Environment Canada
Atmospheric Environment Service

Environnement Canada
Service de l'environnement atmosphérique

Canadian Air and Precipitation Monitoring Network (CAPMoN)
Réseau canadien d'échantillonnage des précipitations et de l'air (RCEPA)

SITE OPERATIONS REFERENCE MANUAL -PRECIPITATION

CANADIAN AIR and PRECIPITATION MONITORING NETWORK (CAPMoN)

APRIL 1985

Canada

RECORD OF CHANGES

Retain this record in front of the manual.

On receipt of changes:

1. Enter the number of the new page
2. Enter the accompanying Bulletin number
3. Enter the insertion date
4. Initial the entry
5. Insert the changed pages in the text
6. Remove deleted or replaced pages

NEW PAGE INSERTED	ACCOMPANYING BULLETIN NUMBER	INSERTED	
		DATE	BY

RECORD OF CHANGES - CONTINUED

NEW PAGE INSERTED	ACCOMPANYING BULLETIN NUMBER	INSERTED	
		DATE	BY

TABLE OF CONTENTS

CAPMoN OPERATOR'S MANUAL

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1

GENERAL INFORMATION

PURPOSE AND SCOPE OF MANUAL

1.1 This manual has been written to instruct all Canadian Air and Precipitation Monitoring Network (CAPMoN) operators on the proper operation of CAPMoN precipitation monitoring sites.

1.1.1 All CAPMoN monitoring sites have a primary operator (responsible for sampling most days of the year) and a backup operator (responsible for sampling during absences of the primary operator). Both operators must be completely familiar with the contents of this manual.

1.1.2 The major focus of this manual is the proper operation of CAPMoN precipitation sampling instrumentation and the proper handling of collected precipitation samples. All procedures described herein have been carefully designed to reduce the possibility of losing or contaminating precipitation samples. These procedures must be followed exactly in order to produce accurate and complete acid precipitation data.

DESCRIPTION OF THE CAPMoN PRECIPITATION SAMPLING PROGRAM

1.2 There is a growing body of information which suggests that precipitation in certain areas of Canada is very acidic. There is major concern that the high acidity has had, and will continue to have, serious effects on both natural and man-made environments. The acidification of soils, lakes and rivers with their attendant effects on the plant and animal

life which they support are of major concern to Canada. The Canadian Air and Precipitation Monitoring Network (CAPMoN) has been implemented to monitor the amount and extent of acidic material begin deposited to the Canadian environment by precipitation.

1.2.1 NETWORK DESIGN Twenty-six CAPMoN precipitation monitoring sites are located across Canada. A map showing the location of all sites is given in Figure 1-1 and a listing site names, latitudes, longitudes and elevations is given in Table 1-1.

1.2.1.1 Most of the monitoring sites shown in Figure 1-1 are located in eastern Canada as this is the area of highest acidic precipitation and highest lake and soil sensitivity. Expansion of CAPMoN into western Canada is anticipated in the future.

1.2.1.2 The locations of all CAPMoN monitoring sites have been carefully selected to ensure that the chemistry of the precipitation is affected only by pollutants which have been transported over long distances from their sources before arriving at the monitoring site, i.e., local pollutant sources must not influence precipitation chemistry at the site.

1.2.2 PRECIPITATION MONITORING METHODS At each CAPMoN monitoring site, precipitation is collected on a daily basis using an automated precipitation chemistry collector. This collector, known as the Type A-M Collector, opens automatically when precipitation occurs and closes automatically when it ends. When the collector is open, a bucket containing a polyethylene bag is exposed to the falling precipitation. When the precipitation stops, a hood on the collector closes and the bucket is sealed from the atmosphere. This closed hood prevents particles and gases from contaminating the collected sample when precipitation is not occurring.

1.2.2.1 Every day at 0800 hours ($\pm$1 hour) the exposed bucket and bag combination is removed from the collector and replaced with a new one by the site operator. This is done whether or not precipitation occurred in the past 24 hours.

Figure 1-1: Location of CAPMoN Monitoring Sites

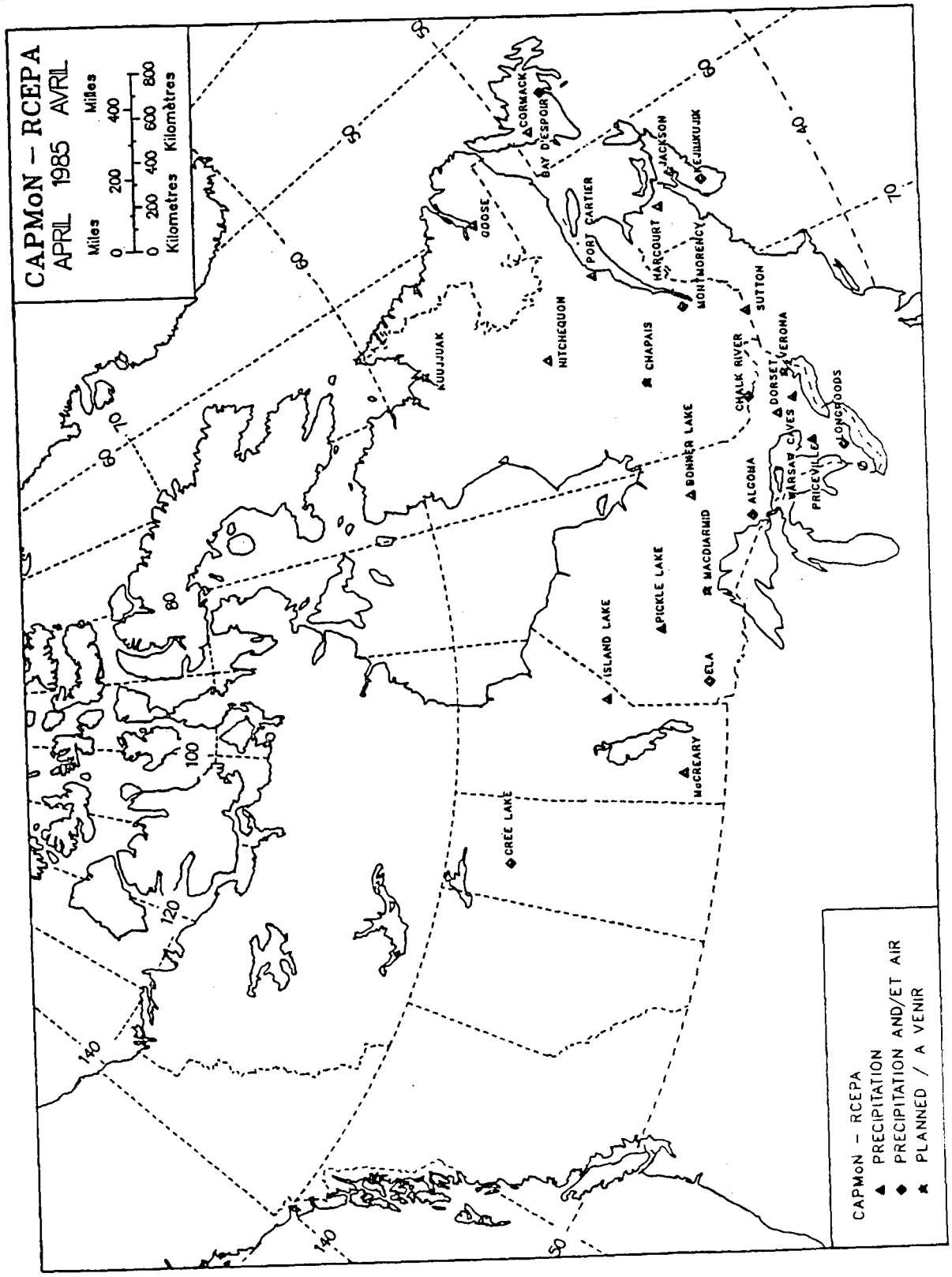


Table 1-1: CAPMoN Site Location Details

NAME (PROVINCE)	LOCATION		ELEVATION
LATITUDE(N)	LONGITUDE(W)	(m MSL)	
Cree Lake (Sask)	57° 21'	107° 08'	497
Island Lake (Man)	53° 52'	94° 40'	245
McCreary (Man)	50° 43'	99° 32'	335
Pickle Lake (Ont)	51° 28'	90° 12'	370
E.L.A. (Ont)	49° 40'	93° 43'	369
Macdiarmid (Ont)	SITE NOT FINALIZED		
Bonner Lake (Ont)	49° 23'	82° 07'	245
Algoma (Ont)	47° 06'	84° 06'	369
Chalk River (Ont)	46° 04'	77° 24'	184
Dorset (Ont)	45° 13'	78° 56'	320
Verona (Ont)	SITE NOT FINALIZED		
Warsaw Caves (Ont)	44° 28'	78° 08'	230
Priceville (Ont)	44° 10'	80° 40'	475
Longwoods (Ont)	42° 53'	81° 29'	278
Kuujjuak	SITE NOT FINALIZED		
Nitchequon (Que)	53° 12'	70° 54'	550
Port Cartier (Que)	50° 08'	67° 07'	180
Chapais (Que)	SITE NOT FINALIZED		
Montmorency (Que)	47° 19'	71° 09'	640
Sutton (Que)	45° 05'	72° 42'	290
Harcourt (NB)	46° 29'	65° 15'	45
Jackson (NS)	45° 36'	63° 50'	90
Kejimkujik (NS)	44° 26'	65° 12'	127
Goose (Nfld)	53° 19'	60° 21'	30
Cormack (Nfld)	49° 16'	57° 28'	120
Bay D'Espoir (Nfld)	47° 59'	55° 49'	190

1.2.2.2 The exposed bucket and bag are taken to a dedicated sample handling area at or near the site. The bag is removed from the bucket, sealed with a heat sealer and labelled with a numbered sticker.

1.2.2.3 If precipitation occurred and was collected in the bag, then the bag is stored in an on-site refrigerator and shipped every second week for analysis at the National Water Quality Laboratory in Burlington, Ontario.

1.2.2.4 If precipitation did not occur and the bag is dry, it is sealed and stored on-site. One dry bag from every week is selected at random and submitted to the laboratory with the precipitation samples.

1.2.2.5 Co-located with the precipitation chemistry collector at every CAPMoN site is a standard rain gauge and a nipher-shielded snow gauge. These instruments are used to determine the actual amount of precipitation which fell during the 24 hour precipitation sample collection period.

1.2.2.6 The precipitation chemistry samples collected in CAPMoN are extremely sensitive to contamination. Extreme care must be exercized when handling CAPMoN precipitation samples in order to prevent contamination. Improper handling, such as touching the inside of the sample bags, or smoking in the vicinity of the bags can render the samples useless.

1.2.3 LABORATORY ANALYSIS OF PRECIPITATION SAMPLES All CAPMoN samples are analyzed at a dedicated precipitation chemistry laboratory operated by the National Water Quality Laboratory of the Inland Waters Directorate of Environment Canada. This laboratory is located at the Canadian Centre for Inland Waters in Burlington, Ontario.

1.2.3.1 The precipitation samples are analyzed for the following species using the analytical methods given below:

(a)	Sulphate ($SO_4^=$)	Ion Chromatography
(b)	Nitrate (NO_3^-)	Ion Chromatography
(c)	Chloride (Cl^-)	Ion Chromatography
(d)	Ammonium (NH_4^+)	Colorimetry
(e)	Sodium (Na^+)	Flame Photometry
(f)	Calcium (Ca^{++})	Flame Photometry
(g)	Magnesium (Mg^{++})	Atomic Absorption Spectroscopy
(h)	Potassium (K^+)	Atomic Absorption Spectroscopy
(i)	pH	Electrometric
(j)	Acidity/Alkalinity	Fixed end-point titration.

1.2.4 QUALITY ASSURANCE / QUALITY CONTROL PROGRAM A comprehensive quality assurance / quality control (QA/QC) program is an integral part of the CAPMoN precipitation monitoring program. The quality assurance program has two functions:

1. to ensure that all CAPMoN sites, instruments, procedures and analyses are of the highest quality possible;

2. to measure the level of quality of the CAPMoN data.

1.2.4.1 A large number of quality assurance / quality control procedures are embedded within the sampling procedures described throughout this manual. Examples of such procedures are the mandatory use of clean disposable gloves whenever handling sample bags and the submission of weekly dry bags for chemical analysis.

1.2.4.2 From time to time, CAPMoN site operators will be requested to carry out additional quality assurance / quality control procedures in order to determine the quality of CAPMoN data. At the time, detailed instructions on

the procedures will be given to the operators. Examples of such procedures are:

1. Submission of Dynamic Field Blanks - a water sample provided by AES is poured into the precipitation chemistry collector and submitted to the laboratory as a real precipitation sample.

2. Periodic Inspections - all CAPMoN sites will be inspected periodically by AES personnel or external auditors. Both primary and backup operators must be available at the time of inspection. The purpose of these inspections is to ensure that all instruments are working properly and standard operating procedures are being followed.

3. Periodic Retraining - CAPMoN operators will occasionally be given retraining, follow-up training or upgrading to ensure that all new and old operating procedures are understood and are being followed.

1.2.4.4 A small number of CAPMoN operators will be contracted to carry out special quality assurance studies at their sites. These studies may include operating two CAPMoN collectors at the same site (to determine network precision) or operating a collector belonging to the U.S. National Atmospheric Deposition Program/National Trends Network (to determine network comparability). Details of these programs and the extra workload involved would be discussed with operators before the onset of the studies.

1.2.5 NETWORK ORGANIZATION The Canadian Air and Precipitation Monitoring Network is operated by the Atmospheric Environment Service (AES) of Environment Canada. Within AES, the Air Quality and Inter-Environmental Research Branch in Downsview, Ontario is responsible for the design, management and quality of the network while six AES Regional Offices are responsible for overseeing the routine operation of the network. Day-to-day site operations are carried out by local operators who are generally contracted for the work.

1.2.5.2 Within the Air Quality and Inter-Environmental Research Directorate the group responsible for managing CAPMoN is the Air Quality Monitoring and Assessment Division (ARQM). Within this Division are the CAPMoN Network Manager, Quality Assurance Scientist, Data Specialist and Technical Support Staff.

1.2.5.3 Within the six AES Regional Offices, the operation of CAPMoN is the responsibility of the Data Acquisition Division. Each Data Acquisition Division is headed by the Chief of Data Acquisition. Directly responsible for CAPMoN operations on a day-to-day basis is the Regional Superintendent of Surface Inspection, Installation and Maintenance. Reporting to the Superintendent are several Regional Inspectors whose responsibility it is to interact directly with CAPMoN site operators. The Inspectors are directly responsible for instrument repairs, operator training, operator communication and routine site inspections.

1.2.5.4 The six AES regions are shown on Figure 1-1. The addresses and telephone numbers of Regional Superintendents of Surface Inspection, Installation and Maintenance are given in Table 1-2.

TABLE 1-2

ADDRESSES AND PHONE NUMBERS OF
REGIONAL SUPERINTENDENTS SURFACE INSPECTION,
INSTALLATION AND MAINTENANCE

Pacific Region:
Atmospheric Environment Service
1200 West 73rd Ave., Suite 700
Vacouver, B.C.
V6P 6H9
Attn: PAEOI
Phone: (604) 666-0590

Western Region:
Atmospheric Environment Service
Argyll Centre
6325-103rd Street
Edmonton, Alta.
T6H 5H6
Attn: WAEOI
Phone: (403) 437-1250

Central Region:
Atmospheric Environment Service
266 Graham Avenue, Room 1000
Winnipeg, Man.
R3C 3V4
Attn: CAEOI
Phone: (204) 949-4384

Ontario Region:
Atmospheric Environment Service
25 St. Clair Ave. East
Toronto, Ont.
M4T 1M2
Attn: OAEOI
Phone: (406) 966-5890

Quebec Region:
Service de l'Environnement atmospheriqueé
100, Boul. Alexis Nihon
Troisième étage
Ville St-Laurent, P.Q.
H4M 2N6
Attn: QAEOI
Phone: (514) 333-3050

Atlantic Region:
Atmospheric Environment Service
1496 Bedford Highway
Bedford, N.S.
B4A 1E5
Attn: MAEOI
Phone: (902) 835-5192

SECTION 2

NETWORK INSTRUMENTATION

GENERAL

2.1 Every CAPMoN site is equipped with two types of instrumentation:

(a) Precipitation Measurement Instrumentation - this instrumentation is located outdoors at each site. It includes:
(i) CAPMoN Type A-M Precipitation Chemistry Collector
(ii) AES Standard Rain Gauge
(iii) AES Nipher-Shielded Snow Gauge
(iv) Snow Ruler;

(b) Auxiliary Instrumentation - these instruments are located indoors in the dedicated sample handling area provided at each site. They include:
(i) Heat Sealer
(ii) Balance
(iii) Refrigerator
(iv) Vacuum.

2.1.1 INSTRUMENT USES The Type A-M Precipitation Chemistry Collector collects daily samples of precipitation in polyethylene-nylon sampling bags (which sit inside a large plastic bucket).

2.1.1.1 The standard rain gauge and nipher-shielded snow gauge measure the depth of precipitation (in summer and winter, respectively) collected over the same 24 hour period as the precipitation chemistry sample. The snow ruler measures the depth of snow accumulated on the ground over the same time period.

2.1.1.2 After the precipitation samples (in the sample bags) are removed from the Type A-M collectors, they are taken to the sample handling area where they are sealed using the heat sealer. These seals prevent leakage and contamination of the samples.

2.1.1.3 The sealed precipitation samples are weighed on the balance to determine the amount of precipitation captured in the collector. This amount is later compared to the amount measured in the rain or snow gauge to determine the capture efficiency of the collector.

2.1.1.4 All of the sealed precipitation samples are stored in the refrigerator until being shipped biweekly to the laboratory. The refrigerator is operated at 4°C in order to maintain the chemical integrity of the samples.

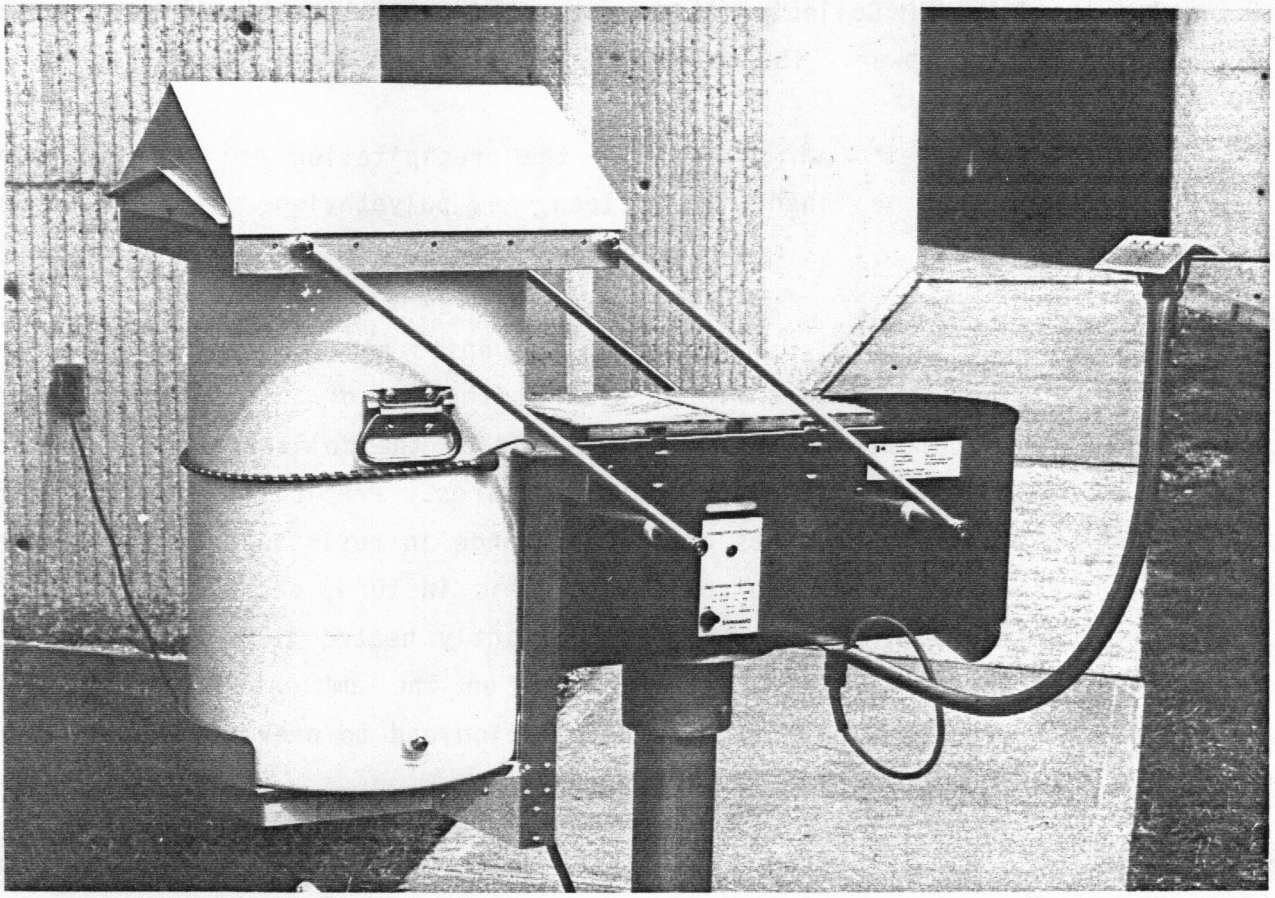
INSTRUMENT DESCRIPTIONS

2.2 A brief description of the CAPMoN instrumentation is provided below. A more detailed description is available in the "CAPMoN Precipitation Sampling Instruments Operations and Maintenance Manual" which was developed specifically for the maintenance and repair of CAPMoN instrumentation and is directed towards high level technical personnel.

2.2.1 TYPE A-M PRECIPITATION CHEMISTRY COLLECTOR Two models of the Type A-M Precipitation Chemistry Collector are used in CAPMoN. They are:

(a) Model A-100 - the Model A-100 Collector which is illustrated in Figure 2-1. This is the model originally installed at all sites and is still the most frequently-used collector in the network. All Model A-100 collectors are recognizable by the counterweight attached to one of the roof support arms and by the printed labels on the outer housing. The Model A-100 collectors are labelled from A100 to A130.

Figure 2-1: Model A-100 Precipitation Chemistry Collector



(b) Model B-200 - the Model B-200 collector which is illustrated in Figure 2-2. It is the current commercial version of the aforementioned Model A-100 collector. It is recognizable by the lack of a counterweight on the roof support arm and by the label on the outer housing (numbered from B200 to B240).

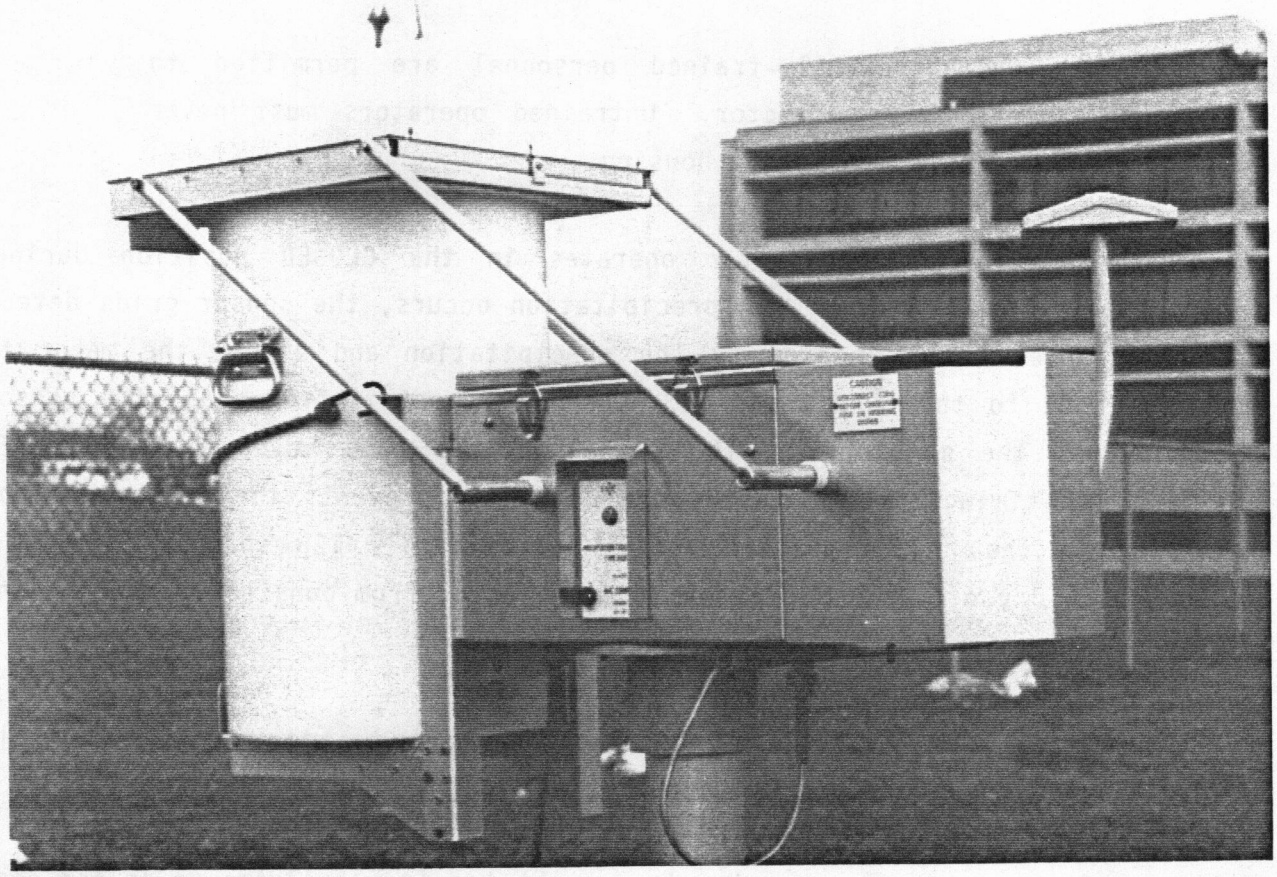
2.2.1.1 The Type A-M Collector is an automated precipitation collector which operates on 120 VAC power. The collector consists of 4 main components:

(a) A Bucket - which collects the precipitation as it falls. The bucket is lined with a clean, new polyethylene-nylon sample bag daily.

(b) Two Sensors - which detect the onset and end of precipitation. The two sensors are located at the end of a sensor support arm which extends out from the body of the collector. Each sensor consists of a set of parallel wires. Precipitation bridges the two sets of wires causing a change in resistance in the control circuitry of the collector. This in turn, causes the collector to open. The sensor is constantly heated to a temperature of approximately 40°C (depending on the ambient temperature) in order to melt frozen precipitation and to prevent dew and frost from bridging the resistance gap.

(c) A Moveable Hood - which covers the bucket when precipitation is not occurring and exposes the bucket when precipitation is occurring. The hood movement is controlled by the sensors and is driven by a motor located inside the collector housing. A gasket made of foam and plastic film is mounted on the underside of the hood. This gasket produces a tight seal between the bucket rim and the hood, thereby preventing dirt and gases from entering the bucket during dry periods. A teflon-coated, peaked snow roof is mounted on top of the hood to prevent snow accumulation in the winter.

Figure 2-2: Model B-200 Precipitation Chemistry Collector



(d) A Housing - which contains the electronic control circuitry for the collector and the drive motor for the hood. The top of the housing is screwed or latched in place and covered with a wire mesh splash guard.

NOTE

Only specially-trained personnel are permitted to open the collector. Untrained operators must never open the collector housing.

2.2.1.2 The Type A-M collector operates in the CLOSED position during non-precipitating periods. When precipitation occurs, the sensor grids detect the resistance change induced by the precipitation and signal the motor to move the hood to the OPEN position. When the precipitation ends, the sensor heater dries the moisture on the grids and the hood moves to the CLOSED position. A timing circuit inside the collector prevents the collector from returning to the CLOSED position until approximately 120 seconds after the sensor grids dry off. This prevents the collector from constantly opening and closing during light precipitation events.

2.2.1.3 Type A-M collectors located at sites with high snowfall accumulations are mounted on telescopic crank stands. The stand consists of a moveable upper pipe which travels up and down inside a fixed lower pipe. A nylon sheath covers the upper pipe to prevent ice from building-up in the gear teeth cut in the upper pipe. The sheath must be unfastened before the stand is raised or lowered. Under normal operating conditions, the crank is used to lift the top of the collector bucket to a height of 150 cm above the snow surface. Extension pipes (50 cm in length) can be attached to the top of the crank stand to extend the collector higher under exceptional snow accumulation conditions.

2.2.2 RAIN GAUGE The Type B plastic rain gauge is the reference gauge used by the Atmospheric Environment Service to measure rainfall. This gauge is used at all CAPMoN sites to provide a standard measure of rainfall during the 24 hour collection period of the precipitation chemistry samples. The rain gauge is shown in Figure 2-3.

2.2.2.1 The dimensions of the Type B Rain Gauge are:

(a) Height of gauge top above ground = 40 cm
(b) Diameter of gauge = 11.3 cm
(c) Measurement Interval = 0.2 mm
(d) Minimum Reading = 0.2 mm
(e) Maximum Collection = 250.0 mm
(f) Precision = 0.1 mm.

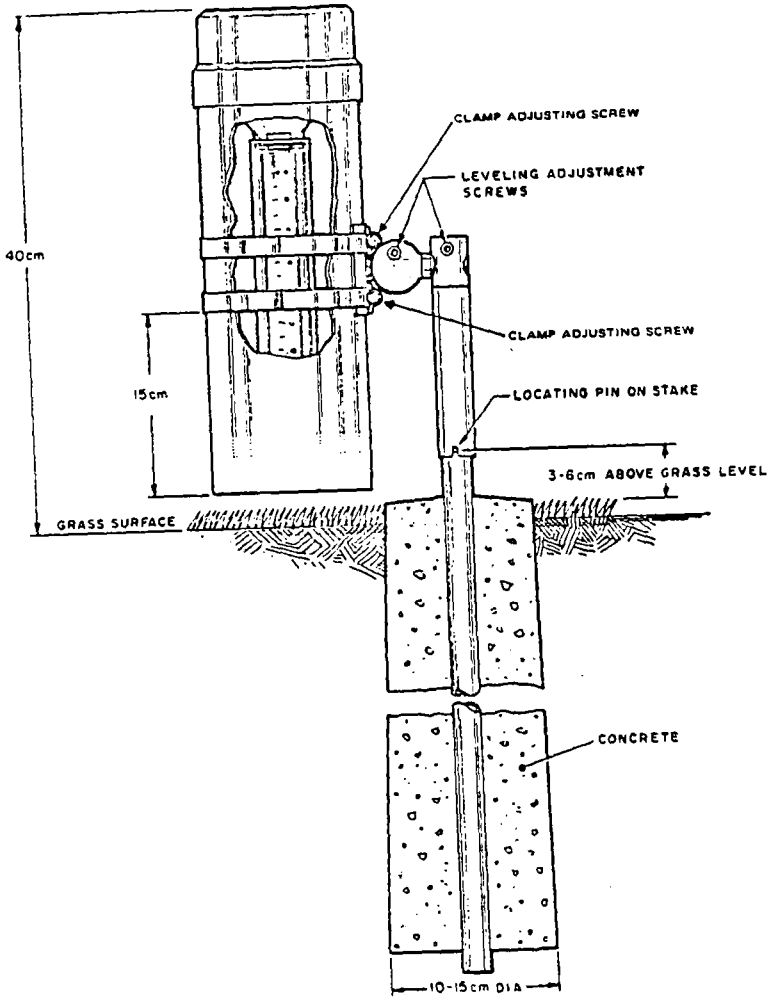
2.2.2.2 The rain gauge consists of 4 main components:

(a) a top funnel
(b) a graduated cylinder
(c) an outer cylindrical housing
(d) a mounting / clamping mechanism.

2.2.2.3 The funnel sits on top of the outer cylindrical housing. The funnel attaches directly to the graduated cylinder which fits inside the outer housing. The outer cylinder is clamped to the mounting post with two hose clamps and is levelled using two adjusting screws on the mounting assembly.

2.2.2.4 Rain falls into the top funnel of the gauge and drains directly into the graduated cylinder. Rain depth is read directly from the graduated cylinder which is scaled in increments of 0.2 mm. Rainfall greater than 25.0 mm overflows into the outer cylinder through a hole in the top of the graduate. This excess rainfall is measured by pouring it into the graduated cylinder.

Figure 2-3: Rain Gauge (Type B)



2.2.3 SNOW GAUGE The nipher-shielded snow gauge is the reference gauge used by the Atmospheric Environment Service to measure freezing precipitation. It is used at CAPMoN sites to provide a standard measure of snow, hail and freezing rain during the 24 hour collection period of the precipitation chemistry collector. The snow gauge is shown in Figure 2-4.

2.2.3.1 The dimensions of the snow gauge are:

(a) Standard operating height of gauge above snow surface = 150 cm
(b) Diameter of nipher shield (upper, O.D.) = 61.0 cm
(c) Diameter of receiver = 12.7 cm
(d) Measurement Interval = 0.2 mm
(e) Precision = 0.1 mm.

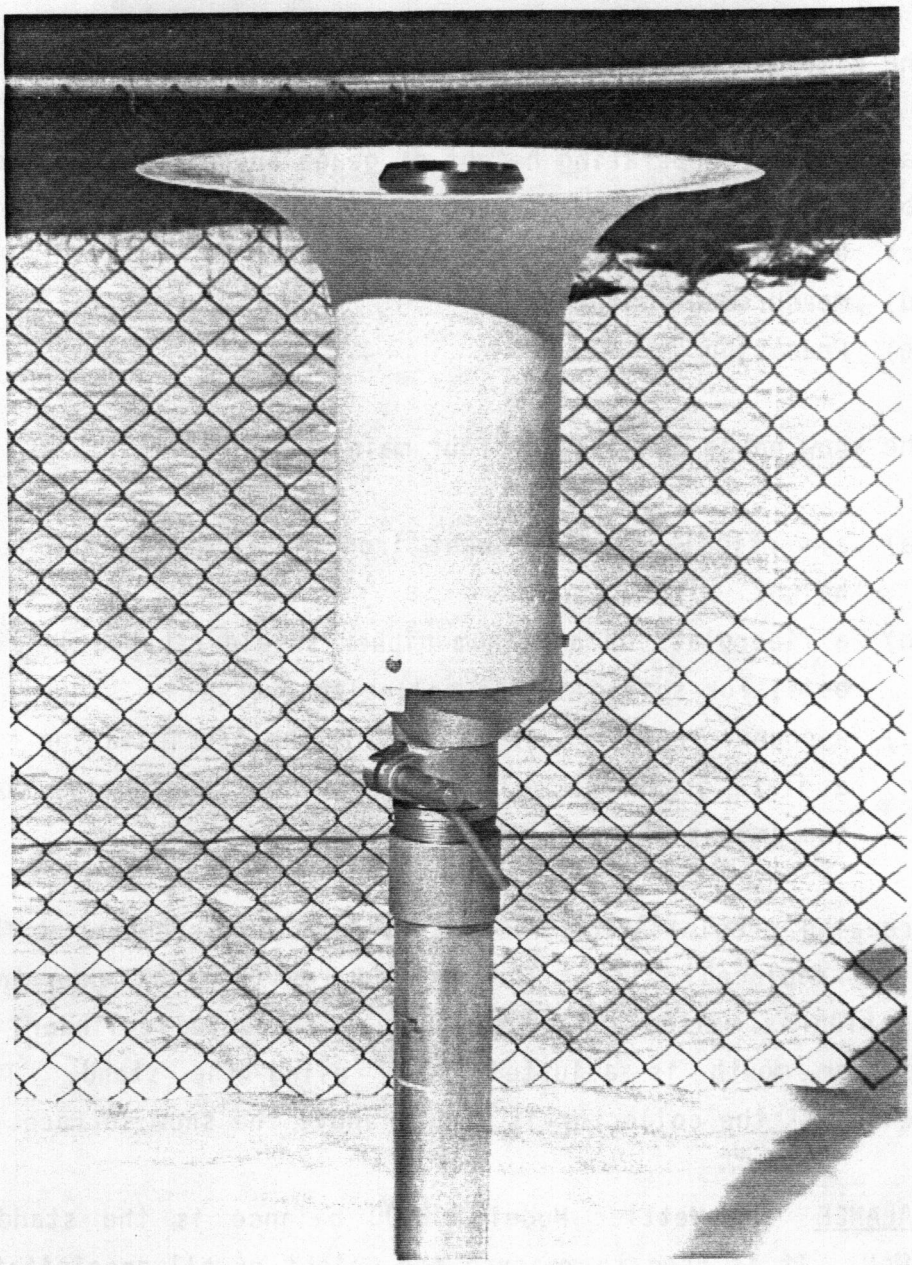
2.2.3.2 The snow gauge consists of four main components:

(a) a vertical stand (wrought iron or aluminum) for adjusting the height
(b) a fiberglass or aluminum nipher shield (shaped like an inverted bell) for shielding the colleciton vessel
(c) a copper receiver for collecting the precipitation
(d) a glass graduated cylinder (provided separately) for measuring the amount of precipitation collected.

2.2.3.3 Freezing precipitation is collected in the receiver. The receiver is removed and replaced daily. The exposed reveiver is taken indoors where the precipitation is melted and measured in a graduated cylinder. The height of the receiver mouth is adjusted daily using the stand. The standard operating height of the collector is 150 cm above the snow surface.

2.2.4 BALANCE The Mettler Model PC8000 balance is the standard balance used in CAPMoN. It is used to measure the weight of all precipitation samples and dry bags collected in the network. The weight of precipitation samples is

Figure 2-4: Snow Gauge



later converted at the Atmospheric Environment Service to precipitation depth. This is done by subtracting the bag weight from the total weight (bag plus sample), dividing by the area of the collection bucket (approximately 830 cm^2) and multiplying by the density of water (1.0 g/ml at 20°C). The balance is shown in Figure 2-5.

2.2.4.1 The specifications of the Mettler Model PC8000 Balance are:

Range	0 - 8200 g
Readability	0.1 g
Automatic Taring	
Digital Display.	

2.2.4.2 A control bar for the balance is located on the lower front face, directly under the digital display. This control bar turns on the balance when depressed and tares the balance automatically when pressed all the way down. Normal CAPMoN operations require that a plastic weighing container be placed on the top pan of the balance when precipitation samples are being weighed.

2.2.5 HEAT SEALER The Sealmaster Model 580 heat sealer is used in the CAPMoN network to seal all sample bags. The heat sealer is shown in Figure 2-6.

2.2.5.1 The specifications of the heat sealer are:

Power	115 VAC
Maximum Sealing Width	58.4 cm (23 in)
Adjustable Time Setting.	

2.2.5.2 The heat sealer is controlled by a foot pedal which, when depressed, forces the top arm of the sealer into contact with a heater bar. When contact is made, the heater bar heats up and seals the bag compressed between the arm and the heater bar.

Figure 2-5: Balance

2.2.5.3 The heating time interval required to make a proper seal depends upon the material being sealed. The heating interval is controlled by a dial on the left side of the sealer. Under normal operation, the dial should be set at setting #4.

2.2.5.4 When the top arm is depressed and a seal is being made, a buzzer will sound for the duration of the sealing interval. The top arm must remain depressed for 1 to 2 seconds after the buzzer ends to allow the seal to cool while compressed between the jaws of the collector.

2.2.6 REFRIGERATOR The Denby Model D143 CPT Refrigerator is provided at every CAPMoN site for refrigerated storage of collected precipitation samples. It is also used to freeze the gel-type freezer packs used during sample shipment to the laboratory. The normal operating temperature of the refrigerator is 4°C ± 1°C. The refrigerator is shown in Figure 2-7.

2.2.6.1 The specifications of the refrigerator are:

Volume	136 dm^3 (4.8 ft^3)
Depth (external)	54.6 cm (23.5 in)
Height (external)	83.8 cm (33.0 in)
Width (external)	47.0 cm (18.5 in).

2.2.6.2 The temperature in the refrigerator is thermostatically controlled. A thermostat setting of medium is recommeded for CAPMoN operations to maintain a temperature of 4°C ± 1°C. The temperature must be checked daily using a refrigerator thermometer mounted in the door compartment. Adjustment of the thermostat must be made when the inside temperature exceeds 4°C ± 1°C.

2.2.6.3 Under normal operating conditions, the shelves inside the refrigerator are removed to maximize storage capacity.

Figure 2-6: Heat Sealer

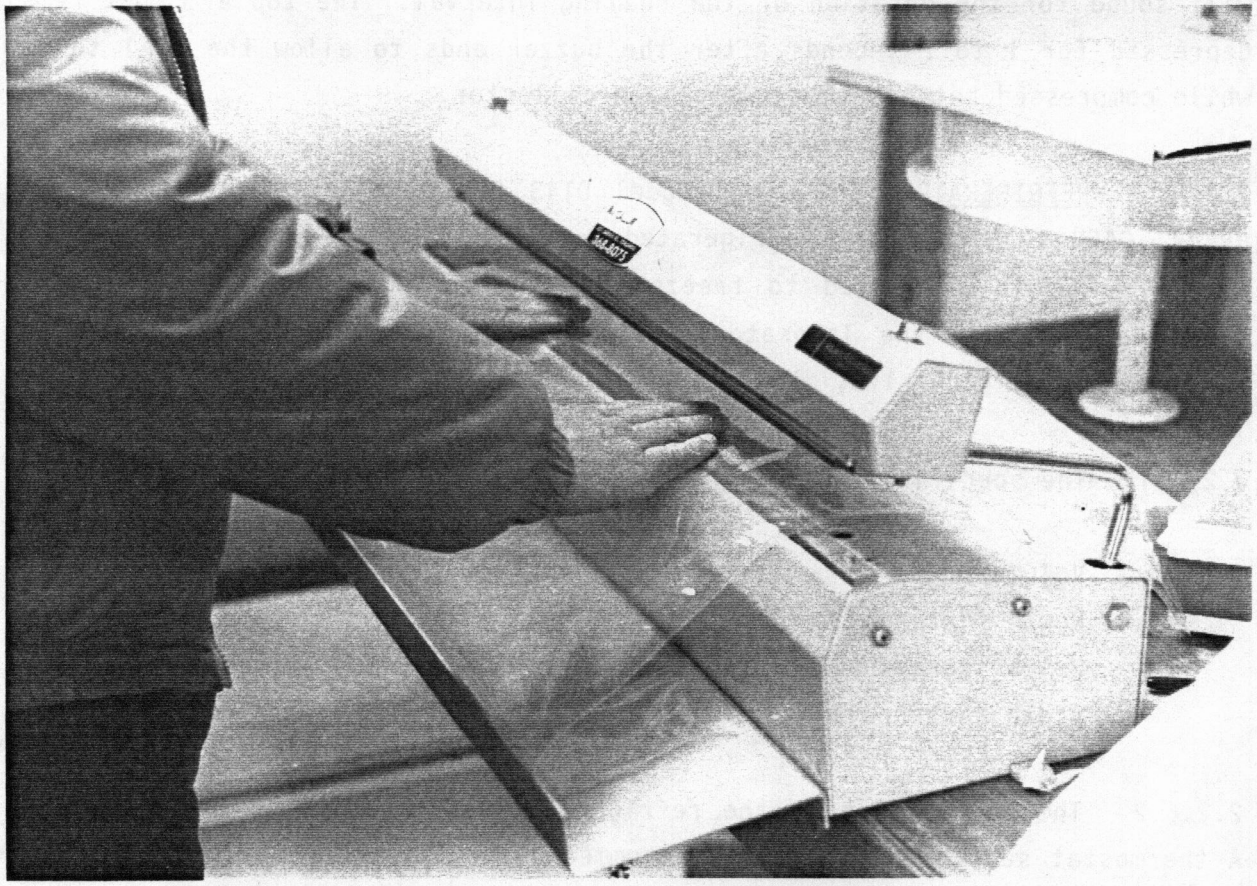
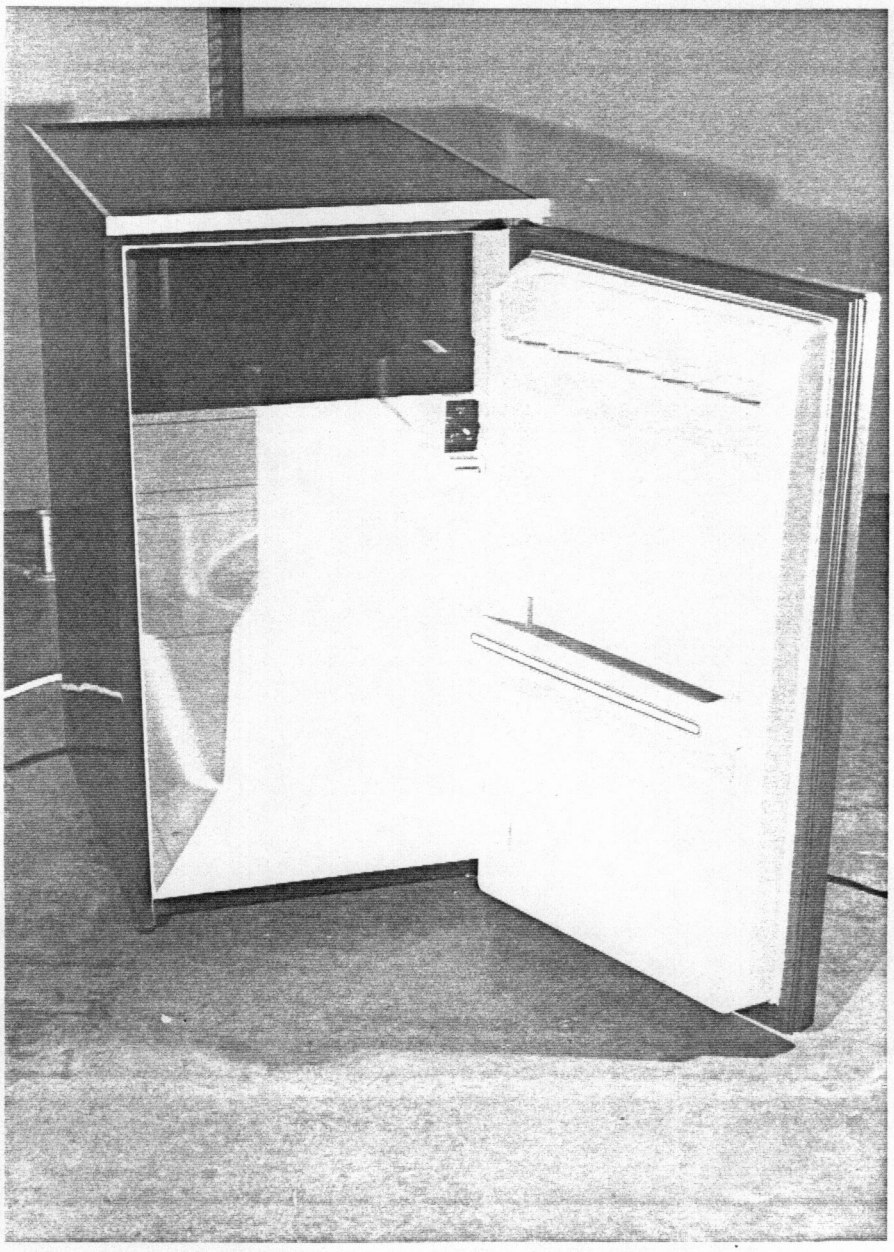


Figure 2-7: Refrigerator



SECTION 3

SITE-RELATED ACTIVITIES

GENERAL

3.1 CAPMoN precipitation monitoring sites have been carefully selected to meet the objectives of the network. The sites have been located far from sources of pollutant emissions and local contamination. Because of this, the chemistry of the precipitation collected at CAPMoN sites is considered to be regionally-representative. That is the chemistry of the precipitation is determined by pollutants transported over long distances from their sources to the sites. Care must be taken to maintain CAPMoN sites so that local pollution does not contaminate the precipitation samples.

SITE CHARACTERISTICS

3.2 In order to collect regionally-representative precipitation, CAPMoN monitoring sites have been selected for their site characteristics. These characteristics are described in detail in this section. CAPMoN operators must regularly assess the ability of their sites to meet these characteristics.

3.2.1 SITE REPRESENTATIVENESS Sites must be representative of the general topography, the general flow patterns and the precipitation characteristics of the area (e.g., not on top of the highest hill in the area).

3.2.2 DISTANCE FROM INDUSTRIAL POLLUTION SOURCES Within 50 km of the site:

(a) there will exist no point source of pollutants with emissions greater than 10,000 tonnes per year of SO_2 or NO_x (e.g., generating station, pulp and paper mill, smelter, chemical plant).

(b) the sum of all point and area sources of emissions will not exceed 10,000 tonnes per year of SO_2 or NO_x.

3.2.3 DISTANCE FROM POPULATION CENTRES Sites must be located no closer than 5 km from the edge of small towns and villages (population less than 5,000), 10 km from the edge of larger towns (population between 5,000 and 10,000), and 40 km from the edge of cities of any size. If the villages , towns or cities contain major sources pollutant emissions, then the emission criterion in Section 3.2.2 will override this criterion.

3.2.4 DISTANCE FROM WATER BODIES Sites must be located at least 10 km from the shoreline of any of the Great Lakes and at least 40 km from the shore of any salt water body (e.g., Atlantic Ocean, Gulf of St. Lawrence).

3.2.5 DISTANCE FROM TRANSPORTATION ROUTES Within 500 m of the site, there should exist no roads, railways or canals (seldom-travelled access roads are excepted). Wherever possible, roads, railways and canals should be separated from the monitoring site by rows of trees. Within 3 km of the site, there should be no small airports; within 10 km there should be no large airports.

3.2.6 DISTANCE FROM LOCAL CONTAMINATION SOURCES Within 500 m of the site there should exist no small-scale sources of pollutant emissions such as electrical generators, wood-burning stoves, vehicle parking lots, vehicle maintenance garages, garbage dumps or sewage lagoons. There should also be no sources of wind-activated contaminants such as salt or sand piles, gravel pits or exposed soils within 500 m of the site.

3.2.7 DISTANCE FROM AGRICULTURAL ACTIVITY Within 500 m of the site there should be no intensive agricultural activity such as cultivation, livestock grazing, fertilizing, herbicide spraying or fruit tree growing. Fallow fields with no exposed soil are acceptable.

3.2.8 DISTANCE FROM ON-SITE OBSTRUCTIONS On-site obstructions (which could influence the precipitation collector by shadowing it from precipitation or by allowing intercepted precipitation to drip into the collector) must be separated from the precipitation collector and the rain and snow gauges by a distance of at least 2.5 times the height of the obstruction. Examples of such obstructions are trees, hydro poles, meteorological towers, communication towers, fences, overhead hydro wires and other instruments.

3.2.9 DISTANCE FROM ON-SITE BUILDINGS On-site buildings such as sample handling huts, houses, offices and laboratories must be located at least 10 building heights from the precipitation collector. This distance is sufficient to minimize precipitation shadowing and wind flow effects at the collector. For buildings containing small sources of pollutants this criterion will be overridden by criterion 3.2.6.

3.2.10 PHYSICAL CHARACTERISTICS OF SITES Sites should be open, flat, grass-(or moss-)covered, and surrounded by trees. The surrounding trees should be 2.5 to 3 times their height away from the collector. On-site slopes should be minimal. Nearby ridges or hills should not extend above the height of the collector within a distance of 100 m. Grass within a radius of 50 m of the collector must be maintained at a height no greater than 15 cm (6 inches) above ground level.

3.2.11 OPERATIONAL REQUIREMENTS Sites must satisfy the following operational requirements:

(a) the site must be accessible daily;

(b) the site must be serviced by reliable 120 VAC electrical power;

(c) the site must be located in an area where biweekly shipping (courier) service is available;

(d) the site must have available a clean, indoor sample handling area where precipitation samples can be suitably handled and stored. A dedicated on-site hut can be built for this purpose;

(e) the site must have both a primary and a backup operator available to carry out the daily sampling program.

3.2.12 NON-CONFORMING SITES Several CAPMoN sites do not have all of the foregoing characteristics. At some sites, compromises have been made and slightly non-conforming sites have been accepted. At sites which do not have these characteristics, AES will strive to improve site quality with time.

OPERATOR RESPONSIBILITIES FOR CHECKING SITE CHARACTERISTICS

3.3 Site operators must constantly monitor activities at the monitoring site and in its local vicinity. It is operator's responsibility to determine whether changes have occurred at or near the site which could affect the quality of the precipitation collected at the site.

3.3.1 REPORTING SITE CHANGES Operators who detect changes at or near their sites must report these changes to their Regional Inspector as soon as possible. The operator should know and understand what type of changes affect the quality of samples. They are given below:

(a) the construction of new or additional pollutant emission sources within 50 km (e.g., power plants, pulp and paper mills, smelters, chemical plants, major industries);

(b) the construction of new housing developments within 5 km of the site;

(c) the construction or discovery of new roads, railways or canals within 500 m of the collector;

(d) the introduction of new agricultural acitivity within 500 m of the collector, e.g., cultivation, spraying, grazing;

(e) the addition of small sources of pollution such as wood stoves, generators, parking lots, garbage dumps, sand piles and exposed earth with 500 m of the collector;

(f) any construction within 1 km of the site including building construction, road resurfacing and major landscaping;

(g) the addition of on-site obstructions such as fences, trees, poles, towers, instruments, and buildings;

(h) changes to site characteristics such as ground cover, topography, access roads, accessibility, power supply, and instrument position.

3.3.2 Operators should enter Code 58 on the Sample History Form on the day that a site change was discovered or noted (see Section 5.2.5.2).

OPERATOR RESPONSIBILITIES FOR SITE MAINTENANCE

3.4 The primary site operator is responsible for the routine maintenance of his/her CAPMoN site. Remuneration is provided for such maintenance activities.

3.4.1 SITE MAINTENANCE Site maintenance duties for primary operators include the following:

(a) routine cutting of ground vegetation (i.e., grass, weeds, brush) within a radius of 50 m of the collector (or to the

surrounding tree line) to maintain it at a height less than 15 cm (6 inches) above ground level. Where necessary, tractors and mowers should be contracted for the work. Grass cutting is to be carried out on days when rain is not anticipated. Grass cutting must never be carried out during periods of precipitation when the collector is open. After the cutting is completed, the collector should be inspected for dust generated by the activity and cleaned with clear water if necessary.

(b) routine cleaning of the site of debris, piles of dirt, etc.

OPERATOR RESPONSIBILITIES FOR THE SITE SAMPLE HANDLING AREA

3.5 Primary operators are responsible for maintaining the dedicated sample handling area at the site in suitable working condition. This area is typically a wooden hut located within working distance of the collector.

3.5.1 MAINTENANCE OF SAMPLE HANDLING AREA Operators are required to clean and maintain the sample handling areas on a regular basis as specified below.

3.5.1.1 Sampling-related equipment and supplies must be carefully stored and organized in the sample handling area to ensure freedom of movement when handling samples. All unused polyethylene sample bags must be carefully stored on or near the work area in the plastic outer pouches in which they were shipped.

3.5.1.2 The sample handling area and the equipment in it must be cleaned once per month with clean water (no soaps, cleansers or solvents). Dust levels in the sample handling area should be kept to an absolute minimum. In the exceptional case where chemical solvents or cleaners (such as ammonia) have been used in the sample handling area, notify an AES Regional Inspector as soon as possible and note the fact in the REMARKS section of the Sample History Form.

3.5.1.3 Soaps, detergents, cleaners, solvents, lubricants and other chemicals must be removed from the sample handling area. Storage of these materials is not permitted.

3.5.1.4 Materials other than CAPMoN sampling supplies and equipment must be removed from the area. Storage of these materials is not allowed.

SECTION 4

STANDARD OPERATING PROCEDURES FOR PRECIPITATION SAMPLE COLLECTION, HANDLING AND SUBMISSION

BACKGROUND

4.1 Procedures to collect and handle CAPMoN precipitation samples are referred to as Standard Operating Procedures (SOPs). Section 4.1 provides background information useful for understanding the SOPs.

4.1.1 AVOIDING CONTAMINATION Precipitation samples contain very low concentrations of the chemical species being measured and are therefore easily contaminated. Contamination will render precipitation samples inaccurate and useless.

4.1.1.1 Operators must adhere strictly to the Standard Operating Procedures specified in this manual. This will ensure that samples are collected and handled properly and will prevent contamination.

4.1.1.2 Contamination of precipitation samples can happen very easily. For example, a single fingerprint on the inside of a sample bag can add more sodium and chloride to the sample than was dissolved in the original precipitation. Adhering to the following simple precautions will avoid most contamination problems:

(a) Do not smoke cigars, cigarettes, pipes, etc. when handling samples, or when at the collector, or when working in the sample handling area. Smoke and falling ash are major contaminants.

(b) Do not lean over an open sampling bucket or bag. Human hair, dust and clothing fibres can easily fall into the bag and contaminate samples.

(c) Always wear a new, clean pair of disposable plastic gloves whenever handling a sample bag.

(d) Never touch the inside of a sample bag.

4.1.2 SITE REQUIREMENTS FOR OPERATORS A primary and a backup operator is required at every CAPMoN site. Both must be approved and trained by AES Regional Inspectors. The primary operator will carry out the SOPs on a regular basis; the backup operator will fill in for the primary operator during periods of illness, leave or incapacitation. It is essential that every CAPMoN site be visited by either the primary or backup operator every day of the week.

4.1.2.1 Operators must inform their Regional Inspectors at least 2 weeks in advance of any known periods when the site cannot be visited by either the primary or backup operator.

4.1.3 SAMPLING TIMES Precipitation sampling in CAPMoN must be carried out daily. The bucket/bag in the collector must be changed every 24 hours - even if precipitation did not occur in the past 24 hours.

4.1.3.1 CAPMoN site operators must carry out the Standard Operating Procedures daily at 0800 $\pm$ 1 hour local time. Approximately 1 hour per day, seven days per week is required to carry out the SOPs at the individual sites.

4.1.4 SITE INSTRUMENTATION, SPARE PARTS AND SUPPLIES Every CAPMoN site operator must maintain an inventory of instruments, spare parts and supplies for normal sampling operations. Operators must ensure that all instruments are in place and that all spare parts and supplies are available and are properly stored.

4.1.4.1 INSTRUMENTATION AND SPARE PARTS CAPMoN sites are equipped with the following instrumentation and spare parts. Note that some sites may have more, but no sites should have less.

(a) 1 Precipitation Collector (Model A100 or B200) plus
- 2 polyethylene buckets
- 1 polyethylene bucket cover
- 1 stand (straight pipe or telescopic)
- 2 spare hood gaskets
- 1 package of heater circuit fuses (1.5 A)
- 1 package of control circuit fuses (1.0 A)
- 2 spare sensors
- 1 spare printed circuit control board.

(b) 1 Rain Gauge (Type B) plus
- 1 spare funnel and graduated cylinder assembly.

(c) 1 Nipher-shielded Snow Gauge plus
- 1 spare copper receiver
- 1 adjustable nipher stand
- 1 graduate cylinder and funnel.

(d) 1 Balance (Model PC8000) plus
- 1 spare 250 MA fuse
- 1 plastic weighing container
- 1 standard reference weight
- 1 carrying case.

(e) 1 Heat Sealer (with foot pedal) plus
- 1 front-mounted sample support bracket
- 1 spare heater bars

(f) 1 Refrigerator plus
- 1 refrigerator thermometer.

(g) 1 Vacuum pump
- 1 recharger and mounting bracket.

4.1.4.2 SUPPLIES CAPMoN supplies include both single-use consumable items plus multiple-use reusable items. They are:

(a) Plastic sample bags (400 per year)
(b) Plastic disposable bucket covers (400 per year)
(c) Disposable plastic gloves (4 boxes per year)
(d) Numbered bag labels (400 per year)
(e) Dry bag labels (100 per year)
(f) CAPMoN Sample History Forms (50 per year)
(g) CAPMoN Operators' Instruction Manual (1)
(h) Cardboard shipping boxes (styrofoam lined)
(i) Plastic shipping containers (4 l and 8 l)
(j) Freezer packs (large and small)
(k) Min/max shipping thermometers
(l) Document file box
(m) Kimwipes
(n) Deionized water
(o) Field Book.

4.1.4.3 RESUPPLY Consumable and reuseable supplies are supplied automatically once per year near the end of the calendar year. If, for some reason, supplies are required before the end of the year, operators should contact their Regional Inspectors for immediate resupply.

STANDARD OPERATING PROCEDURES (SOPs) FOR PRECIPITATION SAMPLING

4.2 The daily Standard Operating Procedures for sampling precipitation in CAPMoN consist of six major steps, namely:

1. Preparation For Sampling - carried out in the sample handling area;
2. Collection of the Sample - carried out at the site;
3. Rain/Snow Gauge/Snow Ruler Measurements - carried out at the site;
4. Instrument Checks - carried out at the site;
5. Sample Handling and Storage - carried out in the sample handling area;
6. Data Reporting (Sample History Form Completion) - carried out in the sample handling area.

A seventh step, Sample Shipping is carried out bi-weekly. Detailed procedures for each of these steps are given below.

NOTE

CAPMoN Standard Operating Procedures (SOPs) have been designed to minimize sample contamination and loss. Failure to adhere strictly to the SOPs will result in unuseable and/or missing data. All CAPMoN operators must follow the SOPs exactly in the order presented.

4.2.1 PREPARATION FOR SAMPLING In the sample handling area, a clean bucket/bag combination must be prepared to replace the one exposed in the precipitation collector for the past 24 hours. The procedures are:

(a) Check the spare bucket and bucket top for cleanliness. If noticeable amounts of particles or dirt can be seen in or on the bucket, clean it carefully with Kinwipes and deionized water (inside and outside).

(b) Check the bucket for roundness at the mouth. If it appears to be out-of-round by more than 1 to 2 cm, press the sides until it is round to within 1 cm.

(c) Place the bucket and the bucket top in their respective mounting brackets on the bench surface. Ensure that the bucket top is upside down.

(d) Remove the threaded drain plug from the side of the bucket.

(e) Open the pouch of sample bags (do not remove any bags) and the pouch of bucket lid covers (do not remove any).

(f) Put on a new, clean pair of disposable plastic gloves.

NOTE

Whenever handling disposable gloves, never touch the outside surface of the glove fingers. Always pull the gloves from the dispenser from the wrist end. When putting gloves on hands, always handle from the wrist end. Failure to follow this protocol will result in contamination of the gloves and potential contamination of the collected precipitation samples.

(g) Remove a clean new sample bag from the package of bags.

(h) Open the new bag by grasping it with one hand on each of the outside surfaces (near the top centre) and pulling apart the two sides of the bag. Air will fill the bag as it is pulled open. Do not lean over the open bag and keep it away from clothing.

(i) Insert the bag into the bucket. At this stage, the bag will be wrinkled and will not fill the bucket cavity completely.

(j) Starting at the side of the bucket furthest from your body, fold the top edge of the bag over the rim of the bucket. Leave approximately 8 cm (3 inches) of the bag folded over the outside of the bucket. Spread out any large wrinkles along the bucket rim by adjusting and smoothing the folded over portion of the bag.

NOTE

Do not lean over the bucket when folding the bag over bucket rim. Do not touch the inside or rim of the bag when in the bucket. If touched, discard the bag and start the procedure again.

(k) Still wearing the disposable gloves, remove a disposable bucket lid cover from its container.

(l) Place the plastic cover over the bucket lid with the inside surface facing out. Start with the bottom, sealed edge of the cover against the bucket and pull the bag inside out over the lid. Do not touch the cover over the bottom part of the lid. Handle the lid only by the outer flange and place it upside down on its bracket.

(m) Move back to the bucket. Suck the sample bag securely into the bucket by placing the portable vacuum over the drain hole and evacuating the air between the bucket and bag. Ensure that the bag is tightly sealed along the bucket rim and inside the bucket. Do not lean over the bucket/bag when doing this.

(n) Inspect the bucket rim for large wrinkles or folds in the bag. If wrinkles or folds exist, put on a clean, new pair of disposable gloves and smooth them out by repositioning the folded-over portion of the bag outside the bucket. Do not touch the rim of the bag. If this method fails, insert a gloved hand under the outside, folded-over portion of the bag and smooth out the wrinkle.

(o) Replace the threaded drain plug in the bucket drain hole.

(p) Lift the bucket lid/plastic cover combination by the rim and place it securely over the bucket top.

(q) Discard the plastic gloves.

(r) Turn on the balance to allow it time to warm up.

(s) Pick up the field note pad and pen to record field data at the site.

4.2.2 SAMPLE COLLECTION AND INSTRUMENT INSPECTION Take the clean bucket/bag/lid combination to the precipitation collector site at 0800 hours plus or minus 1 hour (every day). If it is precipitating at 0800 hours and the precipitation is expected to end within the next hour, wait until the precipitation has ended before going to the site. If it is not expected to stop precipitating within the hour, go to the site at 0800 hours.

NOTE

During transport to the site, the bucket lid must not come off the bucket or be knocked ajar. If either of these occur, return to the sample handling area and replace the sample bag and disposable cover with new ones.

Upon arrival at the site, two basic functions must be carried out (even if precipitation is occurring at the time), namely,

(a) Instrument inspection
(b) Sample collection.

Detailed procedures for each of these functions are given below. These procedures must be followed in the order given.

NOTE

All sample collection procedures must be carried out from the downwind or crosswind side of the collector.

4.2.2.1 INSTRUMENT INSPECTION The purpose of the instrument inspection is to determine whether the precipitation collector operated properly for the past 24 hours and will continue to operate properly for the next 24 hours.

(a) If precipitation is occurring, check that the moveable hood is in the 'OPEN' position and the 2 sensor grids are warm to the touch. If they are cold or very hot, note this fact in the field book and later notify the Regional Inspector for corrective action.

(b) If precipitation is not occurring:
    (i) inspect the seal between the top of the bucket and the foam gasket on the underside of the moveable hood. If the seal is not tight, note this fact in the field book and notify the Regional Inspector for corrective action.

(ii) inspect the upper surfaces of the collector for accumulations of snow or ice (during winter). If they exist, carefully brush or break them away from the collector using the brush provided. Leave as little residual snow or ice as possible because it represents a potential source of contamination. Ensure that the bucket is tightly sealed by the lid when brushing snow off the collector.

(iii) touch a wetted finger to the sensor grids. Check that the grids are warm to the touch and that the hood moves smoothly to the 'OPEN' position. If the sensor grids are not warm (i.e., they are cold or very hot) or the hood does not activate when the sensor grids are wetted, or the hood moves in a noisy or jerky fashion, note the details in the field book and later contact the Regional Inspector for corrective action.

(c) With the collector hood in the 'OPEN' position, carefully check the gasket mounted on the underside for:

(i) cleanliness
(ii) cracks, rips or holes in the plastic film which encases the foam
(iii) evidence of moisture or discoloration in the foam.

If any of the above problems are evident, note them in the field book and replace the gasket with a clean new one (see Section 5.5.1.1 for detailed replacement instructions).

(d) Watch the collector to ensure that the hood moves back to the CLOSED position approximately 2 minutes after opening.

NOTE

If the precipitation collector does not work, the operator should leave the collector in the OPEN position and collect the samples every 24 hours until it is repaired. Samples collected in this fashion should be identified as "BULK" samples and assigned Code 24 on the Sample History Form. If the operator lives near the site, he/she may consider opening the collector manually at the onset of precipitation and closing it manually at the end of precipitation. Samples collected in this manner are preferred over 'BULK' samples and must be assigned Code 33 on the Sample History Form.

4.2.2.2 SAMPLE COLLECTION Once the precipitation collector has been checked for proper operation, the old bucket/bag combination can be removed and replaced by the new one. The procedures are:

(a) If precipitation is occurring, quickly remove the bucket lid from the clean bucket and place it on the exposed bucket in the collector. Do not lean over the bucket when removing the lid and handle it only by the outer rim.

(b) If precipitation is not occurring, touch a wetted finger to a sensor grid and allow the collector hood to move to the 'OPEN' position. Remove the lid (with plastic cover attached) from the clean bucket and place it on the bucket in the collector. Do not lean over the clean bucket when removing the lid. Handle the lid only by its outer rim.

(c) Remove the exposed bucket from the collector and set it down on a level secure place.

(d) Place the clean bucket in the precipitation collector. Do not lean over the bucket when lifting or carrying it to the collector.

(e) Note the time of the sample collection to the nearest hour in the field book.

(f) If it is not precipitating, wait until the collector hood has moved back to the closed position (approximately 2 minutes) and check that the hood gasket makes a good seal with the new bucket rim. If it does not, note this in the field book and call the Regional Inspector for corrective action as soon as possible.

(g) In the winter, if the site is equipped with a telescopic, crank-type stand, adjust the height of the stand so that the bucket mouth is 150 cm above the snow surface.

(h) Before leaving the collector, make one last check to ensure that the on-off switch is in 'ON' position.

4.2.3 RAIN/SNOW GAUGE AND SNOW RULER MEASUREMENTS After the exposed bucket/bag has been covered and removed from the precipitation collector, the catch of the standard rain gauge or snow gauge must be measured. The rain gauge is normally used during months with rainfall, the snow gauge during months with freezing precipitation. During winter months, the accumulation of snow on the ground should also be measured using the snow ruler.

4.2.3.1 RAIN GAUGE MEASUREMENTS The Type B rain gauge is used to measure the amount of rain, drizzle, freezing rain, freezing drizzle and hail which fell in the 24 hour sampling period of the CAPMoN precipitation collector. The millimeter (mm) is the unit of rainfall measurement. Amounts are measured in the gauge's graduated cylinder to the nearest 0.2 mm. Less than 0.2 mm is

called a "TRACE" amount. Procedures for the operation of the rain gauge are as follows:

(a) Check the rain gauge to ensure that it is level and intact.

(b) Remove the funnel and graduate from the outer cylinder of the gauge.

(c) Hold the graduate vertical and read the level of the water using the following guidelines:

(i) The level of the water in the plastic graduate is correctly taken to be the lowest part of its curved surface (miniscus). When this lies between two scale marks, the correct amount is that of the nearer mark. In the exceptional case where the level is midway between two scale marks, the amount reported is the mid-value.

(ii) Whenever the level of the miniscus is below the 0.2 mm scale mark, the amount is considered to be "TRACE".

NOTE

Precipitation amounts below 0.2 mm are extremely difficult to measure. Therefore, all observations below the 0.2 mm scale mark will be recorded as "TRACE". The amount 0.1 mm will not be recorded at any time.

(iii) Rainfall amounts up to 25 mm may be measured directly in the transparent plastic graduate. Rainfalls greater than 25 mm overflow from the graduate into the outer container. The maximum capacity of the gauge when both the inner and outer containers are filled is 250 mm.

(iv) Rainfalls greater than 25 mm which overflow into the outer container are measured as follows:
Remove the funnel and plastic graduate from the outer container. Read and note down the water level in the graduate, discard the water in the graduate and pour less than 25 mm of water from the outer container into the graduate. Read and note the level. Discard this water and repeat until all the water from the outer container has been measured. Add all of the measurements to determine the total rainfall amount.
For example, amount originally in graduate = 25.0 mm
next measurement = 23.8 mm
next measurement = 10.4 mm
the total rainfall is = 59.2 mm

(v) If rain or freezing rain has frozen in the funnel or graduate, remove both the funnel and graduate from the gauge and replace them immediately with the spare funnel and graduate provided as part of the CAPMoN site inventory. Take the frozen graduate and funnel indoors (i.e., to the sample handling area), place it in the mounting bracket provided, cover it with a piece of plastic and allow the precipitation to melt at room temperature. Keep the funnel and graduate away from any heat sources when melting. When the precipitation has melted, read the value, note it down and discard the water. This will normally be done the following day at sample collection time.

(d) Record the amount of rainfall and any other information regarding the measurement (e.g., liquid spilled or overflowed) in the field book.

(e) Empty the graduate and outer cylinder completely and place them back in the gauge. Ensure that the gauge is level, intact and clean before leaving it. If there are problems with the gauge (e.g., chipped, broken, etc..) call the Regional Inspector for corrective action.

4.2.3.2 SNOW GAUGE MEASUREMENTS The nipher-shielded snow gauge is used to measure all types of freezing precipitation as well as winter rainfall. Two catchment containers known as 'receivers' are provided with each gauge and are alternated in the gauge daily. A calibrated graduated cylinder made of glass is also provided and is used to make the measurement of water equivalent snow depth from the snow melted in the receiver. The units of the graduated cylinder are 0.2 mm. As with rainfall, the graduate is read at the lowest part of the curved surface of the water (miniscus) and amounts less than 0.2 mm are considered to be "TRACE". Procedures for operating the snow gauge are as follows:

(a) Take the spare receiver to the snow gauge. Inspect the snow gauge (shield, receiver, stand) to ensure that it is in good condition, i.e., no chips, breaks, dents, etc.

(b) Remove the receiver from the gauge and check to see if precipitation was collected in it. Replace the receiver with the spare one.

(c) If precipitation was not collected, take the exposed receiver to the sample handling area and store it until the next day.

(d) If precipitation was collected, transport the receiver to the sample handling area taking care not to spill any of the contents. If the contents are spilled, note this fact in the field book.

(e) At the sample handling area, the frozen precipitation is melted and measured. There are three possible methods for doing this. Each CAPMoN operator, in consultation with his/her Regional Inspector must choose the method most suited to his/her site. They are:

Method 1: Set the receiver near a source of low heat (e.g. hot air register) and allow it to melt. As soon as the snow has melted, transfer it to the graduated cylinder and measure the water level. NOTE: This method is to be used only at sites where the operator is normally present while the snow melts and can measure it as soon as it is melted.

Method 2: Set the receiver in its storage bracket, away from sources of heat but at room temperature. Cover the receiver mouth with a piece of plastic and leave it to melt over the next 24 hours. The next day, before preparing for the sample collection, pour the water into the graduate and measure the level. NOTE: This method should be used at sites where CAPMoN operators will not be in the vicinity of the receiver for periods long enough for the snow to melt. It eliminates the need for operators to sit and wait for the snow to melt.

Method 3: Add to the receiver a measured amount of warm water (taken from a tap and measured in the graduate cylinder). The total amount of water in the receiver should be measured and the amount of warm water should be subtracted from this measurement. The difference represents the original amount of melted snow. For example:

Measurement of total contents of gauge = 1.4 mm
Amount of warm water added = 1.0 mm
Actual precipitation = 0.4 mm.

NOTE: This method should be used at sites where operators have access to warm water and must complete the operating procedures quickly.

(f) Record all measurements in the field book.

(g) If a phenomenon known as "snow bridging" occurs on the snow gauge (i.e., a layer of snow bridges across the nipher shield opening and builds into a cap above the receiver), hit the shield sharply and allow the snow to fall straight down into the receiver. The amount which fell directly into the receiver is assumed to be equivalent to that which fell on the ground. Note the fact that snow bridging occurred in the field book and measure the receiver contents as normal.

(h) Before leaving the site, adjust the height of the stand so that the mouth of the receiver is 150 cm (5 feet) above the snow surface. Brush away all snow accumulated on the shield.

4.2.3.3 SNOW RULER MEASUREMENTS A snow ruler is located at most CAPMoN sites to measure the depth of snow accumulated on the ground. During winter months, the depth of snow on ground is to be measured daily. The procedures are as follows:

(a) Read the depth of snow to the nearest cm from the scale on the snow ruler.

(b) Record the number in the field book.

4.2.4 SAMPLE HANDLING The bag/bucket/lid combination (with or without collected precipitation) must be transported from the precipitation collector site to the sample handling area where it is sealed, weighed and stored.

These procedures are carried out daily -- whether precipitation was collected in the bag or not. There are three major operations to be carried out on the sample bags, namely:

1. Sample bag removal, sealing and labelling;
2. Sample/bag weighing;
3. Sample bag storage.

Detailed procedures are given below. All procedures must be followed in the order given.

4.2.4.1 BAG REMOVAL, SEALING AND LABELLING

(a) Remove the drain plug from the side of the bucket.

(b) Put on a clean pair of disposable plastic gloves (observe proper handling procedures for gloves).

(c) Place the bucket in in its storage bracket. Remove the bucket top (with its disposable plastic cover) from the bucket and place it upside down on its storage bracket.

(d) Insert the gloved fingers of both hands between the folded-over portion of the bag and the outside of the bucket. Gently lift the bag out of the bucket making sure that the folded over portion of the bag does not unfold. If the operator's fingers are too large to fit under the bag, he/she may grasp the bag on either side of the bucket rim and lift it out of the bucket.

4.2.4.2 IF PRECIPITATION WAS COLLECTED If precipitation (even a trace amount) was collected in the bag over the past 24 hours, carry out the following procedures:

(a) Rest the bottom of the bag on the support bracket attached to the front of the heat sealer. Hold the bag one quarter-way down its length with one hand (to prevent it from spilling) and fold over the top quarter of the bag. This prevents foreign material from entering the bag.

(b) If rain formed droplets in the upper portion of the bag below the fold, gently shake them to the bottom of the bag.

(c) If snow collected in the bag, shake any loose snow accumulated below the fold to the bottom of the bag. Compress the snow into a smaller volume by gently squeezing the outside of the bag.

(d) Gently pull the top of the bag through the jaws of the sealer until the water or snow at the bottom of the bag is just resting on the support bracket. The folded-over portion at the top of the bag must not be unfolded when the bag is pulled through the jaws of the heat sealer.

(e) With both hands, press the outside of the bag against the sample and the body of the sealer until all of the air is evacuated from the area above the sample.

(f) Smooth the bag along the heater bar surface so that no wrinkles or folds exist along the bar.

NOTE

It is extremely important that no wrinkles exist along the seal line of the bag.

(g) Depress the top arm of the sealer using the foot pedal. Wait for 1 to 2 seconds after the buzzer ends before releasing the upper arm.

(h) Make a second seal approximately 1 cm above the first seal.

(i) Inspect both seals for evidence pinholes or unsealed areas.

(j) Turn the sample upside down and check that water does not leak out of the seals. If a leak is found, reseal the bag properly.

(k) Label the bag by placing the next, consecutively-numbered, I.D. sticker on the upper portion of the bag.

4.2.4.3 IF PRECIPITATION WAS NOT COLLECTED (DRY BAG) If precipitation was not collected during the past 24 hours (i.e., the bag was dry) do the following:

(a) Hold the bag by its outer edges and fold over the top of the bag approximately 2.5 cm (1 inch) below the folded-over portion of the bag which was originally on the outside of the bucket. This prevents foreign material from entering the bag during handling. Do not unfold the portion of the bag which was folded over the outside of the bucket.

(b) Place the dry bag in the sealer, smooth out any wrinkles or folds along the sealer bar, gently evacuate the air out of the bag and double seal it approximately 2 to 2.5 cm (1 inch) below the lower edge of the folded-over part of the bag.

(c) Label the bag with the next consecutively-numbered I.D. sticker and a 'DRY BAG' sticker.

4.2.4.4 SAMPLE/BAG WEIGHING Precipitation samples are weighed in order to determine the catch of the collector; dry bags are weighed in order to monitor the weight tolerance of the empty bags. The weighing procedures are the same for both.

(a) If it has not been done already, turn on the balance by pressing the front control bar. Allow it to warm up. (The balance should have been turned on during the preparation for

sampling stage before the sample was collected - Section 4.2.1). NOTE: When the control bar is depressed, the display should first read ± 8.8.8.8.8.8 g, then switch automatically to ± 0.0 g.

(b) If the balance does not exactly display ± 0.0 g with no load on the pan, press the front control bar again. This will produce a ± 0.0 g display.

(c) Place the plastic weighing container on the balance top. Its weight will be displayed.

(d) Press the control bar. The balance will then display ± 0.0 g.

(e) Place the standard reference weight (provided separately) in the centre of the weighing container, wait until the display has stabilized and read the displayed weight. Replace the standard weight in the container provided. Be extremely careful not to dent, chip, scrape or drop the weight.

(f) Record the value of the standard weight in the column titled "REFERENCE WEIGHT" on the CAPMoN Precipitation Sample History Form. See Section 4.2.5 for full details on completing the CAPMoN Precipitation Sample History Form. NOTE: The measured value of this weight may vary from day to day or week to week. Always weigh it; do not assume that it will be constant and record a weight without measuring it.

(g) Remove the reference weight from the weighing container and place it in the container provided. Check that the display returns to a value of 0.0 g (if not, press the control bar again) and place the precipitation sample or dry bag in the middle of the plastic weighing container. Both precipitation sample bags and dry bags should be folded neatly so that they fit within the walls of the weighing container.

(h) Wait for the balance display to stabilize, read the value and record it on the CAPMoN Precipitation Sample History Form under the column titled "SAMPLE/BAG WEIGHT" (see Section 4.2.5).

(i) Inspect the precipitation sample for evidence of particulate matter, organic matter or any other material in the sample. Indicate the existence of such material on the Sample History Form following the procedures given in Section 4.2.5.

(j) Remove the sample and the weighing container from the balance and depress the control bar to turn it off.

4.2.4.5 SAMPLE/BAG STORAGE Every precipitation sample, regardless of the amount of precipitation collected, must be stored in the on-site refrigerator until it is time for shipment to the laboratory. In addition, one 'dry bag' from every week must be randomly selected by the operator and stored in the refrigerator with the sample. All other dry bags must be stored in the cardboard storage container provided at the site. The storage procedures are given below.

(a) Fold the sample bag (or dry bag) neatly and place it in a plastic storage container. Note that two sizes of plastic storage containers are available at every site. The small size, (4 l) is used for most samples; the large size (8 l) is used only when a sample is collected which weighs more then 2500 g. Several samples should be placed in each 4 l or 8 l storage container (as volume permits). Care should be taken to ensure that bags are completely enclosed in the storage containers. Corners of bags left hanging outside the container can be ripped when the container lid is snapped into place.

(b) Precipitation samples weighing more than 2500 g are too large to fit comfortably into 4 l storage containers. These samples must be placed in 8 l containers. Empty space in the 8 l container can be filled with other smaller samples.

(c) Place the sample storage container in the refrigerator. Check the temperature of the refrigerator to see that it is at 4° ± 1° C. If it is not, readjust the thermostat until it is.

4.2.5 DATA REPORTING The CAPMoN Sample History Form must be filled in daily. The Sample History Form is designed to provide a detailed history of all precipitation and dry bag samples collected at the site.

4.2.5.1 CAPMoN SAMPLE HISTORY FORM The CAPMoN Sample History Form is shown in Figure 4-1. It is a 3 page form made of pressure-sensitive paper. Information written on the top of page of the form is automatically transferred to the other two pages without the use of carbon paper. Operators must fill in the form on a hard-backed surface using a black ball point pen. The first two pages (colours: white and yellow) of the Sample History Form are to travel with the precipitation samples to the laboratory. The third page (colour: pink) is to be filed on-site in the file box provided for that purpose. All shaded areas on the form are for laboratory use only and are not to be written in by site operators.

4.2.5.2 GENERAL INSTRUCTIONS FOR COMPLETION OF THE CAPMoN SAMPLE HISTORY FORM General instructions for completing the Sample History Form are given below.

(a) One row on the Sample History Form form is to be filled in every day - whether precipitation occurred or not.

(b) The form must be kept in the sample handling area at all times. It should never be taken to the instrument site because of possible loss or ruin. A field book is given to every operator for recording information at the instrument site. This information can later be transferred to the Sample History Form in the sample handling area.

(c) One form covers a two week sampling period (14 rows are available, one for each day).

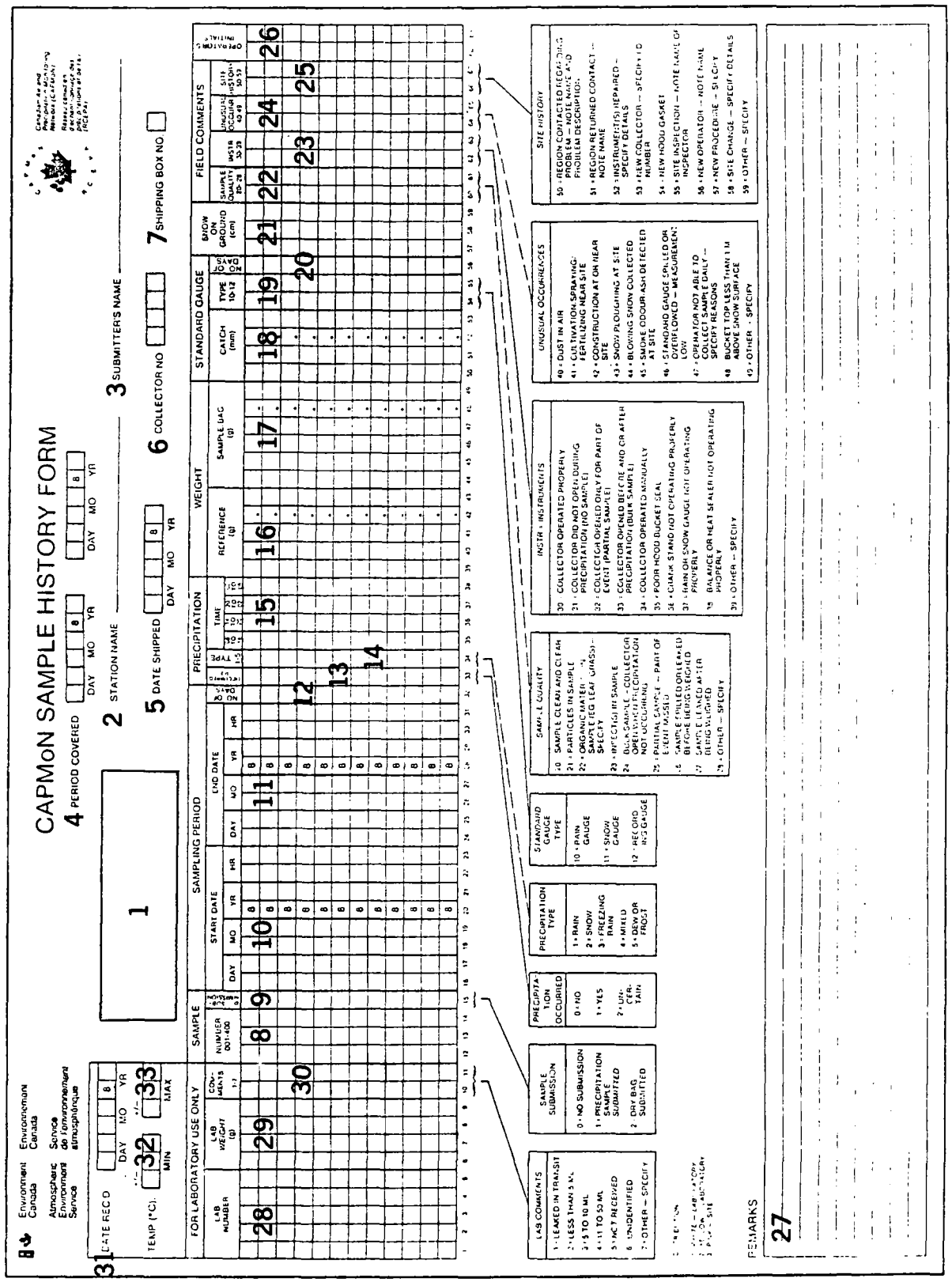


Figure 4-1: CAPMoN History Form

(d) The area at the top of the form (above the rows and columns) is to be filled in only at the end of the two week sampling period when the samples are being prepared for shipment to the laboratory. The area in the middle of the form (rows and columns) is to be filled in daily.

(e) The form is to be filled out from left to right. All entries are to be numerical except for descriptive notes which are to be written in the 'REMARKS' section at the bottom of the form. The darkly shaded area on the left side of the form is for laboratory use only and should not to be filled in by the operator. The eight columns labelled 'FIELD COMMENTS' on the form are to be filled in using numerical codes, the legends for which are presented in boxes at the bottom of the form. When filling in the form, operators should read through all codes in every box to ensure that all are considered. Missing codes can seriously affect the use and accuracy of the resulting data.

(f) If more than one code number is required in one of the "FIELD COMMENTS" columns on the form, the extras can be placed in any empty FIELD COMMENTS column.

4.2.5.3 DETAILED INSTRUCTIONS FOR COMPLETION OF THE CAPMoN SAMPLE HISTORY FORM Detailed instructions on completing the form and detiled descriptions of the various codes are given below. All details of the form described below are numbered to correspond with the numbered entries in Figure 4-1. Observers are encouraged to refer to Figure 4-1 when reading this section.

	ENTRY	DESCRIPTION
(1)	NAQUADAT I.D. NUMBER, TIME ZONE, PROJECT NUMBER:	The NAQUADAT NUMBER, TIME ZONE AND PROJECT NUMBER appear on pre-printed labels attached to the Sample History Forms. Operators are not required to fill in this information.

TO BE COMPLETED ONLY WHEN SHIPPING SAMPLES

(2) STATION NAME: Print the name of the CAPMoN monitoring site.

(3) SUBMITTER'S NAME: Print the name of the operator carrying out the sample shipping procedures.

(4) PERIOD COVERED: Print the two week period from the first start date to the last start date of the sampling period. Use numbers to denote the day, month and year, e.g., 01 07 85 to 14 07 85 for July 1, 1985 to July 14, 1985.

(5) DATE SHIPPED: Print the day, month and year the samples leave the site for shipment to the laboratory. A 6-digit numerical code is to be used, e.g., 15 07 85 for July 15, 1985.

(6) COLLECTOR NUMBER: Print the identification number on the CAPMoN precipitation collector. The number is alpha-numeric, either A100 to A130 or B200 to B250. In the exceptional circumstance where more than one collector was used during the two week period, enter the number of the first collector and note the number and starting date of the other collector in the 'REMARKS' section at the bottom of the form.

(7) BOX NUMBER: Print the number of the shipping box used to transport the samples to the laboratory. This is the 1-digit number which appears on the inside flap of the shipping box.

TO BE FILLED IN DAILY

(8) SAMPLE NUMBER: 001 - 365 — Print the consecutive sample number which appears (beside the site name) on the sample identification sticker attached to the sample. Number 001 is used for the first sampling day of every year (Jan. 1 to Jan. 2) and the numbers run consecutively throughout the year.

(9) SAMPLE SUBMISSION: Refer to SAMPLE SUBMISSION codes at the bottom of the form. These SAMPLE SUBMISSION codes indicate to the laboratory whether a sample, dry bag or nothing at all has been shipped to them.

Enter 0 (= NO SUBMISSION) when no sample or dry bag is being submitted to the laboratory. This will be filled in on all days when dry bags were collected but not submitted and on exceptional days when samples were missed or lost.

Enter 1 (= PRECIPITATION SAMPLE SUBMITTED) when a precipitation sample was collected and is being submitted to the laboratory.

Enter 2 (=DRY BAG SUBMITTED) on the one day of the week when a dry bag was collected and is being submitted to the laboratory.

(10) SAMPLING PERIOD - START DATE: Enter the day, month, year and hour when the sampling period began, i.e., when the clean bucket/bag combination was set out in the precipitation collector. Enter only the hour nearest to the time when the bucket/bag was changed, e.g., 0730 to 0829 will be entered as 08 while 0830 to 0929 will be entered as 09. As an example, the start time of January 17, 1985 at 0805 would be entered as 17 01 85 08.

(11) SAMPLING PERIOD - END DATE: Enter the Day, Month, Year and Hour when the bucket/bag combination was removed from the precipitation collector. This is normally the date following the START DATE.

(12) SAMPLING PERIOD - NUMBER OF DAYS Enter the number of days (1, 2, 3, etc.) which the sample or dry bag remained in the collector, i.e., the number of days (to the nearest day) between the start time and end time. This entry should always be '1' except under exceptional circumstances when multiple day sampling was necessary.

(13) PRECIPITATION - OCCURRED YES/NO Refer to "PRECIPITATION OCCURRED" codes at the bottom of the form. This code indicates whether precipitation occurred or not during the sampling period.

Enter 0 (= NO) when no precipitation occurred. This entry is to be made when no precipitation was collected in the precipitation collector or in the rain or snow gauge and no precipitation was observed to be have fallen during the sampling period.

Enter 1 (= YES) when precipitation was known to have fallen during the sampling period, i.e., when precipitation was collected in either the precipitation collector or the standard gauge, or both. In some situations, the precipitation collector may not have collected falling precipitation while the standard gauge did (and vice versa). These situations must always be given the entry 1 - even if only trace amounts are collected.

Enter 2 (= UNCERTAIN) when it is unknown whether precipitation occurred or not. This code will only be used under exceptional circumstances when both the precipitation collector and the standard gauge are not working and the operator did not know if precipitation fell at the site.

(14) PRECIPITATION - TYPE

To be filled in only when precipitation was known to occur during the sampling period. Refer to "PRECIPITATION TYPE" codes at the bottom of the form. "Precipitation Type" refers to the form of the precipitation which fell during the sampling period. Normally, observations of the CAPMoN site operators are used to determine the precipitation type. During some precipitation events, operators may not be at or near the site (e.g., overnight events). In these cases, operators must use some judgement when specifying precipitation type. For example, an overnight snow event followed by an early morning warm spell could result in water being collected in the precipitation collector and snow gauge. The precipitation type could therefore be erroneously reported as rain when it should have been snow. Operators are asked to observe the weather, check the type of precipitation in the collector and standard gauge and assess all other sources of information (e.g. other people) before specifying the precipitation type.

Enter 1 (= RAIN) for rain-only events.

Enter 2 (= SNOW) for snow and ice pellet events.

Enter 3 (= FREEZING RAIN) for freezing rain events.

Enter 4 (= MIXED) for mixed event of snow and rain, snow and freezing rain, rain and freezing rain, snow and hail, and rain and hail.

Enter 5 (= DEW OR FROST) on days when dew or frost is suspected to have been collected.

(15) PRECIPITATION - TIME

Enter '1' in any (or all) of the 4 six-hour time blocks when precipitation occurred. Leave blank those blocks when precipitation did not occur.

For example, if precipitation occurred from 0930 hours (9:30 AM) to 1500 hours (3:00 PM), then '1' should be enterred in both the '08 to 14' and the '14 to 20' blocks. In the case of continuous precipitation events (i.e. not intermittent) where most of the precipitation occurred in one 6-hour period and continued for less than 30 minutes into the second 6 hour period, only the first period should be given an entry. If precipitation persisted beyond 30 minutes, both periods should be entered.

(16) WEIGHT - REFERENCE (grams)

Enter the measured value of the standard reference weight (see Section 4.2.4.4).

(17) WEIGHT - SAMPLE/BAG (grams)

Enter the measured weight of the sealed precipitation sample or dry bag (see Section 4.2.4.4). All precipitation samples and all dry bags (even those not submitted to the laboratory) must be weighed and reported.

(18) STANDARD GAUGE - CATCH (mm)

"STANDARD GAUGE CATCH" refers to the amount of precipitation collected in the rain or snow gauge during the past 24 hours. It is the depth, in mm, of liquid water measured in the graduated cylinder of the rain or snow gauge (see Section 4.2.3).

Enter the measured depth of water to the nearest 0.2 g. Depths less than 0.2 mm should be entered as T (= Trace) after the decimal point.

NOTE:

The rain or snow gauge catch must be recorded for all sampling periods with precipitation - even those days when the precipitation collector did not work.

The catch of the rain gauge should normally be measured at the precipitation collector site and noted in the field note book. The value should be transferred to the Sample History Form at the sample handling area.

(19) STANDARD GAUGE - TYPE

Refer to "STANDARD GAUGE TYPE" codes at the bottom of the form.
This column indicates the type of instrument used to measure the standard gauge catch.

Enter 10 for rain gauge
Enter 11 for nipher-shielded snow gauge
Enter 12 for recording gauge (e.g., Belfort, tipping-bucket, Fisher-Porter).

Entries of 10 (rain gauge) or 11 (snow gauge) will be normal at CAPMoN sites. Only under unusual circumstances will an entry of 12 be made.

(20) STANDARD GAUGE - # DAYS

Enter the number of days sampled by the snow or rain gauge. Round off the nearest day. Under normal operation, this entry will be '1'. <u>In exceptional cases where the precipitation chemistry collector was not operating, the rain or snow gauge measurement must still be taken and a daily entry should be made</u>.

(21) SNOW ON GROUND (cm)

Enter the depth of snow on ground (cm) measured by the snow ruler provided at most sites. When no snow exists, leave blank.

(22) FIELD COMMENTS - SAMPLE QUALITY

Refer to the "SAMPLE QUALITY" codes at the bottom of the form. This column is meant to describe the quality of the precipitation samples and the dry bags collected.

Enter 20 (= SAMPLE CLEAN AND CLEAR) if there is no foreign material in the precipitation sample.

Enter 21 (= PARTICLES IN SAMPLE) if small particles of dirt or dust appear in the sample.
If a large number of particles are visible, note this with the sample date in the REMARKS section at the bottom of the form.

Enter 22 (= ORGANIC MATERIAL IN SAMPLE - SPECIFY) if grass, algae, fibres, tree needles, tree leaves, bird droppings, hair, cloth, feathers, pollen or other organic material is visible in the sample. Describe the material in the REMARKS section at bottom of form.

Enter 23 (= INSECT(S) IN SAMPLE) if one or more insects (spider, mosquito, fly, etc.) are visible in the sample.

Enter 24 (= BULK SAMPLE -- COLLECTOR OPEN WHEN PRECIPITATION NOT OCCURRING) for precipitation samples and dry bags which were not covered by the collector hood during dry periods. This will occur when: (a) the precipitation collector opened when it should not have during dry periods and (b) when the collector was inoperative so the operator left it in the OPEN position for 24 hours. Note in the REMARKS section the times when the collector was observed to be open when it was dry and whether this occurred before or after precipitation.

Enter 25 (= PARTIAL SAMPLE -- PART OF EVENT MISSED) for precipitation samples which represent only part of the precipitation which fell during the 24 hour period. This would include cases when power failures occurred during precipitation and the collector did not open until power was restored, or when the collector malfunctioned and closed during a precipitation event. Note all details related to the partial sample in the REMARKS section.

Enter 26 (= SAMPLE SPILLED OR LEAKED BEFORE BEING WEIGHED) if the sample spilled or leaked before being weighed on the balance. The weight must still be recorded but Code 26 will indicate that it is incorrect.

Enter 27 (= SAMPLE LEAKED AFTER BEING WEIGHED) if the sample leaked after it was weighed. If it leaked both before and after weighing, enter code 24 in this column and 25 in any empty "FIELD COMMENTS" column for that day.

Enter 28 (= OTHER - SPECIFY) if some other factor which could affect sample or measurement quality is observed. Specify details in the REMARKS section.

(23) FIELD COMMENTS - INSTRUMENTS Refer to "INSTRUMENTS" codes at bottom of form. These codes relate to the operating condition of the CAPMoN instruments. Field notes on instrument operation taken at the site should be transferred to the form using these codes.

Enter 30 (= COLLECTOR OPERATED PROPERLY) if the precipitation collector appeared to operate properly over the sampling period. This code will normally be filled in every day unless a problem is detected with the collector.

Enter 31 (= COLLECTOR DID NOT OPEN DURING PRECIPITATION (NO SAMPLE)) if the collector did not open during a precipitation episode and no sample was collected, e.g., power failure, collector inoperative.

Enter 32 (= COLLECTOR OPENED ONLY FOR PART OF EVENT (PARTIAL SAMPLE)) if the collector opened for part of a precipitation event only. This will produce only a partial sample and code 25 should appear in the SAMPLE QUALITY column.

Enter 33 (= COLLECTOR OPENED BEFORE AND/OR AFTER PRECIPITATION (BULK SAMPLE)) if the collector was open during a dry period. This code should be enterred for both precipitation samples and dry bags which were left uncovered.

Enter 34 (= COLLECTOR OPERATED MANUALLY) on days when the collector did not work so the operator manually opened the collector hood at the onset of precipitation and manually closed it at the end of the precipitation. Note in the REMARKS section the time of opening and closing and when the precipitation started and ended.

Enter 35 (= POOR HOOD - BUCKET SEAL) on days when the gasket on the underside of the collector hood did not make a tight seal with the bucket rim. A poor seal could be caused by misalignment of the gasket, poor condition of the gasket or improper alignment of the bucket.

Enter 36 (= CRANK STAND NOT OPERATING PROPERLY) if the telescopic crank stand did not operate properly. Details of the problem should be noted in the REMARKS section. Problems include: crank will not turn; clamp will not hold. See Code 48 if the bucket height is less than 1 m above the snow surface because the crank will not work.

Enter 37 (= RAIN OR SNOW GAUGE NOT OPERATING PROPERLY) if the rain or snow gauge did not operate properly for the sampling period. Note details of the problem in the REMARKS section. Examples are: gauge broken, cracked or chipped; graduated cylinder broken; gauge knocked over; gauge not level; receiver not placed in gauge; gauge not yet installed at site.

Enter 38 (= BALANCE OR HEAT SEALER NOT OPERATING PROPERLY) if the balance or heat sealer did not operate properly over the sampling period. Note details in the REMARKS section. Examples are: heat sealer will not seal; balance will not operate; balance shows top half of display, balance will not zero; measured weight appears to be wrong.

Enter 39 (= OTHER - SPECIFY) if other instrument problems occur. Note details of the problem in the REMARKS section. Problems include: instruments vandalized, bucket broken.

(24) FIELD COMMENTS - UNUS. OCCUR. Refer to "UNUSUAL OCCURRENCES" codes at bottom of form. These codes refer to unusual occurrences at or near CAPMoN sites which could affect the quality of the collected samples. Under ususal operating conditions, this column will not be filled in. Details of any unusual occurrences should be noted in the REMARKS section after the code is entered.

Enter 40 (= DUST IN AIR) if particulates, dirt, dust or other materials are observed to be windborne at the site during the sampling period. Examples include: strong winds causing nearby soil to be windborne, road dust reaching sites when vehicles pass by, pine pollen in the air.

Enter 41 (= CULTIVATION/SPRAYING/FERTILIZING NEAR SITE) on days when major agricultural activity occurred near the site. Of particular note are: cultivation and harvesting of crops, spraying of insecticides or herbicides, application of fertilizer (solid or liquid). All are potential sources of contamination to the samples.

Enter 42 (= CONSTRUCTION AT OR NEAR SITE) if construction is observed to take place within 500 m of the CAPMoN site. This includes building construction, road construction, excavation, cable laying, pipe laying, road resurfacing, etc. Activities such as these can cause contamination of samples. Specify details in REMARKS.

Enter 43 (= SNOWPLOUGHING AT SITE) if snowploughing or snowblowing took place within 100 m of the site during the sampling period. Indicate in REMARKS whether ploughed or blown snow could have entered the precipitation collector.

Enter 44 (= BLOWING SNOW COLLECTED) if there is reasonable assurance that blowing snow was collected in the precipitation collector. Blowing snow is defined here as snow that was originally on the ground but was picked up and transported by high winds. Falling snow being blown by the wind should not be given Code 44.

Enter 45 (= SMOKE, ODOUR OR ASH DETECTED AT-SITE) if smoke, odour or ash was detected at the CAPMoN sie during the sampling period. Causes include forest fires, garbage fires, chemical spills, fertilizing, industrial emissions, wood burning stove emissions, livestock grazing. Note in the REMARKS section any known causes of the smoke, odour or ash.

Enter 46 (= STANDARD GAUGE SPILLED OR OVERFLOWED - MEASUREMENT LOW) if the rain or snow gauge contents spilled or overflowed before the depth was measured in the graduate cylinder. Spills or overflows cause the measured value to be incorrect (lower than the true value) and must be indicated on the form. Specify details in REMARKS.

Enter 47 (= OPERATOR NOT ABLE TO COLLECT SAMPLE DAILY - SPECIFY REASONS) if the CAPMoN instrumentation was not operated or visited by an operator over a daily sampling period. This code will be used only during exceptional circumstances when access to the site is limited or operators are not available. Note in the REMARKS section the reasons for the operator's absence.

Enter 48 (= BUCKET TOP LESS THAN 1 m ABOVE SNOW SURFACE) if the bucket top on the collector cannot be raised higher than 1 m above the snow surface (normal position is 1.5 m). This will generally be due to problems with the crank stand.

Enter 49 (= OTHER - SPECIFY) if other unusual occurrences which could affect the quality of the precipitation take place at the site. Specify the details in the REMARKS section. Examples include severe weather (hurricanes, tornadoes), nearby explosions, vandalism, bridging of snow gauge.

(25) FIELD COMMENTS - SITE HISTORY Refer to "SITE HISTORY" codes at bottom of form. These codes record the operating history of the site. Any site inspections, problems, or changes in site operations must be indicated on the form on the day they take place.

Enter 50 (= AES REGION CONTACTED REGARDING PROBLEM - NOTE NAME AND PROBLEM DESCRIPTION) on days when a problem occurred with the instrumentation, the site, or the sampling procedures and a Regional Inspector was contacted for corrective action. Note in the REMARKS section, the name of the person contacted at the AES regional office, or the name of a person with whom a message was left. Also note the nature of the problem needing corrective action.

Enter 51 (= REGION RETURNED CONTACT - NOTE NAME) on the day when a Regional Inspector returned contact regarding the problem specified in Code 50. Normally this will be on the same day that the region was contacted and both codes 50 and 51 will be entered in the FIELD COMMENTS area on that day.

Enter 52 (= INSTRUMENT(S) REPAIRED - SPECIFY DETAILS) on days when problems with the instrumentation were corrected. This will normally be done by a Regional Inspector.

Enter 53 (= NEW COLLECTOR - SPECIFY I.D. NUMBER) on days when a new Type A-M precipitation collector is installed to replace a defective collector. Note the new collector number in the REMARKS section.

Enter 54 (= NEW HOOD GASKET) on days when the hood gasket was replaced with a clean new one (monthly).

Enter 55 (= SITE INSPECTION - NOTE NAME OF INSPECTOR) on days when a Regional Inspector, a member of AES Headquarters staff or an external auditor carried out a site inspection. Note the name of the inspector in the REMARKS section.

Enter 56 (= NEW OPERATOR - NOTE NAME) on the first day that a new operator carried out the sampling procedure. This will occur whenever a new operator replaces either a primary or backup operator.

NOTE: New operators must be trained by AES staff before carrying out any sampling procedures. The names of the new operator and the operator being replaced should be specified in the REMARKS section.

Enter 57 (= NEW PROCEDURE - SPECIFY) on the first day that a new or modified sampling procedure is started at a site. Such changes in procedure will only be initiated after an official bulletin or telephone call is given to the site by AES Regional Inspectors.

Enter 58 (= SITE CHANGE - SPECIFY DETAILS) on days when physical changes are made to the CAPMoN site or its surroundings. Note the nature of the site changes in the REMARKS section of the form. Possible changes include: instrument position moved, ground cover changed, trees planted or removed, buildings constructed within 100 m of site, new pollution sources started within 50 km of site, meteorological tower installed on-site, other instruments installed on-site.

Enter 59 (= OTHER- SPECIFY) on days when other factors related to the operation of the site occur. Note details in the REMARKS section of the form. Examples are: special study started, duplicate collector started operation, new sample handling area started up, etc.

(26) OPERATOR'S INITIALS

Enter the initials of the CAPMoN operator who carried out the sampling procedures each day. These will normally be the initials of the primary site operator with occasional entries by the backup operator.

(27) REMARKS — Note any details related to the comment codes entered on the form. Add any further comments which may be of interest to data users.
Precede each comment or remark with the sample number and (start/end) date(s) of the sampling period to which it applies. Attach an extra sheet of paper to the form if further space is required.

FOR LABORATORY USE ONLY

The remaining sections of the Sample History Form are to be completed by laboratory staff only. Details on these sections are provided here for information purposes only.

(28) LAB NUMBER — Internal laboratory identification number assigned to sample at laboratory reception.

(29) LAB WEIGHT (grams) — Weight of sample measured at laboratory. Used to compare with field weight to detect leaks during transport.

(30) COMMENTS (1 - 6) — Comment codes regarding sample condition and analysis:
1 - Leaked in Transit
2 - Less Than 5 ml
3 - 5 to 10 ml
4 - 11 to 50 ml
5 - Unidentified
6 - Other - Specify.

(31) DATE RECEIVED — Day, month and year that the shipment of samples was received by the laboratory.

(32) MIN TEMP — The minimum temperature in the shipping box as measured by the minimum/maximum thermometer shipped in each box.

(33) MAX TEMP — The maximum temperature in the shipping box as measured by the minimum/maximum thermometer shipped in each box.

NOTE

An example of a completed Sample History form is given in Figure 4-2. It can be used for guidance by new site operators.

4.2.5.4 DISTRIBUTION OF THE COMPLETED CAPMoN SAMPLE HISTORY FORMS

Distribute the three copies of the CAPMoN Sample History Form as follows:

Page 1 (White) - send with samples in sample shipping box.
Page 2 (Yellow) - send with samples in sample shipping box.
Page 3 (Pink) - file on-site in the file box.

Check that all information written on the top (white) copy of the form is legible on the second and third copies.

NOTE

If no precipitation occurred during a two week period, the SAMPLE HISTORY FORM must still be completed and distributed according to the instructions above. An empty box can be used to ship the form to the laboratory.

4.2.6 SAMPLE SHIPPING Samples must be shipped to the Water Quality Laboratory at the Canadian Centre for Inland Waters in Burlington, Ontario every 2 weeks. The normal mode of shipping is by courier service, although some remote sites may use mail or special air transport. Shipping arrangements should be made through Regional Inspectors at the time of site start-up. Procedures for shipping the samples are:

(a) Fill in the required information at the top of the Sample History Form, i.e., Station Name, Submitter's Name, Period

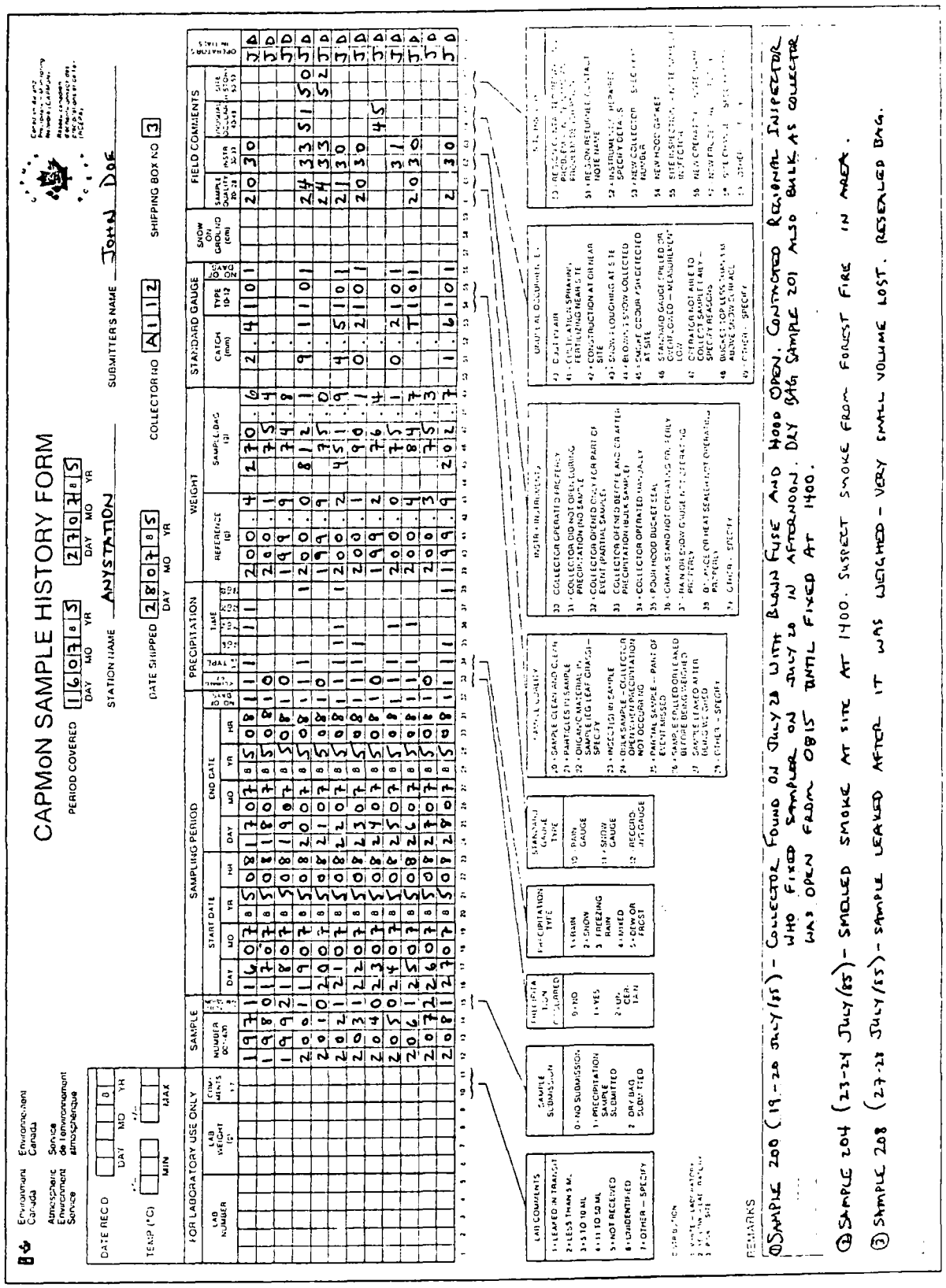


Figure 4-2: Example of a Completed Sample History Form

Covered, Date Shipped, Collector Number and Box Number (see Section 4.2.5 for instructions). Note any remarks that could be useful to network management at the bottom of the form.

(b) Remove the plastic storage containers (with samples in them) from the refrigerator. Quickly check each container to ensure that no bags have leaked. If a leak is detected, repair it using the heat sealer and note that a leak existed on the Sample History Form (Code 27 in the SAMPLE QUALITY column).

(c) Remove a min/max shipping thermometer from the refrigerator. Reset it so that all 3 needles are touching each other and are pointing to approx. the 4°C mark on the scale by using the reset knob at the bottom. Place it in one of the plastic sample storage containers with the samples.

(d) Place three 4 l plastic storage containers containing the sample and dry bags in the cardboard shipping box. When there are too few samples available to fill the three containers, use empty containers.

(e) Place 2 large and 3 small freezer packs (previously frozen in the refrigerator) in the sides of the shipping box.

(f) Place the top two copies (white and yellow) of the Sample History Form on top of the plastic storage containers. Insert the foam lid and tape the box shut.

(g) Attach a pre-printed courier or postal label:

Environment Canada
National Water Quality Laboratory
Inland Waters Directorate
867 Lakeshore Road
P.O. Box 5050
Burlington, Ontario L7R 4A6
Attn: Analytical Service Section

(h) File the third copy (pink) of the Sample History Form in the file box on-site.

(i) Ship the sample box following procedures arranged by the Regional Inspector.

NOTE

No more than 3 hours should elapse between packing the samples into the shipping box and passing them to the courier.

(j) If no samples are collected in a two week period, ship three empty plastic storage containers and the Sample History Forms anyway.

(k) If a sample (or samples) greater than 2500 ml is collected, it must be stored and shipped in an 8 l plastic storage container. In such cases, place the 8 l container and one 4 l container in the shipping box. The number of freezer packs will remain the same.

(l) If more samples are collected than can conveniently fit into one shipping box, then ship two boxes. Do not withhold samples until the next shipping period. Write a note in the REMARKS section of the Sample History Form stating that samples were shipped in two boxes. Record the number of the second box on the note. Insert a piece of paper in the second shipping box stating:

SITE NAME
DATE OF SHIPPING
NUMBER 2 OF 2 BOXES SHIPPED.

4.2.7 PROBLEMS OR QUESITONS Whenever problems or questions arise regarding the Standard Operating Procedures, contact an AES Regional Inspector immediately and discuss them with him.

SECTION 5

INSTRUMENT CORRECTIVE ACTION, INSPECTION AND MAINTENANCE

GENERAL

5.1 Maintaining a high level network requires that instrument inspection, maintenance and corrective action programs be an integral part of the sampling process.

CORRECTIVE ACTION - DEFINITION AND LEVELS

5.2 Corrective action refers to the action taken to repair faulty or inoperative instrumentation. Two levels of corrective action exist within CAPMoN. Level 1 corrective action is carried out by on-site operators; Level 2 is carried out by Regional Inspectors. Both levels are designed to minimize the time of CAPMoN instrument malfunctions in order to minimize data loss.

5.2.1 OPERATOR (LEVEL 1) CORRECTIVE ACTION In general, the standard operator corrective action procedure is to telephone his/her Regional Inspector whenever instrument malfunctions are detected. The Regional Inspector will then carry out the required repairs. Operators are instructed not to repair faulty or inoperative instruments themselves. In certain exceptional cases, some operators may be specially trained by AES personnel to carry out specific corrective action procedures. Instrument repair should only be attempted by those operators who have received this specialized training.

5.2.2 REGIONAL INSPECTOR (LEVEL 2) CORRECTIVE ACTION Level 2 corrective action is carried out by AES Regional Inspectors. It consists of repairing or replacing malfunctioning CAPMoN instrumentation. Level 2 corrective action is generally technical in nature and requires speciallized training. Specific corrective action procedures are described in the CAPMoN Inspector's Manual and the CAPMoN Precipitation Sampling Instruments Operations and Maintenance Manual.

OPERATOR CORRECTIVE ACTION PROCEDURES

5.3 As mentioned earlier, the standard operator corrective action procedure for faulty instrumentation is to notify the AES Regional Inspector responsible for the site as soon as possible. The Regional Inspector will then initiate corrective action to correct the malfunction as soon as possible.

5.3.1 When instrument malfunctions are detected by the operator, they should be carefully noted in the operator's field book and entered in the CAPMoN Sample History Form. A telephone call (collect) should then be made to the AES Regional Office as soon as the sample collection procedures are complete.

5.3.2 When contacting the AES REgional Office, the operator should ask to speak to the Regional Inspector responsible for his/her site or to the Regional Superintendent of Surface Inspection, Installation and Maintenance (see Table 1-2 for telephone numbers). If neither can be reached, leave a message asking them to return your call. Ask for the name of the person taking the message and note it in the field book.

5.3.3 If under exceptional circumstances, no one at the Regional Office can be reached, continue calling until someone is contacted. It is extremely important that all instrument malfunctions be reported as soon as possible. Do not wait for one or more days before contacting the Regional Office.

5.3.4 When the Regional Inspector or Superintendent of Surface Inspection, Installation and Maintenance is contacted, explain the problem or malfunction to him/her in detail. Ask what action should be taken by you and when you can expect the corrective action to be carried out. Continue calling the Regional Inspector if corrective action has not been taken by the expected time.

5.3.5 On days when corrective action is required, a number of entries must be made on the CAPMoN Sample History Form:

(a) Enter a description of the instrument malfunction using Codes 31 to 39 in the INSTRUMENTATION column and written notes in the REMARKS section.

(b) Enter Code 50 in the SITE HISTORY column and note the name of the person contacted (or with whom a message was left) in the REMARKS section.

(c) Enter Code 51 in any empty FIELD COMMENTS column when an Inspector or Superintendent has been contacted and has stated that corrective action will be taken. In most cases this will be the same day as the Regional Office was contacted.

5.3.6 Operator corrective action is frequently referred to in the following section on Operator Inspection and Maintenance Procedures. The corrective action procedures described above are to be followed in all cases.

INSPECTION AND MAINTENANCE - DEFINITION AND LEVELS

5.4 Routine inspection and maintenance of CAPMoN instrumentation is required to ensure that all instrumentation has worked properly in the past end will continue to work properly in the future. Poorly working and non-working instruments result in inaccurate and incomplete data. These must be avoided at all costs. Two levels of inspection and maintenance are used in CAPMoN.

5.4.1 Operator (Level 1) Inspection and Maintenance Level 1 inspection and maintenance procedures are those procedures carried out daily and monthly by CAPMoN site operators. These procedures are generally non-technical in nature. They are designed to keep the instrumentation operating properly and to detect problems before they result in instrument breakdowns. These operator procedures are described in detail later in this section.

5.4.2 Regional Inspector (Level 2) Inspection and Maintenance Level 2 inspection and maintenance procedures are those procedures carried out during regular quarterly site inspection visits of AES Regional Inspectors. These procedures are technical in nature and require speciallized training with the instrumentation. Level 2 procedures are not discussed in this manual. They are presented in detail in the CAPMoN Inspector's Manual.

OPERATOR INSPECTION AND MAINTENANCE PROCEDURES - DAILY

5.5 Daily inspection and maintenance procedures are carried out as part of the Standard Operating Procedures (SOPs) for collecting and handling CAPMoN samples. Most of these daily inspection and maintenance procedures are described in Section 4 of this manual. They are presented again in more detail in this section to clarify their role in network operations.

5.5.1 TYPE A-M PRECIPITATION COLLECTOR The Type A-M Precipitation collector must be inspected and maintained daily to ensure that it operated properly over the past 24 hours and will continue to operate properly for the next 24 hours. The Inspection and Maintenance procedures described below must be carried out in the order given in order to preserve the chemical integrity of the sample in the collector. Refer to Section 4 for the exact position of these procedures within the SOPs.

5.5.1.1 If precipitation is occurring at the time of inspection, check that:

(a) the sensor grids are wet

(b) the hood is in the OPEN position

(c) the sensor grids are warm to the touch (not cold or extremely hot).

If these conditions are not met, note the details in the field book and initiate Corrective Action (Section 5.3).

5.5.1.2 If precipitation is not occurring:

(a) inspect the seal between the bucket rim and hood gasket for gaps or air spaces.

(b) inspect the top surfaces of the collector for any accumulation of debris (e.g. leaves) snow or ice (during winter). Carefully brush or knock away any accumulations which exist.

(c) touch a wetted finger to he sensor grids. Check that both are warm to the touch and that the hood moves smoothly to the OPEN position. If the hood does not activate or move smoothly, or sensor grids are cold or very hot, note the details in the field book and initiate Corrective Action.

5.5.1.3 When the hood is in the OPEN position, check the gasket for evidence of:

(a) dirt on the surface of the plastic film

(b) cracks, rips or holes in the plastic film

(c) moisture, discolouration or breakdown in the foam under the plastic film.

If such evidence exists, note the details in the field book and initiate Corrective Action to replace the gasket (Section 5).

5.5.1.4 Check that the hood returns to the CLOSED position approximately 2 minutes after the sensor grids dry off. If it does not, note and initiate Corrective Action.

5.5.1.5 When the empty sampling bucket is in the sample handling area, check that its top rim is round. Where it appears to be out-of-round, adjust it by pushing in the sides of the bucket.

5.5.2 RAIN GAUGE Daily Inspection and maintenance procedures for the Type B plastic rain gauge consist of the following:

(a) Check that the gauge is level and secure. If it is not, relevel and resecure it.

(b) Check that the gauge is in good operating condition; i.e., no chips or breaks. If it is chipped or broken, replace it.

(c) Check the graduate cylinder for cracks. In cold temperatures, water can freeze in the graduate causing it to expand an crack. This renders the graduate unusable. If this has occurred, note the details in the field book, measure the depth with the spare graduate and contact the Regional Inspector for another spare.

5.5.3 SNOW GAUGE Daily Inspection and Maintenance procedures for the Nipher-shielded snow gauge are:

(a) Check that the gauge is level and secure. If it is not, relevel and resecure it.

(b) Check that the gauge is in good working order, i.e., no cracks or chips in the shield, no dents in the receiver. If these occur note details and replace the damaged parts.

(c) Check that the receiver mouth is 150 cm above the surrounding snow or ground surface. Adjust the height using the telescopic stand and clamp. If the stand has been extended to the maximum height but the snow pack continues to increase in height, note this in the Field Note Book and contact the Regional Inspector immediately.

5.5.4 BALANCE Daily Inspection and Maintenance procedures consist of the following:

(a) Check that the balance is clean and level.

(b) Check that the balance displays a value of 0.0 g after the plastic weighing container is placed on the top pan and the control bar is depressed. If it does not, note details and initiate Corrective Action.

5.5.5 REFRIGERATOR Daily Inspection and Maintenance procedures for the refrigerator are:

(a) Check that the temperature inside the refrigerator is 4°C (between 1° and 5°C). If it is outside this range, adjust the thermostat until a temperature of 4°C is maintained.

(b) Ensure that the refrigerator is clean, dry and free from ice buildup.

OPERATOR INSPECTION AND MAINTENANCE PROCEDURES - MONTHLY

5.6 Monthly Inspection and Maintenance is to be carried out by the site operator on the first day of every month (weather permitting).

5.6.1 TYPE A-M PRECIPITATION COLLECTOR Monthly maintenance of the Type A-M Precipitation Collector must be done on the hood gasket, the sensor grids, the body of the collector and the buckets.

5.6.1.1 HOOD GASKET The hood gasket is made of foam covered with a polyethylene-nylon film. The gasket is meant to provide a tight seal between the bucket/bag rim and the collector hood. This will prevent the evaporation of collected rain and the entry of gases or particulates into the sample bag during non-precipitating periods. The gasket can be a significant source of contamination to the precipitation samples if it is dirty or damaged. On the first day of every month, the hood gasket must be changed on the collector (weather permitting). This is done as follows:

(a) In the sample handling area, lay the new gasket (still in its protective bag) on a clean work surface;

(b) Cut one end of the protective bag;

(c) Remove two clean plastic gloves from their box (holding them by the wrist section). Drop them into the protective bag on the aluminum plate side of the gasket;

(d) Fold over the protective bag and carry it to the collector;

(e) At the collector, open the hood by touching one of the sensors with a wetted finger. When the hood is almost in the fully OPEN position, turn the collector OFF;

(f) Remove the old gasket from the underside of the collector hood by pulling it straight down until the Velcro fastners release. Discard this gasket;

(g) Remove the clean plastic gloves from the new gasket's protective bag. Take care to touch only the wrist section of the gloves;

(h) Put on the plastic gloves and remove the gasket from the protective bag. Touch only the sides of the new gasket when handling it;

(i) Attach the new gasket to the underside of the hood by lining up the Velcro fastners and pushing it into position;

(j) TURN THE COLLECTOR 'ON'. Watch the hood return and ensure that the gasket makes a good seal with the bucket rim.

5.6.1.2 SENSOR GRIDS The sensor grids are exposed to weather, dirt and pollutants and must be kept clean to avoid malfunctions. The grids should be cleaned every month by dampening a Kimwipe with deionized water and gently wiping the grids. In extremely cold and windy conditions a dry Kimwipe should be used.

5.6.1.3 BUCKET Clean the inside and outside of the bucket with a Kimwipe and distilled water.

5.6.2 RAIN GAUGE Clean the funnel of the standard rain gauge with a Kimwipe and tap water. The graduate cylinder should be cleaned with the sponge provided and tap water. Ensure that both are dry before placing them in the Field.

5.6.3 SNOW GAUGE Clean the inside of both snow gauge receivers with Kimwipes and tap water. Ensure that receivers are dry before placing them in the field.

5.6.4 BALANCE Gently wipe the top and sides of the balance with a Kimwipe and tap water. Wipe again with a dry Kimwipe to ensure that the balance is dry.

5.6.5 REFRIGERATOR If frost has accumulated on the freezer to a thickness of 0.6 mm (1/4 inch), the refrigerator should be defrosted.

5.6.5.1 Remove the freezer packs from the freezer compartment.

5.6.5.2 Push the defrost button located in the centre of the control dial. Do not turn the control dial to 0. The refrigerator will come on automatically when the defrost cycle is complete.

5.6.5.3 When the defrost cycle is complete, wipe moisture from the freezer compartment and drain the defroster tray.

DOCUMENT IMPROVEMENT PROPOSAL

The purpose of this form is to solicit comments from users regarding the contents of this document. The identification of deficiencies or errors, any constructive criticism or other comments that will enhance the use of this document are encouraged and welcomed. If additional pages are required, attach them to this form and submit in an envelope to:

Atmospheric Environment Service
Air Quality Monitoring and Assessment Division
4905 Dufferin Street
Downsview, Ontario
M3H 5T4

Comments:

Submitted By:	Telephone Number
	Date