Japanese Comments on the draft "Particle Number Counter Calibration Procedure" proposed by AEA

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Major points

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1. What is described in Chapter 4 is not 'calibration' but 'validation'.

'Calibration' of an instrument is to determine quantitatively the relationship between measurement value of the instrument and the true value, of which the purpose is often to compensate measurement error. On the other hand, 'validation' is to judge whether the performance of an instrument meets certain specifications. Chapter 4 describes methods to check whether a PNC meets PMP specifications (i.e., the linearity and lower cut-off diameter). Therefore, the correct term for it is 'validation' rather than 'calibration'.

2. PMP should consider validation by qualified third-party personnel.

The current validation procedure does not have a mechanism that assures the quality of the validation result. PMP should consider allowing validation being performed by qualified third-party personnel, who have enough equipment and proved skills.

3. The material of particles used in validation must be specified.

In the current draft, the procedure for the lower cut-off diameter test (Section 4.3) only states that "The aerosol used must be of the same material used by the manufacturers for determining the cut-off characteristics of both test and transfer PNCs." Since there is currently no rule or consensus that imposes a certain material on PNC manufactures for evaluation of the lower cut-off diameter, the material can vary among the manufactures. On the other hand, experimental data are being accumulated among researchers that show clear dependence of the cut-off characteristics on the material. This means that validation results may depend on the selection of the material. PMP should initiate discussion among experts for choosing the most appropriate material for the PMP purpose.

4. It is inconsistent and unnecessary to do validation at concentration below 10^3 cm^{-3} in the secondary linearity test method (Section 4.2).

- The inconsistency in the concentration range between the primary and secondary methods must be resolved. If validation at concentrations below 10^3 cm^{-3} is really necessary, it means that the primary method is not acceptable, and only the secondary method should be allowed. If, for some reason, both methods must be allowed, then the concentration ranges should be the same, with the lower limit at 10^3 cm^{-3}.
- Apart from the fact that calibration with an AE at concentrations below 10^3 cm^{-3} is difficult, calibration at the low concentrations is not necessary if a good linearity is observed at concentrations between 10^3 and 10^4 cm^{-3}, and if the offset at zero concentration due to false counts is negligible. It is true that the random scattering error may be large at the low concentrations because the number of detected particles per unit time is low. This error, however, is not systematic and the average of it is zero, which means that the linearity is not affected by this error.

Minor comments

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- The addition of an aerosol charge neutralizer after the DMA in the secondary linearity test method (Section 4.2, Figure 3) needs justification.

It is known that the particle charge state influences the PNC detection efficiency in the size

range below 10 nm (see, for example, Stolzenburg and McMurry (1991), Aerosol Sci. Technol., Vol. 14, pp 48-65), but we are not aware if it occurs too at particle sizes above 10 nm. Without convincing data being presented, we propose to eliminate the neutralizer after the DMA because it just adds more complication than simplification.

- Requirements on the sizing accuracy of the DMA must be specified.

There is no specification given to the DMA used in validating the PNC, while the validation results may be affected by error of the DMA sizing. ISO CD15900 provides some clue for methods in testing the DMA sizing accuracy.

- There should be a process to check that the contamination of multiply-charged particles is negligible in the primary linearity test method (4.1).

The assumption of negligible contamination by multiply-charged particles relies on the performance of the electrospray, which may sometimes fail. Therefore, there should be a mechanism to check the monodispersity of electrosprayed particles, for example by measurement of size distribution with an SMPS and comparison of the geometric standard deviation with a certain criterial value.

- Regarding the accuracy of the PNC (quotation of PMP specification 1.3.4.2 in Section 3.1)

There are two accuracies at 10 cm^{-3}; "*± 10 cm^{-3} across the range 10 cm^{-3} to 100 cm^{-3}*" and "*± 2 cm^{-3} below this concentration range*". Why is the accuracy discontinuous like this?

- Regarding the quotation 2.1.1 of PMP specification on PNC calibration in Section 3.2

"traceable to a ... method" is not a commonly acceptable form of traceability in metrology.

- Regarding the quotation 2.1.1 of PMP specification on PNC calibration in Section 3.2

What is the basis of the value of 0.97 which is the minimum requirement of the R^2 value?

- Regarding the experimental setups in Chapter 4

The equivalence of the two flow paths after the flow is split to the PNC under validation and the reference PNC/AE must be checked in terms of particle penetration. It can be done by switching the flow tubes and checking if the result is still the same.

- Regarding "It may also be necessary to take into account the pathway within each instrument from the inlet to the measurement volume, if there are significant differences between the instruments." in Chapter 4, the second general points

A PNC should be considered as a non-separable unit beginning at the very edge of the inlet tube. It is inappropriate that evaluation of only the measurement volume is attempted.

Additional Information: Calibration service by AIST will begin in October 2007.

AIST(Advanced Industrial Science and Technology, Japan) will begin calibration service for aerosol particle number concentration this October. The overview of the procedure and the calibration capability is as follows:

- Calibration is done by comparison directly to Japan's primary standard, which is the Faraday-cup aerosol electrometer developed by AIST, with DMA-classified charged particles, at several condition points that are specified by particle size and concentration.

- Target instruments: PNC or AE
- Particle size range: 10 - 200 nm
- Concentration range: 10^3 - 10^4 cm^{-3}
- Flow rate range: 1.0 - 1.5 L/min
- Typical expanded uncertainty (k = 2): less than 5%

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