NPM 3

OPERATION MANUAL

Met One Instruments, Inc

NPM 3-9800 Manual Rev A

Copyright Notice

NPM 3 Manual

NOTICE
⚠ **CAUTION** – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.
⚠ **WARNING** – This product, when properly installed and operated, is considered a Class I laser product. Class I products are not considered to be hazardous.
There are no user serviceable parts located inside the cover of this device.
Do not attempt to remove the cover of this product. Failure to comply with this instruction could cause accidental exposure to laser radiation.

Table of Contents

1 INTRODUCTION

1.1 About This Manual

This document is organized with the most important information grouped together for easy reference by the user. All owners and operators should read and understand the sections on installation, setup, and maintenance. Other sections should be consulted as needed. An electronic version of this manual is also available.

1.2 Technical Service and Warranty

This manual is structured by customer feedback to provide the required information for setup, operation, testing and maintaining your unit. Should you still require support after consulting your printed documentation, we encourage you to contact one of our expert Technical Service representatives during normal business hours of 7:00 a.m. to 4:00 p.m. Pacific Time, Monday through Friday. In addition, technical information and service bulletins are often posted on our website. Please contact us and obtain a Return Authorization (RA) number before sending any equipment back to the factory. This allows us to track and schedule service work and to expedite customer service.

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1.3 About the NPM 3

The Met One Instruments, Inc. NPM 3 is a type of nephelometer which automatically measures real-time airborne TSP, PM_{10}, $PM_{2.5}$, or $PM_{1.0}$ particulate concentration levels. Each NPM 3 will have a serial connection and serial cable that allows the device to connect to a laptop or data logger and the real-time data logged for review at a later date.

1.4 Laser Radiation Safety and Conformity

The NPM 3, when properly installed and operated, is considered a Class I laser product. Class I products are not considered hazardous.

This system contains a 5 mW diode laser operating at 670 nm wavelength. This is visible to the naked eye, and can cause damage to the eye if directly exposed. A protective optical housing fully encapsulates the laser beam and optics system within the device. Do not attempt to disassemble the optical module. Failure to comply with this instruction could cause accidental exposure to laser radiation. The manufacturer certifies that this product operates in compliance with the following standards and regulations:

- **FDA / CDRH This product is tested and complies with 21 CFR, Subchapter J, of the health and Safety Act of 1968.**

- **US 21 CFR 1040.10.**

Always power down the system whenever service or repair work is being performed inside the instrument enclosure. Only trained technicians should attempt to repair the device. Routine maintenance does not require removing the instrument from its weatherproof enclosure.

1.5 NPM 3 Specifications

Parameter	Specification
Measurement Principles:	Particulate concentration by forward light scatter laser nephelometer.
Available Cut Points:	$PM_{1.0}$ sharp-cut cyclone (SCC 111), $PM_{2.5}$ sharp-cut cyclone (SCC 112), PM_{10} sharp-cut cyclone (SCC 110)
Measurement Range:	0 to 100 mg/m^3 (0 to 100,000 μg/m^3)
Measurement Sensitivity:	0.001 mg/m^3 (1 μg/m^3)
Nephelometer Accuracy:	± 5% traceable standard with 0.54um PSL.
Particle Size Sensitivity:	0.1 to 100 micron. Optimal sensitivity 0.5 to 10 micron particles.
Long Term Stability:	5% with clean optics.
Laser Type:	Diode Laser, 5 mW, 670 nm. Visible red.
Flow Rate:	2.0 liters/minute
Pump Type:	Brushless Diaphragm
Power:	11 – 40 VDC @ 1.5 A maximum.
Power Consumption:	350 mA (no heater) 1.1 A (with heater) @ 15 VDC.
Operating Temperature:	0 to +50°C . (Ambient Temperature Sensor Range -30 to +50°C).
Ambient Humidity Range:	0 to 90% RH, non-condensing.
Humidity Control:	Automatic 12 Watt inlet heater module controlled to sample RH, with set point.
Factory Service Interval:	24 Months typical, under continuous use in normal ambient air.
Mounting Options:	Pole mount bracket standard. Optional mounting tripod.
Purge Filter:	0.2 micron
Pump Protection Filter:	5.0 micron
Unit Weight:	2.7 kg (6 lbs.)
Unit Dimensions:	54.6 cm high, 38.1 cm wide, 17.8 cm deep (21.5" x 15" x 7")

**Specifications may be subject to change without notice**.

2 Setup and Startup

The NPM 3 is designed for rapid deployment and easy setup by a single person. This section describes the basic assembly, setup, and start-up of the instrument.

2.1 Unpacking the NPM 3

When unpacking a new NPM 3, verify that the contents are undamaged. Any damages sustained by the equipment during shipping are the responsibility of the carrier. If any damage to the shipment is noticed before unpacking, **a claim must be filed with the commercial carrier immediately**. You should follow any special unpacking instructions provided by the carrier as you then carefully remove all items from the containers and inspect each component. It is recommended to document and photograph all damaged packages and items before, during, and after unpacking them. Contact Met One Instruments (see section 1.2 of this manual) to arrange for any replacement items needed.

2.2 Components

Figure 2-1 NPM 3 Deployment
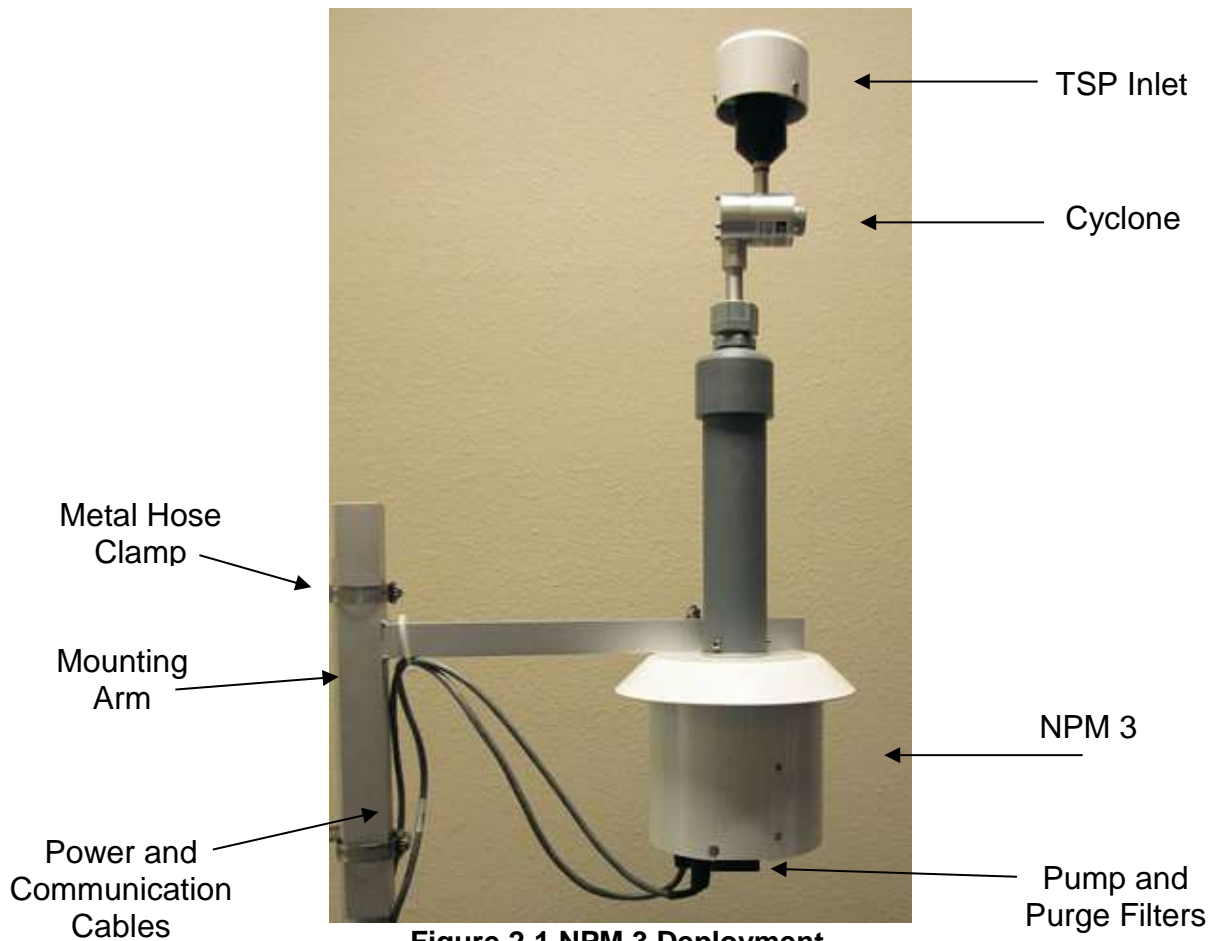
2.3 Setting up the NPM 3

Some assembly is required before the NPM 3 can begin collecting data. The device will need to be mounted to a pole or post as shown in Figure 2-1. Using the metal hose clamps, tighten the mounting arm to your surface. If equipped, install the SCC 112 PM2.5 Sharp Cut Cyclone on the inlet of the NPM 3. Install the TSP inlet on NPM 3 inlet tube, or the SCC 112, if equipped.

The monitor is now ready to be powered up and begin collecting data.

2.4   NPM 3 Operational sequence

When the NPM 3 is powered up, it will perform an initial Zero Offset Calibration, after which, it will start standard sampling operation. At the end of the Sample Time interval, the NPM 3 will perform a periodic Zero Offset Calibration and return to normal sampling.

If the NPM 3 sample cycle is terminated by issuing an E (end) command, either through a terminal interface or with a data logger, the NPM 3 will enter Purge mode for approximately 20 seconds and stop sampling.

NOTE: When the NPM 3 is removed from service, or if the NPM 3 will be left in place but powered down for an extended period of time, remove the TSP inlet cap and install the 770025 black Inlet Cap which shipped with the instrument. This will help keep the sensor interior cleaner when the instrument is not in service.

2.5   Communication Wiring

Data collected by the NPM 3 is available on the serial output of the monitor using the 82905 cable assembly, sold separately. The sampler has no onboard memory and must be connected to a PC, data logger or Comet Cloud Services Modem (CCS) to archive data.

The 82905 cable assembly has a round connector on one end to mate with the 8 pin power and communications port located on the bottom of the monitor. The other end of the cable is prepared as a breakout of 9 wires that are stripped and tinned to make installation in a data logger or PC a simple matter.
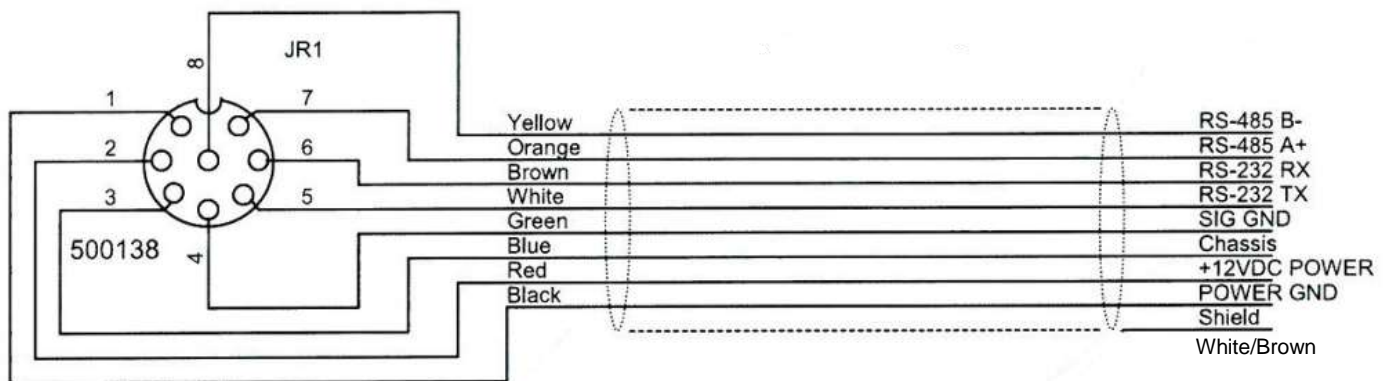
Figure 2-2 Pin Out of Cable 82905

All wires are available for use when the Sensor is powered on. Any wiring not needed should have the tinned ends cut off and insulated to prevent accidentally touching live wires to ground, each other, or personnel.

The white wire with the brown stripe (White/Brown) is the drain wire for the cable shielding. This wire should be grounded at the computer/logger end for noise suppression.

The blue wire is connected to the chassis of the NPM 3. This should be tied to earth ground to help prevent static from building up from wind and other sources of static.

2.5.1 Connecting to a Data Logger

Simply connect the necessary wires to the appropriate terminals of the data logger (see Figure 2-2 for wiring details). If the logger is using RS485 for communications, it is important that the green or black wire be tied to the same earth ground point as the blue chassis ground. Any wiring not needed should have the tinned ends cut off and insulated to prevent accidentally touching live wires to ground, each other, or personnel.

2.5.2 Connecting to a Computer

If RS-232 communications to a PC are needed, connect the 82905 cable assembly to a DB9 style connector as follows:

- pin 5 of DB9 connects to Green Ground wire
- pin 3 of DB9 connects to Brown RXD wire
- pin 2 of DB9 connects to the White TXD wire.

All other wiring should have the tinned ends cut off and insulated to prevent accidentally touching live wires to ground, each other, or personnel.

2.5.3 Connecting to Met One Instruments' CCS Modem

The Met One Instruments, Inc. Comet Cloud Service (CCS) modem provides real time remote connectivity to a range of Met One particulate and weather sensors. The CCS package includes the cellular modem hardware, a personalized webpage dashboard, and cellular and cloud website data hosting services.

The NPM 3 connects to the CCS Modem using the 82906 cable assembly.

2.6 Powering on the Device

The red and black wires of the 82905 cable assembly, or the optional 80943 Power Cable can be used to power up the NPM 3. To power the device, connect the stripped/tinned end to a +12 VDC power source (Red + 12 VDC, BLK GND). A voltage range of 11-40 VDC may be used. Plug the 82905 or 80943 power cable into the bottom of the NPM 3. An optional 9438-4 weatherproof power supply may also be used to power the unit with 110-230 VAC. Once the device is powered on, it will immediately start. The NPM 3 will collect data and report concentration continuously until powered down or commanded to stop sampling.

Additionally the NPM 3 is powered by the CCS Modem when connected with the 82906 power and signal cable assembly.

3 Collecting Data

The NPM 3 has no onboard memory. If observed data is to be archived for future reference, the sensor must be connected to a Comet Cloud Services Modem (CCS), directly to a PC or to a data logger capable of parsing its serial string output.

See CCS manual for cloud modem communications details.

The default RS-232 settings are as follows:

Baud Rate: 9600 fixed

Data Bits: 8

Parity: None

Stop Bits: 1

Flow Control:None

3.1   Using the NPM 3 with a Computer

In the User Communication (or Terminal) mode, commands are issued by entering a letter or number command and then pressing the Enter, `<cr>`, key.

Press the Enter key three times to enter User Communication mode. An asterisk character appears confirming you have entered the mode and that the instrument is ready for a new command. Commands will be echoed back from the instrument and an asterisk will appear after a command has completed.

COMMAND	DESCRIPTION
1	Request settings report
H	Help menu
Q	Quit and exit terminal mode
S	Start a Measurement
E	End sample
CU	Concentration Units: CU 0=µg/m^3, CU 1=mg/m^3.
OP	Get Operation Status (Sampling, Zeroing, Stopped)
ID	Get/Set location ID or address ID xxx
OI	Get/Set output interval in seconds
QH	Get current readings header
RF	Used to calibrate inlet flow rate.
RQ	Get current readings without header
RV	Get Model, Firmware Part # and Revision
SK	Get/Set K factor 0.1 – 10 nominal range SK x.xx
SPR	Get/Set RH set point for heater control, 0 – 100%. Default 40% SPR xx
SS	Get Met One serial number
ST	Get/Set Sample Time in seconds. Sample Time controls the period at which the NPM 3 performs automatic Zero Calibration. Factory default is 3600, so automatic Zero Calibration occurs once per hour.

Table 1 Common Serial Command Set

To issue one of the commands listed in Table 1, type the command listed and press the Enter key. The command will run and display the requested information or current setting, as appropriate.

For example, to view the location ID you would type the letters ID followed by the Enter key. You would then see the location ID reported. The sequence would appear like this:

```
ID<cr>
ID 001 <cr><lf>
```

To change a setting, the typical sequence is to type the command, press the space bar one time, enter the new value in the same format that is displayed when checking the setting, and then pressing the Enter key.

Continuing the example above, to change the location ID setting you would type ID, space, and then the desired location ID followed by the Enter key. You would then see confirmation of the new location ID reported. The sequence would appear like this:

```
ID 123<cr>
ID 123<cr><lf>
```

Pressing <Esc> or Q<cr> will exit terminal mode. Also, terminal mode will expire after ~2 minutes.

For a detailed listing of all commands and their formats, consult the NPM 3-7500 document. Contact Met One Service Department to obtain a copy (see Section 1.2 for contact details).

3.1.1 Output Format

Below is an example of the output format from the NPM 3.

0000002,00,*00522

0000001,00,*00521

mmmmmmm,ss,*ccccc

Where

mmmmmmm is the reported mass concentration in µg/m^3.

ss is the Status field. This is a numeric field where 00 indicates no errors and a non-zero value will indicate various error conditions. (See Below).

ccccc field is a 5 character checksum field with leading zeros as necessary. This is the 16 bit sum of all the characters from the start of the output string (after the <esc> character) up to but not including the '*' delimiter character. This value is in Decimal.

3.1.2 Status Field

The Status Field contains an "alarm" code column to indicate if there were any alarm or error flags during that particular sample period.

The following table defines the possible error codes that can appear in the "status" column of the NPM 3 data output:

Code	Error/Alarm Type
0	No alarm
1	Auto Zero Low
2	Auto Zero High
3	Auto Zero Stability
10	Laser Current Failure
20	Detector Failure
40	Flow Failure

Table 2 NPM 3 Status Fields

Note: If multiple errors or alarms occur in the same data period, then the alarm code stored in the data array will be the *sum of the two* individual *code numbers*. This is a rare occurrence.

3.1.3   Comet Software

The NPM 3 is compatible with a free copy of the Comet™ program. Comet is a simple Windows-based communications terminal program developed by Met One Instruments. The software is available for download at the following weblink:

https://metone.com/software/

The Comet Software also contains a pdf user's manual for the program. Install the program onto the computer that you will be using, and review the manual for more details.

To connect to an NPM 3 with Comet, create a new station and select MET as the Device Product Type, then Digital Sensor as the product. Comet will allow the user to view real-time data and optionally, to log data to a data file on the computer in .csv (comma separated values) format.

3.2   Using the NPM 3 with a Data Logger

In the Computer Communication mode, character echo is suppressed. This means if you are issuing commands in this mode using a keyboard, you will not see what you are typing displayed on the screen. This is the mode that should be used when monitoring data with a data logger. The command format includes a checksum to verify data integrity.

The mode is entered whenever an <Esc> character is sent to the instrument. Commands are issued using the following format:

```
<Esc>Cmd p1 p2*cs<cr>
```

Computer commands are prefaced with an <Esc> character followed directly by a command (Cmd). After the command there can be zero or more parameter fields (p1 and p2) where each field is separated by a space. The end of the message is signaled by the Checksum Delimiter character (*) followed by the checksum itself (cs). Finally, the command is terminated with a carriage return (<cr>).

A computer command example requesting the unit ID would look like this:

```
<Esc>ID*1234<cr>
```

All command responses are terminated with a checksum. The above command response would have this format:

```
ID 123*00596<cr><lf>
```

Optionally, a command integrity checksum can be added.   If used, a "*" delimiter character will be added to the end of the command string followed by the decimal checksum of all characters in the command line up to but not including the "*" character. If the command integrity checksum is supplied, the response string will also include an integrity checksum. The command will be ignored if an incorrect checksum is given. For ease in human operation, the special checksum string "*//" (without quotation marks) will resolve as a correct checksum without the need to calculate it.

The checksum is the 16 bit sum of all the characters from the start of the output string (after the <esc> character) up to but not including the '*' delimiter character. This value is in Decimal.

For a listing of all commands and their formats along with additional in depth Computer Communication details, consult NPM 3-7500 document contained (contact the Met One Instruments service department. See section 1.2).

3.3   K Factor

The NPM 3 is calibrated using 0.6 micron latex micro-spheres. These provide an extremely consistent calibration, but do not generally match the characteristics of all ambient particulate.

A K Factor (multiplier) <u>must</u> be established for good accuracy and correlation to collocated instruments. The default factory K Factor is 1.0.

The K Factor is only valid at the same site and for the same particulate type. If the local particulate source changes, the K Factor may need to be adjusted.

To determine a local K Factor, collocate the NPM 3 with a trusted reference instrument (a BAM, for example). Operate the NPM 3 and the reference instrument for between a few hours to a few days. Calculate the K Factor for the NPM 3 as:

$$KFactor = \frac{Reference\ Sensor\ Average\ Concentration}{NPM\ 3\ Average\ Concentration}$$

Set the K Factor in the NPM 3 using the SK command.

`SK x.xx<cr>` Where x.xx is the new K Factor.

4 Maintenance

The NPM 3 is designed for minimal field maintenance. The NPM 3 case should never be removed or opened for any reason. **Opening or removing the case will void the warranty and may result in exposure to laser radiation, which can cause eye injury.** Should a NPM 3 require maintenance, refer to section 1.2 to contact Met One for more information and technical support.

4.1 Suggested Periodic Maintenance Intervals

The following table shows the recommended periods for routine maintenance items.

Some of these items will need to be performed more or less often depending on the exact characteristics of your location. The program administrator should review these items and establish SOPs appropriate for your application.

Maintenance Item	Suggested Period
Clean sharp-cut cyclone particle trap	Monthly
Clean sharp-cut cyclone, particle trap, and inlet.	3 Months
Flow Audit/Calibration	Monthly
Replace Pump and Purge Filters	12 Months
Factory service for inlet heater, pump, and optical module cleaning.	24 Months

Table 3 Suggested Periodic Maintenance Intervals

4.1.1 Inlet and Cyclone Cleaning

The particle traps on the PM2.5 cyclone should be emptied monthly, by unscrewing the grit cap and cleaning it out. The cyclone body should be fully disassembled and cleaned quarterly for best accuracy and to prevent corrosion.

4.1.2 Flow Audit and Calibration

The flow system may be audited periodically by connecting a traceable flow reference, such as the Met One Instruments p/n 81755, Bios DryCal or other suitable flow reference to the inlet of the device. The flow is factory set for 2.0 L/min. The flow rate should be verified to be within ± 20% (± 0.4 L/min) for most relative particulate trending applications. When optimal cyclone cut-point accuracy is desired, the flow should be within ± 10% (± 0.2 L/min).

1) Send the serial command CAL <ENTER> to put the NPM 3 into flow calibration mode and will automatically regulate to the set point (2.0 L/min). This may take a moment. CAL mode will display Flow, AT, RH, and BP once per second.
2) Enter the inlet flow value from a calibrated flowmeter with a 'RF #.###'command.
3) Allow the flow to stabilize.
4) Repeat as necessary to achieve 2.0 L/min.
5) Exit the flow calibration mode by typing CAX <ENTER>.

4.1.3 Replacing the Pump and Purge Filter

The NPM 3 Pump Filter and Purge Filter are the two filter cartridges located on the bottom of the instrument. They can be removed by unscrewing the black aluminum filter holders with a coin using the slot in the face of the holder. The expected lifetime of the two filters is greater than one year, but in heavy particulate areas they may need to be replaced more often.

The 5 micron PUMP filter (MOI part number 580345) keeps any large particles from entering the flow sensor or sample pump. The 0.2 micron PURGE filter (MOI part number 580302) cleans the recirculated purge air which is used to keep the optics clean during normal operation and the zero self-test.

Figure 3 Pump Filter and Purge Filter Replacement

4.1.4 Zero Offset Calibration

The NPM 3 performs the Zero Offset Calibration automatically. The factory default frequency is once per hour (3600 seconds). The frequency is controlled by the Sample Time setting. If a different frequency is desired for this automatic calibration, it can be adjusted by changing the Sample Time, in seconds. The minimum period recommended is 1 hour. The longest the Sample Time can be set to is 99 hours or 356,400 seconds. Setting the Sample Time to 0 will disable periodic automatic zero calibration.

To perform a manual Zero Offset Calibration on the NPM 3, issue the S command. This will cause the NPM 3 to restart and perform its initial Zero Offset Calibration and re-start sampling.

4.1.5 Factory Service

The internal RH sensor, inlet heater, pump, and optical module should only be serviced by factory technicians. The NPM 3 should be returned for factory service on a periodic basis. High concentration environments will require more frequent service.

5 ACCESSORIES and PARTS

5.1 Consumables, Replacement Parts, and Accessories

The following parts are available from Met One for maintenance, replacement, service, and upgrades. If unsure about a part you need, please contact the technical service department. Some of these parts may require technical skills or special instructions before use or installation.

Description	Part Number	Graphic
NPM 3 Power and Signal Cable Assembly	**82905**	
External DC Power Cable Assembly	**80943**	
Weatherproof AC Power Supply	**9438-4**	
Purge Filter Holder, Black Aluminum	**8912**	
Pump Filter Holder, Black Aluminum	**8913**	
Purge Air Filter, 0.2 micron	**580302**	
Pump Filter, 5.0 micron	**580345**	
O-Ring, For Purge and Pump Filter Holders	**720063**	
PM2.5 Sharp Cut Cyclone, 2 LPM	**SCC 112**	
PM10 Sharp Cut Cyclone, 2 LPM	**SCC 110**	
PM1 Sharp Cut Cyclone, 2 LPM	**SCC 111**	
TSP Sampling Inlet Harsh environment, with insect screen and rain cap	**9441**	
Cloud Service Modem LTE	**CCS Modem-LTE**	
NPM to CCS Modem Power and Signal Cable Assembly	**82906**	