NEON SENSOR COMMAND, CONTROL, AND CONFIGURATION: PARTICULATE ANALYZER (MASS) ASSEMBLY

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1 DESCRIPTION

This document specifies the command, control, and configuration details for operating the dust 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 dust particulate analyzer (mass) (American EcoTech HiVol 3000 sampler) is a standalone instrument. It does not require any heating and cooling control system and does not require external commands and controls.

The dust particulate analyzer (mass) assembly consists of the following sensors (AD [02]):

- American EcoTech HiVol 3000 sampler with pyramid TSP (Total Suspended Particulate) inlet (NEON P/N 0334980000).
    - Other accessories:
        - 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)

External references include manuals for American EcoTech HiVol 3000 sampler (ER [01]) and for M202 Absolute manometer (ER [02]), and the US EPA method for high volume sampling method (ER [03]).

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.XXXXXX	NEON Particulate Analyzer (mass) Assembly SOP (TBW)

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

3 INTRODUCTION

The American EcoTech HiVol 3000 is a High Volume Air Sampler designed primarily for particulate sampling using 8”x10” filters. At NEON sites, air will be pulled through a TSP inlet and through a quartz filter by a high volume pump to collect total suspended particles 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 L1 DPs, 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. 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 TSP samplings method will follow EPA standard procedures for TSP 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 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 OVERVIEW OF SENSOR CONFIGURATION

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 TSP 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. 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 can be calculated from the flow-rate multiplied by the sampling time. Results are expressed as micrograms per cubic meter of air sampled (µg/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. 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
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 Table 2.

Table 2. L0 data product from HiVol 3000 (Data are streamed at 1 min interval)

Parameters	Units	L0 Data Products
Barometric pressure	mm Hg	NEON.DXX.XXX.DP0.00062.001.001.001.00N.001
Ambient temperature	°C	NEON.DXX.XXX.DP0.00062.001.002.001.00N.001
Flow rate	m^3/h	NEON.DXX.XXX.DP0.00062.001.003.001.00N.001
Corrected accumulated sample volume	std m^3	NEON.DXX.XXX.DP0.00062.001.004.001.00N.001
Uncorrected accumulated sample volume	m^3	NEON.DXX.XXX.DP0.00062.001.005.001.00N.001

5 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.

Table 3. 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*	Flow rate flag

Table 4. L0 data product for blockage flag (frequency: 1-min data)

Parameters	L0 Data Products	Note
Flow rate flag 1	NEON.DXX.XXX.DP0.00062.001.006.001.00N.001	0 is ok flow rate, 1 is potential blockage

5.2 Sensor <device> controls specification

NA

6 ASSEMBLY INTEGRATION

NA