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NORTH CAROLINA
Environmental Quality

DAQ-07-004.1 Standard Operating Procedure (SOP)
MetOne 370D Rain Gauge
Electronics and Calibration Branch (ECB) RESPONSIBILITIES

Revision 0

North Carolina Department of Environmental Quality | Division of Air Quality
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1.0 Approval Sign Off-Sheet

I certify that I have read and approve of the contents of the DAQ-07-004.1 Standard Operating Procedure for the MetOne 370D Rain Gauge ECB Responsibilities with an effective date of September 30, 2021.

Director, Air Quality Division

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Disclaimer: This document, and any revision hereto, is intended solely as a reference guide to assist individuals in the operation of the instrument, related to the North Carolina Division of Air Quality's Ambient Monitoring Program.

SOP Acronym Glossary

ADQ - Audit of data quality

AQS - Air Quality System (EPA's Air database)

°C – Degrees Celsius

CFR – Code of Federal Regulations

Chief – Ambient Monitoring Section chief

COM or COMM – Communications Port

DAQ - North Carolina Division of Air Quality

DAS – Data acquisition system

DEQ – North Carolina Department of Environmental Quality

Director – Division of Air Quality Director

ECB – Electronics and Calibration Branch

e-log – electronic logbook

EPA – United States Environmental Protection Agency

°F – Degrees Fahrenheit

FEM – Federal equivalent method

FRM – Federal reference method

in – Inch

kg - Kilograms

lbs - Pounds

MDL – Method detection limit

mA - milliamp

mL – milliliters

mm – millimeters

PM – Particulate matter

PPB – Projects and Procedures Branch

QA – Quality assurance

QA/QC - Quality assurance/quality control

QAPP - Quality assurance project plan

QC – Quality control

RCO – Raleigh central office

SOP - Standard operating procedure

TSA - Technical systems audit

USB – Universal Serial Bus

VDC – Direct Current Voltage

V - Volt

Table of Contents

2.0 SCOPE AND PURPOSE

The purpose of this document is to describe the procedures that should be employed, at a minimum, by ECB staff for the acceptance testing, employment in the field, regular maintenance, and performance auditing of the Met One Model 370D Tipping Bucket Rain Gauge.

3.0 EQUIPMENT SELECTION

The 370D is a low-maintenance sensor designed to measure rainfall on a continuous basis. Water is not retained in the sensor. It is drained each time an internal bucket fills with 0.25 millimeters (mm) of rainfall. The unit may be calibrated to measure a range of rainfall events but comes from the factory calibrated to measure 0.25 mm rainfall events. The unit is designed to drain water as each measurement is taken. As the bucket tips over and pours the water out the base of the sensor, a switch closure pulse is sent to a connected translator module or data logger for counting.

4.0 EQUIPMENT DESCRIPTION

- **Measurement Principle**: Tipping bucket
- **Orifice**: Eight inches
- **Switch Type**: Magnet & Reed
- **Switch Specification**: 500 milliamp (mA), 200 direct current voltage (VDC) maximum
- **Operating Temperature**: 0 degrees Celsius (°C) to 70°C Ambient Temperature
- **Calibration (standard)**: 0.01 inches (in) per switch closure
- **Calibration (options)**: 0.2 mm, 0.25 mm per switch closure
- **Calibration (372D)**: 0.5 mm per switch closure
- **Accuracy**: +/-1% at one inch per hour at 70 degrees Fahrenheit (°F)
- **Deployed Dimensions**: 18-¼ in high, 8 in diameter not including mounting pads
- **Mounting**: 3 Pads for ¼-in bolts on a 9-21/32 in (9.656 in) diameter circle
- **Weight**: 6.7 pounds (lbs)/3 killograms (kg) without cabling
- **Shipping Weight**: Approximately 10 lbs with cabling

Figure 1 - MetOne 370D Rain Gauge

5.0 DESCRIPTION OF EQUIPMENT CHECKS

This section provides a description of checks to be performed on the sensor upon receipt from the manufacturer and the checks performed on the instrument prior to deployment in the field.

5.1 Shipment Inspection:

The rain gauge shipping container must be inspected for damage and all documents should be filed away properly. **Section 6.1** provides exact procedures for shipment inspection.

5.2 Instrument Inspection:

The rain gauge must be checked for functionality prior to field deployment. Typically, functionality tests include connecting the instrument to a data logger and computer and verifying instrument response. **Section 6.2** provides detailed procedures for instrument acceptance inspection.

6.0 INITIAL STARTUP PROCEDURES

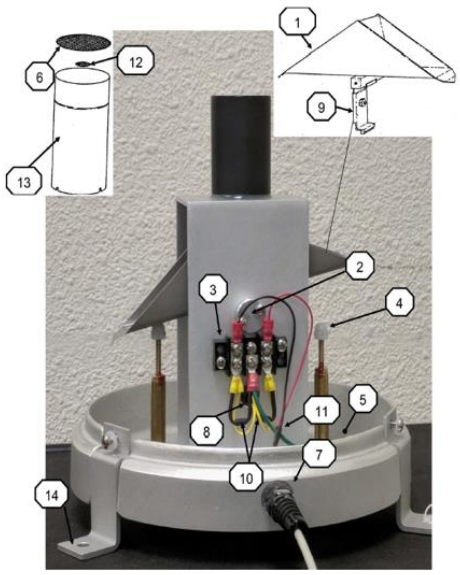
6.1 Shipment Inspection

1. Immediately upon receipt and before opening the shipping container, inspect the shipping container for any signs of damage. In the event of damage, photographs should be taken to document the state of the packaging as received. These photographs will be shared with the equipment manufacturer if the instrument is found to be damaged.
2. Upon unpacking the instrument, locate the calibration test certificate and packing slip and match the model number and serial numbers printed on the test certificate and verify all items shipped match the packing slip.
3. Initial and date the test certificate, scan it and save a scanned copy on the **P-drive** located here:
   P:\Ambient\SThomas\MET Equipment\Instruments Calibration Certificates\Met One Rain Gauge Test Certificates
4. Send the packing slip to the administrative assistant.

6.2 Instrument Acceptance Check

1. Place the instrument on a level work bench.
2. Remove the outer housing assembly and set aside. This is done by first removing the three screws located around the base of the unit. This will expose the tipping mechanism, terminal block, and built-in level on the base of the gauge.
3. At this point, **do not remove** the shipping restraint securing the tipping bucket in place.
4. Closely inspect the unit and compare to **Figure 2** below. Check for and note any inconsistencies or abnormalities.
5. If the unit appears to be intact and undamaged, use washers for shims, and the built-in level, to level the instrument on the work bench.
6. Remove the shipping restraint from the instrument bucket.
7. Verify the bucket moves freely and that all adjusting screws are tight.
8. Route the signal cable through the access in the base of the sensor then connect the lugs to terminals 1 and 3 (outer terminals).

9. Tighten the included strain relief fitting to secure the cable in place.
10. Connect the other end of the signal cable to the data logger or to the MetOne 10600 Module as described in **Section 6.3** below.
11. Program the data logger to convert rain gauge tips to rainfall amount. Use factory calibrated 0.25 mm of rainfall for each tip.
12. Setup a rainfall channel in the **Envidas SETUP** program to capture rainfall amounts transmitted by the data logger. Save your settings and restart the **Envidas SETUP** program.
13. Open **Envidas VIEWER** to see instant reading from the rain gauge.
14. Manually tip the bucket one time to observe the displayed value on the **Envidas VIEWER** screen. The displayed amount should read **0.25 mm**.
15. Allow the **Envidas VIEWER** rainfall value to **reset** to zero. Slowly, manually tip the bucket 10 times in succession allowing 5 seconds between each tip. Observe a displayed value of **2.5 mm** on the Envidas VIEWER screen.
16. If no response is observed on the **Envidas VIEWER**, repeat steps 14 and 15 but observe the displayed reading from the data logger.
17. If no response is observed on the data logger, contact MetOne for troubleshooting guidance.



Item No.	Part No.	Description
1	10825	Assembly, Tip Bucket (.01", .2 mm, .25 mm)
2	10840	Pivot Block Assembly
3	340070	Barrier, Strip – 3 pos
4	480210	Nut, Crown, Nylon #8-32
5	2598	Screen, Base
6	2503	Screen, Primary Top
7	480510	Clamp, Liquid-Tight
8	2934	Reed Switch Cartridge
9	2936	Adjustable Magnet Bracket
10	2937	Lightning Protection Diode
11	1566	Standard Cable Assembly
12	2504	Screen, Secondary
13	2831	Assembly, Housing/Funnel 8 inch
14	2516	Foot

Figure 2 – MetOne Model 370D Tipping Bucket Rain Gauge Diagram and Parts List

6.3 MetOne Model 10600 Data Module Installation and Setup

6.3.1 MET Module

1. Open the MetOne 10600 data module cover by removing the 4 screws located on top of the unit.
2. Using RS232 cable, connect AIO2 to terminal TB1 on model 10600, and connect the other end to your computer's Universal Serial Bus (USB) port.

NOTE: The MetOne model 370D Rain Gauge will not work with the 10600 Module unless a MetOne AIO2 sensor is connected to it. If you are not going to use or connect an AIO2 sensor at the site, do not use the MetOne 10600 module. Instead use the MetOne AutoMet 580 data logger. Then follow the same standard setup procedure detailed here.

6.3.2 MetOne Tipping Rain Gauge

1. Connect 370D Rain Gauge to terminal TB5 on the MetOne model 10600 module.
2. Connect orange wire from AIO2 sensor to the 'RAIN' Terminal TB9 on the MetOne model 10600 module.
3. Set **SW1** to **ON** for the RS232 **C1** position.
4. Connect 12 V power supply that came with the unit.
5. Power on the module.

6.3.3 Comet 2 Setup to Read MET Data via Model 10600 Module

1. Connect RS232 USB from MetOne 10600 module to desired **COM PORT** on the computer.
2. Check to make sure the COMM Port on the computer matches the selected **COM Port** number on the MetOne Comet 2 software.
3. On site computer, open Comet 2 software.
4. Add Module:

- **Select Ξ** icon on top left of screen
- **Click** on **add new station**
- **Click MET** and **click** <**next**>
- **Click digital sensor (MSD, AIO2, 597)** and click <**next**>
- **Select serial port** and click <**next**>
- From Drop Down Menu select **COM PORT** and click <**next**>
- **Select 9600** Baud Rate.
- **Enter station name** and click **finish**
- **Click** the **Terminal** Icon

  Note: Envidas COMM PORT must be temporarily disabled before proceeding to program Comet. Envidas must be re-enabled when programming is complete.
- Place the mouse cursor at the end of the computer program string
- **Press <enter> at least three times** until asterisk symbol appears (*)
- **Enter 0i1** and press <**enter**>. (This sets the time interval to one second)
- **Type Q** to quit program and follow instructions on screen. Now close screen.
- **Re- enable the Envidas Manager start- up**
- **Close** all programs and **start Envidas Viewer**.

7.0 SITE INSTALLATION

1. The chosen site for installation must adhere to siting criteria listed in the **EPA Meteorological Volume IV handbook**.
2. Mount the instrument on a solid, sturdy, and level surface.
3. Attach the instrument to the mounting surface using ¼-in diameter bolts. The rain gauge must be mounted as level as possible for accurate readings. Use washers for shims to adjust level as needed.
4. Follow steps 8-17 in **Section 6.2, and Section 6.3** to connect the instrument to the data logger, site computer, and Envidas SETUP.
5. Perform a calibration verification. See steps 1-5 in **Section 9.0** for more details.
6. Record the site installation details in the site logbook. Fill out and sign an AQ-109 form, give a copy of the signed form to the ECB supervisor for signature and retention.

NOTE: Maximum Cable Length Considerations:

RS232C	50-foot maximum
RS-485	4000-foot maximum
SDI-12	200-foot maximum

8.0 ROUTINE MAINTENANCE

Additional items may include, grass cutting, pest control, cleaning the mesh screens, cleaning gauge surfaces with water, visually checking wire condition and connections outside of gauge, but at a minimum every 6 months, or more often, if necessary, a technician should:

1. Remove and clean the upper and lower debris screens.
2. Remove the sensor housing assembly and thoroughly clean the collection funnel.
3. Carefully clean both sides of the tipping bucket assembly.
4. Clean the lower drain screen in the base of the sensor.
5. Do **NOT** lubricate the pivot shafts, as any lubricant may attract dust and dirt.
6. Verify the bucket moves freely and that the translator card or data logger registers 0.25 mm (or as calibrated) for each bucket tip.

9.0 ACCURACY AUDITS

Accuracy audits of the Rain Gauge will be performed by ECB technicians upon deployment in field and at least once every two years. The multi- point check will verify function of the Rain Gauge and the DAS calculations used to report the hourly rain event amount. Audit form to be used is attached under Appendix B. The audit procedure is listed below:

1. Remove the outer housing assembly. This will expose the tipping mechanism, terminal block, and built-in level on the base of the gauge.
2. Verify the sensor is level using the built-in level in the base of the sensor.
3. Wet the mechanism and tipping bucket assembly by pouring water (in a controlled manner) through the inner funnel and into the tipping bucket until it tips. Repeat this for the other half of the bucket. Tip the bucket one more time by hand to allow any excess water to drain. ***Do not wipe out or dry off any residual water droplets!***
4. Using a calibrated graduated cylinder or pipet, slowly pour the measured quantity of water shown in table below through the inner funnel to the tipping bucket, which should then tip. Repeat for the alternate bucket. If both buckets tip when filled with the measured quantity of water, the sensor is properly calibrated. If they do not, recalibrate as follows:
    a. Release the lock nuts on the cup adjustments.
    b. Move the adjustment screws down to a position that would place the bucket far out of calibration.
    c. Allow the measured quantity of water to enter the bucket.
    d. Turn the cup adjustment screw up until the bucket assembly tips. Tighten the lock nut.
    e. Repeat steps 3 and 4 for the opposite bucket.
    f. Measure the quantity of water necessary to tip each bucket several times to ensure proper calibration.

g. After verification or calibration (as needed), replace the sensor housing assembly making sure to tighten the screws at base. Note that the housing should be positioned between the base and the nylon washers. The screw heads should not press directly against the housing assembly.

5. Document calibration check results, and any adjustments necessary on the audit form and in sensor logbook.

Table 1: Tip Calibration and Water Volume Equivalency	
Tip Calibration (mm)	**Water Volume (mL)**
0.25	8.11
0.20	6.49
0.50	16.2
2.50	81.1

10.0 REVISION HISTORY

1. 09/30/2021 **ML –** Initial Publication

11.0 REFERENCES

1. Met One (2018). 370D/372D 8 Inch Rain Gauge Manual. 370D-9800, Rev A. Grants Pass, OR. Met One Instruments, Inc.
2. United States Environmental Protection Agency: Office of Air Quality Planning and Standards (2008). Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements. Version 2.0. Research Triangle Park, NC. Mikel, Dennis; Landreneua, Joey; Fields, Daniel; Bush, David; Fransiola, Paul; Eagan, Tammy; Field, Kent; Baxter, Bob; Dye, Tim; Acemount, Gary and Heffern, Richard.

12.0 APPENDICES

1. Appendix A – MetOne 370D Tipping Bucket Rain Gauge Audit Form
2. Appendix B – AQ-109 Form

Appendix A – MetOne 370D Tipping Bucket Rain Gauge Audit Form

MetOne 370D Tipping Bucket Rain Gauge Calibration Verification

Date	
Test Site Location	
Data Logger Model	
Data Logger SN	
MetOne 370D SN	
Start Time	
Stop Time	
Cal/Audit Device Model/SN	

BEFORE ADJUSTMENT

Test #	Nominal # of Tips	Input Volume (mL)	Nominal rainfall amount (mm/hr)	Measured rainfall amount (mm/hr) DAS/Envista Sum	% Difference
1	30	250	7.6		-100.0
2	30	250	7.6		-100.0
3	61	500	15.2		-100.0
4	61	500	15.2		-100.0
5	122	1000	30.5		-100.0
6	122	1000	30.5		-100.0

PASS/FAIL:	
Auditor (initials):	

AFTER ADJUSTMENT

Test #	Nominal # of Tips	Input Volume (mL)	Nominal rainfall amount (mm/hr)	Measured rainfall amount (mm/hr) DAS/Envista Sum	% Difference
1	30	250	7.6		-100.0
2	30	250	7.6		-100.0
3	61	500	15.2		-100.0
4	61	500	15.2		-100.0
5	122	1000	30.5		-100.0
6	122	1000	30.5		-100.0

PASS/FAIL:	
Auditor (initials):	

Comments:

-

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Appendix B – AQ-109 Form

AIR QUALITY SECTION
MAINTENANCE ORDER

Region: _____ Site: _____ Date of Service: _____

Requested By: _____

Action Requested: Repair _____ Supply _____ Maintain _____ Audit _____ Installation _____ Removal _____

Requested Action: _____

_____

_____

_____

_____

Action Taken (Shop Use Only): _____

_____

_____

_____

_____

_____

Parts Used: _____

_____

_____

_____

_____

Cylinders (Installed):

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Cylinders (Removed):

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Cylinder: Type _____ PPM _____ SN _____ PSI _____ Expires _____

Travel Time: Departed: _____ AM PM Returned: _____ AM PM

Vehicle (1): _____ Vehicle (2): _____

Vehicle Number: _____ Vehicle Number: _____

Logbook(s) Updated: YES NO N/A Comment(s): _____

Comment(s): _____

_____

_____

_____

Date Signed: _____ Technician(s): _____ Supervisor's Initials ____

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