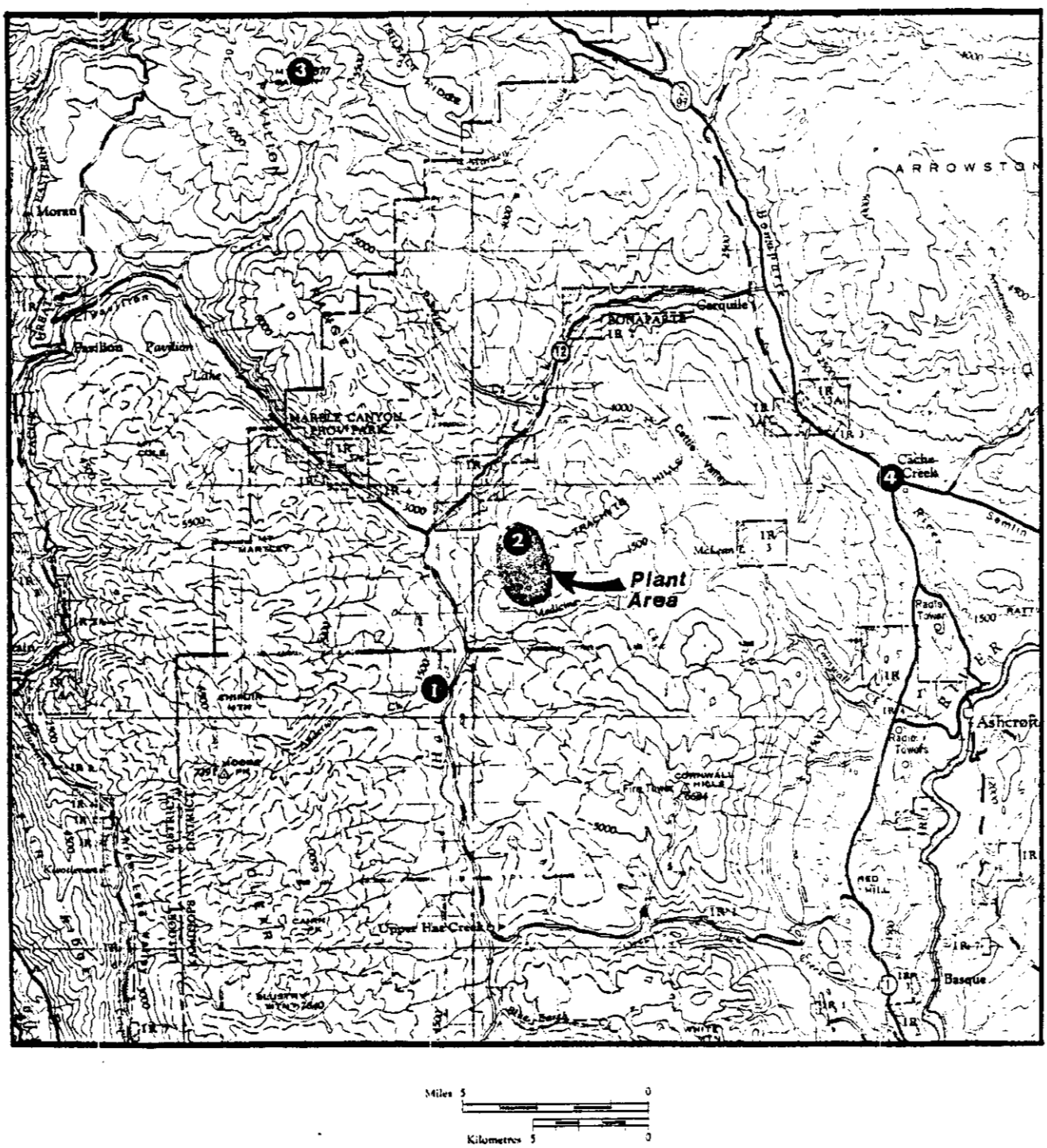


FIGURE 1: British Columbia Hydro and Power Authority - Hat Creek Thermal Power Plant
PROPOSED METEOROLOGICAL AND AIR QUALITY MONITORING STATIONS

The station should be established primarily for the collection of air quality data prior to plant start-up. It is recommended that this station be mobile to allow the collection of background air quality data in the Ashcroft area which lies about six miles southeast of Cache Creek.

The recommended monitoring network is intended to replace the existing mechanical weather station network. Once a suitable overlap of records (approximately six months) has been accumulated, B.C. Hydro is proposing that the mechanical weather stations be taken out of service.

V RECOMMENDED INSTRUMENTATION

The individual instruments installed at each monitoring station will have to provide data to B.C. Hydro that will satisfy the objectives of the program. Based on present information, suitable instrumentation for each of the sites has been recommended.

A. Continuous Monitoring

Site 1 The station in the Hat Creek Valley would be established primarily for the purpose of monitoring background air quality levels. Contaminants such as oxides of nitrogen and particulates might be a concern as a result of the mining operations. This station should therefore be equipped with instruments for measuring existing ambient levels of these contaminants. Suspended particulate may be evaluated with the use of high-volume samplers and visibility measuring devices.

There will be two potential causes of visibility restrictions: suspended particulate and water vapour. Suspended particulate might be associated with earth moving activity in the mining area, vehicle traffic or strong winds. Ground-based layers of water vapour (fog) may be generated by artificial sources such as vehicles or cooling towers but may also occur due to meteorological activity such as the advection of warm moist air over cold land surfaces. Because of their different natures, it is recommended that devices be employed which can separately evaluate visibility restrictions due to each cause prior to mining operations.

Variations in ozone levels are often indicative of photochemical activity which may be important as a result of the presence of oxides of nitrogen. For this reason measurements should also be made of ozone levels. Background measurements of sulphur dioxide should be made in order to define possible future influences of the power plant plume.

Wind, temperature and dewpoint data should also be collected in order to correlate the meteorological conditions with observed variations in air quality. Illustration 1 is an artist's conception of such a station.

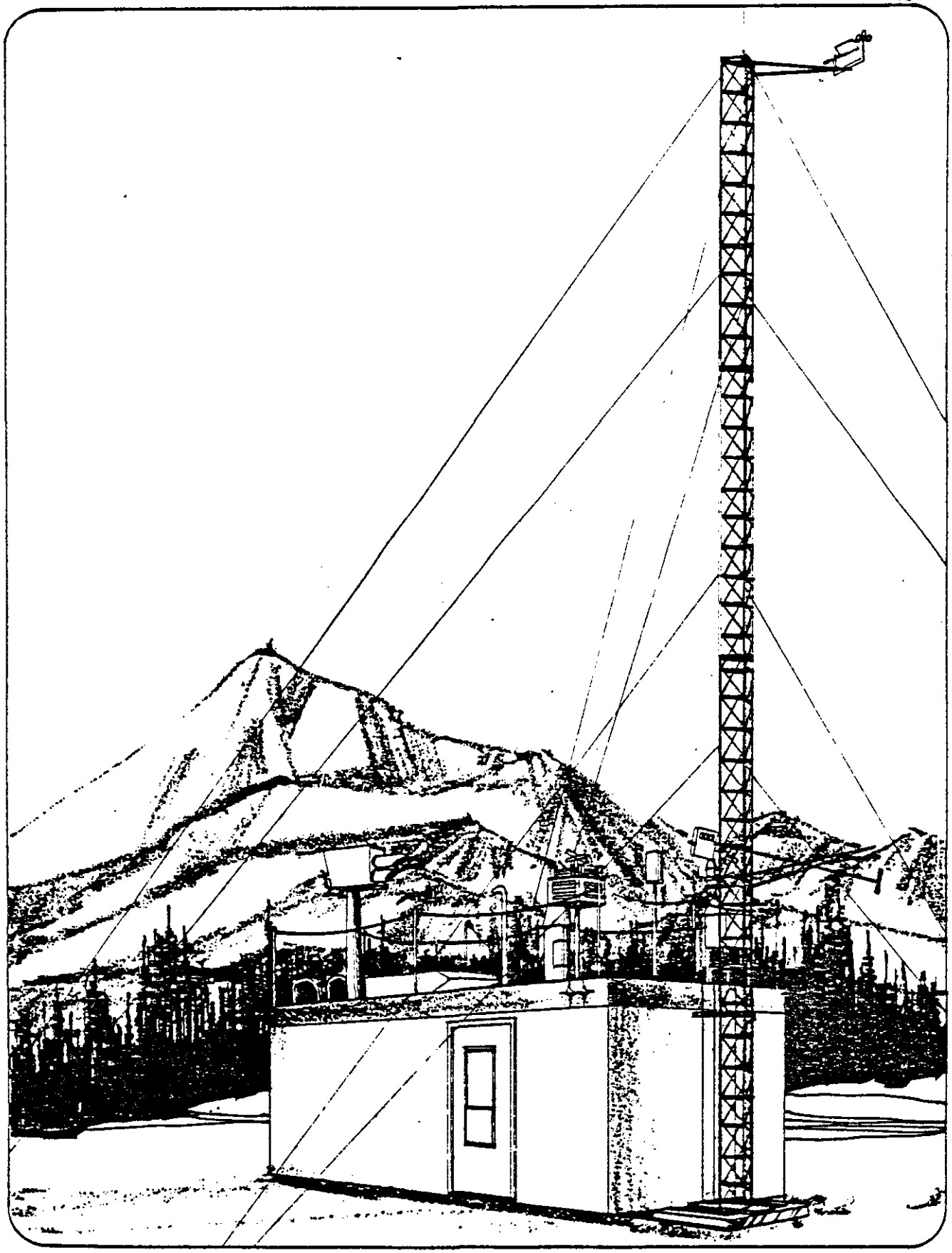


Illustration 1 - Typical installation with a 10m tower

Site 2 The monitoring station at the proposed plant site should be used for collecting meteorological data needed for application of vapour plume models. This data should provide climatological information on wind speeds, temperatures, atmospheric vapour contents and turbulence intensities at an altitude which would be relevant to the cooling tower plume. The least expensive and most efficient manner of collecting the information for a wide range of seasonal meteorological situations would be through instrumentation on a meteorological tower.

A 100 m tower should be of sufficient height to provide a platform for the required instrumentation. This tower should contain, at the 10 m and 100 m levels, wind devices, aspirated temperature and dewpoint sensors. Relevant data on vertical wind velocities and turbulence conditions could be collected by means of a U-V-W Anemometer situated at the 100 m level (Illustration 2).

Site 3 The Pavilion mountain site would be established for the purposes of collecting meteorological and air quality data which would be pertinent to an elevated location. It should be equipped with instrumentation for measuring wind, temperature and precipitation.

Site 4 The mobile monitoring trailer at Cache Creek would be installed primarily for the purpose of monitoring background air quality levels of oxides of nitrogen and sulphur dioxide which might be eventually affected by the power plant operation.

Photochemical activity which may be of importance could be evaluated through ozone measurements. Evaluations of carbon monoxide levels and visibility would also be important as indicators of general air quality. Relevant meteorological information associated with the air quality changes should be collected by wind, temperature and dewpoint measuring devices. The layout of this station is shown in Illustration 3.

Suspended Particulate Measurement B.C. Hydro personnel recently initiated a program for suspended particulate measurement. In consideration of other industrial activities presently in the area the expansion of this

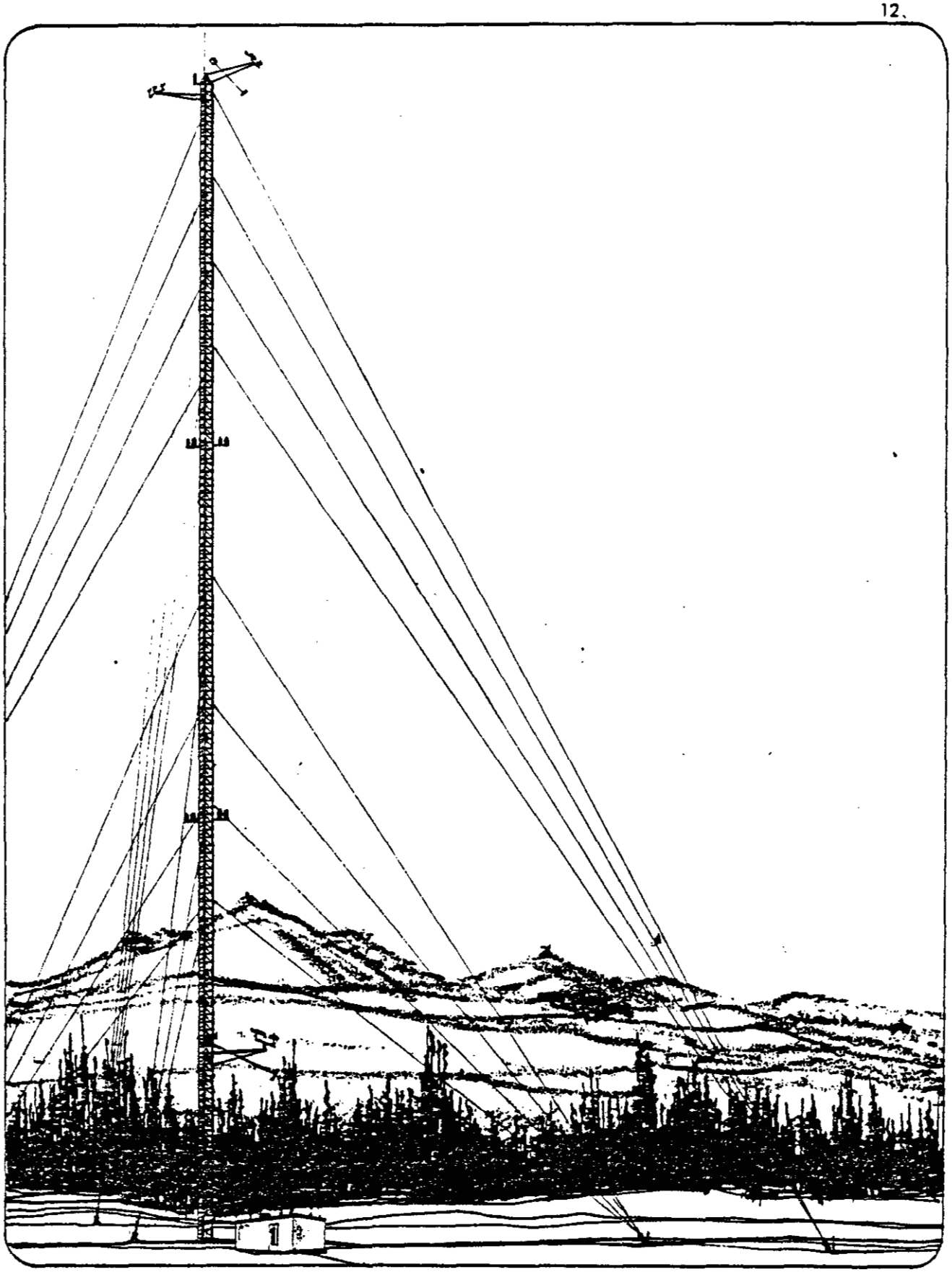


Illustration 2 - The 100m tower installation

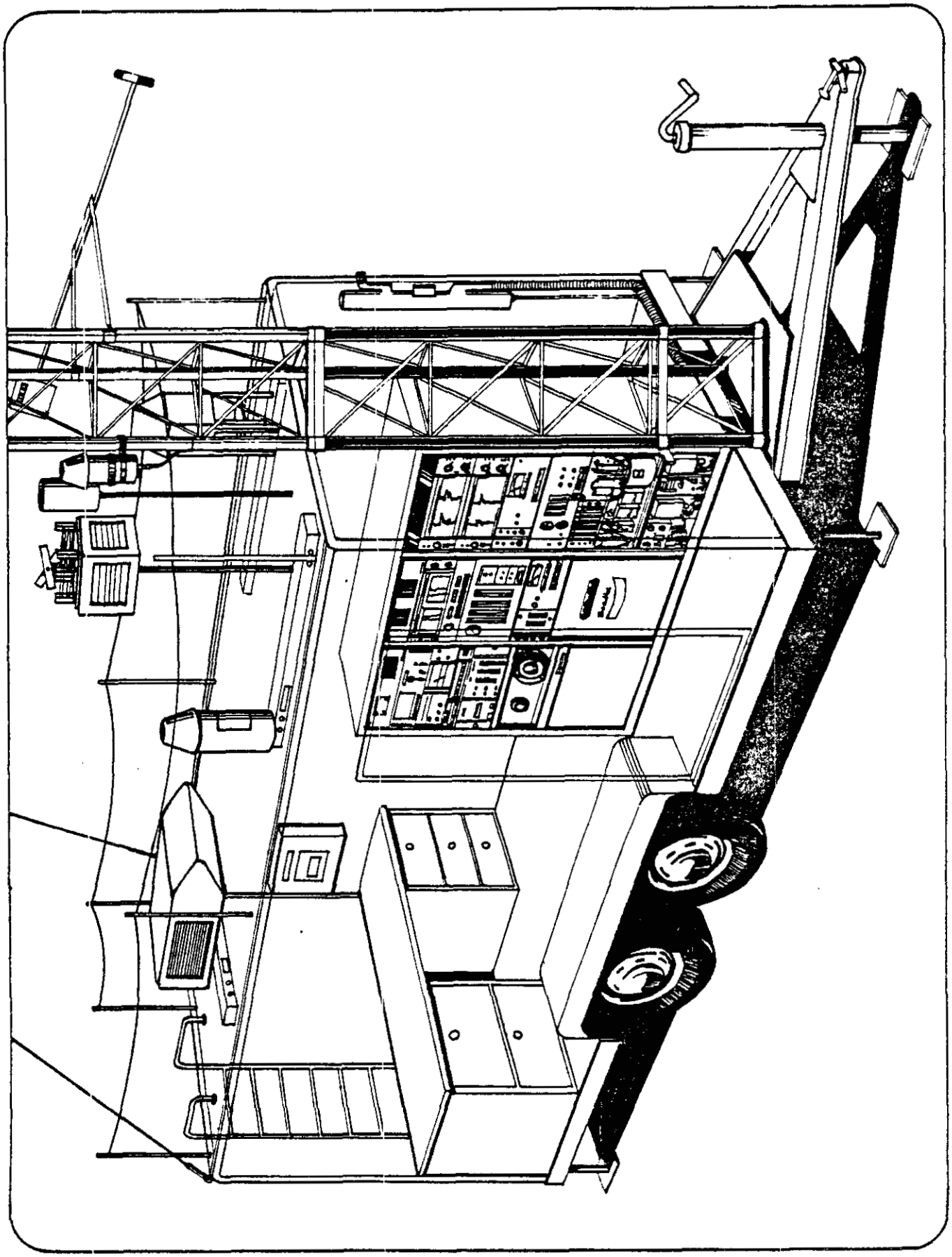


Illustration 3 – Mobile monitoring unit

program is recommended. In addition to the high-volume samplers at three of the major sites, three additional samplers positioned at strategic locations would help considerably in the establishment of the existing particulate loading. The locations recommended for this purpose are shown on Figure 2.

B. Static Monitoring

In addition to the meteorological and analytical instrumentation discussed above the following additional monitoring devices are recommended.

1. Dustfall and Total Sulphation Stations Dustfall cylinders and sulphation plates are considered as semi-quantitative indicators of suspended particulates and levels of sulphur dioxide. Since these devices are relatively inexpensive to install and operate they are used in large numbers to give a general idea of contaminant distribution over a wide geographic area. Including the four major locations, it is recommended that a total of sixteen dustfall and sulphation stations be established in the area. The location of these stations is shown on Figure 3.

2. Atmospheric Corrosion Stations Similar to the dustfall and sulphation devices atmospheric corrosion stations are designed to give a semi-quantitative indication of corrosive materials in the atmosphere. Studies on this subject indicate that corrosion rates in the atmosphere can be related to atmospheric contaminant concentrations. The installation of eight such stations in the area (Figure 4), including the major sites, is recommended.

The instrumentation recommended for the four major sites is summarized in Table 1.

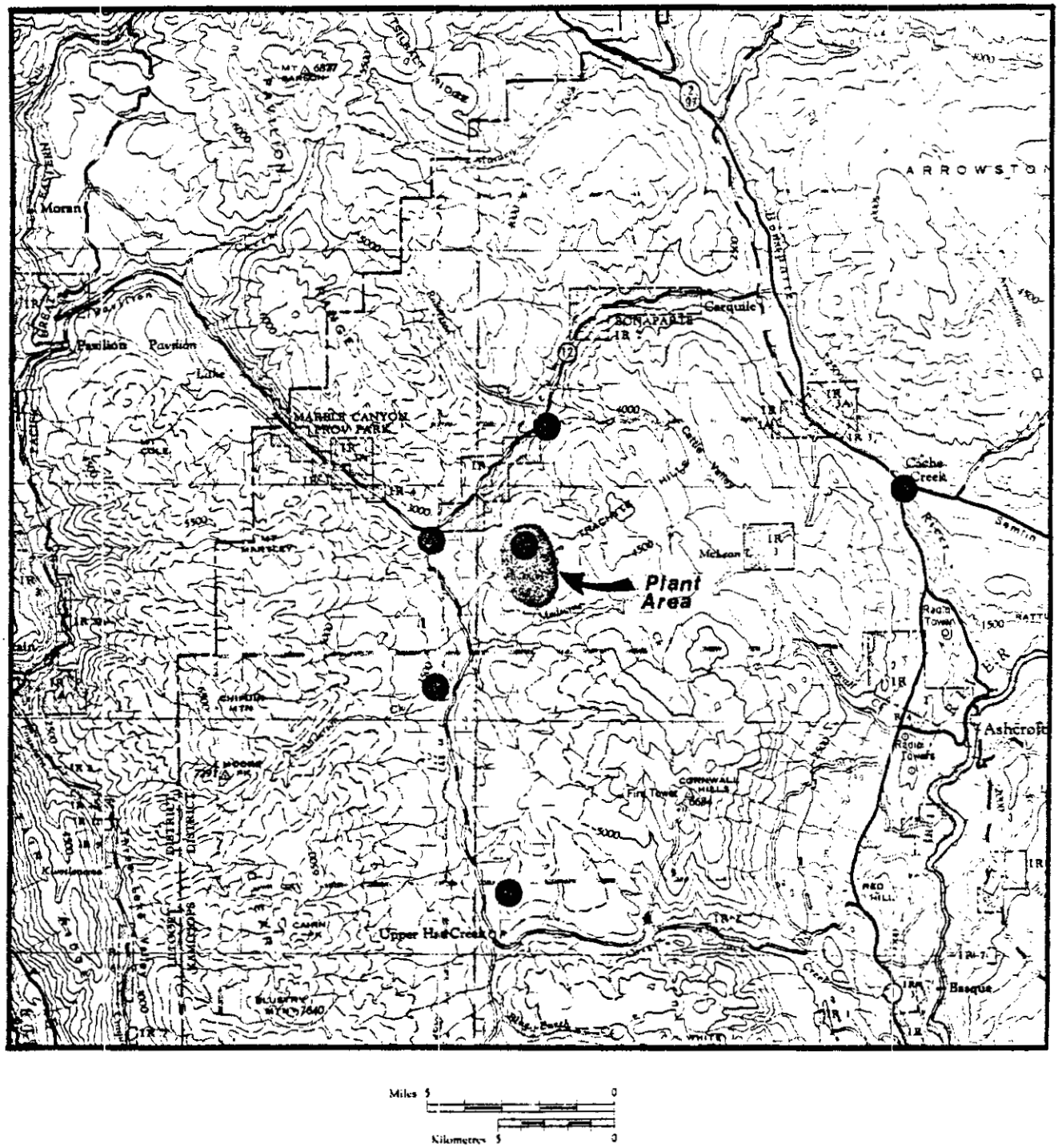


FIGURE 2: British Columbia Hydro and Power Authority - Hat Creek Thermal Power Plant

PROPOSED HIGH VOLUME SAMPLER LOCATIONS

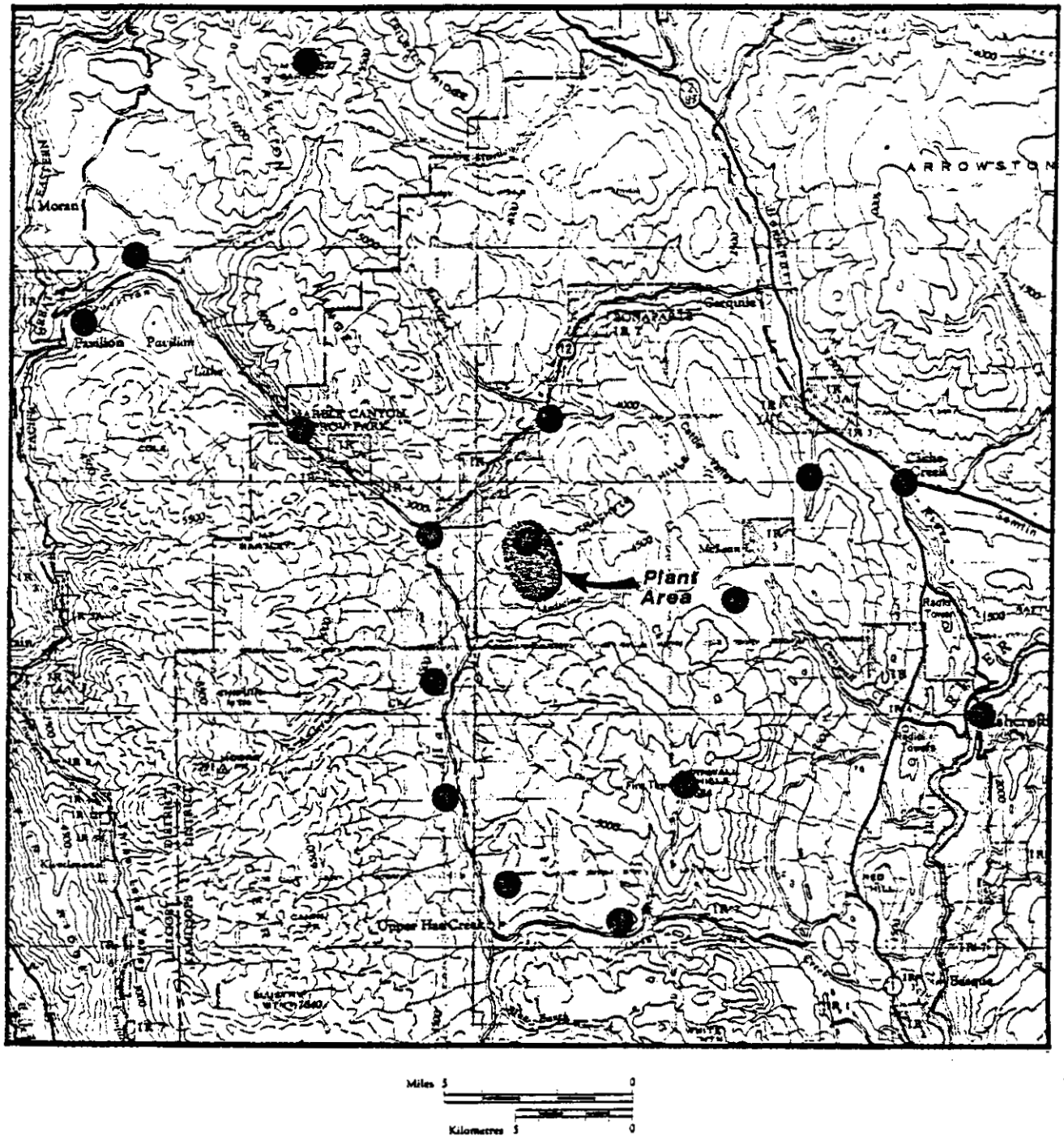


FIGURE 3: British Columbia Hydro and Power Authority - Hat Creek Thermal Power Plant

PROPOSED DUSTFALL AND SULPHATION STATIONS

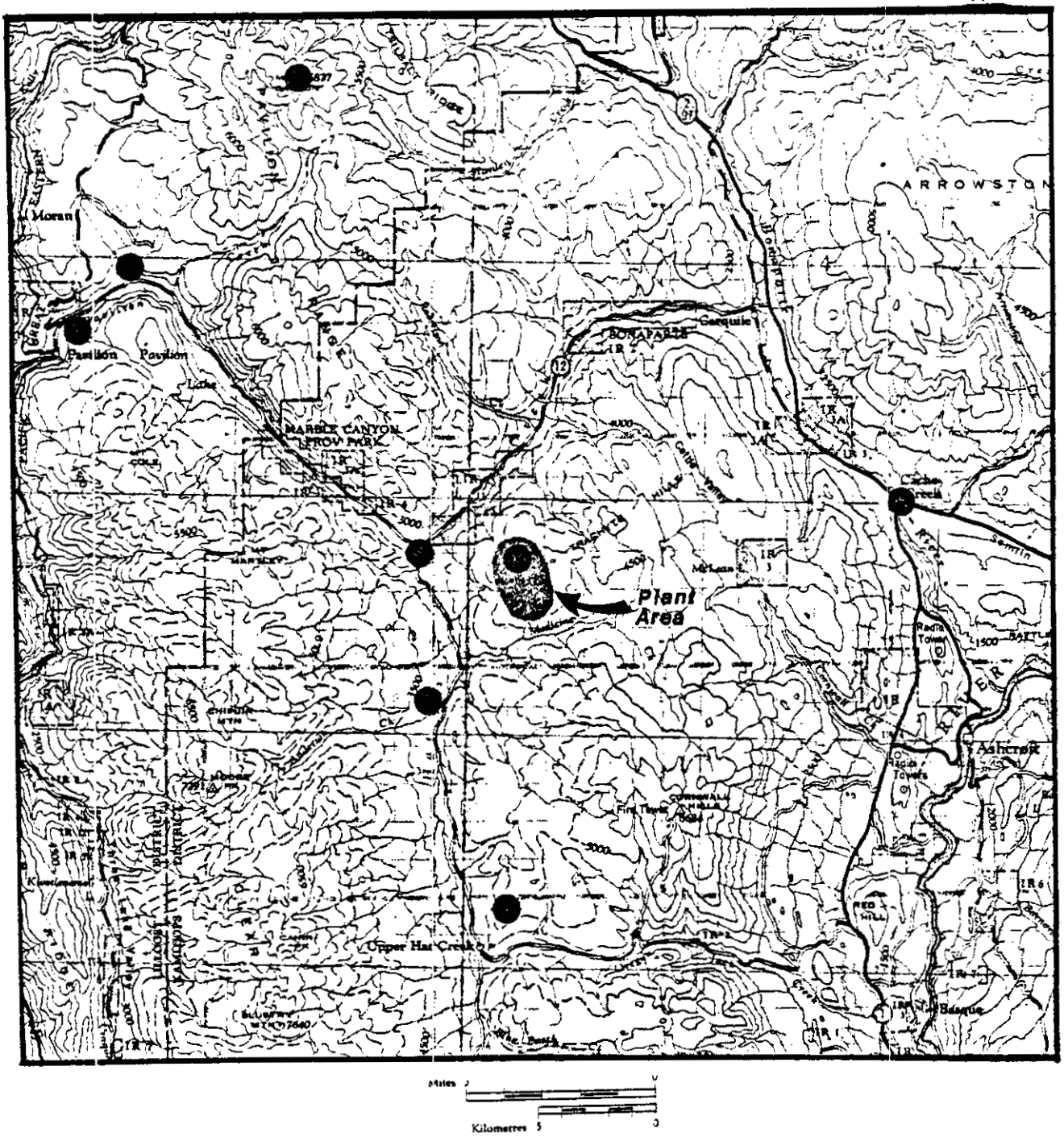


FIGURE 4: British Columbia Hydro and Power Authority - Hat Creek Thermal Power Plant

PROPOSED ATMOSPHERIC CORROSION STATIONS

Table 1

British Columbia Hydro and Power Authority
Hat Creek Thermal Power Plant
SUMMARY OF RECOMMENDED INSTRUMENTATION FOR MAJOR SITES

Site	Recommended Instruments
1. Valley Station	- wind recorder device at 10 m above ground elevation - dew point and temperature sensor - high-volume sampler - visibility sensors (haze and fog) - light intensity sensor - sulphur dioxide analyzer - ozone analyzer - oxides of nitrogen analyzer - precipitation sensor - dustfall and sulphation stations - atmospheric corrosion station
2. Plant Station	- a 100 m meteorological tower - 2 wind recorders - 2 air temperature sensors - differential temperature sensor - 2 dew point sensors - U-V-W Anemometer for measuring wind turbulence and vertical velocities - evaporation sensor - precipitation sensor - barometric pressure sensor - high-volume sampler - dustfall and sulphation station - atmospheric corrosion station
3. Mountain Station	- wind recorder device at 10 m above ground elevation - air temperature sensor - precipitation sensor - dustfall and sulphation station - atmospheric corrosion station
4. Mobile Unit	- wind recorder device at 10 m above ground elevation - air temperature sensor - dew point sensor - high-volume sampler - sulphur dioxide analyzer - oxides of nitrogen analyzer - ozone analyzer - carbon monoxide analyzer - visibility sensor (haze) - precipitation sensor - dustfall and sulphation stations - atmospheric corrosion station

VI MONITORING SITE PREPARATION

The preparation of the air monitoring sites in the Hat Creek area is critical to effective air quality monitoring. Routine station checks for instrument servicing and data collection require easy access during all weather conditions.

Western Research recommends site preparation be carried out with the following in mind:

- Unobstructed sampling area for collecting representative air quality and meteorological data.
- All-weather access by vehicle.
- Adequate power requirements for shelter and instrumentation be made available. At certain stations, emergency diesel generated power may be considered for tower aviation light failures and extended line interruptions.
  A stable 110 volt AC, 60 Hz line is essential for both instrumentation and data aquisition operation. Where diesel generated power is used, a voltage stabilization unit is required. If line power is unstable, all shelters are recommended to be equipped with stabilization units.
- Sturdy base for shelter and concrete anchor points for tiedowns. High winds in exposed areas have blown shelters over in the past. Steel cable tiedowns of the shelter to the concrete anchorages are strongly recommended.
- A barbed wire and chain link fence surrounding the shelter and towers with lockable gate(s) to prevent theft and vandalism.

The following excerpts from Air Monitoring Directives by other Government Authorities should also be considered in site preparation:

- Stations should be located in accordance with the Standard Site Criteria wherever and whenever possible (attached table and figure).

- In forested and populated areas it will, in general, be difficult to find ideal sites for static monitoring stations. Areas that are relatively open, especially in the direction of the plant, should be selected. The top of a fence post is often a convenient mount. Static monitoring stations should never be located under trees, next to hedges, against buildings, or on the side of power/telephone poles.

- In forested areas a site meeting the exposure criterion for the sampling inlet of a continuous monitor can be found by locating the station in the centre of a clearing that has a diameter of about four tree canopy heights (typically 200 - 400 feet). The wind instrument must then be installed at a height greater than or equal to four-fifths of the tree canopy height.

- A clearing that is only three canopy heights in diameter may be used if the station is located off centre such that it is two tree canopy heights away from the trees in the direction of the plant. The wind instrument must then be installed at a height greater than or equal to nine-tenths of the tree canopy height.

- Clearings smaller than three canopy heights in diameter may be used if the sampling inlet is raised to meet the thirty degree exposure criterion in the direction of the plant and a forty-five degree exposure in all other directions. Wind instruments must be raised high enough to meet the six degree exposure criterion.

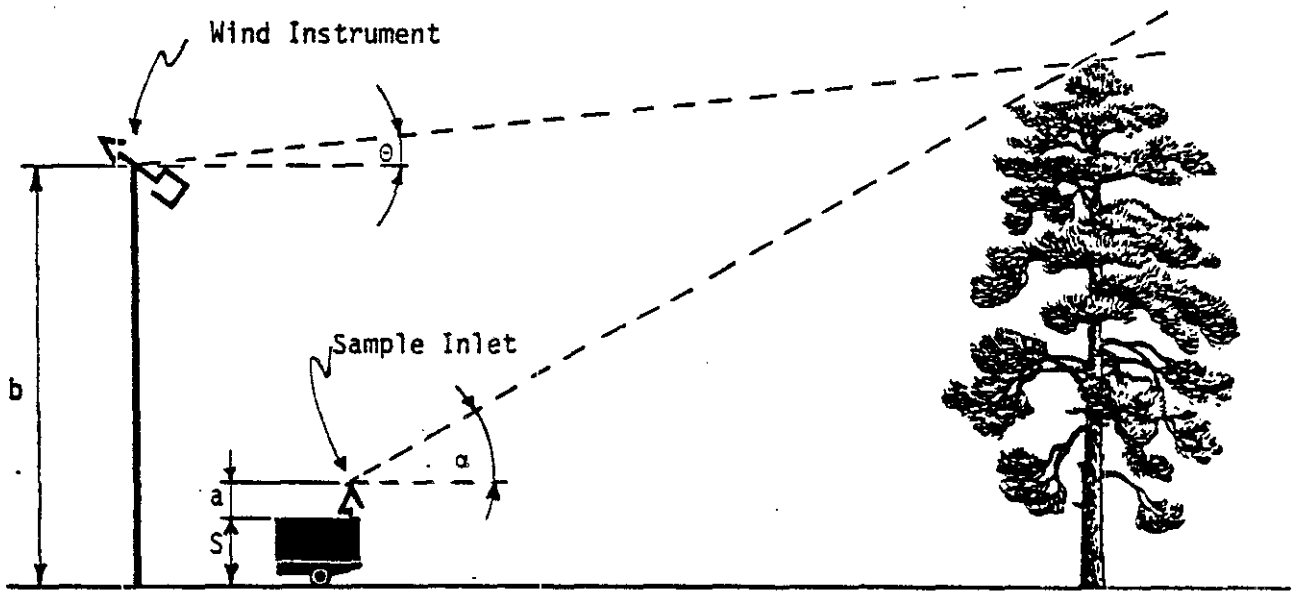
- If no clearings are available the wind instrument should be erected two metres above the forest canopy and the sampling inlet should be placed at least one-half metre above the tree canopy.

- The site should have a good gravel surface, be fenced to keep animals away. A sign identifying the installation is advisable.

STANDARD SITE CRITERIA

An ideal air monitoring station meets the criteria given in the following table:

Site Characteristic \ Station Component	Continuous Monitor Sampling Inlet	Wind Instrument	Static Monitors
Height above ground (m)	3 - 5	10	1 - 3
Height above instrument shelter (m)	>0.5	>2.5 times the shelter	Not Applicable
Elevation Angle to top of any Obstruction (degrees)	<30	<6	<30



Where: $a \geq 0.5$ m; $3\text{ m} \leq a + S \leq 5$ m

$b \geq 10$ m; $b \geq 2.5S$

$\alpha < 30°$

$\theta < 6°$

Source: Alberta Environment

VII SELECTION OF SUPPLIERS AND INSTRUMENTATION

To achieve the objective of the monitoring program, two important factors needed special consideration:

- The instruments will be located in a rugged and remote area of Western Canada, where they will be subject to severe winter conditions. Servicing will be both difficult and expensive.

- The air quality monitoring instruments in the network will be for the purpose of gathering background data. It is expected that the measured concentrations will be in the very low range. This will require the use of highly accurate and very stable instruments.

It became apparent that the end result of providing pertinent, accurate data could only be achieved by using the most up-to-date and sophisticated instrumentation. Uptime and proven performance is a primary concern as well. Excellent data is not useful if it is only produced a fraction of the time. Therefore the two most important criteria used in making the decision on an instrument were:

- accuracy and the capture of useful data;
- reliability and ruggedness for field use.

While many factors were considered, these two generally encompass all and were essential in the final selection.

As a general rule for most instrumentation, the accuracy is directly proportional to its complexity. While such complexity is necessary for accuracy, the maintenance requirements increase and usually the reliability and uptime suffer. To strike a balance is critical in order to achieve the monitoring objectives.

The monitoring network proposed by Western Research for this project contains varied instruments. Some of the instruments to be used are well-known and there are many suppliers available. However, other instruments are more specialized and not widely used, at least not in Western Canada. In such cases, present users were contacted for information and recommendations.

Western Research contacted several regulatory agencies for information on the monitoring of all parameters. Their experience combined with that of Western Research provided the base for the selection.

The government agencies contacted are listed below:

British Columbia Pollution Control Branch
Atmospheric Environment Services
Environment Canada
Alberta Environment
Ministry of Transport, Canada
Environment Protection Agency, U.S.A.

A. Suppliers

Based on the experience and recommendations of the above government agencies and Western Research, as well as input by B.C. Hydro, Environmental Research & Technology, Inc. and Envirosphere Company, the following suppliers were selected.

1. Meteorological Instrumentation

Hemisphere Systems, representing Climet instruments
Extech Ltd., respresenting MRI instruments
Canadian Dynamics, representing Weather Measure instruments
Science Associates, Inc., representing various manufacturers
Rosemount Instruments Ltd., suppliers of temperature sensors
R.M. Young Company, manufacturers of bivane and U-V-W anemometers
E G & G, manufacturers of dew point systems
Fischer and Porter, manufacturers of precipitation gauge

2. Gas Analyzers and Calibration Equipment

Galvanic Analytical Systems Ltd., representing Monitor Labs instruments
Aviation Electric Ltd., representing Bendix instruments
Canadian Dynamics, representing TECO instruments
Philips Electronic Industries Ltd., manufacturer of SO_2 monitor
Simmonds Precision Canada Ltd., representing Meloy instruments
Analytical Instrument Development Inc., manufacturer of calibrators

3. Instrument Housing

ATCO Structures Ltd.
Bridge Trailer Industries
Red Deer Recreation Vehicle Ltd.

4. Meteorological Towers

Leblanc & Royle
J.F. Communications Ltd.
Custom Riggers Ltd.
Tower Systems Inc. for elevator systems only

5. Chart Recorders

Galvanic Analytical Systems Ltd., representing Chessel
Showalter Agencies Ltd., representing Esterline Angus
Domshy Industries Ltd., representing Rustrak
Soltec Corporation
Honeywell
Science Associates, representing Esterline Angus

B. Instrumentation

The specifications for each instrument were prepared prior to requesting a quotation. Specifications vary among instruments, but were to include shelter temperatures, unattended operation, cold weather operation, calibration features and others.

In cases where technical information was lacking, the factory was contacted directly.

When quotations were received, they were evaluated and ranked on their merits. Specifically, the more important considerations for selection of instrumentation can be summarized as follows.

1. Supplier

Western Canadian and/or Western U.S.A. supplier preferred for service and parts.

2. Principle of Operation

method of measurement
stability
adaptability of method for continuous field use
sensitivity
response time
freedom from interference
linearity over the measurement interval, etc.

3. Specifications

accuracy
lower detection limit
calibration features
other pertinent specifications

4. Market Experience

number sold in Canada and U.S.A.
time on market
major users and references

5. Service

availability of service and spare parts
ease of maintenance
reliability
maintenance frequency
unattended operating features
cold weather operating features, etc.

In the Appendix a more detailed summary is presented for each instrument. For brevity, only the justification for the final instrument selection is presented. Manufacturers brochures for each instrument selected will be included in Volume 2. The preparation of Volume 2 is currently in progress.

The time constraint for the selection of equipment necessitated compilation of data by telephone with written follow-up. Therefore, decision material on certain items may still be forthcoming. The Gill U-V-W Anemometer is such a case. It requires a three channel recorder. The only suitable recorder located was the Esterline Angus Model E1104. Unfortunately, data has not arrived at the time of this report. It will be appended in a future report (Volume 2).

Table 2 is a summary of all the selected instrumentation and equipment, including manufacturer, supplier, and model number.

TABLE 2

British Columbia Hydro and Power Authority
Hat Creek Thermal Power Plant
RECOMMENDED EQUIPMENT LIST

Instrument	Manufacturer	Model	Supplier	Location	Valley	Plant	Mountain	Mobile	No. To Be Purchased
1. *Dew Point & Air Temperature*	EG &G	*110*	EG &G	*Boston*	1	2	-	1	4
2. *Differential Temperature*	WR&D	*1500*	WR&D	*Calgary*	-	1	-	-	1
3. *Precipitation Sensor*	Fischer and Porter	*35B1558ND136C2*	Fischer and Porter	*Warminster, Penn.*	1	1	1	1	4
4. *Evaporation Sensor*	Science Associates	*No. 242, 582, 248*	Science Associates	*Princeton, N.J.*	-	1	-	-	1
5. *Barometric Pressure*	Science Associates	*No. 363 & No. 364*	Science Associates	*Princeton, N.J.*	-	1	-	-	1
6. *Air Temperature Sensor*	Science Associates	*No. 190 & No. 174-1*	Science Associates	*Princeton, N.J.*	-	-	1	-	1
7. *Wind Speed and Direction*	WR&D	*Windflo 540*	WR&D	*Calgary*	1	2	1	1	5
8. *U-V-W Anemometer*	Gill U-V-W	*No. 454*	Science Associates	*Princeton, N.J.*	-	1	-	-	1
9. *Light Intensity*	Eppley	*No. 645-48*	Science Associates	*Princeton, N.J.*	Existing	-	-	-	-
10. *Visibility (Haze)*	Nephelometer	*MRI 1560*	Extech	*Vancouver*	1	-	-	1	2
11. *Visibility (Fog)*	Fog Visiometer	*MRI 1580*	Extech	*Vancouver*	1	-	-	-	1
	Videograph	*B*	Sperry Gyroscope	*Ottawa*	1	-	-	-	1
12. *Sulphur Dioxide*	Philips	*9755*	Philips	*Edmonton*	1	-	-	Existing	1
13. *Oxides of Nitrogen*	Monitor Labs	*8440R*	Galvanic	*Calgary*	1	-	-	Existing	1
14. *Ozone*	Monitor Labs	*8410R*	Galvanic	*Calgary*	1	-	-	Existing	1
15. *Carbon Monoxide*	Bendix	*8501*	Aviation Electric	*Montreal*	-	-	-	Existing	-
16. *High-Volume Sampler*	Sierra Instruments	*Ultra - Vol 3*	Extech	*Vancouver*	Existing	1	-	1	2
17. *Dustfall*		*1 qt plastic containers*	Western Industrial	*Edmonton*	1	1	1	1	16
18. *Sulphation*		*Sulphation Plates*	Western Industrial	*Edmonton*	1	1	1	1	16
19. *Atmospheric Corrosion*	WR&D		WR&D	*Calgary*	1	1	1	1	8
20. *Calibrator*	Monitor Labs	*8500R*	Galvanic	*Calgary*	1	-	-	1	3
21. *Instrument Shelter*	ATCO	*12' x 8' & 16' x 8'*	ATCO	*Calgary*	1	1	Existing	-	2
22. *Instrument Trailer*	Bridge Trailer	*16' x 8'*	Bridge Trailer	*Calgary*	-	-	-	1	1
23. *Tower - 100 m guyed*	LeBlanc & Royle	*LR24 (no elevator)*	LeBlanc & Royle	*Vancouver*	-	1	-	-	1
24. *Tower - 10 m guyed*	LeBlanc & Royle	*LR10*	LeBlanc & Royle	*Vancouver*	1	-	1	-	2
25. *Tower - 10 m telescopic*	LeBlanc & Royle	*Crank-up & guyed*	LeBlanc & Royle	*Vancouver*	-	-	-	1	1
26. *Recorders - meteorological*	Chessel	*301E 2-Channel*	Galvanic	*Calgary*	4	5	2	3	14
27. *Recorders - analyzers*	Soltec	*VP-6232S 2-Channel*	Soltec	*Sun Valley, Calif.*	2	-	-	3	5
28. *Recorders - U-V-W*	Esterline Angus	*E1104 4-Channel*	Science Associates	*Princeton, N.J.*	-	1	-	-	1

VIII DATA HANDLING

The data collection and handling system is a very important part of the entire project. Manual reduction of analog charts is slow and expensive. The plan is to design an automatic system that will efficiently collect and store the data.

Time constraints did not allow completion of the design of such a system. Although numerous discussions were held with appropriate suppliers, the investigation is continuing. Final recommendations are expected to be completed by January 1, 1977.

In the interval, the balance of the monitoring network is designed to complement the ultimate objectives for data handling and utilization. It is anticipated that by the time the monitoring equipment is installed and commissioned in the field, the automatic data collection facility will also be ready for installation. During the commissioning period, all data will be recorded on analog charts so that manual data reduction may be carried out.

All instruments selected are equipped with standard analog outputs compatible with data acquisition systems.

IX TRAINING PROGRAM, MAINTENANCE, SUPPLIES AND SPARE PARTS

A training program will be necessary for B.C. Hydro personnel prior to shipping of equipment to the Hat Creek area. Technicians from B.C. Hydro should spend a minimum of one week in Western Research's Calgary laboratory for familiarization and training on the instruments. Further field exposure with a Western Research technologist during the first few months of operation is also advisable.

Since the analyzers and meteorological equipment have just been selected, a maintenance program cannot be developed until a full evaluation of instrumentation takes place. Western Research will undertake, at that time, to develop a suitable maintenance program and make recommendations accordingly. The same applies for the supplies and spare parts.

X CALIBRATION OF AMBIENT AIR QUALITY MONITORS

The proposed ambient air quality monitors for B.C. Hydro at the Hat Creek sites are:

Measured Component	Recommended Analyzer	Detection Method	Minimum Detectibility (ppb)	Expected Monitoring Range (ppb)
Sulphur dioxide	Philips 9755	Coulometric	2 or less	0-300
Carbon monoxide	Bendix 8501	Nondispersive IR	500	0-50,000
Ozone	Monitor Labs 8410	Chemiluminescent	1 or less	0-200
Nitrogen dioxide	Monitor Labs 8440	Chemiluminescent	2	0-200
Nitric oxide	Monitor Labs 8440	Chemiluminescent	2	0-200

The above monitoring ranges are the lowest ranges available on the monitors.

The need for accurate calibration of the above analyzers is essential to the validity of the results. The accuracy of the analyzers is directly proportional to the confidence limits of calibration. In order to attain the highest level of confidence in instrument accuracy, the following conditions should be considered.

- Type of calibration method selected and its approval as a Primary Standard or equivalent.
- Frequency of calibration. Monthly multipoint calibration and daily single point check.
- A calibration system should be selected that will satisfy both of the above and have ± 5 percent accuracy.

A. Type of Calibration Method Recommended

1. Sulphur dioxide The calibration of SO_2 monitors by the permeation device method has acceptance by several regulatory agencies. B.C. Pollution Control Branch tentatively recognizes NBS Permeation Tubes as a primary standard. For mandatory sulphur dioxide calibration in an around Alberta Gas Plant Operations, the permeation method is considered a primary standard by Alberta Environment. It is similarly used by Environment Canada and EPA.

2. Carbon Monoxide The accepted method for calibrating CO monitors is with a certified cylinder. Since no practical permeation devices are available; a NBS certified CO cylinder with an appropriate practical dilution system is recommended. ASTM data on aluminum treated cylinders indicates negligible deterioration of CO and N_2 mixtures.

B.C. Pollution Control Branch recommends a NBS approved CO cylinder with a Wostoff Gas Dilution System. EPA and Alberta Environment recommend certified cylinders as well.

Since the Wostoff System is not amenable to automatic control for daily checks, Western Research recommends that it be replaced by an automated mass flow controller system. The resulting decrease in accuracy from ± 1 to ± 2 percent is offset by the advantages gained by the automation.

3. Ozone An O_3 generator is the only acceptable source for O_3. The difficulty arises in determining the O_3 generator output. One method for O_3 determination uses neutral buffered potassium iodide wet chemistry, but such wet chemical analyses should be avoided in the field. Also, the method is insensitive and not reproducible.

An alternative method is Gas Phase Titration (G.P.T.) of NO and O_3 in which a known amount of NO is mixed with O_3 from the generator. The resulting decrease in O_3 measured by the O_3 monitor is used to calculate O_3 output from the generator. The NO cylinder can be purchased with NBS certification.

The G.P.T. method is preferable because of its versatility and sensitivity, and it does eliminate the inherent errors of the wet chemistry methods. Also it is applicable to NO and NO_2 calibrations.

The G.P.T. method is used by B.C. Pollution Control Branch, Alberta Environment and EPA.

Another method considered for O_3 is the Dasibi U.V. Photometer. More information on this method and its use is being collected.

4. Nitric Oxide The B.C. Pollution Control Branch tentatively approves the use of NBS certified NO cylinders for calibration of NO analyzers. Western Research recommends aluminum treated cylinders of NO in N_2. ASTM data on aluminim treated cylinders shows negligible deterioration of NO in N_2 as low as 0.2 ppm. The EPA approved Gas Phase Titration can convert NO to NO_2. The direct comparison on a chemiluminescent analyzer between a NBS approved permeation device and G.P.T. generated NO_2 can verify the contents of the NO cylinder. This approach is advantageous because it correlates two approved standards.

5. Nitrogen Dioxide The calibrations of NO_2 analyzers by both permeation devices and G.P.T. generated NO_2 are widely accepted.

The B.C. Pollution Control Branch recognizes NBS permeation tubes as a primary standard. Alberta Environment uses both methods with good correlation.

B. Frequency of Calibration

Regulatory agencies differ on the frequency of mandatory analyzer calibration. However, with state-of-the-art analyzers, the general concensus is that there are three types of calibration functions:

(1) A single input system check, designed to provide information on correct analyzer operation. Western Research advises such a check, whether performed manually or automatically, once per 24 hour day.

(2) The routine operator performed calibration, performed once monthly and consisting of:

   (a) Pre- and post-calibration zeroing of analyzer with zero gas.
   (b) A multi-point linearity and span check, with at least one calibration point done twice for a reproducibility check.
   (c) Appropriate zero and span adjustments, where possible.

(3) A quarterly verification of calibration accuracy by independent calibration system. This verification would be performed like the monthly calibration.

All regulatory agencies contacted indicated preference for some analyzer check involving input of zero and span gas at least once a week, if not once a day. Such a check would verify correct analyzer functioning.

The regulatory agencies contacted preferred and even required monthly calibrations of analyzers. These calibrations would validate data and also provide a basis for correcting the drift of any parameter resulting from continuous operation.

A quarterly calibration by an independent calibration system would detect any inherent error in calibration and would provide added confidence to analyzer results. This is the reason for the additional calibration system indicated in Table 2.

C. The Calibration System

In the interest of accuracy, efficiency, and practicality, the most suitable system would be the one that could perform daily checks plus the monthly calibration. The selected system, Monitor Labs 8500R Calibrator and the 8530 Controller, can provide these functions. The CO system exceeds the limitations of the calibrator; therefore, an additional flow system is required. The Controller has the capacity to handle the CO daily check.

The daily check (refer to Figure 5) utilizes the Controller to actuate solenoid valves for a zero-calibrate-zero sequence once daily. The Controller is compatible with the Calibrator. The rotameters are pre-set to the required levels and the controller switches the flow mode from standby to run prior to the check. All analyzers are checked at the same time.

The monthly calibration (refer to Figure 5) requires an operator because the rotameters (and flow controllers) must be adjusted to provide various concentrations for a multipoint check. Because of a dilution flow constraint, only two analyzers can be calibrated at one time. The monthly calibration will also utilize the zero-air system for a pre- and post-calibration zero. The Controller is operated manually to select the correct function.

The outputs of the calibrator for the daily checks and multipoint calibrations for each component are indicated in Table 3.

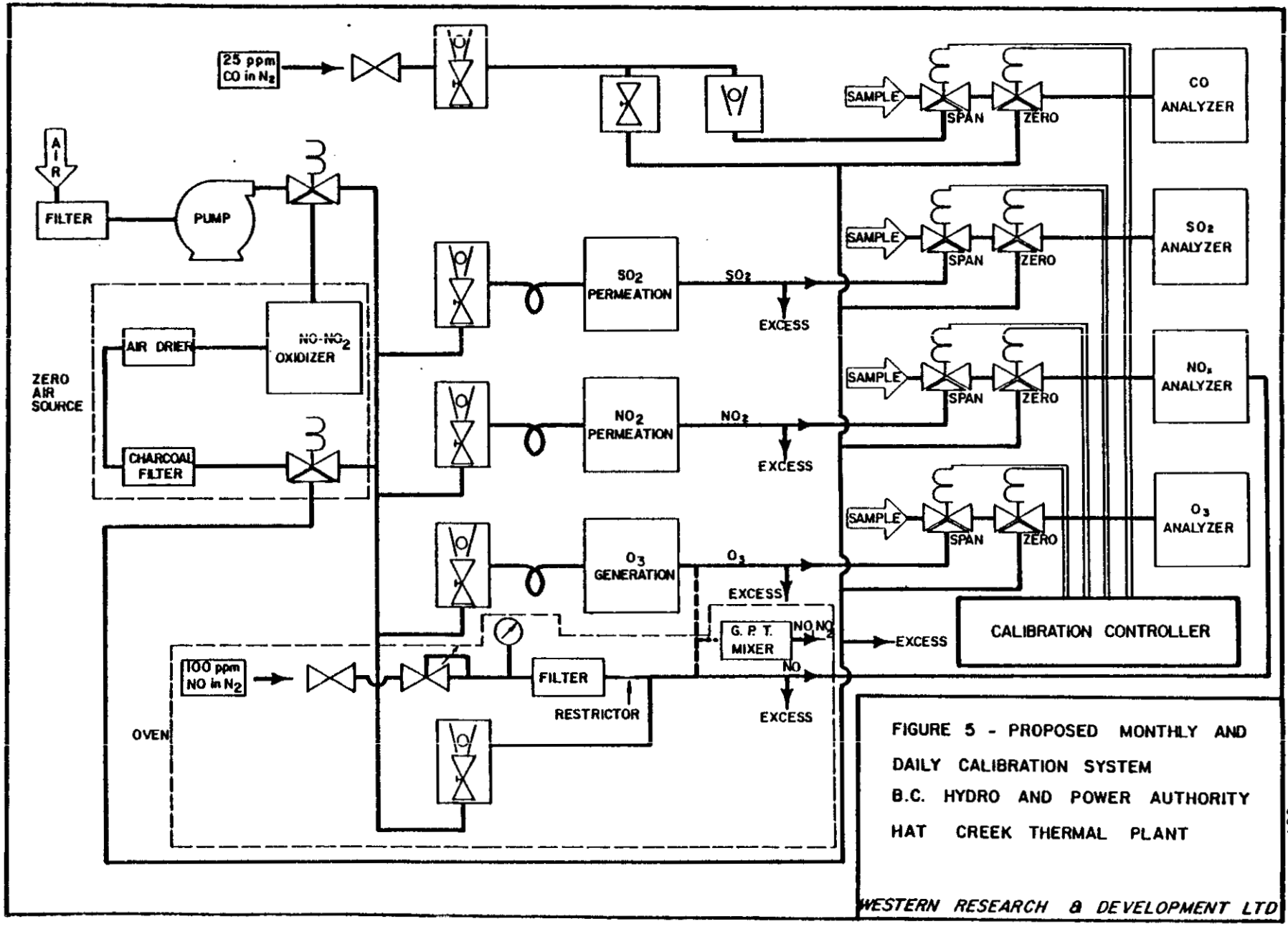


FIGURE 5 - PROPOSED MONTHLY AND DAILY CALIBRATION SYSTEM
B.C. HYDRO AND POWER AUTHORITY
HAT CREEK THERMAL PLANT

WESTERN RESEARCH & DEVELOPMENT LTD

Table 3

British Columbia Hydro and Power Authority
Hat Creek Thermal Power Plant
PROPOSED CALIBRATION OUTPUTS

Calibration Gas	Source	Analyzer Range (ppb)	Daily Check (ppb)	Daily Dilution Requirements	Certified Method Traceability	Multipoint Calibration Range (ppb)
SO_2	Monitor Labs permeation device	0-300	100	1000 cc/min	NBS traceable	25-100
CO	Treated aluminum cylinder, 25 ppm in N_2	0-50,000	25,000	None	Cylinder can be NBS (or equivalent) certified	10,000-50,000
O_3	Monitor Labs O_3 generator	0-200	150	2000 cc/min on low O_3 output	O_3 output can be verified by G.P.T.	75-200
NO	Treated aluminum cylinder NO in N_2	0-200	100	1000 cc/min	NBS Certified	5-200
NO_2	Monitor Labs permeation device	0-200	100	2000 cc/min with low NO_2 output	NBS traceable	50-200

APPENDIX

Annotated List of Equipment Specifications

APPENDIX

This appendix is an anotated list of the specifications for each instrument selected for the Hat Creek air quality and meteorological monitoring network. In addition to the specifications on accuracy, sensitivity, detection limits and method of calibration, comments on principle of operation, user experience, reliability and cold weather operation are included where appropriate.

The information was compiled partially from published sources and partially from telephone communications with suppliers, manufacturers, and users. The documentation of instrument specifications will be completed by Volume 2 (preparation in progress) of this report which will contain the instrument brochures supplied by each manufacturer.

Further, Volume 2 will contain the formal definitions of such instrument parameters as accuracy, sensitivity, reliability, detection limits, etc.

INSTRUMENT:	CHILLED MIRROR DEW POINT SYSTEM
Selected Model:	EG&G Model 110 with Control Unit
Supplier:	EG&G, Waltham, Massachusetts
Canadian Supplier:	Willer Engineering, Toronto, Ontario
Comments:	The two systems compared were EG&G and Climet. The Climet unit has been on the market for one year and only 7 units are in service, according to our information. Western Research contacted two parties using 4 of the 7 units. Their comments about reliability indicated the instruments were not proven. Both parties also had EG&G units and were satisfied with their performance. The Model 110 is used throughout Canada and the U.S.A. As a standard for comparison, A.E.S. recommends the Model 110.
Description:	The EG&G Model 110 comprises a dew point and temperature sensing unit (in an aspirated shield) and a control unit. The dew point sensor is the chilled mirror type with a sensing photomultiplier tube. The mirror is cooled by a Peltier cooler and the unit contains an automatic standardization circuit. The air temperature is measured by a platinum sensor and is traceable to National Bureau of Standards. The system operates by the Peltier cooler reducing the mirror surface temperature to the dew point and the optic sensors measuring the resultant change in reflectivity. A DC power supply to the cooler is proportionally controlled allowing the mirror to track the dew point continuously. This is a primary standard measurement of the water vapor content of air.
Specifications:	
Accuracy:	±0.5°F traceable to NBS.
Sensitivity:	±0.1°F Both Sensors.
Calibration:	Automatic standardization: On a variable clock, standardization can occur every one to 24 hours. Standardization consists of a bias sensitizer circuit in the photomultiplier tube which subtracts electronically any accumulated contaminants on the mirror face.
Other:	Dew Point Range: -80°F to +120°F Typical Response Time: 3-5°F per second 1°F per second below frost point.

Experiences:

Number Sold:	Over 600 (104 since 1973)
Time on Market:	12 - 15 years
Major Users & Comments:	United States Department of Agriculture, IBM, General Electric, MRI, Bendix Corporation, University of California. The usage in Canada by A.E.S. is significant because they use it as a primary standard for calibrating other dew point sensors. All the users contacted by Western Research indicated the Model 110 to be trouble free and reliable. The Jet Propulsion Laboratory, Pasadena, California, have an old EG&G Model 110 that has been performing trouble free for seven years.

Service:

Availability of Parts & Service:	Both Waltham, Mass., or Willer Engineering, Toronto, carry parts.
Reliability:	From users' comments, the EG&G Model 110 is very reliable and easy to service.
Unattended Operating Features:	The Model 110 is designed for unattended use. Features are: 1. Automatic standardization 2. Aspirated shield 3. Rugged, field constructed sensor.
Cold Weather Operation:	Designed for use to -80°F and below.
Western's Comments:	The users contacted had a common maintenance suggestion that was borne out by the EG&G sales manager. Regardless of aspiration and standardization, it is physically impossible to design a chilled mirror unit to eliminate routine face cleaning. Our information suggests that in the Hat Creek area, a 9-month interval is expected between cleanings.
Remarks & Further Recommendations:	The sensor weighs approximately 10 lbs. and is 8" in diameter by 13" long. It mounts on a tower. The control unit is 19" rack mountable and is installed in the shelter.

The Model 110 is being phased out in favor of the Model 220. Both are identical in principle of operation; however, the 220 will be considerably less expensive and electronically streamlined. EG&G, however, states the 110 is not obsolete and they will continue service and spare parts manufacture.

The Model 220 will be available in pre-production runs in February-March, 1977. The Model 220 will be less accurate and not proven; therefore, we recommend against it. The continued supply of parts and service assured by EG&G is further balanced by the fact that many components in the 220 and 110 will be shared.

INSTRUMENT:	DIFFERENTIAL TEMPERATURE TRANSLATOR
Selected Model:	Western Research & Development Ltd. manufactured translator to accept EG&G 0-5 VDC temperature output
Supplier:	Western Research & Development Ltd. (manufacturer and supplier)
Comments:	Western Research & Development has designed, built and operated three of these instruments successfully in the past. Since only one of these units is required, an outside supplier would probably mean a considerable price increase provided a manufacturer could be found.
Description:	The Differential Temperature Translator will compare the 0-5 VDC temperature outputs from dual EG&G Dew Point sensors, mounted on the 100 m tower, to provide a DC voltage proportional to the ΔT. This function is independent of dew point. The recorder will indicate ΔT as plus or minus. The translator will be housed in the shelter.
Specifications:	
Accuracy:	Identical to EG&G temperature specifications.
Sensitivity:	Identical to EG&G temperature specifications.
Calibration:	Pre-calibrated electronically.
Experiences:	
Time on Market:	5 years.
Major Users & Comments:	The Translator is a straightforward electronic circuit housed in the shelter.
Service:	
Availability of Parts & Service:	Western Research & Development Ltd., Calgary, Alberta.
Reliability:	Good. No translator problems in the units built so far.
Unattended Operating Features:	Operates unattended indefinitely.

INSTRUMENT:	PRECIPITATION SENSOR
Selected Model:	Fischer and Porter Model 35B1558ND13BC2
Supplier:	Fischer and Porter, Warmister, Pennsylvania
Comments:	Western Research has used both tipping bucket and digital recording (Fischer and Porter) gauges in the past. Fischer and Porter is recommended because it is a rugged instrument having fewer moving parts. The -4°F lower operating temperature indicated on the specification sheet refers to the standard model equipped with a mechanical clock. For cold weather operation, a solid state timer is used with an operating range of -40°F to +160°F. This is included in the quoted price.
Specifications:	
Accuracy:	0.1 inches resolution.
Sensitivity:	0.1 inches resolution.
Other:	The optional windshield is not recommended by the manufacturer. The solid state timer is necessary for Canadian operation. The bucket has a 20" capacity and is self-syphoning.
Experiences:	
Time on Market:	Several years.
Major Users & Comments:	This unit is the standard for the National Weather Service in the United States. Atmospheric Environment Services are using this instrument throughout Canada as well as the U.S. National Weather Service across the U.S.A. including the Northern States. Additionally, Western Research has one unit operating in the Arctic near Swimming Point, N.W.T.
Service:	
Availability of Parts & Service:	Science Associates, Princeton, New Jersey; or Fischer and Porter, Warmister, Pennsylvania.

Reliability:	No problems in the past.
Unattended Operating Features:	Tape device can operate up to 5 months; however, use in the winter necessitates checks more frequently.
Cold Weather Operation:	With solid state timer, no problem operating to -40°F.
Comments:	It is recommended by the manufacturer that during winter operation a gallon of antifreeze be used in the collection bucket to prevent freezing and to melt snow.

INSTRUMENT:	EVAPORATION SENSOR
Selected Model:	Science Associates No. 242 Evaporation Pan, No. 582 Water Level Transmitter, and No. 246 Fixed Point Gage
Supplier:	Science Associates, Princeton, New Jersey
Canadian Supplier:	None
Comments:	Previously the Climet 015-1 position sensor was recommended as the evaporation transducer. Since there is only one unit required, Climet declined to supply this instrument. The only other supplier to quote on an evaporation sensor was Science Associates.
Description:	The evaporation unit consists of an evaporation pan and sensor. The pan is straightforward. The sensor is the No. 582 Water Level Transmitter with a 0-20 VDC output.
Specifications:	
Accuracy:	±0.1% accuracy.
Lower Detection Limits:	±0.5% sensitivity.
Range:	0-10 inches.
Calibration:	Not necessary.
Other:	Construction (Water Level Transmitter): -precision stainless steel bearings -non-corrosive materials -all weather cast aluminum -5 w heater
Experiences:	
Time on Market:	3 years.
Major Users & Comments:	The evaporation pan is universally used at Canadian and U.S. Weather Stations. The water level transmitter is not that widely used because of the manual pan-filling method; however, it is recommended for use at remote or automatic stations.

Service:

Availability of Parts & Service:	Science Associates, Princeton, New Jersey.
Reliability:	No problems in the past.
Unattended Operating Features:	A 5 watt heater should provide continuous operation of the level transmitter above freezing. Routine maintenance and cleaning during dusty season is expected.
Remarks and Further Recommendations:	This is a straightforward, routine measuring device and other than normal maintenance, no problems are anticipated.

INSTRUMENT:	BAROMETRIC PRESSURE SENSOR AND TRANSDUCER
Selected Model:	Science Associates No. 363 with 364 Translator
Supplier:	Science Associates, Princeton, New Jersey
Comments:	There are numerous transducers on the market, therefore a decision was made based on: 1. Other routine meteorological equipment purchased from Science Associates. 2. This unit along with the evaporation sensor at the same location could use the same power supply.
Description:	This unit is designed for conversion of Barometric Pressure to a linear and proportional output. Combined with Translator 364, the Transducer will give continuous Barometric Pressure output to a recorder.
Specifications:	
Accuracy:	Linearity ±0.3% of span.
Lower Detection Limits:	Resolution ±0.15% for 3000 ohms.
Calibration:	A certified calibration is supplied.
Other:	Operating temperature -30/180°F. The weatherproof housing is suggested.
Range:	22-28 in Hg.
Experiences:	
Time on Market:	5 years.
Major Users & Comments:	No comments from users; however, sensor is straightforward and supplied with weatherproof housing.
Service:	
Availability of Parts & Service:	Science Associates, Princeton, New Jersey.
Reliability:	No problems in the past.
Unattended Operating Features:	Designed for unattended operation.
Cold Weather Operation:	Good to -30°F. Weatherproof housing is recommended.

INSTRUMENT:	AIR TEMPERATURE SENSOR & SHIELD
Selected Model:	Science Associates No. 190 Temperature Transmitter No. 174-1 Aspirated Solar Radiation Shield
Supplier:	Science Associates, Princeton, New Jersey
Comments:	As with Barometric Pressure, it was decided the best way to go was with Science Associates for routine meteorological equipment. Western Research has used S.A.'s products for the last five years and has had excellent results. The Number 174 solar radiation shield is recommended for ice and snow conditions.
Description:	The air temperature sensor comprises a Platinum RTD and an output converter to 0-5 VDC. To protect the temperature sensing probe and ensure correct temperature measurement, an aspirated shield is required. The Number 174 also has an air flow detector to warn if the shield becomes plugged with ice.
Specifications:	
Accuracy:	± 0.1% of full-scale.
Lower Detection Limits:	Range -50°C to +50°C.
Calibration:	No calibration necessary except to compensate for lead wire.
Other:	Shield Specifications: Operating Range: -40°F to 150°C. Under maximum solar radiation, within -40°F/150°F, radiation error is limited to ± 0.2°F.
Experiences:	
Time on Market:	3 - 5 years.
Major Users & Comments:	No data available on usage; however, this is a state-of-the-art system and is recommended by Science Associates for Canadian use.

Service:

Availability of Parts & Service:	Science Associates, Princeton, New Jersey.
Reliability:	No problems in the past.
Unattended Operating Features:	Designed for unattended use. Status signal will warn of shield icing under severe conditions.
Cold Weather Operation:	Good to -40°F.
Comments:	No problems anticipated with this equipment.

INSTRUMENT: WIND SPEED AND DIRECTION SENSOR

Selected Model: Western Research Windflo 540 and Translator

Supplier: Western Research and Development, Calgary, Alberta

Comments: Decision was made by B.C. Hydro to select the Western Research Windflo over the Science Associates No. 480-2.

They are both low threshold instruments with approximately the same price. The Windflo 540 will have heaters installed in the transmitter head. It is manufactured and serviced in Western Canada.

Description: The Windflo 540 is a wind speed and direction indicator built to Canadian climatic conditions. It consists of a 3-cup aluminum anemometer on precision bearings. The principle of operation is no load strobe disc with infra red emitter and sensor. Speed is proportional to IR pulsing through strobe disc. The direction indicator consists of no load spaced magnetic coupling driving dual synchronized potentiometers for 540° coverage and no chart wiping.

Construction is aluminum.

Specifications:

Accuracy: Speed: ± 1%
Direction: ± 3°

Threshold: Speed: below 0.5 mph
Direction: below 0.5 mph

Calibration: With external frequency generator.

Other: Heaters included in speed and direction transmitter assemblies.

Experiences:

Number Sold: Over 60

Time on Market: 6 - 8 years

Major Users & Comments: Shell Canada, Hudson's Bay Oil & Gas, Alberta Environment, Petrogas Processing; all report good operational uptime.

Most problems encountered with wind systems are recorder problems. Because of the continuous action of the pens, inking problems are common, therefore, electric pens are recommended.

Service:

Availability of Parts & Service:	Western Research & Development, Calgary
Reliability:	Good. All servicing problems can be corrected in Calgary.
Unattended Operating Features:	Designed for unattended use, year round.
Cold Weather Operation:	Tested to -60°F.
Comments:	There are 3 Windflo's presently operating in the Arctic. There have been no problems thus far.

INSTRUMENT:	U-V-W ANEMOMETER
Selected Model:	Gill U-V-W Anemometer Science Associates No. 454
Supplier:	Science Associates, Princeton, New Jersey
Canadian Supplier:	None
Comments:	A Gill U-V-W Anemometer (Science Associates No. 454) is recommended for two reasons: 1. Western Research familiarity and success with R.M. Young bivane. R.M. Young manufactures both of these instruments. 2. Lowest price.
Description:	The U-V-W Anemometer measures the three orthogonal vectors of wind. The propeller motions generate a DC signal which drives a translator. A three-channel recorder or equivalent is necessary for data collection.
Specifications:	
Accuracy:	±5% cosine function (see recommendations).
Lower Detection Limits:	Depending on propeller selected, threshold is well under 1 m/sec.
Calibration:	A synchronous calibration unit is available as an option for propeller calibration (see recommendations).
Experiences:	
Time on Market:	3 - 5 years.
Major Users & Comments:	U-V-W Anemometers are specialty items. User comments are therefore limited.
Service:	
Availability of Parts & Service:	Science Associates, Princeton, New Jersey.
Unattended Operating Features:	See recommendations below.
Cold Weather Operation:	No temperature limits quoted in specifications.

Remarks & Further Recommendations:

The standard propellers are polystyrene construction for low inertia and excellent sensitivity; however, a wind limitation of 90 mph requires the use of less sensitive-more durable ABS plastic propellers. These propellers increase cosine uncertainty to ±5% from ±2% but the maximum speed of 120+ mph is more acceptable.

Present user information is conflicting as to reliability of bearing systems. Further, data interpretation is difficult. Western Research recommends:

1. Further evaluation of the Gill U-V-W Anemometer users.

2. A bivane be installed to back up the U-V-W.

INSTRUMENT: NEPHELOMETER

Selected Model: MRI Nephelometer Model 1550

Supplier: MRI, California

Canadian Supplier: Extech, Vancouver

Comments: The MRI Nephelometer appears to be the only commercially available one on the market. It appears to be widely used across the U.S.

Description: The Nephelometer is a scatter device which optically senses scattered pulsed light from a Xenon lamp source. The Nephelometer aspirates a heated sample and is therefore no good for fog.

The unit is self-contained and compact. It integrates light scattered from all directions. The Nephelometer with intake heater will give only particulate plus haze readout. No fog will be detected.

Combined with a fog visiometer, all parameters of visibility are measured.

Specifications:

Major Users & Comments: The MRI Nephelometer is used by British Columbia Ministry of the Environment, Environment Canada and Alberta Environment. University of Calgary also has a unit. According to MRI, the Nephelometer is widely used in the United States particularly in high density smog regions.

The users had no unfavorable comments on reliability or maintenance, however, suggested prolonged monitoring be conducted with the Nephelometer indoors and the sample intake outside. This would prevent damage to the Nephelometer which is not designed for continuous outdoor exposure.

Service:

Availability of Parts & Service: MRI, California, or Extech, Vancouver.

Reliability: Good.

Unattended Operating Features: Designed for unattended use. Some routine cleaning maintenance will have to be performed in the summer since the air intake is not filtered.

Cold Weather Operation: Instrument must be mounted inside, with intakes outside. Range 0° to 150°F.

Remarks and Further Recommendations: Because of our lack of familiarity with this type of visibility measuring device, WR&D will undertake extensive field testing of the unit.

INSTRUMENT: FOG MEASUREMENT

Selected Model: Videograph B

Supplier: Sperry Gyroscope, Ottawa

Comments: Based on A.E.S. information, five fog measuring devices were evaluated:

Videograph-recommended by A.E.S.
- -over 300 in service across Canada
- -excellent maintenance record

AGA
- -new solid state unit has some initial problems
- -presently being evaluated

EG&G
- -excellent but expensive-$12,000. plus
- -made to US Airforce specifications
- -none in Canada
- -unknown service

MRI
- -limited use in Canada to our available information
- -unknown service record
- -attractive price
- -used widely in U.S.

Transmissometer
- -expensive and bulky
- -requires minimum 250' aligned path length
- -requires a great deal of maintenance
- -designed for airports.

Description: The videograph uses the forward projection of a pulsed Xenon lamp and its subsequent particulate plus fog back scatter of radiation in the 300-700 nm range to a parabolic detector.

The alignment problems of a conventional transmissometer are therefore eliminated.

Specifications:

Accuracy: ± 2% over the range of measurement

Range: 0.1 - 10 nautical miles

Calibration: Optional field calibration recommended. An internal self-check feature is provided to calibrate the optics.

Other: Temperature range -30° to 45°C.
Xenon pulsed lamp flash rate 72/minute with deterioration rate of less than 2% over two years.
Recorder output 0.1 ma DC
Low visibility alarm.
Thermostatically heated window.

Experiences:

Number Sold: Over 300

Time on Market: 10 years

Major Users & Comments: A.E.S. uses Videograph for its various studies. The bulk of videographs are used in coastal lighthouses to trigger foghorns during reduced visibility.

Maintenance reports are good. The Coastal Service reports little or no maintenance in remote areas.

Rugged construction, Canadian manufacture and service and large sample volumes (over 600 feet back scatter plane) are features quoted by Maine Coastal Maintenance Supervisor.

Service:

Availability of Parts & Service: Sperry Gyroscope, Ottawa

Reliability: Good, all reports indicate Videograph to be relatively trouble free.

Unattended Operating Features: Designed for continuous unattended operating. Heated windows prevent condensation on optics.

Cold Weather Operation: Designed for use -40°C/+55°C.

Comments: Several videographs have been used in the far north and arctic.

Western Research has comprehensive literature of tests of the Videograph by both Canadian and U.S. government agencies.

Remarks & Further Recommendations: Manufactured in Canada by Sperry Gyroscope (under licence) in batches of 20 for the government costing approximately $7,000.00. Not available outside of those batch productions unless imported from Germany at $12,000.00. The next production run will commence early 1977 and completion expected in September of 1977.

Since this instrument will not be available for about another year the use of MRI's Model 1580 Fog Visometer is suggested in the interim to collect base line data this winter. Once the Videograph is received the two instruments should be run parallel to ensure correlation between them.

INSTRUMENT: SULPHUR DIOXIDE ANALYZER

Selected Model: Philips PW 9755

Supplier: Philips Canada Ltd.

Comments: The Philips PW 9755 was selected by B. C. Hydro.

Description: The PW 9755 is a coulometric sulphur dioxide analyzer, the bromine electrolyte being continuously titrated with SO_2 in the sample. The solution is continuously regenerated. The Philips is a sensitive analyzer and appears to be relatively interference free.

Philips has an automatic calibrate, zero, and measure cycle, complete with an internal permeation source. The analyzer can be zeroed and calibrated once every twelve hours automatically.

Specifications:

Accuracy: 2% reproducibility above 2 ppb.

Lower Detection Limits: Less than 2 ppb.

Calibration: External calibration required.
Internal calibration - permeation device $\pm$ 4% reproducibility.

Other: Interferences: NO_2 < 5 ppb at dewpoint - 15°C
NO undetectable
O_3 < 10 ppb at dewpoint - 15°C
H_2S undetectable
CO, HCl, NH_3, Cl_2, and CH_3SH - undetectable.

Experiences:

Time on Market: Model 9755 about 2 years
Model 9700 about 7 years

Major Users & Comments: The 9755 is an updated version of the 9700. The 9700 is a highly reliable, stable, sensitive analyzer that Western Research has 5 years experience maintaining and calibrating.

Prior to the introduction of the 9755, WR&D was the largest user of Philips in Canada.

Service:

Availability of Parts & Service: WR&D, Calgary, and Philips, Edmonton

Reliability: Assuming 9700 performance, the 9755 should be very reliable and easy to maintain.

Unattended Operating Features: Designed to run continuously.

Remarks & Further Recommendations: The Philips 9755 is being evaluated presently for interferences and reliability. A Flame Photometric Sulphur analyzer is being considered as an alternative; however, further evaluation is necessary.

INSTRUMENT:	OXIDES OF NITROGEN ANALYZER
Selected Model:	Monitor Labs Model 8440
Supplier:	Galvanic Analytical Systems, Calgary
Comments:	The Monitor Labs has these advantages over other NOx monitors: 1. Dual chamber, simultaneous determination of NO, NO_2. 2. Two units for ease of service. 3. No negative NO_2 readings commonly associated with single channel instruments. 4. State-of-the-art electronics. 5. Western supplier. 6. EPA approval and use. 7. Excellent flow control specifications.
Description:	The Monitor Labs NO-NO_2-NO_X analyzer uses two reaction chambers to determine NO and NO_2 simultaneously. The method is chemiluminescent gas phase reaction between O_3 and NO under vacuum. NO_2 is converted to NO via a catalytic converter. Flow control is critical for stable calibration.
Specifications:	
Accuracy:	±1% NO, ±1.4% NO_2
Lower Detection Limits:	1 ppb
Calibration:	External NO and NO_2 calibration required.
Other:	No interferences specified. Method is very specific to NO.
Experiences:	
Time on Market:	Less than 2 years.
Major Users & Comments:	Used extensively throughout U.S.A. A model is presently under field evaluation at Western Research. Initial impressions are good.
Service:	
Availability of Parts & Service:	Galvanic Analytical Systems, Calgary.
Reliability:	Good
Unattended Operating Features:	Designed for continuous unattended use.

INSTRUMENT:	OZONE ANALYZER
Selected Model:	Monitor Labs 8410
Supplier:	Galvanic Analytical Systems, Calgary
Comments:	The Ozone monitor comes with excellent specifications and recommendation from EPA. The Western supplier is recommended over other suppliers for parts and service. The Ozone analyzer has improved electronics and should provide the stability and lack of noise for low ppb measurements.
Description:	The Ozone analyzer uses the gas phase chemiluminescent reaction of ozone and ethylene to measure ambient ozone. Monitor Labs uses improved state-of-the-art electronics to improve stability and zero drift.
Specifications:	
Accuracy:	0.8 ppb, O_3
Lower Detection Limits:	1 ppb O_3
Calibration:	External calibration required.
Experiences:	
Major Users & Comments:	EPA uses ML Ozone Analyzers throughout the U.S. WR&D is presently evaluating an ML Ozone analyzer. Initial impressions are good.
Service:	
Availability of Parts & Service:	Galvanic Analytical Systems, Calgary
Reliability:	Good
Unattended Operating Features:	Designed for continuous unattended operation.

INSTRUMENT:	CARBON MONOXIDE ANALYZER
Selected Model:	Bendix 8501
Supplier:	Aviation Electric, Montreal
Comments:	The Bendix unit was chosen by B.C. Hydro. Western Research concurs with this choice.
Description:	Bendix uses the non-dispersive infrared detection of carbon monoxide absorption compared to a reference cell for CO evaluation.
Specifications:	
Accuracy:	1% of full-scale.
Lower Detection Limits:	0.5 ppm CO.
Calibration:	External calibration required.
Other:	Ambient temperature change (within shelter) before zero drift begins ±5°C.
Experiences:	
Major Users & Comments:	Environment Canada and Alberta Environment use Bendix CO.
	They report excellent results and low maintenance.
Service:	
Availability of Parts & Service:	Aviation Electric, Montreal
Reliability:	Good
Unattended Operating Features:	Designed for continuous unattended operation.
Comments:	The Bendix is temperature controlled; however, the factory recommends the shelter to be temperature controlled ±5°C to eliminate all drift. The unit is designed to run between 0°C to 30°C.

INSTRUMENT:	HIGH VOLUME SAMPLER
Selected Model:	Sierra Instruments Ultra-Vol complete with Model 305/80 Timer Programmer Model 235 High Volume Cascade Impactor Model 310 High Volume Constant Flow Controller
Supplier:	Extech, Vancouver
Comments:	At this time, B.C. Hydro has five Sierra Instrument Ultra-Vol samplers. Since two more are required, Western Research recommends the same type and supplier be used.
Description:	The measurement of ambient dust levels is of concern when considering coal-fired plant emissions. High-volume dust sampler - is a straightforward analyzer consisting of a high-rate air pump and a weighable dust filter in a weatherproof enclosure. The pump is operated continuously for a time interval and the associated dust pick-up is weighed. The Ultra-Vol has a timer for automatic start-up and shut-down. There is also a constant flow controller for more accurate and consistent flow measurement. The Cascade impactor has 5 stages and measures particle sizes from 0.5 to 10 microns.
Accuracy:	(with Flow Controller) ±1 SCFM from -20°C to +55°C over range 20 to 60 SCFM.
Calibration:	Both WR&D and ERT recommend an orifice plate calibrator be used for routine sampler flow rate calibration. In addition to the flow controller, the calibrator will ensure accurate and useful particulate loading data.

INSTRUMENT: DUSTFALL AND SULPHATION CYLINDERS

Supplier: Western Industrial Laboratories, Edmonton
Western Research & Development Ltd. will supply sulphation cylinder houses

Description: The dustfall cylinders consist of one quart collector attached to a post for mounting in the field.

The sulphation station consists of a 48 mm I.D. plastic Petrie dish containing lead dioxide paste. This arrangement commonly referred to as sulphation plate is housed in a louvered shelter and exposed to the atmosphere for a period of one month before analysis.

The chemical analyses are to be done by Western Industrial Laboratories.

Since the cylinders have to be retrieved at regular intervals during summer and winter, locations with easy access are preferred.

INSTRUMENT: ATMOSPHERIC CORROSION STATIONS

Supplier: Western Research & Development Ltd.

Description: Atmospheric corrosion stations are designed to subject metals and common paints to the atmosphere. Each station contains two different types of barbed wire (Canadian and Japanese), steel plates (galvanized and mild steel), telephone wires, and barn red and white painted blocks.

Corrosion stations are exposed in the environment for up to one year. They are then photographed and described (to determine paint damage) and weighed. The weighing determines a metal corrosiveness of the atmosphere which can be correlated with other meteorological and air quality data.

Since corrosion can be related to atmospheric contaminants, these stations are recommended for use in a background study.

INSTRUMENT: CALIBRATOR

Selected Model: Monitor Labs 8500R Calibrator
Monitor Labs 8530 Six Channel Controller

Supplier: Galvanic Analytical Systems, Calgary

Comments: Three leading manufacturers of calibration systems were contacted and compared. Monitor Labs Inc., Meloy Labs, and Bendix were studied. Of the three, Monitor Labs appears to be the best choice.

Reasons for elimination of Meloy Labs:

1. high price
2. no internal pump for dilution flow
3. no automatic controller for daily operation.

Reasons for elimination of Bendix:

1. three-channel operation only
2. no internal pump for dilution flow
3. no automatic controller for daily operation
4. flow capillaries reduce versatility.

Reasons for choice of Monitor Labs:

1. Model 8500R has four channels. NO_2 (permeation device), SO_2, NO, and O_3. NO_2 can also be generated by Gas Phase Titration.
2. Combined with Model 8530 Controller can be activated once daily for analyzer checks.
3. Attractive price.
4. Western Research, Shell Canada - Waterton Gas Plant, and Western Co-operative Fertilizers are all users. These people are happy with the 8500 performance.
5. Controller Model 8530 can activate CO system to do a daily calibration check.

Specifications:

Accuracy: ±5% relative to lab standards

Reproducibility: Less than ±2%

Calibration: Expected ranges:

SO_2	25-100 ppb
O_3	75-200 ppb
NO	5-100 ppb
NO_2	50-200 ppb

Primary Standard Traceability: The NO_2 and SO_2 devices are traceable to NBS. The NO source can also be certified. Ozone is verified by NO and NO_2 gas phase titrations.

Experiences:

Number Sold:	Several
Time on Market:	5 years
Major Users & Comments:	Shell Canada - Waterton was one of the first buyers of an ML Calibrator. WR&D has done comparison tests over the last 5 years between Waterton's Monitor Labs calibrator and units of other manufacturers. The results have shown favorable agreement. Western Co-Op Fertilizer has also bought a unit and had favorable results. Western Research has just recently purchased a unit complete with Gas Phase Titration. Our impressions are very favorable at this time.

Service:

Availability of Parts & Service:	Galvanic Analytical Systems, Calgary
Reliability:	Very good
Unattended Operating Features:	The ML 8500R can be used in conjunction with the 8530 Controller to automatically calibrate up to four channels. This single point calibration can occur once every 24 hours.
Comments:	Routine servicing would consist of zero air scrubber replacement and permeation device replacement. The permeation devices have a guaranteed life of 15 months.
Remarks & Further Recommendations:	A third calibration unit is recommended for use as an independent check on the accuracy of the main units in the two shelters. This unit could be used to verify the output from the main units on a quarterly basis. It could further act as a standby in case of failure of a main unit. It would be identical to the one specified above.

ITEM:	INSTRUMENT SHELTERS
Selection:	ATCO, Calgary for non-mobile shelters. Bridge Trailer for mobile trailer.
Comments:	One mobile trailer and two skid shelters will be required at the present time. Three manufacturers were invited to bid on the combination. One was immediately eliminated based on their very low bid price. It was concluded that they did not have a full understanding or the experience with these type of structures.
Experience:	Based on Western's previous experience the recommendation was made to B.C. Hydro to award the contract for the mobile unit to Bridge Trailer Industries and the skid units to ATCO Structures Ltd., both of Calgary. Western Research has used both these suppliers in the past with satisfactory results. ATCO's experience in helicopter portable skid shelters is more extensive than Bridge's while Bridge has supplied in the past WR&D and other companies including Alberta Environment with rugged, light weight trailers.
Specifications:	
Skid Shelters:	Air conditioned and heated, one 8' x 12' and one 8' x 16' for extremes in weather. Shelters contain instrument racks, power, and lighting. Temperature control 70°F $\pm$ 5°F
Mobile Trailer:	8' x 16' air conditioned and heated, tandem axle, winterized trailer complete with instrument racks, power and lighting.
Service:	
Availability of Parts & Service:	ATCO and Bridge, Calgary
Reliability:	Very good
Cold Weather Operation:	Designed for -40°F operation

ITEM:	METEOROLOGICAL INSTRUMENTATION TOWERS
Selected Model:	LeBlanc and Royle LR24 - 100 meter
Canadian Supplier:	LeBlanc and Royle, Vancouver, Edmondon
Comments:	Three companies were invited to bid on supplying and erecting the towers. Formal bid was received from two only, LeBlanc & Royle of Vancouver and Edmonton and J.F. Communications Ltd. of Edmonton. LeBlanc & Royle is chosen on the lower price. It appears that since LeBlanc and Royle has their own manufacturing facilities they are able to do it at a lower price while J.F. Communications has to buy their structures from other suppliers.
Description:	The recommended towers are one 100 meter for the plant site and two 10 meter towers for the air monitoring stations. An additional 10 meter telescopic tower will be attached to the mobile unit.
Specifications:	All towers are guyed and built to withstand 85 mph winds and 1 inch icing. The 100 meter tower will have sufficient wind loading strength to handle the meteorological instruments at the 100 and the 10 meter level. The towers will conform to all Department of Transport rules and regulations, and are CSA approved.
Experiences:	
Major Users & Comments:	LeBlanc and Royle has supplied towers across Canada. AES uses LeBlanc & Royle towers as does the Ministry of Transport and Department of Communication.
Service:	
Availability of Parts & Service;	LeBlanc & Royle, Vancouver
Remarks & Further Recommendations:	Tower Systems, Inc. of Cambridge, Minnesota was contacted for elevator prices. This feature adds considerably to the cost. We could not find anyone having experience under Canadian climatic conditions with elevator on a tower over 30 m. According to Tower Systems, the elevator can be added later on, providing the structure is strong enough. Considering that the potential problems with the elevator, under the severe weather conditions, we recommend against it until we are able to obtain more operating experience with the tower and the related instrumentation.

INSTRUMENT:	METEOROLOGICAL INSTRUMENTATION RECORDERS
Selected Model:	Chessel Model 301
Supplier:	Galvanic Analytical Systems, Calgary
Comments:	The Chessel Model 301 was chosen over Leeds & Northrup, Philips, Esterline Angus and several other recorder vendors for the following reasons: 1. The Chessel 301 is compact. 2. Available with electric pens, eliminating troublesome ink systems. 3. Western vendor - Galvanic Analytical Systems, Calgary. 4. Western has purchased over twenty of these recorders for wind system use. Results have been satisfactory. Three units are operational in the Arctic at a remote station. 5. The 301 is available as a single, dual, or three channel.
Specifications:	
Accuracy:	± 0.25% full span including hysteresis.
Lower Detection Limits:	Full scale sensitivity 1 mv. Linearity ± 0.2% span.
Calibration;	No calibration necessary. External standard EMF cell may be used for calibration.
Experiences:	
Time on Market:	Several years.
Major Users & Comments:	Western Research is a major user of Chessel. Over 20 units have been purchased and are in service in Alberta. The electric pens have functioned well eliminating most of the problems associated with ink systems. Most of the Chessel 301 recorders are used for meteorological measurements.
Service:	
Availability of Parts & Service:	Galvanic Analytical Systems, Calgary
Reliability:	Good. A few problems with chart drives have been encountered but these have been rectified under warranty.
Unattended Operating Features:	A month long chart is available, at 2 cm/hr chart speed however, because of the high activity of meteorological recording, weekly checks of recorders are recommended.

INSTRUMENT: ANALYZER RECORDERS

Selected Model: Soltec VP-6232S

Supplier: Soltec, Sun Valley, California

Comments: The choice of the VP-6232S is based on Western Research's general displeasure with inking systems. Our experience with unattended recorders is that over 90% of operational problems originate in the inking system. Therefore, the alternative has been to use electric pens, or sensitized paper. The Soltec VP-6232S is the only recorder from a known manufacturer to offer inkless thermal writing in two colors. The two colors are contained in the paper and activated by the different temperatures of the pen tips.

Western Research has used other Soltec recorder models and found them to be:

1. Above average in chart drive design.
2. Well manufactured.
3. Reliable and easily serviceable.

The dual thermal pens should provide excellent operational uptime and the different colors are ideal for chart interpretation.

Specifications:

Accuracy: ± 0.25% full-scale, linearity ± 0.25% (full-scale)

Lower Detection Limits: Dead band ± 0.15% full scale.

Calibration: Zero-measure switch built in. Pre-calibrated scale at factory. Output easily verified by standard EMF cell.

Other:
Zero drift: less than ± 1 microvolt @ 1 mV range.
Temperature drift: less than ± 3 microvolts/10°C @ 1 mV range.
Balance time: less than 0.8 seconds after full scale deflection.
Chart speed: 22 available (metric).

Experiences:

Time on Market: Less than 2 years.

Major Users & Comments: Because of recent introduction onto the market, user information is limited. Western Research has used one of these models previously and our field evaluation was most impressive.

INSTRUMENT:	U-V-W ANEMOMETER RECORDER
Selected Model:	Esterline Angus Model E1104
Supplier:	Science Associates, Princeton, New Jersey
Comments:	Only four-channel thermal trace recorder from known vendor. Details are forthcoming. This recorder is recommended by Science Associates for use with the U-V-W Anemometer. A three-channel recorder would be adequate, however, they are rare and charts are hard to get.
Description:	A distinct four-channel, single chart recorder with 11 inch chart, subdivided into 4 grids of various optional scales.
Specifications:	Chart drive speeds to be determined later. Grid ranges also to be determined later when all information is assembled.
Experiences:	No user information at present.
Service:	
Availability of Parts & Service:	Science Associates, New Jersey
Unattended Operating Features:	Thermal writing alleviates inking problems and should provide continuous unattended operation for duration of chart supply.
Remarks & Further Recommendations:	More information forthcoming. The fourth channel is to be used to record ΔT.