PM_{10} measurement methods and correction factors:

2009 status report

ETC/ACM Technical Paper 2011/21

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Front page picture:
Particulate Matter filters as used in air quality measurement monitors. (The reference methods for sampling and measuring PM10 (EN12341, 1998) and PM2.5 (EN14907, 2005) in ambient air is based on a 24-hour sample collection and gravimetric analysis)

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Summary

Although the current European reference methods for sampling and measuring PM10 (EN12341, 1998) and PM2.5 (EN14907, 2005) in ambient air is based on a 24-hour sample collection and gravimetric analysis, the monitoring networks often use continuous automated monitors to provide real-time information. The measurements obtained with these techniques may show a large deviation from the reference method and the networks should demonstrate that the automated instruments can produce results that are comparable to the reference method. This process is called *Demonstration of Equivalence* and mainly consists of performing comparative measurements between the reference method and the automated monitors. There is no specific mandatory procedure to perform the test of equivalence, but a guidance document produced by the Working Group on Guidance for the Demonstration of Equivalence (EC Working Group 2010) is available.

The present technical paper is based on information extracted from the questionnaire (QFWD) prepared by EU Member States (MS) obtained under the Framework Directive (EU, 2004) and reflects the situation for 2009 monitoring data. Information on PM10 measurements and correction factors (CF, to be applied to the non-gravimetric measurements) reported in the QFWD were submitted by 28 countries. Some countries also reported information on PM2.5 measurements and correction factors (CF) to QWFD.

Although the above EC guidelines suggest a basic protocol, there is no single procedure for calculating CF by the Member States. Countries calculate the CF by applying different strategies, according to their networks and instruments, but references to their strategies are in general not reported. Although the guidance suggests performing side-by-side inter-comparison exercises, a high number of countries reported a unique CF for network and type of measurement technique. The evaluation of the CF applied by the Member States for PM10 reveals that CF varies considerably, fluctuating between 0.57 and 1.63, with a median of 1.03. For PM2.5 the CF reported varied from 0.65 to 1.60, with a median of 0.99. This variation of the CF may be partially caused by the measurement technique and conditions, although there is no clear difference between the three most widely used methods (TEOM, beta-attenuation and light scattering). An influence of the site type (rural, urban, traffic, industrial) on the CF is not evidenced. In addition, no clear pattern regarding the spatial variation of the CF across Europe was observed. Only a number of sites report the evidence of a seasonal variation for CF. For the rest of the sites, reporting one single CF, it is not specified whether this CF is actually constant throughout the year or whether the inter-comparison exercises were performed during one season and then extrapolated to the entire year.

The results from this study evidence that CF depend on the specific instrument and site. The applicability of a unique CF for a given network of a Member State, a relative common practice among countries, is questionable. That implies that, as recommended in the Guidance for the Demonstration of Equivalence (EC Working Group 2010), inter-comparison exercises should be carried out.

General conclusions are:

1. It is necessary to perform the demonstration of equivalence at each site for each automated instrument. It is strongly advisable to perform the demonstration of equivalence following the recommendations of the Guide on Demonstration of equivalences (EC Working Group, 2010).
2. MS that are reporting the default CF or a unique CF for network or instrument should perform more inter-comparison exercises. The same applies to countries that are not reporting enough CF.
3. The CF may vary with time due to changes in the instrument and other factors; therefore it is necessary to perform the test with a defined frequency. Periodic side-by-side comparisons should be carried out between the reference and the equivalent methods to confirm that the calibration is still valid.
4. Some recommendations for future reporting in the questionnaire may be provided:
   4.1. Supply references, accessible, for the demonstration of equivalence.
   4.2. Indicate if the CF is the default factor or not.
   4.3. Indicate if there is or not seasonal variation, or if it has not been tested.
   4.4. Define the codes of the additional automated instruments not listed now, to avoid the extra codes meaning different things for different MS.
5. To conclude, as regards the questionnaire reporting, it seems that most countries in general are either not carrying out correction of automated instruments, or reporting correction factors correctly. An effort in reporting is clearly necessary, as it is difficult to understand the information provided by the MS.

1 Introduction

The Council Decision 97/101/EC (EU, 1997) established a procedure to exchange information on air quality between the Member States (the “Exchange of Information decision” or EoI decision). Technical details such as pollutants covered, information on stations and networks within a country to be communicated by the Member States are specified in the annexes of the Decision. These annexes were amended by Commission Decision 2001/752/EC (EU, 2001).

According to these documents, data on concentrations of atmospheric pollutants obtained in the different countries and provided to AirBase must be measured with comparable and harmonized techniques.

As regards the pollutant PM10 (particulate matter with aerodynamic diameter below 10µm), the Directive 2008/50/EC (EU 2008) established in Annex VI, section A, that the reference method for the sampling and measurement of PM10 is that described in EN 12341:1998 "*Air Quality – Determination of the PM10 fraction of suspended particulate matter – Reference method and field test procedure to demonstrate reference equivalence of measurement methods".* The reference method for the sampling and measurement of PM2.5 (particulate matter with aerodynamic diameter below 2.5µm) is that described in EN 14907:2005 *‘Standard gravimetric measurement method for the determination of the PM2.5 mass fraction of suspended particulate matter’.*

Although the current European reference method for measuring PM10 (EN12341, 1998) and PM2.5 (EN14907, 2005) in ambient air is based on a 24-hour sample collection and gravimetric analysis, the monitoring networks generally use continuous automated monitors to provide real-time information. There are different methods to measure PM10 and PM2.5, using other operation principles than the reference method. Consequently, measurements obtained with these techniques may show a large deviation from the reference method (as described in CEN standard EN 12341; EU, 2003). Therefore, the networks should demonstrate that the automated instruments can produce results that are comparable to those of the reference method.

Thus, as stated in Annex VI, section B “Demonstration of Equivalence” from the Directive 2008/50/EC (EU 2008):
“1. 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.
2. The Commission may require the Member States to prepare and submit a report on the demonstration of equivalence in accordance with paragraph 1.
3. When assessing the acceptability of the report mentioned in paragraph 2, the Commission will make reference to its guidance on the demonstration of equivalence (to be published). Where Member States have been using interim factors to approximate equivalence, the latter shall be confirmed and/or amended with reference to the Commission's guidance.*
4. Member States should ensure that whenever appropriate, the correction is also applied retroactively to past measurement data in order to achieve better data comparability.”

*The original text reads ‘to be published’, but it is currently published: The Guidance for the Demonstration of Equivalence by EC Working Group (2010), available at http://ec.europa.eu/environment/air/quality/legislation/pdf/equivalence.pdf.

The process to demonstrate that automated measurements produce results comparable to the reference methods is called *Demonstration of Equivalence* and mainly consists in performing comparative measurements between the reference method and the automated monitors. There is no mandatory procedure to perform the test of equivalence. The current recommended, but not mandatory, procedure for this can be found in the 'Demonstration of equivalence of ambient air monitoring methods" (http://ec.europa.eu/environment/air/quality/legislation/pdf/equivalence.pdf) report by EC Working Group on Guidance for the Demonstration of Equivalence (2010).

Guidelines for demonstration of equivalence

Before the current directive, the Directive 1999/30/EC, the first Daughter Directive of the Air Quality Framework Directive 1996/62/EC, required Member States to implement programmes for the monitoring of ambient air particulate matter from 19 July 2001, to report data over one calendar year to the Commission and make information available to the public. The Directive set out the methodologies and techniques for measuring data either through reference method instrumentation or the use of instruments for which equivalence to a reference instrument could be demonstrated.

To this end, the Working Group on Particulate Matter provided guidance on PM10 monitoring and intercomparisons with the reference method (EC working group, 2001), which would enable Member States to establish factors or equations by which they would relate the results of their continuous measurements to the reference procedures. The approach described a recommended set of principles to be adopted by MS in carrying out their own intercomparison exercises with reference methods. These may be summarized as follows:

• Parallel measurements of the continuous instrument and the gravimetric reference instrument should be performed at least at two sites per Member State, or Region in a larger Member State, which are representative, as far as possible, for the majority of conditions in the Member State or Region.
• As a minimum requirement there should be two sets of intercomparison measurements; one set should be performed during a cold season (such as winter), and one set during a warm season (such as summer). The Member State or Region should also check for variations in the correction factors/equations obtained at different geographical locations. If there are indications that conditions (composition of aerosols, climatic factors, etc.) vary significantly from site to site within the network, then the Member State or Region should check whether the same correction factor/equation can be applied to all sites.
• The minimum number of validated data points (pairs of daily averages) per summer and winter data set should not be less than 30 at any location.
• The correlation between candidate and reference instruments is regarded as valid if the regression or determination coefficient R^2 is >0.8 and the intercept is within -5 $\mu g/m^3$ and 5 $\mu g/m^3$. The fulfillment of these criteria means that the data can be used to determine the relationship between the two methods.
• The correction factors/equations used for correct the data obtained with the candidate measurement may be equations such as Y=aX + b; Y=aX; or the mean ratio of daily means over the study period.
• Routine monitoring with continuous measurement will start with the correction factors/equations determined as described above. However, the Member State or Region should check periodically during the routine operation of the network to ensure whether the correction factors/equations once determined are stable over time scales longer than those used in the original study.

At that time, the Working Group recognized that some Member States might not have started any programme of equivalence or intercomparison measurements, or had only a few data from limited geographical locations and field test conditions. In the event that Member States had not been able to agree in corrections to their automatic data before they had to report data to the Commission, as required by the Daughter Directive, default procedures could be used. On the basis of information supplied by the member states on reference measurements or equivalence monitoring the Group accordingly concluded that a **default correction factor of 1.3** could be applied to automated measurements. This single factor could be applied to both daily averages and to annual means obtained by the automated measurement techniques. This CF has no technical-scientific basis, but was suggested as a penalty-like CF for those State Members not carrying out their own intercomparison exercises.

In 2005, the EC Working Group on Guidance for the Demonstration of Equivalence prepared a guide to harmonize the process of demonstrating the equivalency of the candidate method with the reference method. The EC Guidance for the Demonstration of Equivalence of Ambient Air Monitoring Methods was first published in 2005, reviewed in 2009 and finally published in 2010 in its latest version. This document defined, for the first time, the equivalent method as: "*An equivalent method to the reference method for the measurement of a specified air pollutant, is a method meeting the data quality objectives for fixed measurements specified in the relevant air quality directive'.*

This guidance refers to different atmospheric pollutants, not only to particulate matter. As regards for PM, a procedure (Test program 3) is presented for determining whether a candidate method (CM) is suitable to be considered equivalent to the reference method for the measurement of particulate matter in ambient air, using manual or automated measuring systems. The approach described enables the establishment of relationships with the reference method that can be applied to "calibrate" the CM in order to meet the uncertainty data quality objective. The term "correction" has been used historically, but is replaced in the context of demonstrating equivalence of CM for monitoring PM by the term "calibration".

This test program is suitable to evaluate CM for monitoring the PM10 or PM2.5 fraction of total suspended particulates in ambient air. This methodology may be used to evaluate: alternative sample inlets, with characteristics differing from those specified in PM10 and PM2.5 standards for the reference sampler; automated methods such as those based on the use of oscillating microbalances or ß-ray attenuation; and other methods, such as in-situ optical methods. Minor parts of the reference method can be modified resulting in 'variations on a theme'. Possible variations are the use of different sampling media/substrates, the use of different PM filter storage procedures or the use of automated filter changers for manual PM samplers.

The procedure sets the experimental conditions to carry out the demonstrations of equivalence. A minimum of 4 comparisons at a minimum of 2 sites shall be performed preferably in different climatic seasons. Test sites shall be representative for typical conditions for which equivalence will be claimed, including possible episodes of high concentrations. All results obtained shall be averaged over a period of 24 hours. In each comparison a minimum of 40 valid daily data pairs (a data pair representing at least one result from the reference method and one from the candidate method from the same 24-hour period) shall be obtained.

It is also precisely described how to perform the comparison with the standard method. The procedure states when the candidate method may be accepted as equivalent to the reference method and, if not, how it may be calibrated by applying the regression equation to the complete data set obtained by combining all results of the candidate method. To facilitate the use of the test program for checking the equivalence of the candidate methods for PM monitoring, an Excel macro was made available.

The EC Working Group on Particulate Matter 2001 document concludes the requirement for ensuring the ongoing verification of the particulate measurement results obtained using the equivalent method. This is particularly important because the equivalence procedure depends only on field tests between the reference and equivalent method, and there is limited QA/QC (quality assurance and control) that can be carried out on a routine basis (flow calibration, calibration of temperature and pressure sensors). In addition, the equivalence tests were necessarily carried out under a limited range of particulate compositions, which may not continue to be representative for the current conditions. Therefore, it is necessary that periodic side-by-side comparisons are carried out between the reference and the equivalent methods to confirm that the equivalence claims are still valid. The fraction of sites to be tested under this regime (with a minimum) will depend on the degree of equivalence with the reference method, i.e., with the uncertainty obtained as a result of the combined equivalence tests performed.

Although not mandatory, MS are requested to provide information on PM10 CF which have been applied to the results from automated instruments. For proper information to AirBase users, The European Topic Centre on Air and Climate Change (ETC/ACC) produced a first overview (Buijsman and de Leeuw, 2004) of current practices with respect to the (automated) PM10 measurement data which are present in AirBase. This paper was based on the information submitted in the 2003 EoI-data exchange cycle and on an enquiry amongst data suppliers of PM10 measurement data in the EEA member countries. During the EoI-2004 update cycle (on 2003 data) the ETC/ACC was informed on changes in PM10 reporting procedures by various Member States. The first report by Buijsman and de Leeuw covering the PM10 data for the year 2002 might therefore not longer reflect the current situation in a correct way. In an ETC/ACC technical paper by de Leeuw (2005) new information obtained from the data suppliers is combined with information extracted from the questionnaire prepared by EU Member States under the Framework Directive (EU, 2004).

This report is based on information extracted from the FWD questionnaire, submitted by EU Member States obtained under the Framework Directive (EU, 2004 The report reflects the situation on 2009 monitoring data.

2 Methods

The present report is based on information taken from the QFWD questionnaire for the year 2009. Although they were not the objective of the present study, a number of reporting and formal inconsistencies were evidenced in the questionnaire; these are listed in Annex II. Information on PM10 measurements and correction factors (CF) reported in the QFWD were submitted by 28 countries (EU27 Member states and Norway). The collected information was summarized in a spreadsheet, using codes for the different measurement methods available.

PM10 concentration data reported to AirBase are measured by different methods. Correction factors will directly depend on the measurement technique. The first step in this overview has been to classify the measurement techniques used by the Member States. This study is based on the instruments reported in the QFWD. The different measurement techniques are identified in the questionnaire by specific codes, which are common for the most frequently used techniques. Nevertheless the codes may vary for specific techniques in different networks, which rendered the interpretation and summary of results more complex.

The measurement methods most commonly used in the different networks are: Gravimetry (reference method), Beta-attenuation (or Beta-absorption), TEOM (Tapered Element Oscillating Microbalance), TEOM-FDMS (TEOM with Filter Dynamics Measurement System), and Light Scattering. A description of these methods is available in de Leeuw (2005). In the present work, the automated instruments have been classified in these five groups following the criteria described below. A sixth group named as “Others” includes instruments which cannot be classified in any of these groups.

- Gravimetry: this group includes the reference method and other equivalent (or not) gravimetric methods with both high and low volume instruments. Information on which kind of instrument was used was not provided by all Member States.
- Beta absorption (code M1): this group includes also Beta absorption with RST module (Temperature Regulated Sampling Tubes, code M1a for FR), ß-Absorption + Nephelometer (code M30 for AT and IS, and code M1a for DE), and Light scattering photometry and Beta (code LB, for FI)
- TEOM (not including TEOM FDMS, code M3 for all Member States). TEOM FDMS has not been considered in this group because CF reported for these instruments was usually 1.
- TEOM FDMS (code M3a). It is important to notice that some Member States reported code M3a in the QFWD but this is equivalent to TEOM in AirBase; it is not clear in these cases if the measurement instrument used is TEOM, with or without FDMS.
- Light scattering: this group comprises measurements labelled as GRIMM monitors (code M31 for BE), light scattering (code M1b for DE), scattering efficiency (code O1 for ES) and Laser spectroscopy (code LS for FI).
- Others: these methods refer to Nephelometry (code Mnef for IT), unknown method (code Y for IT), PM10 estimated from TSP (code MPL1 from PL), PM10 estimated from Black smoke (code MPL2 from PL), and black smoke (code BS for PL). These methods have not been considered in this report given that no CF is provided for any of them.

Three important considerations have to be taken into account to interpret results obtained in this study:

1. A number of networks report a CF of 1.3 (to be applied to the automatic measurement), corresponding to the default factor suggested by EC Working Group on particulate matter in the Guidance to member states on PM10 monitoring and intercomparisons with the reference method (2001). In the QFWD, no information is provided on whether this is the default factor or whether intercomparison exercises were carried out and a factor of 1.3 was obtained. There is a general misunderstanding of the meaning of the 1.3 default CF. This CF has no technical-scientific basis, but was suggested as a penalty-like CF for those Member States not carrying out their own intercomparison exercises. In the Directive 2008/50/EC and in the recent Guidance on demonstration of equivalence (EC Working Group) it is not considered the use of a default CF.
2. Some networks using TEOM FDMS report a CF of 1; however other networks do not report any CF for this kind of instruments.
3. In addition to the case of TEOM FDMS instruments, CF of 1 were frequently reported for other instruments. Once more, based on the current data it is not possible to conclude whether this is the result of intercomparison exercises or whether it indicates that no intercomparison was performed.

3 Results

3.1 Measurement sites and correction factors reported

Table 1 summarizes the reporting of PM10 data and correction factors (CF) by Member States under QFWD. A total of 28 countries reported PM10 measurements in the QFWD and to AirBase, with the exception of NO, reporting PM10 data in AirBase but for which no PM10 measurements were indicated in Form 3 in the QFWD.

Table 1. Total number of measurement sites (reporting any pollutant) and instruments reporting PM10 under the FWD Questionnaire. Number of total automated instruments and number of automated instruments reporting correction factor (CF).

Member State		QFWD	QFWD	QFWD	QFWD	QFWD	References /comments
		Sites	Reporting PM10	Automated instruments	Reporting CF	Reporting CF (%)	
Austria	AT	144	143	93	49	53	
Belgium	BE	65	58	57	57	100	a)
Bulgaria	BG	42	42	28	28	100	
Cyprus	CY	5	2	-	-	-	
Czech Republic	CZ	123	123	80	-	-	
Denmark	DK	10	7	9	9	100	
Estonia	EE	7	7	6	6	100	
Finland	FI	30	26	26	26	100	
France	FR	378	373	373	-	-	
Germany	DE	447	437	344	343	100	b)
Greece	GR	18	17	17	-	-	
Hungary	HU	25	25	24	24	100	
Iceland	IS	8	8	7	-	-	
Ireland	IE	18	16	5	4	80	
Italy	IT	406	390	308	-	-	
Latvia	LV	9	9	9	9	100	
Lithuania	LT	15	14	14	14	100	
Luxembourg	LU	6	6	3	-	-	
Netherlands	NL	52	44	41	41	100	c)
Norway	NO	30	-	-	-	-	
Poland	PL	320	300	158	-	-	
Portugal	PT	56	52	52	49	94	
Romania	RO	73	50	-	-	-	
Slovak Republic	SK	32	32	32	-	-	
Slovenia	SI	14	13	10	10	100	d)
Spain	ES	450	415	297	294	99	e)
Sweden	SE	40	37	20	20	100	
United Kingdom	GB	82	71	92	59	64	

a) Comparative PM10 and PM2.5 measurement in Flanders (Belgium) Period 2008-2009
b) Parallel operation of different measuring methods (PM10), but method used for equivalence is not referred
c) RIVM Report 680708001/2007
d) Correction factors are 1.30 or are determined with referential monitors Leckel according to the GUIDE TO THE DEMONSTRATION OF EQUIVALENCE OF AMBIENT AIR MONITORING METHODS, JULY 2009.
e) Correction factor report 2009:"Informe MURCIA 2/2009 sobre determinación del factor pertinente entre el captador de referencia para PM_{10} y el analizador de partículas PM10 de la estación de contaminación atmosférica de Aljorra (Murcia))"; Correction factor determined by report:'Determinación de los factores de corrección de medida de PM10 por el método de atenuación de la radiación beta'; Correction factor report 2009: "ANALISIS INTERCOMPARACIONES CANARIAS"; Correction factor report 2009. N/Ref.: C-024/2010; Correction factor studies carried out by Universidad de Navarra; Correction factor report 2009."Intercomparación Albacete"; Correction factor report 2009."Intercomparación Toledo"

Excluding NO, most countries reported PM10 data measured by automatic monitors, with the exception of CY and RO using only gravimetric methods. A total of 18 Member

States reported CF for all or for a part of the automatic instruments measuring PM10 in their networks. Only 4 countries listed references (see section 3.2).

Table 2 shows the number of monitoring sites reported in QFWD by each Member State and the number of instruments used grouped as described in the Methods section: Gravimetry (reference method), Beta-attenuation (or Beta-absorption), TEOM (Tapered Element Oscillating Microbalance), TEOM FDMS (TEOM with Filter Dynamics Measurement System) and Light Scattering. “Others” refers to other methods such as Black smoke (BS) and PM10 recalculated from TSP (Total suspended particulates) and form BS in Poland.

Table 2. Total number of measurement instruments reporting PM10 and number of instruments for each measurement technique reported in QFWD.

Member State		Total number of instruments reporting PM10	Number of instruments					
			Gravimetry	Beta -absorption	TEOM (NO FDMS)	TEOM FDMS	Light scattering	Others
Austria	AT	143	50	33	21	39		
Belgium	BE	58	1	25	6	12	14	
Bulgaria	BG	42	14	28				
Cyprus	CY	2	2					
Czech Republic	CZ	123	43	80				
Denmark	DK	7		7	2			
Estonia	EE	7	1	6	0			
Finland	FI	26		6	18		2	
France	FR	373		48	9	316		
Germany	DE	437	171	229	65		25	
Greece	GR	17		17				
Hungary	HU	25	1	23	1			
Iceland	IS	8	1	7				
Ireland	IE	16	11			5		
Italy	IT	390	66	260	44			4
Latvia	LV	9		9				
Lithuania	LT	14		14				
Luxembourg	LU	6	5		3			
Netherlands	NL	44	3	41				
Norway	NO	-						
Poland	PL	300	142	36	36	7		79
Portugal	PT	52		49		3		
Romania	RO	50	50					
Slovak Republic	SK	32				32		
Slovenia	SI	13	4		8	2		
Spain	ES	415	119	204	74		19	
Sweden	SE	37	17	2	15	3		
United Kingdom	GB	71	8	1	33	58		

Some countries also reported PM2.5 measurement instruments to QWFD (see Table 3), certain of them reporting CF for all their instruments (BE, BG, DK, EE, DE, HU, IE, LV, LT, SE, and GB). On the contrary, some countries did not report any CF, such as

AT, FR, IT, LU, PL and SK for TEOM, and CZ, GR, IS, IT, PL and PT for beta. FI reported CF for 33% of the beta instruments and ES reported CF for 63% of the beta instruments and 46% of the TEOM instruments. CF reported varied from 0.65 to 1.60, with an average value of 0.99.

Table 3. Total number of measurement instruments reporting PM2.5 and number of instruments measuring PM2.5 for each measurement technique reported in QFWD.

Member State		Total number of instruments reporting PM2.5	Number of instruments					
			Gravimetry	Beta - absorption	TEOM (NO FDMS)	TEOM FDMS	Light scattering	Others
Austria	AT	12	10			2		
Belgium	BE	32	5	3		10	14	
Bulgaria	BG	9	4	5				
Cyprus	CY	4	4					
Czech Republic	CZ	31	8	23				
Denmark	DK	11		8	3			
Estonia	EE	3		3				
Finland	FI	7		3	5		1	
France	FR	85			2	83		
Germany	DE	116	44	50	7		13	
Greece	GR	4		4				
Hungary	HU	3		3				
Iceland	IS	5		5				
Ireland	IE	5	3			2		
Italy	IT	81	15	64	2			
Latvia	LV	7		7				
Lithuania	LT	7	4	3				
Luxembourg	LU	3	2		1			
Netherlands	NL	31	31					
Norway	NO	0						
Poland	PL	46	37	6	3			
Portugal	PT	24	1	23				
Romania	RO	24	24					
Slovak Republic	SK	3				3		
Slovenia	SI	4	4					
Spain	ES	130	67	38	13		12	
Sweden	SE	16	7		6	3		
United Kingdom	GB	71	5	1	5	62		

Given the lower number of CF for PM2.5 this report focuses on PM10. The conclusions obtained in this work for PM10 (regarding the factors determining the CF) are applicable to PM2.5, although the magnitude of CF may differ.

The type and proportion of PM10 instruments varied between Member States and between networks within Member States. Some Member States (DK, FI, FR, GR, LV, LT, NO, PT, SK) did not report any gravimetric measurements, even though all the PM10 data reported were determined by automated instruments. Some Member States used a single type of automated measurement; it is the case of BG, CZ, EE, GR, IS, LV, LT, NL, which only reported data measured by Beta attenuation. Other countries (IE, LU, SK and SI) only reported data measured by TEOM. Thirteen countries (AT, BE, DK, FI, FR, GE, HU, IT, PL, PO, SP, SE and UK) reported data for more than one type of automated instrument. In some of these countries, the proportion of one specific type of instrument was clearly higher (Beta attenuation in DE, IT, PT and ES, and TEOM in FR, SE and GB). The data available in the QFWD questionnaire was not sufficient to elucidate whether the use of one or other type of instrument is network or station dependent.

These results are summarized in Figure 1, where the total number of instruments and the number of instruments for which correction factors were reported are plotted for each Member State for the total of measurement methods. In these graphs the minimum, maximum, median, 1st and 3rd quartiles of the correction factors reported by each country and for each measurement method are also shown. Variations can be due to different CF applied to different instruments and/or to different CF applied for different seasons. It is possible to see the cases where no correction at all or a unique correction factor was used in general or for a specific measurement method.

Frequently, MS do not provide correction factors for gravimetric methods. Only, at a few sites correction factors were provided for gravimetric measurements (1 site in AT and 19 sites in DE), with CF varying from 1 to 1.3. This probably means that gravimetric methods used in these sites were neither reference nor equivalent methods, and therefore, a correction factor should be applied. It should be clearly stated in the QFWD if the gravimetric method used is a reference or equivalent method; if not, a correction factor should be reported. Given the low number of sites reporting CF for gravimetric methods, these correction factors have not been studied in the present report.

Some networks reported a single number as correction factor while others reported a correction equation (ax±b): in these cases, only the slope has been considered for the evaluation of the correction factors, the intercept being lower than 5 for most cases (only in one site b=7).

Countries calculate the CF by applying different strategies, according to their networks and instruments. The following cases have been identified (Table 2):

1. **Correction not applicable.** Two countries (CY and RO) use exclusively the gravimetric method. No correction is needed in this case, but it is not indicated if the gravimetric method used is a reference or equivalent method.
2. **No correction factors submitted**. In 8 countries (CZ, FR, GR, IS, IT, LU, PL and SK) no CF were submitted for any instrument or site. E.g. FR makes reference to "cf. courrier nº1344 du 15/05/07" in the cell where the CF should have been reported. The Slovak Republic does not report CF because they use only TEOM FDMS. Similarly, in France most of the instruments are TEOM FDMS or Beta with module RST. In some Member States no CF was submitted for specific sites. AT and UK do not submit CF for TEOM FDMS which accounted for 42 and 63% of the total automated instruments in their networks, respectively.
3. **Correction factors submitted for all the automated PM10 instruments.** Eleven countries (BE, BG, DK, EE, FI, HU, LV, LT, NL, SI, and SE)

submitted CF for all the automated instruments reporting PM10. In addition, DE, PT, and ES reported CF for most sites (>94%). In IE, CF are reported for 4 sites out of 5 (80%).

4. **One uniform correction factor for one measuring method submitted for a network (or for all networks in a Member State).** Many countries (BG, DK, EE, FI, IE, LV, LT, NL, SE, and UK) reported a unique CF for each measuring method for all the networks. For some Member States a unique CF was provided for a number of instruments of the same measurement technique, probably reflecting the attribution of a unique correction factor for instruments belonging to a network. This is probably the case of some networks in of AT, BE, DE, ES, HU, and SI.
5. **Site dependent correction factors.** Different CF were provided for specific sites and instruments. Most instruments of the network have been intercompared with gravimetrical measurements. This is the case of AT, BE, DE, ES, HU, and SI. In PT a unique CF was reported for rural sites and another CF for traffic sites, independently on the location and network.
6. **Time and space dependent correction factors.** Different CF were provided for different seasons at some sites in AT and DE, and probably in SI where two CF were provided for some instruments.
7. **No PM10 data reported to QFWD.** NO did not correctly fill in the QFWD; "Y" was introduced in column K in Form 3 instead of the measurement code. Nevertheless PM10 data were submitted to AirBase, but the CF was not reported.
8. **No correction factors indicated on AirBase data.** Some Member States reporting correction factors in QFWD did not report these factors in AirBase, whereas others reported CF in both. Although it is not mandatory to report CF in AirBase, it would be advisable to do so for consistency reasons.

The CF reported (to be applied to the automatic measurements) have been studied in detail (Figure 1 and Tables A1-A3 and Figure A1 in Annex1) as a function of the measurement technique. The results may be summarized as follows:

1. As regards Beta attenuation monitors, CF ranged from 0.57 (ES) to 1.51 (DE). Median CF varied from 0.83 (UK) to 1.3 (AT, BG, and LT).
2. For TEOM (considering only TEOM without FDMS), CF ranged from 0.8 (ES) to 1.63 (DE). Median CF varied from 1.0 (BG, HU, IE; ES) to 1.35 (BE).
3. For TEOM FDMS, most countries reported CF=1. However, no evidence was provided regarding whether comparisons were done or not. Most countries seem to assume that CF is not necessary for TEOM FDMS. Thus, UK considered CF=1 for TEOM FDMS and corrected TEOM with respect to FDMS by using the VCM model (http://www.volatile-correction-model.info/Default.aspx). Other countries did not report any CF for TEOM FDMS. In this group the case of AT should be highlighted, with 39 TEOM FDMS instruments, but reporting CF for only one of these (CF=1.3).
4. For the Light scattering instruments, CF ranged from 0.87 (DE) to 1.2 (ES). Median CF was 1.0 for all Member States reporting data for light scattering systems (BE, DE, ES, UK).

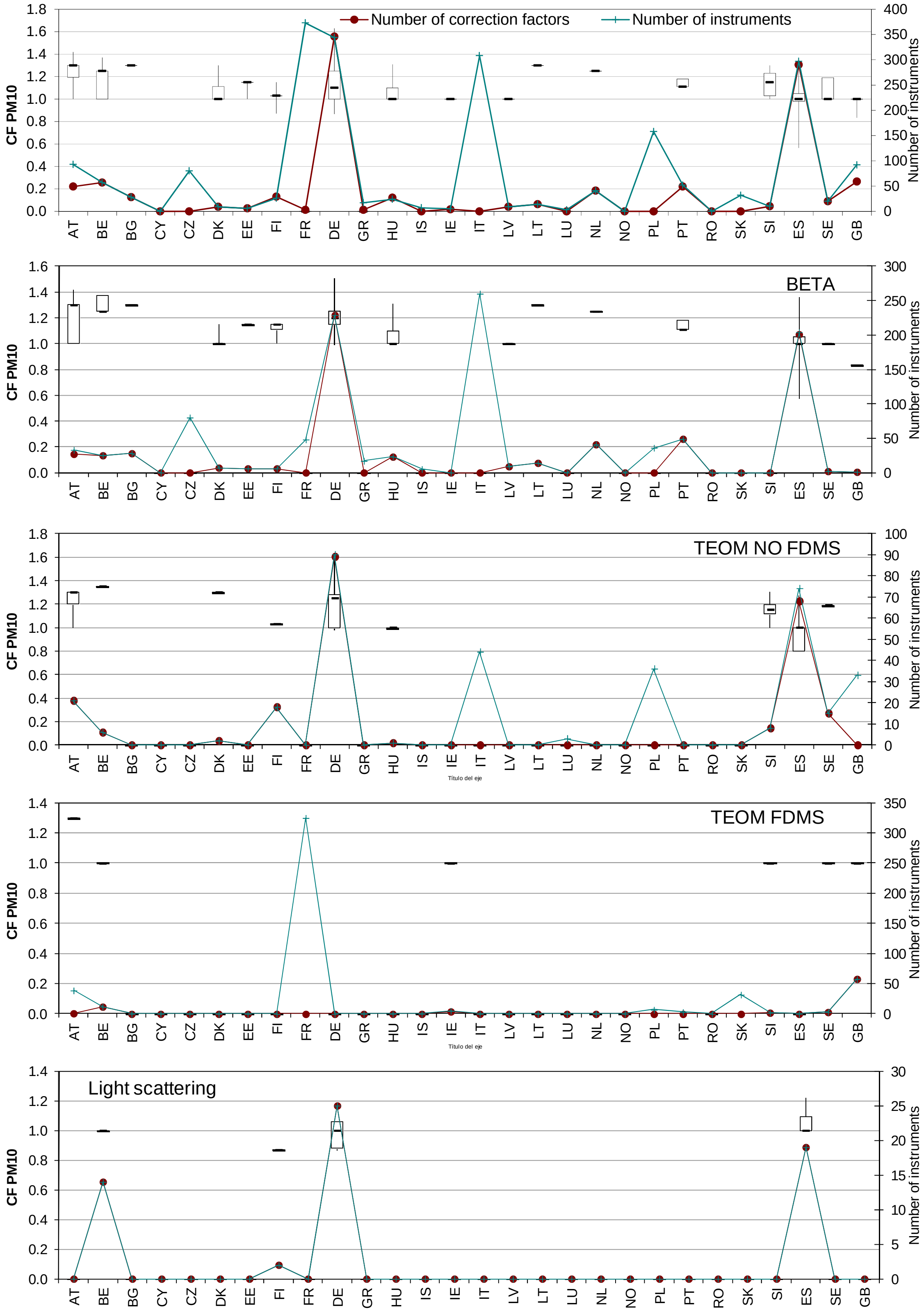

Figure 1. Total number of instruments and number of instruments for which CF were reported in each Member State. Minimum, maximum, median, 1st and 3rd quartiles of the CF reported by each Member State for all the measurement methods and for each one of the main measurement methods.

CF (to be applied to the automatic measurements) lower than 1 were reported in some cases by DE, ES, FI and GB. These were usually comprised between 0.8 and 1 and were submitted for Beta, light scattering and TEOM instruments.

- In GB a CF of 0.83 was submitted for the unique Beta monitor reporting PM10.
- For DE and FI, CF <1 were reported for light scattering instruments (8 in DE and 2 in FI).
- In ES a relatively high number of CF reported were <1; 46 corresponding to Beta monitors and 28 to TEOM.

Some Beta monitor brands have been found to yield much higher values than gravimetry measurements, as in the case of the following example (Figure 2). In Valencia (ES), three brand new Beta attenuation monitors from the same brand, purchased simultaneously and working in measuring stations distant <30 km were intercompared with gravimetric PM10 measurements carried out simultaneously with high volume samplers (Digitel). In the three cases, the CF to be applied to the automatic measurements was <1. Note also that CF differs considerably due to local PM composition differences.

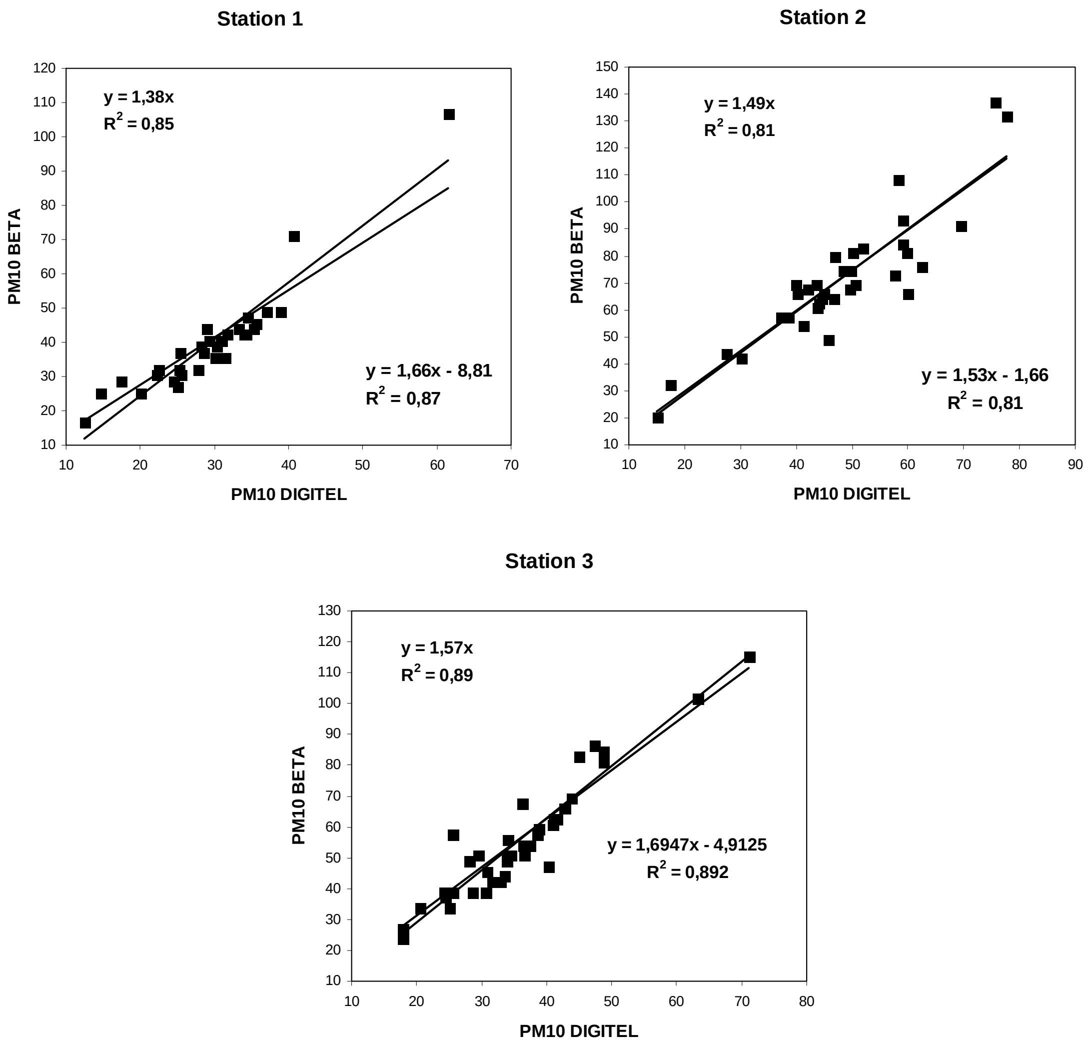

Figure 2. Example of the intercomparison of 3 new Beta attenuation instruments with PM_{10} gravimetric measurements carried out with a high volume sampler (Digitel) in Valencia (ES).

Some Member States reported a unique CF of 1.3 for all their measurements. This is the default CF proposed in the "Guidance paper on PM10 monitoring and intercomparisons with the reference method" by the EC working group on particulate matter (EC, 2001). A default factor of 1.3 for the correction of the results from the automated instruments was proposed as an "*interim solution for those Member States who had not conducted such intercomparison measurements until now".* This CF has no technical-scientific basis, but was suggested as a penalty-like CF for those Member States not carrying out their own intercomparison exercises. In the Second Position Paper on Particulate Matter, the CAFE Working Group on Particulate Matter (EC, 2004) concludes that, given the variability of CF, *the application of a default factor is not a satisfactory solution, and recommends the networks to use their own correction factors, rather than applying a default factor*. It is not clearly reflected in the QFWD whether the 1.3 used in some networks is the default factor or the real factor.

3.2 Reference to the equivalence tests

The majority of countries did not provide any reference for the equivalence tests carried out.

Belgium listed 2 references (VMM, 2008 and 2010). These documents are written in English and available online. They are published by the Flemish Environment Agency. They report the results of PM10 and PM2.5 comparison tests between automated monitors and the gravimetric reference method in the periods 2006-2007 and 2008-2009. Both reports follow the procedure described on the Guide to the demonstration of equivalence of ambient air monitoring methods (EC Working Group, 2010). The equivalence tests are well documented. Moreover, the 2006-2007 report includes results on tests with different types/brands of filters used for the reference method.

The Netherlands referred to an inter comparison exercise carried out in 2006 (Beijk et al., 2007). This document is written in Dutch with an abstract in English and available online. It reports the results on the intercomparison of automated instruments and reference methods. Moreover, it reports the results of intercomparison of different brands of filters used in the reference method. The procedure is also based in the Guide to the demonstration of equivalence of ambient air monitoring methods (EC Working Group, 2010).

Spain reported a large number of references. These documents are in Spanish and they are not available online.

Slovenia reported one reference not available online.

3.3 Causes of variation of correction factors

The evaluation of the CF applied by the Member States to the different measurement methods used shows that CF (to be applied to the automatic measurements) vary considerably, fluctuating between 0.57 and 1.63, with a median of 1.03.

This variation of the CF may be partially caused by the measurement technique. Figure 3 shows the range of the CF depending on the type of instrument (for all Member States). There is no clear difference between the three methods. The range of CF is narrower for the Light scattering instruments, probably due to the lower number of instruments of this type used in networks. However, for the TEOM instruments, in spite of the relatively lower number of instruments, the dispersion of CF is higher than for the Beta monitors.

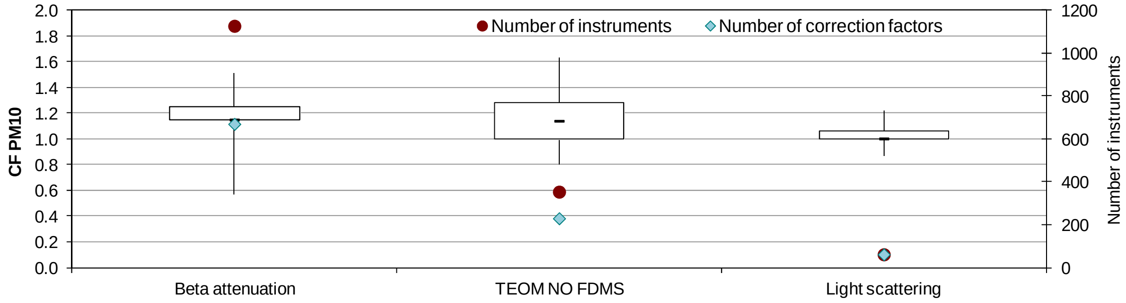

Figure 3. Total number of instruments and number of instruments for which CF were reported. Minimum, maximum, median, 1st and 3rd quartiles of the CF reported for the main automated measurement methods. For the Light scattering the number of instruments coincides with the number of CF.

CF may also depend on other issues such as the composition of PM which mainly depends on the meteorology (local or long range) and local and regional emission sources of PM. Specific meteorological situations, such as winter inversions or African dust outbreaks, may have a considerable impact on composition of PM and therefore on the CF to be applied. These scenarios may have a distinct impact in different areas in Europe. Emission sources may have an important influence in PM composition. For example, in the surroundings of cement manufacturing plants CF ~1 because the volatile fraction is not important; however at an urban background site the volatile fraction is higher and this may affect the differences found between automatic and gravimetric methods.

The type of site (rural, urban, traffic, industrial) and area is reported in AirBase but not in the QFWD. Most Member States report a unique CF for a given network; therefore it is not possible to elucidate a variation of CF as a function of the type of sites. For some Member States, such as Portugal, the CF ratio varies with the type of site: CF is always 1.18 for traffic sites and 1.11 for background sites. For some networks from Spain and Germany, where a higher number of different CF is reported, it is possible to evaluate the variation of CF as a function of the type of site. A quick evaluation does not reveal a clear influence of the type of site in the CF. As an example, in the North of Spain (Euskadi), in a network using Beta monitors (Figure 4), CF range from 0.8 to 1.2 at industrial, traffic, and urban background sites without a defined variation pattern, showing a unique CF for rural sites.

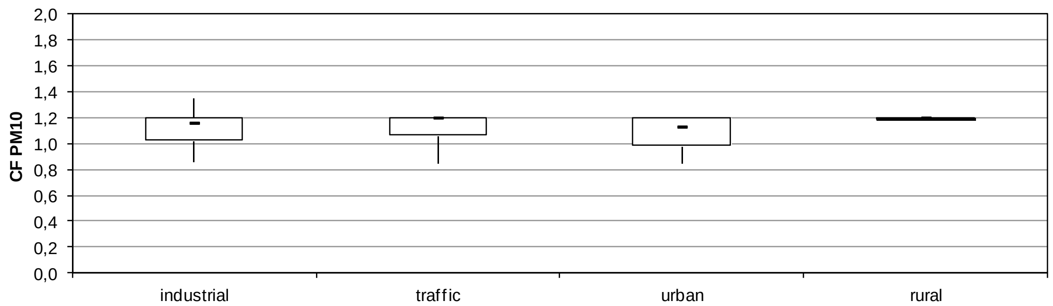

Figure 4. CF for different types of station (industrial, traffic, urban and rural) reported by a network using Beta monitors in the North of Spain (Euskadi).

Temperature and atmospheric humidity influence the stability and formation of secondary compounds, limiting the performance of specific automated instruments. In order to determine the influence of climatology and geography on the CF, the medians and percentiles of CF have been depicted in Figure 5, for Beta and TEOM instruments. A clear pattern is not observed in the spatial variation of the CF. Relatively higher CF are reported for central Europe (AT, DE, NL, BE) although also high CF are reported for BG. It must be noted that neighbouring countries, such as LV, LT and EE reported very different CF for the same type of instrument in 2009. It should be also highlighted that CF in UK for beta monitors are clearly lower than the CF reported for the other State Members, but this factor is reported for one single station.

CF are site and instrument specific. Sites of the same type, in similar environments, with similar PM composition, and with the same type of instruments may report different CF. Conversely; sites in different environments with distinct climatic features may report the same CF, using the same or different type of measurement.

Therefore, the applicability of a unique CF for a given network of a Member State is questionable, despite the fact that this is common practice among certain Member States. It is necessary to demonstrate that the CF obtained is adequate for all the instruments and sites in a given network. That implies that, as recommended in the PM Working Group Guidance document of 2001 and the new Guidance for the Demonstration of Equivalence (EC Working Group 2010), inter-comparison exercises are carried out.

Only a limited number of sites reported the evidence of a seasonal variation for CF. For the rest of the sites, reporting one single CF, it is not possible to know whether this CF is actually constant throughout the year, or whether the CF was determined during one single season and extrapolated to the entire year.

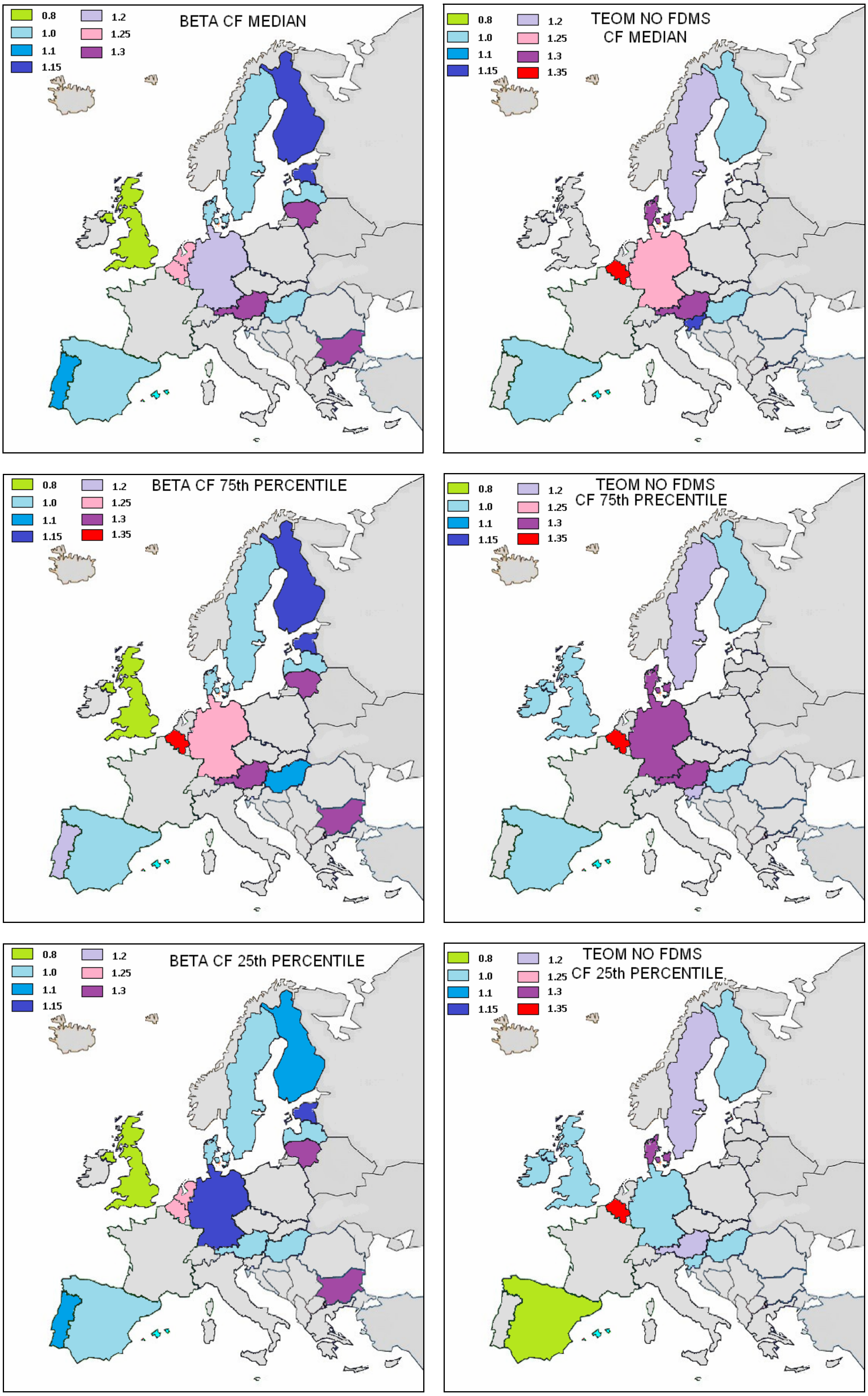

Figure 5. Median (top), percentile 75 (middle) and percentile 25 (bottom) of CF reported for Beta absorption (left) and TEOM NO FDMS (right) by State Members.

4 Conclusions

Member States should demonstrate that the PM measurement methods used are equivalent to the reference method.

There is no mandatory procedure for calculating correction factors (CF) by the Member States but a guidance document produced by the Working Group on Guidance for the Demonstration of Equivalence (EC Working Group 2010) is available. Countries calculate the CF by applying different strategies, according to their networks and instruments. It is not clearly stated which criteria they followed for the estimation of the CF.

After analyzing the data on PM measurements and CF reported in the QFWD questionnaire, it is concluded that the information provided in the questionnaire for the year 2009 is incomplete. References to background documents demonstrating the equivalence are largely missing.

An important number of Member States (MS) do not submit CF for PM automated instruments in their networks and most MS reported a unique CF for each measurement technique within a network or country, revealing that the exercises for intercomparison or demonstration of equivalence have not been carried out for most PM automated instruments used in the monitoring networks.

The evaluation of the CF applied for the Member States to the different measurement methods used shows that CF vary considerably, fluctuating between 0.57 and 1.63, with a median of 1.03 for PM10 instruments, and from 0.65 to 1.60, with a median of 0.99 for PM2.5 instruments. This variation of the CF may be partially caused by the measurement technique, although there is no clear difference between the three most widely used methods.

A number of networks report a CF of 1.3 (to be applied to the automatic measurements), corresponding to the default factor suggested by EC Working Group on particulate matter in the Guidance to member states on PM10 monitoring and intercomparisons with the reference method (2001). In the QFWD, no information is provided on whether this is the default factor or whether intercomparison exercises were carried out and resulted in a CF of 1.3.

Most countries assumed a CF=1 for TEOM FDMS and did not carry out demonstration of equivalences for these kind of instruments. However, sometimes CF for TEOM FDMS could be different than 1 as shown for the case of Austria.

The influence of the type of site (rural, urban, traffic, industrial) on the CF is not evidenced, given that unique CF are reported for most networks independently of the type of environment.

No clear pattern in the spatial variation of CF across Europe was observed.

The results from this study evidence that the CF depend on the specific instrument and site.

General conclusions are:

1. It is necessary to perform the demonstration of equivalence at each site for each automated instrument. It is strongly advisable to perform the demonstration of equivalence following the recommendations of the Guide on Demonstration of equivalences (EC Working Group, 2010).

2. MS that are reporting the default CF or a unique CF for network or instrument should perform more intercomparison exercises. The same applies to countries that are not reporting enough CF.
3. The CF may vary with time due to changes in the instrument; therefore it is necessary to perform the test with a defined frequency. Periodic side-by-side comparisons should be carried out between the reference and the equivalent methods to confirm that the calibration is still valid.
4. Some recommendations for future reporting in the questionnaire may be provided:
   4.1. Supply references, accessible, for the demonstration of equivalence.
   4.2. Indicate if the CF is the default factor or not.
   4.3. Indicate if there is or not seasonal variation, or if it has not been tested.
   4.4. Define the codes of the additional automated instruments not listed now, to avoid the extra codes meaning different things for different Member States.
5. To conclude, as regards the QFWD, it seems that most countries in general are either not carrying out correction of automated instruments, or reporting correction factors correctly. An effort in reporting is clearly necessary, as it is difficult to understand the information provided by the Member States.

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VMM (2010) Comparative PM10 and PM2.5 Measurements in Flanders, Period 2008-2009. Publisher: Philippe D'Hondt; Air, Environment and Communication Department; Flemish Environment Agency.

ANNEX 1. ADDITIONAL TABLES AND FIGURES

The following tables include an overview of the CF reported by each Member State for the three main different automated measurement methods (Beta-absorption, TEOM and light scattering), including the total number of instruments, the number of instruments that are reporting CF, and the minimum, maximum, median, 1st and 3rd quartile of the reported CF.

Figure A 1 summarizes the number of CF reported within different ranges per Member State and instrument type.

Table A 1. Overview of correction factor for beta-absorption measurements reported: minimum, maximum, median, 1st and 3rd quartile.

State Member		Beta-absorption						
				CF				
		Number of instruments	Reported CF	min	q1	Median	q3	max
Austria	AT	33	27	1.00	1.00	1.30	1.30	1.42
Belgium	BE	25	25	1.25	1.25	1.25	1.37	1.37
Bulgaria	BG	28	28	1.30	1.30	1.30	1.30	1.30
Cyprus	CY	-	-					
Czech Republic	CZ	80	-					
Denmark	DK	7	7	1.00	1.00	1.00	1.00	1.15
Estonia	EE	6	6	1.15	1.15	1.15	1.15	1.15
Finland	FI	6	6	1.00	1.11	1.15	1.15	1.15
France	FR	48	-					
Germany	DE	229	229	0.99	1.15	1.20	1.25	1.51
Greece	GR	17	-					
Hungary	HU	23	23	1.00	1.00	1.00	1.10	1.31
Iceland	IS	7	-					
Ireland	IE	-	-					
Italy	IT	260	-					
Latvia	LV	9	9	1.00	1.00	1.00	1.00	1.00
Lithuania	LT	14	14	1.30	1.30	1.30	1.30	1.30
Luxembourg	LU	-	-					
Netherlands	NL	41	41	1.25	1.25	1.25	1.25	1.25
Norway	NO	-	-					
Poland	PL	36	-					
Portugal	PT	49	49	1.11	1.11	1.11	1.18	1.18
Romania	RO	-	-					
Slovak Republic	SK	-	-					
Slovenia	SI	-	-					
Spain	ES	204	201	0.57	1.00	1.00	1.05	1.36
Sweden	SE	2	2	1.00	1.00	1.00	1.00	1.00
United Kingdom	GB	1	1	0.83	0.83	0.83	0.83	0.83

Table A 2. Overview of correction factor for oscillating micro-balance (TEOM) measurements without FDMS reported: minimum, maximum, median, 1st and 3rd quartile.

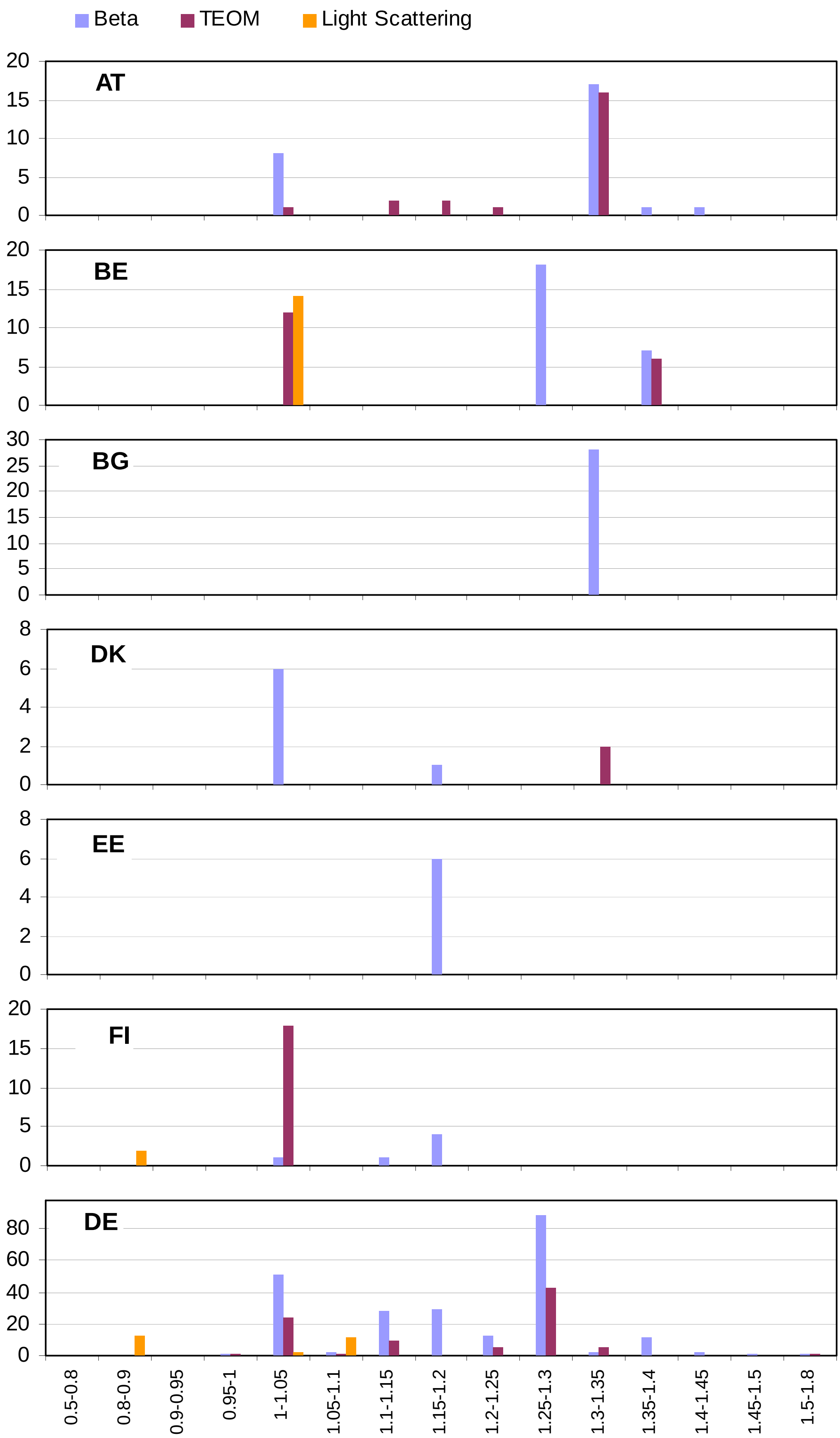
State Member		TEOM (oscillating micro-balance)						
				CF				
		Number of instruments	Reported CF	min	q1	Median	q3	max
Austria	AT	21	21	1.00	1.20	1.30	1.30	1.30
Belgium	BE	6	6	1.35	1.35	1.35	1.35	1.36
Bulgaria	BG	-	-					
Cyprus	CY	-	-					
Czech Republic	CZ	-	-					
Denmark	DK	2	2	1.30	1.30	1.30	1.30	1.30
Estonia	EE	-	-					
Finland	FI	18	18	1.03	1.03	1.03	1.03	1.03
France	FR	-	-					
Germany	DE	90	89	0.98	1.00	1.25	1.28	1.63
Greece	GR	-	-					
Hungary	HU	1	1	1.00	1.00	1.00	1.00	1.00
Iceland	IS	-	-					
Ireland	IE	-	-					
Italy	IT	44	-					
Latvia	LV	-	-					
Lithuania	LT	-	-					
Luxembourg	LU	3	-					
Netherlands	NL	-	-					
Norway	NO	-	-					
Poland	PL	36	-					
Portugal	PT	-	-					
Romania	RO	-	-					
Slovak Republic	SK	-	-					
Slovenia	SI	8	8	1.00	1.12	1.15	1.20	1.30
Spain	ES	74	68	0.80	0.80	1.00	1.00	1.27
Sweden	SE	15	15	1.19	1.19	1.19	1.19	1.19
United Kingdom	GB	33	-					

Table A 3. Overview of correction factor for TEOM FDMS measurements reported: minimum, maximum, median, 1st and 3rd quartile.

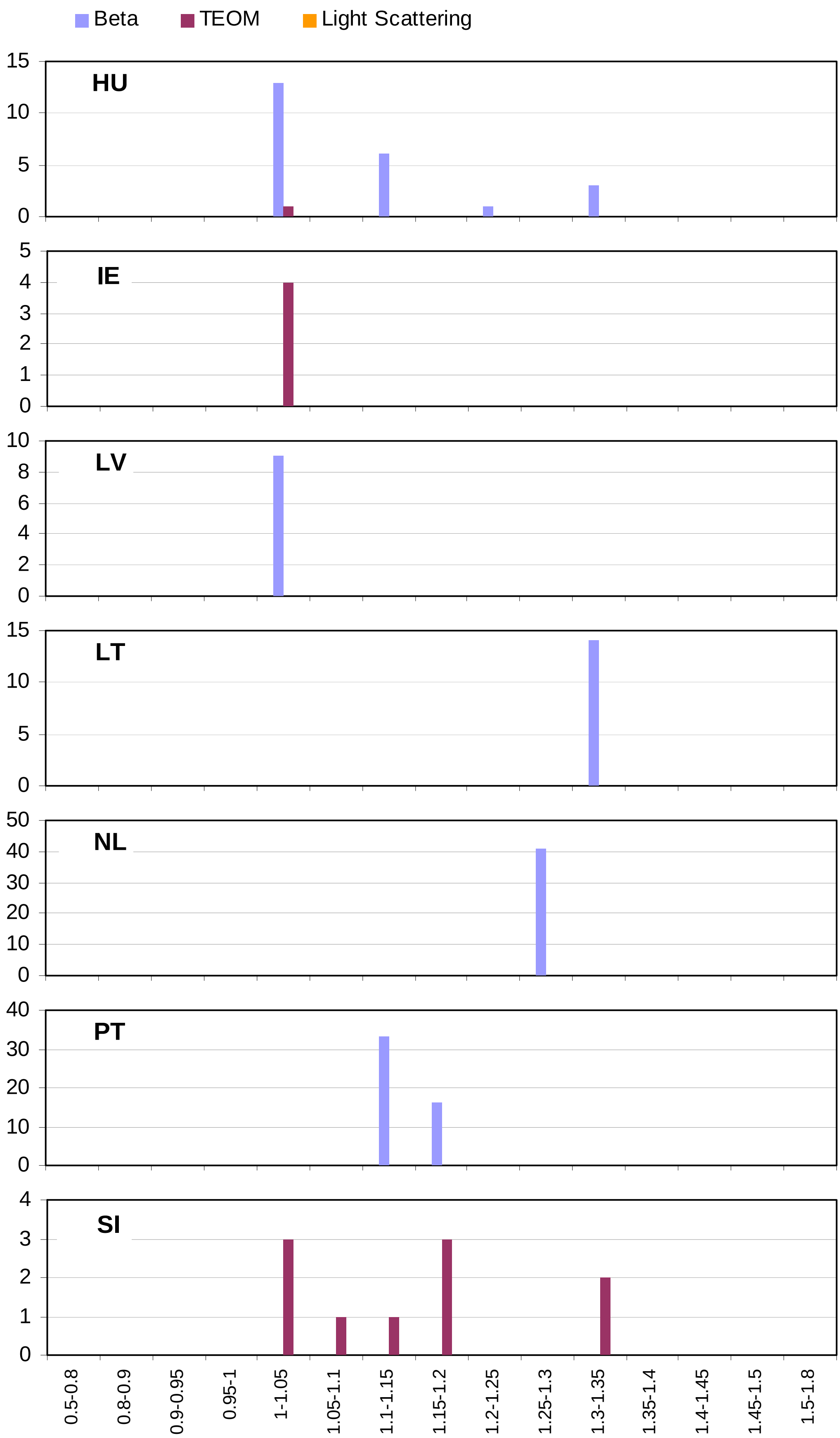
State Member		TEOM (oscillating micro-balance)						
						CF		
		Number of instruments	Reported CF	min	q1	Median	q3	max
Austria	AT	39	1	1.30	1.30	1.30	1.30	1.30
Belgium	BE	12	12	1.00	1.00	1.00	1.00	1.00
Bulgaria	BG	-	-					
Cyprus	CY	-	-					
Czech Republic	CZ	-	-					
Denmark	DK	-	-					
Estonia	EE	-	-					
Finland	FI	-	-					
France	FR	325	-					
Germany	DE	-	-					
Greece	GR	-	-					
Hungary	HU	-	-					
Iceland	IS	-	-					
Ireland	IE	5	4	1.00	1.00	1.00	1.00	1.00
Italy	IT	-	-					
Latvia	LV	-	-					
Lithuania	LT	-	-					
Luxembourg	LU	-	-					
Netherlands	NL	-	-					
Norway	NO	-	-					
Poland	PL	7	-					
Portugal	PT	3	-					
Romania	RO	-	-					
Slovak Republic	SK	32	-					
Slovenia	SI	2	2	1.00	1.00	1.00	1.00	1.00
Spain	ES	-	-					
Sweden	SE	3	3	1.00	1.00	1.00	1.00	1.00
United Kingdom	GB	58	58	1.00	1.00	1.00	1.00	1.00

Table A 4. Overview of correction factor for light scattering measurements reported: minimum, maximum, median, 1st and 3rd quartile.

State Member		Light scattering						
				CF				
		Number of instruments	Reported CF	min	q1	Median	q3	max
Austria	AT	-	-					
Belgium	BE	14	14	1.00	1.00	1.00	1.00	1.00
Bulgaria	BG	-	-					
Cyprus	CY	-	-					
Czech Republic	CZ	-	-					
Denmark	DK	-	-					
Estonia	EE	-	-					
Finland	FI	2	2	0.87	0.87	0.87	0.87	0.87
France	FR	-	-					
Germany	DE	25	25	0.87	0.88	1.00	1.06	1.06
Greece	GR	-	-					
Hungary	HU	-	-					
Iceland	IS	-	-					
Ireland	IE	-	-					
Italy	IT	-	-					
Latvia	LV	-	-					
Lithuania	LT	-	-					
Luxembourg	LU	-	-					
Netherlands	NL	-	-					
Norway	NO	-	-					
Poland	PL	-	-					
Portugal	PT	-	-					
Romania	RO	-	-					
Slovak Republic	SK	-	-					
Slovenia	SI	-	-					
Spain	ES	19	19	1.00	1.00	1.00	1.09	1.22
Sweden	SE	-	-					
United Kingdom	GB	-	-					



Beta
TEOM
Light Scattering
AT
BE
BG
DK
EE
FI
DE
0.5-0.8
0.8-0.9
0.9-0.95
0.95-1
1-1.05
1.05-1.1
1.1-1.15
1.15-1.2
1.2-1.25
1.25-1.3
1.3-1.35
1.35-1.4
1.4-1.45
1.45-1.5
1.5-1.8


Beta
TEOM
Light Scattering
HU
IE
LV
LT
NL
PT
SI
0.5-0.8
0.8-0.9
0.9-0.95
0.95-1
1-1.05
1.05-1.1
1.1-1.15
1.15-1.2
1.2-1.25
1.25-1.3
1.3-1.35
1.35-1.4
1.4-1.45
1.45-1.5
1.5-1.8

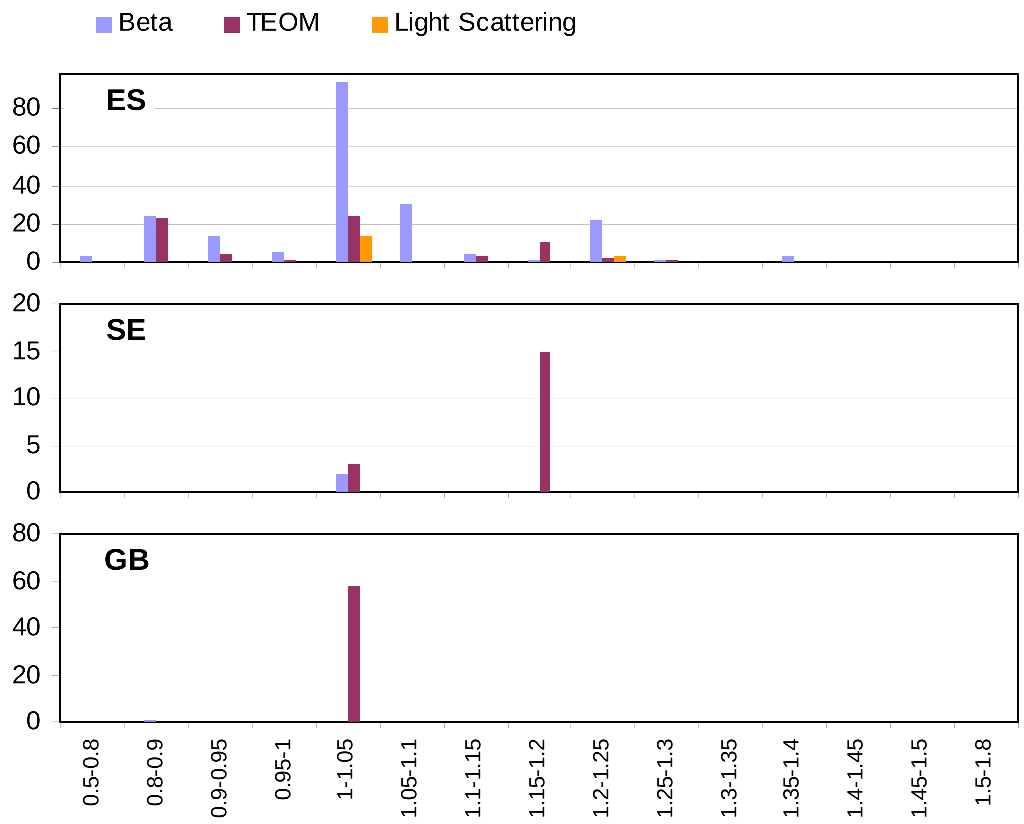


Figure A 1. Number of CF reported within different ranges per Member State and instrument type

ANNEX 2. REPORTING MISTAKES

Some reporting mistakes were found in the QFWD form:

DE

- Reports a range of correction factors in cell 'CF PM10' as text.
- Reports text in cell 'CF PM10' noting that the CF varies with the season and writes the different equations in cell 'comment or reference'.
- Sometimes reports a range of correction factors in cell 'CF PM10' and it is clarified in comments, but sometimes in comments it says that correction factor varied but there is only one single value in 'CF PM10'.

ES

- Reports text instead of number
- Uses comma instead of point
- Writes CF*b instead of writing only the CF in cell 'CF PM2.5'

FR

- Does not give CF, only says "cf. courrier n°1344 du 15/05/07"

GB

- Reports a range of correction factors in cell 'CF PM10' as text
- Writes "VCM;1" in cell 'CF PM10'

HU

- Uses comma instead of point
- Reports text instead of number

IT

- Does not give CF, only says "vedi relazione allegata Lombardia"

NO

- Does not report the method, only reports 'Y'

IS

- The meaning of Code M30 is unclear

PL

- Does not submit CF in QFWD but it does in AirBase; sometimes CF>1 for gravimetry

SI

- Two factors for the same instrument, probably reflecting seasonal variation.