



CLIMET

MEASUREMENT AND ANALYSIS OF PARTICLE NUMBER SIZE DISTRIBUTIONS IN AMBIENT AIR USING THE CLIMET

1. PURPOSE AND APPLICABILITY

This OP contains the protocol for performing measurements of particle number size distribution (0.3 μm – 10 μm in diameter) in outdoor air for the Baltimore PM supersite study. The spectrometer consists of a whitelight optical particle sizer (CLIMET 208 C, CLIMET). This is an evaluation version of an anticipated standard operating procedure (SOP), which will result from experiences with this OP. Due to this fact this OP is subject to changes. Every addition to this OP will be added as an Appendix during this study.

2. DEFINITIONS

OPC optical particle counter
Gillibrator: soap-bubble flow meter

Minimum Sizing Channels Required for OPC ^a

	Lower Limit	Upper Limit	geometric mean
1	0.30	0.40	0.35
2	0.40	0.55	0.47
3	0.55	0.70	0.62
4	0.70	1.00	0.84
5	1.00	1.30	1.14
6	1.30	1.60	1.44
7	1.60	2.20	1.88
8	2.20	3.00	2.57
9	3.00	4.00	3.46
10	4.00	5.50	4.69
11	5.50	7.00	6.20
12	7.00	10.00	8.37

^aFrom ASHRAE 52.2P (1998)

Available sizing channels (standard)

1	0.30	0.50
2	0.50	0.70
3	0.70	1.00
4	1.00	3.00
5	5.00	7.00
6	7.00	10.0
7	10.0	



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3. REFERENCES

ASHRAE Proposed Standard 52.2P, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size, Fourth Composite Working Draft*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA, 1998. (Draft released for a limited time for review and is currently not available from ASHRAE.)

4. DISCUSSION

NA

5. RESPONSIBILITIES

NA

6. EQUIPMENT AND MATERIALS

6.1 Equipment

6.1.1 CLIMET

- a) CLIMET CI 208 C
- b) Multichannel analyzer
- c) Personal computer
- e) Spare parts Climet (lamps, filters, fitting, tubing, computer cables)

6.1.2 Flow meter

- a) Gilian Gilibrator 2 S/N: 0044669
- b) Flow cell 2-30 lpm S/N: 003454-H
- c) Flow cell soap

6.2 Materials

- a) Spare quartz lamps
- b) HEPA filters (Gelman Sci.),

6.3 Paper materials

- a) Field forms to record performance parameters of CLIMET in the field



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b) Laboratory book for CLIMET



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7. PROCEDURES

ALL MAINTANCE PROCEDURES MUST BE RECORDED IN THE FIELD FORM

a. Every second day maintenance of Climet

- b) Check front panel indicators

a. Weekly maintainance of the Climet

- a) Check sample flow with Gilibrator

b. Biweekly maintenance of the Climet

- a) Check 0-counts with HEPA filter attached to the inlet. Record time and file name.
b) Test cut sizes with at least 2 sizes of PSL. Record time and file name.

c. Monthly maintenance of the Climet

- a) Exchange of the quartz lamp
b) Adjustment of lamp alignment

7.5 Handling of persistent instrumental deviations

If any adjustment of the operating parameters (see 7.1 - 7.3) yields no sufficient result (i.e. normal operating conditions can not be achieved, personal doing the routine maintenance is requested to report the problem and actions undertaken to solve it to an experienced operator as soon as possible.

7.6 Beginning and end of the study

Check Sizing properties of each selected cut size with PSL particles of nominal cut diameter. 50% of the particles should be counted in the upper and the lower size channels.

Check counting efficiency with focus on small particles.

8. ANALYTICAL PROCEDURES

8.1 Averaging of hourly and daily mean size distributions

Hourly average concentrations are calculated if at least 66% of the valid data (see 8.5) for one hour are available. Daily average number concentrations are valid, if at least 16 hourly averages are available for one day.

Daily means will be provided for time intervals from midnight to midnight.

Strange particle size distributions must only be rejected from the data set if the unusual size distributions are caused by an instrument failure (see 8.5).



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8.2 Number concentrations and spectral data

8.2.1 Calculation of particle number concentrations per size range

The particle number concentrations, total as well as in the specified below size ranges, is done by summing up the number concentrations of hourly averaged (see 8.1) instrumental channels which fall into the specified size range.

Number concentrations in the following size ranges are calculated:

PLACEHOLDER

~~Main particle size ranges:~~

~~NC_{0.01-0.5}: total particle number concentration (cm⁻³) in the size range 0.01–0.5 μm~~

~~NC_{0.01-0.1}: particle number concentration (cm⁻³) in the size range 0.01–0.1 μm~~

~~NC_{0.1-0.5}: particle number concentration (cm⁻³) in the size range 0.01–0.1 μm~~

~~Sub particle size ranges:~~

~~NC_{0.01-0.03}: particle number concentration (cm⁻³) in the size range 0.01–0.03 μm~~

~~NC_{0.03-0.05}: particle number concentration (cm⁻³) in the size range 0.03–0.05 μm~~

~~NC_{0.05-0.1}: particle number concentration (cm⁻³) in the size range 0.05–0.1 μm~~

8.3. Quality control

Quality control of the data is achieved on daily basis by:

- checking the critical operation parameters of the instruments (flow rates etc., see 8.3.1)
- visual checks of hourly averaged size distributions (see 8.3.2)

8.3.1. Check for critical operation parameters

The following operation parameters are checked on daily basis:

- Sample flow rate of Climet should be within 10% of the set points of the flow meter.
- sizing accuracy of Climet as determined with PSL is within 20%

If one or more operating parameters are deviating from the nominal, the instrument should be checked and adjusted to the nominal parameters as soon as possible. Data collected with that instrument during the period of malfunction should be corrected, if possible, for the observed deviations (see 8.4).

8.3.2. Visual checks of hourly averaged size distributions

Hourly-averaged size distributions should be checked visually by an experienced operator for persistent (for more than 3 hours in a row) “gaps” i.e. whether the spectra appear to be missing particles at some sizes.



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If such persistent gaps are found the instruments should be checked as soon as possible by an experienced operator. If instrument is found to be malfunctioning, it should be adjusted to normal operation. Data collected with that instrument during the period of malfunction should be corrected, if possible, for the observed deviations from nominal operating parameters (see 8.4). If no malfunctioning is found, data from the instruments is accepted as is and is not rejected.

8.4. Correction of data for recoverable instrumental malfunction

If an instrumental malfunction was found, the data can be corrected for the observed deviation, in the following cases:

- a) Sample flow of Climate deviates by less than 50% from 0.25 cf/min

Corrected data should be marked, the reason and the procedure of correction should be described.

8.5. Data validation

The data are considered invalid, if it is discovered that the instrument was operated outside the nominal operating conditions, for which no correction can be applied (see 8.4), or if one or more critical parts of the instrument were not functioning or were out of order.

8.6. Calculation of particle volume and mass concentrations

8.6.1. Convolution to particle volume distributions

The number concentration distribution data will be convoluted into particle volume distributions assuming spherical particles of the nominal particle diameter of the given size intervals.

8.6.2. Calculation of apparent particle density

From the daily means of the particle volume concentrations and the daily PM_{2.5} measurements an apparent density will be determined for each day which will be averaged over the entire measuring period.

8.6.3. Calculation of particle mass concentrations

Based on the particle volume distribution data and the mean apparent particle density particle mass concentration will be calculated for the following size ranges:

~~Main size ranges:~~

~~MC_{0.1-1.0}: mass concentration ($\mu\text{g m}^{-3}$) in the size range between 0.1–1.0 μm~~

~~MC_{1.0-2.5}: mass concentration ($\mu\text{g m}^{-3}$) in the size range between 1.0–2.5 μm~~

~~Sub particle size ranges:~~



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~~MC_{0.1-0.5}: mass concentration ($\mu\text{g m}^{-3}$) in the size range between 0.1–0.5 μm~~

~~MC_{0.5-1.0}: mass concentration ($\mu\text{g m}^{-3}$) in the size range between 0.5–1.0 μm~~

8.7. Data storage

All original data and the cleaned sets of data will be stored in duplicate on appropriate media for further re-evaluations.