Title: Standard Operating Procedure for Meteorological Instruments of Canada (MIC) precipitation collector		
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1. INTRODUCTION AND SCOPE

The Alberta Precipitation Quality Monitoring Program uses the MIC Type AU Precipitation Collector to collect samples of wet precipitation on a weekly basis for later chemical analysis. The main objectives of the program are to monitor changes and trends in the quality of precipitation in Alberta and to provide a data base which may be used to determine the effects of wet deposition of chemical species on the environment.

This procedure describes the operation and maintenance of the Meteorological Instruments of Canada (MIC) precipitation collector. The MIC precipitation collector has been configured for a variety of applications including Mercury deposition sampling. The collector is simple and versatile for wet and dry deposition collection. The collector is triggered by wet deposition via the wetness sensor, which opens the cover to the wet deposition collector. If it is configured with a dry deposition collector, the cover then covers the dry deposition collector during rain events.

This method adheres to the requirements of the current Air Monitoring Directive (AMD). In some cases the limits and specifications exceed the requirements of the current AMD. It should be considered that the current and any future amendments of the AMD will be used as the benchmark for requirements and criteria for ambient air monitoring practices conducted in the Province of Alberta. Information used to write this procedure was also taken from sources identified in the reference section.

2. PRINCIPLE OF THE METHOD

Basically, the unit consists of a standard polyethylene bucket mounted on a stand; a moveable cover for the bucket and specially designed precipitation sensors, which are mounted on a common support. A picture of the collector is shown in Figure 1.1. The housing is of stainless steel construction with splash screens and quick release fasteners for the body cover.

The MIC precipitation collector is a simple design, and can be configured for wet only, or wet and dry deposition collection. For wet deposition collection, it can be configured with a bucket only to collect the sample. A mechanical cover covers the wet deposition collector bucket when it is not raining/snowing. During dry periods the automatic cover stays on the precipitation collection bucket to prevent the entrance of unwanted dry particulate matter and to reduce evaporation.

When rain or snow falls upon the sensor grids, a relay is energized and the motor, acting through a chain and sprocket and torque limiter drive system, moves the cover from the precipitation bucket to the other side of the stand and switches off. When the precipitation stops, the sensor grids dry out causing the relay to de-energize and move the cover, automatically to the original position.

Samples are then collected manually on a frequency determined by the particular study that collector is employed in. These samples are returned to the laboratory for analysis.

Figure 1.1 Precipitation Collector

3. MEASUREMENT RANGE AND SENSITIVITY

The range of this unit would be the volume of precipitation that it could hold. As this volume is quite large, it defeats the purpose of sampling as the manual sample collection should be completed at a frequency that would not allow the collector to come even close to its full volume.

Sensitivity is governed by the wetness sensor that triggers the cover to open and close. When new, the sensitivity is quite high (one raindrop will trigger the cover). This sensor needs routine maintenance to ensure proper operation. See section 9 for details on these procedures.

The chemical parameters measured in the laboratory for each weekly precipitation sample include:

a) pH
b) specific conductance
c) acidity (by Gran's plot)
d) sulphate
e) nitrate
f) ammonium
g) sodium
h) chloride
i) potassium
j) calcium
k) magnesium
l) ortho-phosphate

4. EQUIPMENT AND APPARATUS

The MIC precipitation collectors are no longer manufactured. Yankee Environmental Systems Inc. in the USA or GHM Engineering in Oakland Ontario have built a new generation unit that performs the same tasks as the MIC collector.

When using the existing MIC collector, apparatus required are:

- Field sample sheets to record sample information

- Sample jars to hold sample while shipping to the lab
- Distilled water to rinse the sample bucket
- Shipping container or cooler
- Disposable Poly Gloves
- Wiping cloths to wipe out the bucket

5. INTERFERENCES

Interferences with both wet and dry precipitation collection are windblown debris that gets in to the sample bucket during deployment. Any debris found should be left in the bucket for the lab to handle.

Ice and snow build up on the wetness sensor will cause the sensor to not function properly. If this is observed during visits, it should be cleaned and dried.

6. PRECISION AND ACCURACY

Precision and accuracy is determined by the laboratory method of analysis. See the laboratory methods for these values depending on the analysis performed.

7. SITE REQUIREMENTS

Site location of the MIC collector should be determined according to the intended application of the monitoring data. The detailed requirements for selection of sites for precipitation collection in Alberta can be found in the Station Site Criteria section of the AMD. The US EPA Siting Requirements for Meteorological Equipment – Volume II, Section 2.0.8 is also a useful resource.

8. INSTALLATION REQUIREMENTS

All the installation requirements as specified by the manufacturer in the installation procedures of the operations manual as well as the general requirements below must be followed.

PRECIPITATION QUALITY MONITORING SITE SELECTION CRITERIA

Site criteria is as per US. National Atmospheric Deposition Program - NADP Manual 2009-09. http://nadp.isws.illinois.edu Some criteria are summarized below

Criteria	Reason
1. Height above ground, 1-3m	To reduce or eliminate the influence of ground level absorbing surfaces such as grass and other foliage.
2. The distance between the sample collector and the drip line of the tree must be at least twice the height of the tree or at least 10m away whichever is greater.	Trees and vegetation can cause disturbances of airflow patterns and affect the collection of precipitation.
3. Elevation angle to top of any obstruction, <30 degrees Angle of projection from top of instrument to tops of trees is less than 45 degrees	To reduce or eliminate the influence of turbulence.
4. Distance from major stationary fuel combustion or industrial source (greater than 25 tonnes/day SO_2 or NO_x) >30km	To prevent non-representative effects on regional precipitation quality
5. Distance from dust source (i.e., roads), >100m	To reduce or eliminate the influence of dust on precipitation quality.
6. Distance from AC power source no greater than 100m	To prevent significant loss of voltage in power cord.

7. Instrument orientation, an East-West direction	To allow deposition into the bucket without undue influence of turbulence caused by the physical presence of the instrument.
8. Site security; within areas that allow restricted access or no access by the public.	To prevent tampering and vandalism unauthorized personnel.
10. Flat and grassy terrain	To reduce or eliminate the influence of local dust source on precipitation quality.

11. Sampler must be at least 5 m from objects >1 meter tall and >5cm in width or depth

Note that the ultimate choice for each site will be a compromise optimizing these various criteria.

9. OPERATIONAL REQUIREMENTS

The following table of activities must be performed when collecting samples from an MIC precipitation collector. The following documentation must be available to the operators on site: operational and maintenance manual(s), and station site documentation.

9.1 Collection of Samples & Precipitation Measurement

At the end of the week the collection bucket must be removed from the collector and taken indoors for transferring the sample into sample bottles and/or prepared for shipment to the laboratory.

Where the sampler is located at the worksite of the operator, when the precipitation is in the form of rain, composite sampling is to be used. After each rain episode during a given week, the sample is poured into the sample container(s) to minimize evaporation loss. The accumulated composite sample is sent to the laboratory for analysis at the end of the week.

Even if no precipitation occurred during the week, a **Sample History Form must still be completed** noting that there was **NO SAMPLE**. Without a submitted form to confirm a dry week, a "No Data" will be registered in the database since analysis lab personnel and data base managers cannot differentiate this from missing or destroyed samples.

Scheduled analysis for sample volumes provided:

NOTE : send in any sample greater than 1 millilitre (ml)

Sample Volume	Analysis conducted
75 ml and over	full suite - pH, ions, Grans acidity, conductivity
50 to 74 ml	pH, ions, Grans acidity
10 to 49 ml	pH, ions
1-9 ml	pH

9.1.1 The Precipitation Sample

HANDLING OF PRECIPITATION SAMPLES

Precautions

Careful handling of equipment and especially the samples to prevent contamination is extremely important. The dissolved substances in the precipitation sample have a low concentration and any contamination will yield erroneous results. No smoking is allowed during sample handling periods. Disposable gloves are to be worn when handling samples.

Note: Do not touch the inside surface of the collection buckets, except while wearing sterile disposable gloves.

Definition of End of Week

If precipitation is occurring at the station during the collection period wait until the end of precipitation before obtaining the sample.

Note: All references to time shall use the 24-hour clock. Use Mountain Standard or Daylight Saving Time – whichever is in effect at the time.

The Precipitation Sample

The following steps describe the method of removal and handling of the precipitation sample in the collector:

- Activate the sensor with a wet finger. Wait until the hood moves away from the bucket and reaches the other side, then turn off the power switch.
- Remove the precipitation collection bucket from the collector and carry indoors.
- If the sample is frozen, allow it to melt at room temperature before proceeding to the next step.
- Put on a pair of disposable gloves. Carefully pour the precipitation sample from the collection bucket into the 40oz. (1136 ml) sterilized sample shipping bottle and fill until within about 1 in. (2.5 cm) from the top. Screw top snugly onto the sample shipping bottle. Repeat for the second or more sample bottle with remaining sample if necessary. In rare cases where there is more sample than will fit into the sample bottles provided, fill the last bottle, then empty it and pour the remaining sample into it. Make note of this on the Sample History Form. Store sample at room temperature prior to shipping.
- Where the sampler is located at the worksite of the operator, rain samples are transferred after each episode or on the next working day. Note: the bucket is not rinsed after each transfer during a given weekly sample period. Snow samples are left in the bucket for entire sampling period.
- Each week, rinse the collection bucket with de-ionized water, wipe the bucket dry with a clean wiping cloth, repeat the rinse and allow it to drain before retuning it to the collector for the next weekly sample.
- Return the collection bucket to the precipitation collector. Turn the power switch back to “on” position and make sure the hood returns to cover the bucket.
- Before the start of next weekly sampling, remove hood gasket and wash the surface with de-ionized water. Replace the gasket at the same time as the collection bucket is returned to the collector. Clean disposable gloves must be worn when handling the gasket.

Note: Ensure that the bucket handles are aligned with the sampler, otherwise the handles will interfere with movements of the automatic cover.

Note: Send all sample collected as the amount of sample is measured at lab.

9.1.2 RECORDING OF SAMPLE DATA

Consistent with careful handling of precipitation is the recording of sample data pertinent to every collected sample. The Precipitation Sample History form is provided for this purpose.

Completing the Precipitation Sample History Form

The information below is a guide in completing the sample history form:

Heading	Entry
STATION	Station Name
MONTH	Month of the Year
COLLECTOR	Enter the collector name and number (eg. MIC Type AU #05)
COLLECTION PERIOD	From year/Month/Day/Hour to Year/Month/Day/Hour using whichever time (MST or DST) is in effect
DATE SHIPPED	Enter date of sample shipment to the laboratory
PRECIP SAMPLE SENT TO LAB (Y/N)	Enter Y (yes) or N (no). The sample history form has to be sent to the laboratory weekly whether or not there is measurable sample collected for the week
DAY, PRECIPITATION, STANDARD GAUGE, FIELD COMMENTS	Enter information on day of occurrence, precipitation episodes, and field observations related to sampling
DAY	Enter day of occurrence of the observations
PRECIPITATION OCCURRENCE	Enter 0 = no, 1 = yes or 2 = uncertain for the day

PRECIPITATION TYPE	Enter 1 = rain, 2 = snow, 3 = freezing rain, 4 = mixed, or 5 = dew or frost if there is precipitation occurrence
PRECIPITATION TIME	Select the appropriate time period for its occurrence
NO. OF DAYS	Enter the number of days since last visit.
FIELD COMMENTS	Enter brief statements related to the sample quality, instrument operation and nature of events. Examples are: a) particles in sample b) organic material in sample (eg. Leaf, grass) c) insect(s) in sample d) collector open when precipitation not occurring e) partial sample, part of the event missed/collector does not open during event f) poor hood-bucket seal g) power failure with an estimate of the lost time h) construction at or near site i) snow ploughing or lawn mowing at the site j) blowing snow collected k) smoke/odor/ash detected at site l) rain or snow gauge not operating Note: Any objects found n the collector shall not be removed by the operator. They

	should be sent to the lab as part of the sample.
OPERATOR'S INITIALS	The initial of the person who carried out the task on that day.
SUPPLY ORDER	Enter the appropriate quantity of the items required. Circle the size L (large), M (medium), or S (small) of the disposable gloves required. Supplies will be shipped to the operator on receipt of the notice.
SAMPLE ASSESSMENT	Mark either "sample quality OK" or "sample quality unsure" depending on the observations
OPERATOR	Sign by the station operator before sending the form with the sample to the laboratory.

An example of a blank and completed Precipitation Sample History form are shown on the following pages.

9.1.3 SHIPPING OF SAMPLE

After completion of the Precipitation Sample History form, compete sample identification labels on the sample bottle, as shown below, and place onto the sample bottle(s):

ALBERTA ENVIRONMENT

Station:_____

Month: _____ Year: _____

Collector:

These labeled bottle(s) containing precipitation are sent to the laboratory with the original Precipitation Sample History form.

The collection bucket must be rinsed, a Precipitation Sample History form and a Preventive Maintenance form completed and submitted even if no precipitation sample is collected.

Laboratory Address

After placing the sample(s) in the shipping container, ship to:

Alberta Innovates - Technology Futures

Sustainable Ecosystems

Bag 4000

Vegreville, Alberta

T9C 1T4

9.2 Maintenance Procedure

Maintenance procedures and checks should be completed every time the site is visited unless other wise stated. This maintenance will enable the operator to ensure smooth operation of the precipitation collector. Conduct the following procedures:

- Testing the wetness sensor – the sensor that triggers the cover to open and close should be tested every visit. Simply wet the sensor with some water, and the cover should open. If it does not, consult the manual for troubleshooting steps.
- Sensor grids - The sensor grids are exposed to weather, dust, dirt and pollutants and must be kept clean to avoid malfunctioning (See Diagram 1.1). the grids should be cleaned every two weeks during the regular check. Turn the power off and use a damp sponge or cloth to wipe the grids; use a mild detergent, if necessary, but be sure to wipe away any dry film that may appear on the grid. Proper operation of the grids can be checked at the same time by touching a damp finger to each. The cover should move almost immediately.

- Sensor grid Heater - The sensor grid heater laminated to the underside of the sensor grids accelerates evaporation. A temperature of approximately 40°C in ambient air is maintained by the heater. The operation of the heater can be tested by placing a hand just slightly above the surface of each grid and feeling the warmth from the grid.
- Moving Cover - To help minimize sample contamination, the cover should be kept clean and free of debris. This should be checked on a routine basis. During winter months the observer may have to remove build-ups contaminate the exposed cylinder.
- Cover mechanism –Ensure the arms are not bent and move freely during open and close cycles. If there are any unusual noises, hesitation in the movement, consult the operations manual for troubleshooting procedures.
- Ice Build-ups - During the winter months the gap between the cover arms and the housing (see figure 1.1) will be susceptible to icing, which could cause instrument damage. Routine checks should be made to ensure the removal of any ice build-ups in this area. Also check for snow/ice accumulation on the support plate of the bucket holder since failure to do so may result in damage to the drive mechanism due to improper closing of the cover.
- Check that the gasket pad seals the top of the sample bucket. Replace the gasket annually. To replace the gasket wet the sensor grid so the cover moves off the sample bucket. Turn off the power while the cover is off the sample bucket. Replace the gasket and turn the power on. Ensure the pad seats properly when cover closes.
- Chain Tension - Disconnect power cord and remove screen and body cover. Check the tension on the chain by moving the automatic cover slightly back and forth. If there is more than ½ cm (1/8”) movement, the chain requires retensioning.
- As a last check, please make sure all of the screws are secure on any of the moving components, especially the moving cover. The screws tend to work loose over time and fall out. The kit has some spare nuts and bots if needed.

9.3 Adjustments

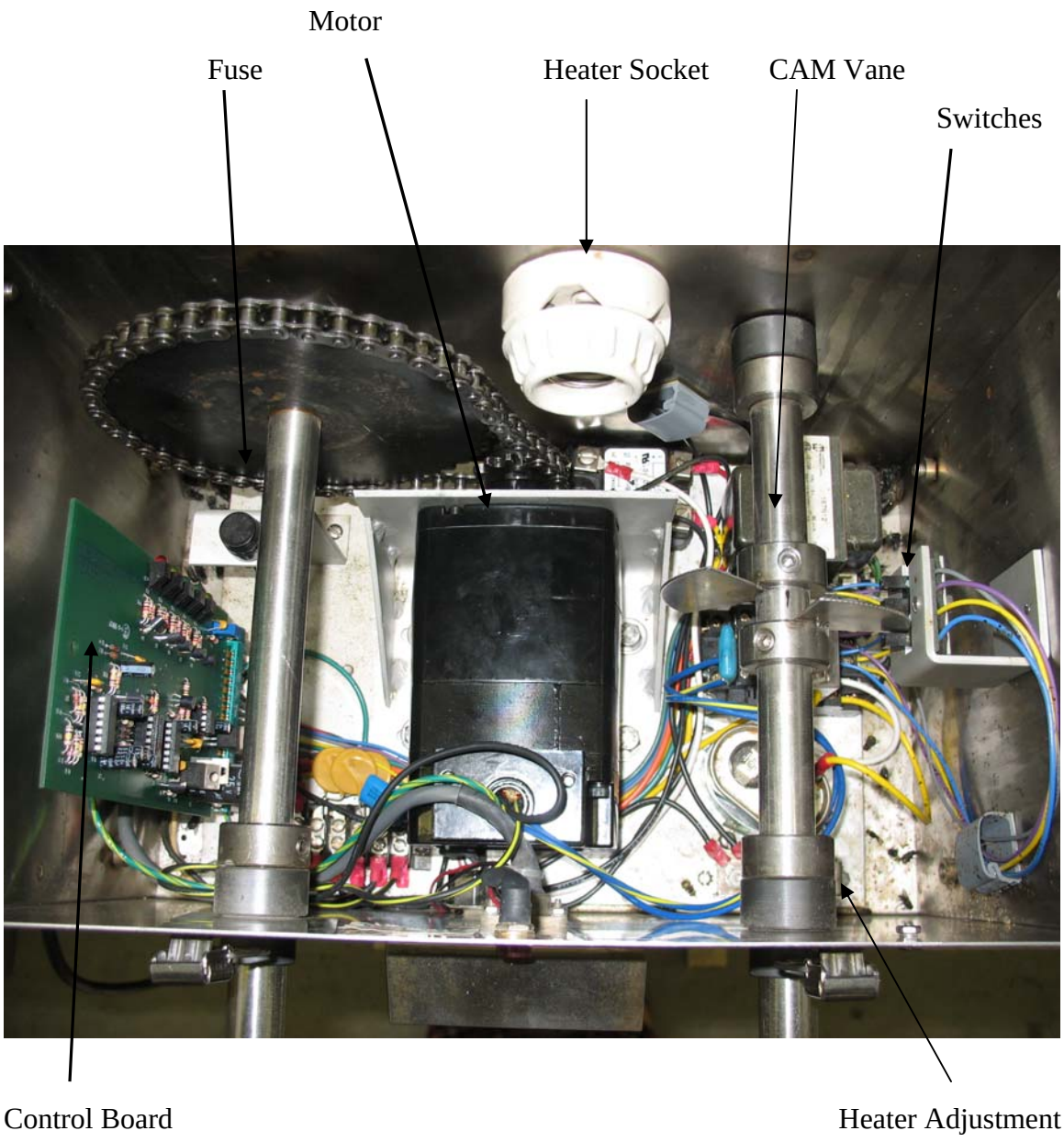

Figure 3.1 Internal View of Collector

9.3.1 There are two items that can be adjusted:

a) CAM Limit Switches- With the cover on the left bucket, and the sensor boards dry, switch on the main switch. No mechanical movement will occur, however on the P.C. board the 4th LED from the top will be lit green, indicating the cover is properly seated on the left bucket. With a wetted finger touch either of the two sensor boards. After a short delay you will see the second LED from the top light up yellow, indicating the sensor board is wet. {this yellow light may only come on very briefly, it depends on the amount of wetness on the sensor board (s)} Right after this yellow light comes on you will hear the mechanical motor direction relay click and immediately after the noiseless solid state relay will start the motor, moving the cover to the right bucket, or the top of the right leg if no bucket is used on that side. As the cover reaches its right limit the cam-vane will block the 2nd photo cell, switch off the motor, reset the direction relay and light the third LED from the top (green). This indicates that the cover is properly seated on the right side. Wait until the delay cycle times out, about 1 ½ to 2 minutes. When it times out the motor will start driving the cover back to the left and the green LED will turn off. When the cover is seated properly on the left again the,green LED will light up again. This completes the operating cycle and the instrument is now ready for operation. Switch off the power, unplug the cord and replace the body and screen cover. (see figure 3.1)

b) Sensor Sensitivity Control – To increase the sensitivity of the heated sensor grids which control the movement of the bucket cover, turn the potentiometer on control board counterclockwise, and vice versa (see figure 3.1)

9.3.2 To retension the drive chain:

i) Move the automatic cover to a neutral position between the two bucket housings and, using a 7/16" socket, slightly loosen the four (4) bolts holding the motor base plate to the chassis.

ii) Push the motor away from the large sprocket while wiggling the automatic cover.

iii) Hold the motor and retighten the four bolts.

iv) Recheck the tension as given in 9.2.

Reconnect power cord and run the automatic cover from one side to another several times (by touching a damp finger to one of the sensors to ensure a smooth movement). If any unusual noises occur, the chain is over-tightened and readjustment of the chain tension is necessary.

Periodically apply a small amount of light grease to the chain. Ensure that no grease gets on the torque limiter clutch pads (See Figure 3.1).

10. CALIBRATION

There is no calibration procedure for MIC precipitation collector

11. APPLICABLE DOCUMENTS

EM-007a MIC operator's manual

12. LITERATURE REFERENCES

US EPA Siting Requirements for Meteorological Equipment – Volume II, Section 2.0.8

Alberta Environment Air Monitoring Directive – 1989 & 2006

Alberta Precipitation Quality Monitoring Program Operations Manual - May 1987

National Atmospheric Deposition Program 2009-09

13. REVISION HISTORY

Revision 1.0 June 28, 2010 - Add NADP as a site criteria specification reference

Revision 1.1 December 2, 2010- 9.1.3 Change name of lab at Vegreville

Revision 1.2 January 17, 2010 slight change to procedure in 9.1.1

14. APPROVAL

Harry Benders

Approved by: **Harry Benders** **Date: January 17, 2011**

Title: **Air Monitoring Manager**