National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Using measurement uncertainties in the MQO

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Measurement uncertainty PM10

Fixed measurements PM10/PM2,5: Uncertainty 25% (2008/50/EC)

The uncertainty (expressed at a 95 % confidence level) of the assessment methods will be evaluated in accordance with the principles of the CEN Guide ... The percentages for uncertainty in the above table are given for individual measurements averaged over the period considered by the limit value (or target value in the case of ozone), for a 95 % confidence interval. The uncertainty for the fixed measurements shall be interpreted as being applicable in the region of the appropriate limit value …

Demonstration of equivalence

A Member State may use any other method which it can demonstrate gives results equivalent to any of the methods referred to in Section A or, in the case of particulate matter, any other method which the Member State concerned can demonstrate displays a consistent relationship to the reference method. In that event the results achieved by that method must be corrected to produce results equivalent to those that would have been achieved by using the reference method.

I.E. The measurement values of the reference and other method are, if necessary after correction, equivalent and the uncertainty of the other method does not exceed 25% (95%CI).

MQO Yearly average concentrations

Model Quality Objective: $MQO = \frac{|M - O|}{2RMS_U}$

<= 1 → **OK**

> 1 → **!OK**

Zone	Bias	Standard deviation	Correlation	MQO	Ref
1	$\frac{Bias^2}{(2RMS_U)^2} \le 1$	$\frac{(\sigma_M - \sigma_O)^2}{(2RMS_U)^2} \le 1$	$\frac{\sigma_O^2(1-R)}{2RMS_U^2} \le 1$	$MQO \le 1$	(10)
2	$0.5 < \frac{Bias^2}{(2RMS_U)^2} \le 1$	$0.5 < \frac{(\sigma_M - \sigma_O)^2}{(2RMS_U)^2} \le 1$	$0.5 < \frac{\sigma_M\sigma_O(1-R)}{2RMS_U^2} \le 1$		(11)
3	$\frac{Bias^2}{(2RMS_U)^2} \le 0.5$	$\frac{(\sigma_M - \sigma_O)^2}{(2RMS_U)^2} \le 0.5$	$\frac{\sigma_M\sigma_O(1-R)}{2RMS_U^2} \le 0.5$	$MQO \le 0.5$	(12)

Formulation of $U_{measured}$

PM10G: Gravimetric
PM10T: TEOM
PM10B: Beta-ray

Expression for measurement uncertainty:

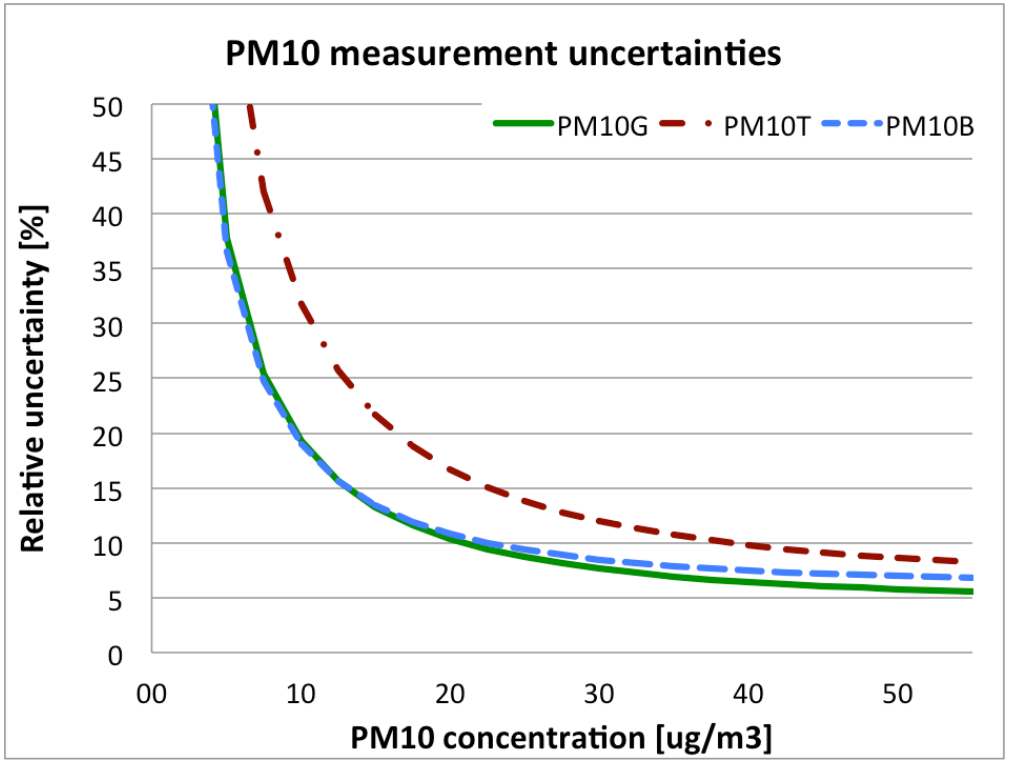
$$RMS_U = U(\overline{O}) = ku_r^{RV}\sqrt{\frac{(1-\alpha)}{N_p}\overline{O}^2 + \frac{\alpha * RV^2}{N_{np}}}$$

Hourly/daily values:

	k	! ¦ "	LV (ug/m3)	#	Np	Nnp
NO2	2.00	0.120	200	0.040	1	1
O3	1.40	0.090	120	0.620	1	1
PM10	2.00	0.140	50	0.018	1	1
PM25	2.00	0.180	25	0.018	1	1

Yearly average values:

	Average	Np	Nnp
NO2	Yearly	5	12
PM10	Yearly	40	1
PM25	Yearly	40	1



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Yearly average values:

	Average	Np	Nnp
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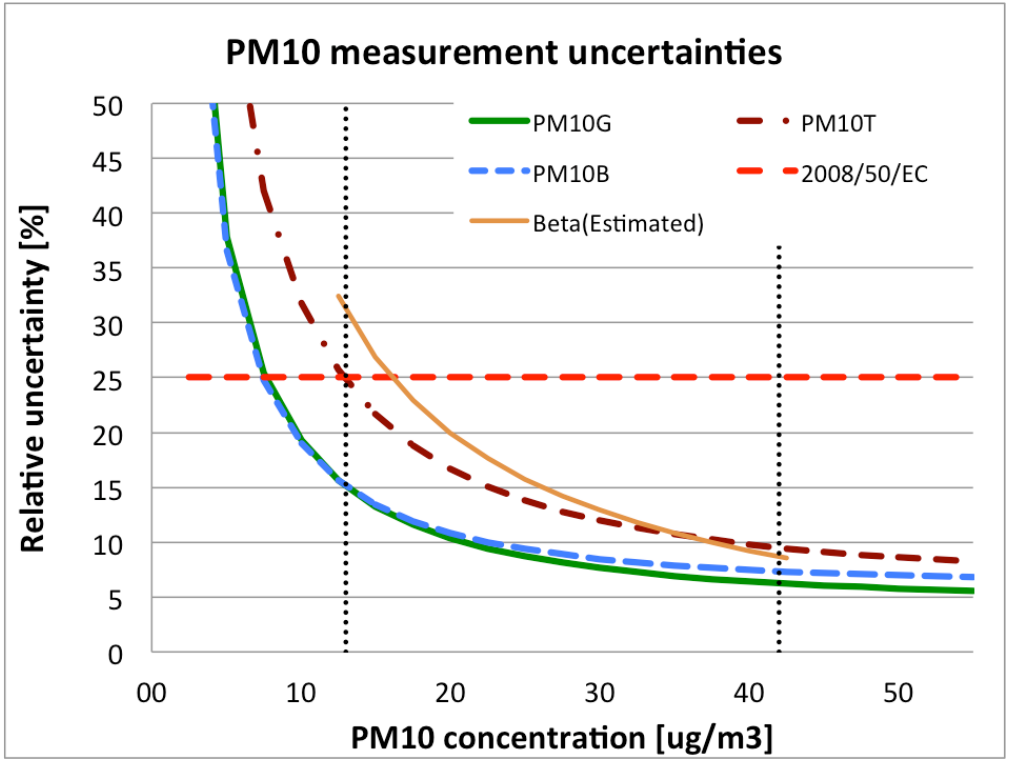

Model uncertainty

- Air quality models need background maps, also for PM10.
- In the Netherlands, these maps are calibrated using the equivalent PM10 measurements.
- The uncertainty in the maps is linked to that in the PM10 measurements.
- The official uncertainty in the PM10 maps is 30% (95%CI), in practice it is slightly better, roughly 25%(95%CI).

- From the definition of the MQO it follows that at MQO = 1 the allowed model uncertainty (95%CI) is roughly twice as large as the measurement uncertainty (95%CI).

Model uncertainty

- Using the measurement uncertainty of the reference method as a basis, the Dutch models may/may not fully comply with MQO <= 1. Estimated ~10%, year, @20 ug/m3.

- Using the measurement uncertainty of the actually used beta-ray method as a basis, the Dutch models will comply with MQO <= 1. Estimated ~20%, year, @20 ug/m3.

Conclusions

- It is not logical to use the uncertainty in the reference method to assess models when all measurements and calibrations are performed using results of equivalent methods, of which the uncertainty is allowed to exceed the actual uncertainty of the reference method, as long as it conforms to 2008/50/EC.

- The uncertainty of the method used for the actual PM10 measurements should be used in the evaluation of the MQO for PM10.

- Alternative: Link the MQO to results from a model-benchmark, in stead of to measurement uncertainties.

THANK YOU