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MEASUREMENT OF PARTICLE NUMBER CONCENTRATION IN AMBIENT AIR USING THE CONDENSATION PARTICLE COUNTER

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1.0 Purpose and applicability

This Standard Operating Procedure (SOP) contains the protocol for performing measurements of total particle number concentration in outdoor air for the EU-multicenter study ULTRA-2.

2.0 Definitions

CPC Condensation Particle Counter
SOP Standard Operating Procedure

3.0 References

Agarwal, J.K. and Sem, G.J. (1980) J Aerosol Sci. Continuous Flow, Single-Particle-Counting Condensation Nucleus Counter *Journal of Aerosol Science* 11, 343-357.

Mertes, S., Schröder, F., and Wiedensohler, A. (1995) The Particle Detection Efficiency Curve of the TSI-3010 CPC as a Function of the Temperature Difference Between Saturator andf Condenser *Aerosol Science and Technology*, 23, 257-261

Wiedensohler, A. Orsini, D., Covert, D.S., Coffmann, D., Cantrell, W., Havlicek, M. Russell L.M., Weber, R.J., Gras, J., Hudson, J.G. and Litchy M. (1997) Intercomparison Study of the Size-Dependent Counting Efficiency of 26 Condensation Particle Counters *Aerosol Science and Technology*, 27, 224-242

4.0 Discussion

Calibration of the instruments is not included in this Standard Operating Procedure. In addition, computer programs that are used to run the CPC are not specified in this SOP.

5.0 Responsibilities

N.A.

6.0 Equipment and materials

6.1 Equipment

a) CPC 3022A –instrument
b) Spare parts: tubings, valves
c) Spare parts: butanol, filters, etc.

6.2 Materials

a) Filters for CPC
b) 1-butanol or n-butanol (‘pro analysis’ -quality)
c) Field form (Figure 1)
d) Field notebook

7.0 Procedures

7.1 Before the campaign

It is recommendable to check the CPC in the laboratory before the campaign by comparing it with other CPC's and/or an aerosol spectrometer to make sure that the CPC is in operational condition. It is advisable to

a) run a table check up for sample flows to determine the nominal flow value for the given CPC using a gilibrator, and
b) intercompare concentration readings on standard aerosol (monodispersed aerosol generated by spectrometer is preferred)

7.2 Daily maintenance of CPC

Observe and record the status of the measurements in the field form:

a) Record date and time
b) Check that the data acquisition program is running (the screen is regularly updated); if the program is not running, try to restart it. If the program doesn't restart, proceed to 7.2.1
c) Check LED indicators of TEMPERATURE and LASER on the CPC's front panel. If a LED is not lit, go to 7.2.1
d) Read sample flow from the display in the CPC's front panel ('SHIFT' – 'STATUS') and record the reading in the field form. The flow should be within ± 20 % of the nominal. If sample flow deviates more than ± 20 % from the nominal value that has been set prior to the campaign, proceed to 7.2.1
e) Fill CPC with butanol and record time and duration of the procedure in the field form. Do not leave the refill bottle connected to the CPC !

7.2.1 When the CPC is not working properly

Possible malfunctioning indicators/situations of the CPC:

- a LED is not lit
- sample flow is incorrect
- CPC has run out of butanol
- data acquisition program has halted

If these, or any other, problems are encountered:

1) Make a reference note in the field form
2) Write all data in the field notebook, and
3) **IMMEDIATELY contact the expert personnel !**

This way we can minimize loss of data and try to track down the episodes when the CPC has not been working properly.

7.3 Weekly maintenance of CPC

a) Drain CPC and refill with fresh butanol (to be done by routine personnel). Record the time and duration of the refill operation in the field form and the notebook
b) Measure the flow rate of the CPC using a low pressure drop flowmeter (Gilibrator). Read the flow also from the CPC's own display. Record both flow readings in the field form.
c) Verify and record zero counts using a filter in front of the CPC
d) Check the sampling line and tightness of all fittings to prevent any leakage

8.0 Analytical procedures

8.1 Calculating hourly mean concentrations

Calculation of hourly and daily average concentrations and data quality management are done according to paragraph 5.10 "Submitting data to coordinating center" (In "Main Contents of the ULTRA II Field Work"). Hourly average concentrations will be calculated if at least 66% of the data for one hour are available.

Strange particle number concentrations must be rejected from the data set only if the unusual concentrations were caused by an instrument failure.

8.2 Data Quality Control

Run a plausibility check of collected data on a daily basis by checking if deviation between three consecutive hourly concentrations of CPC-N_{tot} and parallel running aerosol spectrometer-N_{tot} is within 30 %. If the two instruments deviate for three consecutive hours by more than 30%, both 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 8.3). If no malfunctioning is found, data from both instruments is accepted as is and is not rejected. However, it should be marked appropriately to indicate the discrepancy between the two instruments.

8.3 Correction of data for recoverable instrumental malfunction

If an instrumental malfunction was found, the CPC concentration data can be corrected for the observed deviations if the sample flow deviates more than ± 20 % from the nominal flow. Corrected data should be marked, and the reason for and the procedure of the corrections should be described.

8.4 Data validation

Daily average total number concentrations measured by the CPC 3022A and a parallel running aerosol spectrometer should not differ more than 30 %. If there is no instrumental

reason for a larger difference in the average concentrations, those data should be marked in the data set but not be rejected.

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, or if one or more critical parts of the instrument (i.e. laser of CPC, pumps, empty butanol reservoir of CPC, etc.) were not functioning or were out of order.

8.5 Data management and storage

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

9.0 Attachments

Figure 1. Field form for daily and weekly operation and maintenance CPC 3022A.
Figure 2. Local and temporal deviation from or local change of the SOP.
Figure 3. SOP confirmation sheet

Figure 1. **Field form for daily and weekly operation and maintenance of CPC 3022A**

A. DAILY MAINTENANCE

DATE (dd.mm.yy)	TIME (hh:mm)	CPC program running ? (Yes / No)	Laser & Temp LEDs are on? (Yes / No)	Flow Rate CPC (cm^3/min)	CPC Refill Start time (hh:mm) Duration (min)	**NOTES** (If needed, use to the notebook and refer to it here) **OPERATOR'S INITIALS**

B. WEEKLY MAINTENANCE **WEEK** _____ **DATE** _____

CPC Drain & Refill Start time (hh:mm) Duration (min)	Flow Rate Standard (cm^3/min)	Flow Rate CPC (cm^3/min)	Zero count (particles/cm^3)	Sampling line OK ? (Yes / No)	**NOTES** (If needed, use the notebook and refer to it here) **OPERATOR'S INITIALS**

C. EXTRA NOTES

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Figure 2. Local and temporal deviation from or local change of the SOP.

Identification code:	Center: _____
Deviation Change No:___ pages___	Approval by Principal Investigator
Begin date: __/__/__ End date:__/__/__	Date and Signature:__/__/__ _____
Original text(s); full paragraph, page No:	Changed text(s), full paragraph:

Figure 3. SOP confirmation sheet.

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This SOP has been received by Principal Investigator of

Research center _____ Date ___ / ___ / _____

Signature of PI: _____

INSTRUCTIONS :

0) **Keep this sheet attached to the original copy of the corresponding SOP**
1) When copying the SOP, mark the date of copying for each copy, number each copy
2) When delivering the SOP copy, take the signature and mark the date
3) When delivering a new revision to this SOP, collect previous SOP copies away and confirm with signature and mark the date
4) After each change fax this sheet to coordinator

Copy	Date of the copy	Delivered to Signature	Date of delivery	Received back PI signature	Received back Date
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