NEON SENSOR COMMAND, CONTROL AND CONFIGURATION (C3) DOCUMENT: PARTICULATE ANALYZER - MASS

PREPARED BY	ORGANIZATION	DATE
Hongyan Luo	FIU	12/23/2015

APPROVALS	ORGANIZATION	APPROVAL DATE
Andrea Thorpe	SCI	02/26/2016
Vlad Aleksiev	PSE	02/22/2016

RELEASED BY	ORGANIZATION	RELEASE DATE
Judy Salazar	CM	02/29/2016

See configuration management system for approval history.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	04/17/2014	ECO-01558	Initial Release
B	02/29/2016	ECO-03635	Use new C3 template; add DGD number info; update L0 data products; change TSP inlet to PM10 inlet

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1   DESCRIPTION

This document specifies the command, control, and configuration details for operating the particulate analyzer - mass assembly (i.e., American EcoTech HiVol 3000 sampler and associated infrastructures).   It includes a detailed discussion of all necessary requirements for operational control parameters, conditions/constraints, set points, and any necessary error handling. All Level 0 Data Products generated by the sensor are identified. Raw data from the sensor are collected by the DAS, but received at HQ for further processing as a L0 unfiltered and uncorrected data product until its associated algorithms are applied to produce a quality-controlled and -assured L1 data product in standard scientific units.

1.1   Scope

This document specifies the command, control, and configuration that are needed for operating particulate analyzer – mass assembly. It does not provide implementation details, except for cases where these stem directly from the sensor conditions as described here.

A complete set of the Level 0 data products generated in this document can be found in appendix.

The particulate analyzer – mass assembly will consist of following Data Generating Device (DGD) based on Data Generating Device DGD List and Hierarchies doc (AD [06]):

DGD Agile PN	DGD Agile Description
0334980000	Sensor, HiVol 3000 Particulate Mass Analyzer, NEON Custom

Further detailed sensor info under DGD 0334980000 is as following:

- It contains a PM10 Size Selective Inlet (NEON P/N0334980006).

Other important parts that are not a DGD:

- Quartz filter: manufacture: Pall Life Sciences; model no.: 7204; Description: 2500QAT-UP, 8 x 10 in.; packaging: 25/pkg. (NEON P/N: 0334980003)
- Top loading orifice plate for calibration, EcoTech mfg model: HVS3000, DESC: ECO-HVS3000-21. (NEON P/N: 0334980002)
- M202 Absolute manometer for calibration of the built-in barometric pressure sensor and flow rate meter, M202-AI0017 0 - 17.403 PSIA (0 - 900 mm Hg Abs.); mfg P/N: AE-ATM-M202 (NEON P/N: 0334980004)

This C^3 document specifies the command, control, and configuration that are needed for operating this sensor and accessories. It does not provide implementation details, except for cases where these stem directly from the sensor conditions as described here.

2   RELATED DOCUMENTS AND ACRONYMS

2.1   Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD [01]	NEON.DOC.000001	NEON Observatory Design
AD [02]	NEON.DOC.000291	NEON Configured Sensor List
AD [03]	NEON.DOC.005003	NEON Scientific Data Products Catalog
AD [04]	NEON.DOC.005005	NEON Level 0 Data Products Catalog
AD [05]	NEON.DOC.003505	Sensor Maintenance Procedure: Particulate Analyzer - Mass
AD [06]	NEON.DOC.001104	Data Generating Device DGD List and Hierarchies

2.2   Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms

2.3   External References

External references contain information pertinent to this document, but are not NEON configuration-controlled. Examples include manuals, brochures, technical notes, and external websites.

ER [01]	EcoTech Environmental Monitoring — HiVol 3000 High Volume Air Sampler User Manual (Version: 1.7, 2009)
ER [02]	M2 – Series user manual — M202 precision absolute manometer
ER [03]	U.S. EPA Standards 40 CFR Parts 50 APPENDIX B — Reference method for the determination of suspended particulate matter in the atmosphere (high-volume method)

2.4   Acronyms

Acronym	Explanation
C^3	Command, Control, and Configuration Document
SOP	Standard Operating Procedures
QA/QC	Quality Assurance/Quality Control
L0	Level 0
L1	Level 1
ENG	NEON Engineering group
CI	NEON Cyberinfrastructure group
EPA	Environmental Protection Agency
TSP	Total Suspended Particulate

HQ	Headquarters
PM10	Particulate matter up to 10 micrometers in size

3   PARTICULATE ANALYZER - MASS, INTRODUCTION (DGD 0334980000)

The American EcoTech HiVol 3000 is a High Volume Air Sampler designed primarily for particulate sampling using 8"x10" filters, which is the sensor component of the NEON Particulate Analyzer – Mass assembly. At NEON sites, air will be pulled through a PM10 Size Selective inlet and through a quartz filter by a high volume pump to collect suspended particles of 10 micron and smaller on the filter. The HiVol 3000 incorporates volumetric flow control, data logging and advanced programming functions. Through the filter weight difference between pre-exposed and post-exposed to the atmosphere and the flow volume, the particulate mass concentration can be calculated. Here we assume the weight of filter before and after exposure to the air, as well as the particulate mass concentration will be L0 and L1 DPs in a separate ATBD document, thus not part of this document. The constant flow at setting point will be achieved through a true volumetric flow-rate controller (via temperature and pressure compensation of a mass flow sensor). The flow rate and the built-in pressure sensor and temperature sensor should be calibrated periodically to ensure the constant flow and proper pressure and temperature compensation. This instrument is capable of start/stop the sampling activity automatically according to the pre-programmed tasks and intervals.

Collecting exposed filter and re-loading new filter will be performed manually once every two weeks by field techs. The new filter will be ID, conditioned and weighed in an environmental controlled lab (ER [03]) prior to sending to sites; and the exposed filter after collecting at field will be conditioned and weighed at the same controlled environmental conditions in lab prior to archiving. The filter will be archived for NEON future chemistry analysis or for science community uses. Filter handling and PM10 samplings method will follow EPA standard procedures for PM10 using high volume method (ER [03]), and will be described in a separate SOP document (AD [05]). The instrument settings, programs and field calibration will also be specified in this SOP document (AD [05]).

The data produced by this instrument (e.g., flow rate, pressure, temperature, etc.] will be stored in its data logger up to 150 data lines, and can be downloaded / streamed periodically through RS232 port on the instrument.

4   PARTICULATE ANALYZER - MASS, OVERVIEW OF SENSOR CONFIGURATION (DGD 0334980000)

This instrument is a standalone sensor and run on the pre-programmed tasks and intervals. It doesn't require a heating or cooling system, and doesn't rely on any other sensor outputs for the command and control. Although it has capability to add wind sensor and precipitation sensors to monitor and trigger the sampling on/off at certain environmental conditions, NEON conducts PM10 particle sampling under all environmental conditions, thus there is no need to add these wind and precipitation sensors.

The internal data logger can only store up to 150 lines of data before the data collection is stop. Under typical operation, once the data is downloaded and the logger accumulator is cleared manually, new data can be collected in the data logger again. However, NEON will stream data and clear the logger

accumulator automatically; therefore, the internal data logger capacity does not impact our data collection. Sampling frequency at once every minute will be sufficient to monitor the air flow rate, temperature and pressure.

When field tech collects filter, maintains the sensor, or conducts field calibration, this instrument will be stopped prior to these activities. The start and stop time will be reflected in the data stream, therefore, no flag info for these activities is needed for the data streams. However, the metadata and filed logging information should be recorded for future use, similar to all other TIS sensors. The DAS system will collect and stream data at 1-min interval. The timestamp for the data streams will be assigned by GRAPE, not from the instrument itself.

The total volume of air pass through the filter can be calculated from the flow-rate multiplied by the sampling time. Results are expressed as micrograms per cubic meter of air sampled ($\mu g/m^3$) in situ, then corrected to the standard (or reference) conditions of temperature and pressure (STP). This reference conditions vary from country to country. NEON will use U.S. EPA standards. Therefore, U.S. EPA should be preset in the instrument prior to operation for all NEON units. EPA reference conditions are as following (ER[03]):

Standard temperature defined as 298K (25°C); Standard pressure defined as 101.3 kPa (760mm Hg).

Some key sensor configurations can be found in table below. Other instrument settings can be found in instrument manual (ER [01]) and SOP document (AD [05]).

Table 1 Some key instrument configurations

Parameters	settings
interface	RS-232
Flow rate	67.8 m^3/h
AvPeriod /Data averaging	1 min
Flow alarms/ Major fault – Retry delay	30 s
Flow alarms/Maximum number of retries	5 times
Ref. Temp.	25°C
Ref. BP	760 mm Hg

L0 DPs output from this sensor can be found in Appendix Section 7.1.

5   PARTICULATE ANALYZER - MASS, COMMAND AND CONTROL

5.1   Error handling

When the flow from a HiVol 3000 drops considerably, an error occurs and the instrument stops sampling, then after a delay, it attempts to restart.

"Filter Blocked" error is displayed when a drop in flow occurs and indicates that the filter is full / saturated with particulates.

"Motor Drive Error or Major Blockage" error is displayed when the drop in flow is large and is caused by:

- The blower motor not working properly (motor breaking down)
- Either a high or low supply voltage to instrument
- Large blockage within the instruments flow path

The instrument will attempt to reset itself a number of times (see table 1) and if unsuccessful the instrument will shut down until an operator visits the instrument and fixes the problem.

When above error occur, the error message will only display on the instrument screen, and will not be saved as part of data stream. While the instrument attempt to reset itself, the flow rate may be overshot above 67.8 m^3/h, but the flow rate will decrease dramatically from setting flow rate (67.8 m^3/h ±10%) thereafter. Here we arbitrarily set a flow rate of 34 m^3/h as threshold (half of the setting point, this is when the "Filter Blocked" screen will appear on the instrument display) to flag and send out the trouble ticket. This flag will likely be generated back at NEON HQ as a L1 data product.

Table 2 Truth table for error handling

Control parameter(s)	Condition	Data acquisition system action	Output to CI
Flow rate	Filter blocked, Motor drive error or major blockage	Send trouble ticket when over half of the 1-min flow rate <34 m^3/h for 15 min*	None

5.2   Sensor <device> controls specification

NA

6   PARTICULATE ANALYZER - MASS, ASSEMBLY INTEGRATION

NA

7   APPENDIX

7.1   List of Level 0 data product

Table 3 List of Level 0 data product associated with DPName: Particulate Mass

DGD Agile PN	DPNumber	fieldName	description	Acquisition frequency (Hz)	dataType	units
0334980000	NEON.DOM.SITE.DP0.00101.001 .01814.HOR.VER.000	baroPressParticulate Mass	Barometric pressure measurements for proper pressure compensation to ensure constant flow rate	1 min	real	millimetersOfMercury
	NEON.DOM.SITE.DP0.00101.001 .01309.HOR.VER.000	sensorTemp	Temperature of sensor	1 min	real	celsius
	NEON.DOM.SITE.DP0.00101.001 .01815.HOR.VER.000	flowRate	Flow rate in cubic meters per hour	1 min	real	cubicMetersPerHour
	NEON.DOM.SITE.DP0.00101.001 .01816.HOR.VER.000	corrAirVolume	Accumulated sample air volume, corrected to standard conditions of temperature and pressure of 298 K (25 degrees C) and 101.3 kPa (760mm Hg)	1 min	real	cubicMeter
	NEON.DOM.SITE.DP0.00101.001 .01817.HOR.VER.000	uncorrAirVolume	Accumulated sample air volume, uncorrected	1 min	real	cubicMeter

7.2   Assembly schematic drawing

N/A

8   BIBLIOGRAPHY

- EcoTech Environmental Monitoring — HiVol 3000 High Volume Air Sampler User Manual (Version: 1.7, 2009)
- M2 – Series user manual — M202 precision absolute manometer
- U.S. EPA Standards 40 CFR Parts 50 APPENDIX B — Reference method for the determination of suspended particulate matter in the atmosphere (high-volume method)