EC WORKING GROUP ON PARTICULATE MATTER

A REPORT

ON

GUIDANCE TO MEMBER STATES

ON PM_{10} MONITORING AND INTERCOMPARISONS

WITH THE REFERENCE METHOD

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EC WORKING GROUP ON PARTICULATE MATTER

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EXECUTIVE SUMMARY

Directive 1999/30/EC, the first Daughter Directive of the Air Quality Framework Directive 1996/62/EC, requires Member States to implement programmes monitoring ambient air particulate matter from 19 July 2001, and report data over one calendar year from those programmes to the Commission and make information available to the public. The Directive sets 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 can be demonstrated.

Workshops on Particulate Matter Monitoring in London in October 1999 and Venice, June 2000, identified that whilst many Member States are carrying out the necessary programmes some will not have made sufficient progress to achieve this legal requirement by the appropriate dates. This was a special problem for Member States using continuous, automatic instruments and those who have only recently started programmes and will have insufficient data on which to make full intercomparison and thus determine equivalence factors.

There is a certain conflict regarding measurement methods within Directive 1999/30/EC. Whilst the Directive requires Member States to use non-automatic methods for monitoring, there is also the requirement to provide information to the public on a daily basis which requires automatic monitoring.

Therefore, The European Commission (DG Environment) reconvened the Working Group on Particulate Matter, with its original Member States and other members, to summarise progress by Member States so far and determine whether it would be possible to draft guidance and advice on the methodology for demonstrating equivalence between Reference Method and other methods, under Directive 1999/30/EC. The Working Group was also asked to consider guidance on monitoring and reporting exceedences caused by natural events.

The Terms of Reference for the Group were:

- To obtain information from Member States about work carried out to compare the different methods for measuring particulate matter and to summarise the results.

- To draft advice on demonstrating equivalence with the aim of helping Member States fulfil the requirements of Directive 1999/30/EC.

- To advise on any difficulties and, if necessary, to suggest practical solutions during the first stage of implementation of Directive 1999/30/EC.

- To draft recommendations for the development of correction factors or correction equations which may be applied to data obtained by measurement methods, for

PM_{10}, other than the reference method set out in Directive 1999/30/EC in order to produce equivalent results.

- To draft recommendations in respect of default factors which might be applied by Member States who have not completed intercomparison tests in time for implementation of the Directive.

- The Group should also consider whether it is advisable to draft advice on demonstrating that exceedences of limit values for PM_{10} are due to natural events, and if so, whether it is feasible to do so within the two planned meetings. It should be noted that the Venice Workshop agreed that results presented by Spain and the UK were sufficient to demonstrate the influence of long range transport, and that this work will be published.

Following its first meeting in September 2000 the Working Group called for data on measurement and monitoring programmes from all Member States, which it then considered at its meeting in November 2000. The Working Group set out a three tiered approach:

Stage 1: Member States use the reference methods specified in the Directive. However, this will cause disproportionate efforts to fulfil the obligation of providing information to the public, updated on a daily basis, which would be best served by automatic monitors
Stage 2 The (manual) reference method is, therefore, unlikely to be used at all sites. To fulfil the reporting requirements of the directive, Member States may wish to use continuous monitors. In this case, they have either to use a monitor which has already been demonstrated to be equivalent to the reference method, or to determine equivalence to the reference method or to establish a consistent relationship, by carrying out their intercomparison measurements. The Commission has asked CEN to prepare guidance on demonstrating equivalence. This document provides "best practice" guidance for use as an interim solution until advice from CEN is available. Finally, Member States have to obtain bilateral agreement with the Commission.
Stage 3: If Stage 1 is not adopted and Stage 2 has not been finished a Member State can, as an interim solution only, use default factors/equations to convert data from continuous instruments for the purposes of reporting under Directive 1999/30/EC. It is stressed that this is an interim arrangement, and that Member States should carry out their own inter-comparison exercises as soon as possible.

At the start of its work, the Working Group requested data from those Member States who were already carrying out their own intercomparison exercises. The Working Group analysed all available appropriate data and concluded that a single default factor of 1.3 could be applied to data reporting both daily averages and annual means from either TEOM or β-attenuation instruments. This default factor was chosen to be on the safe side for annual or seasonal means. The Working Group agreed that whilst in their view, use of this correction factor by Member States should be acceptable to the Commission as an interim approach there was an over-riding legal responsibility on Member States to demonstrate equivalence or to establish a constant relationship between the reference method and any other method they choose to use, as set out in Stage 2 above.

The Working Group suggests an interim approach since without it there may be hardly any data or public information available on particulate matter in the early stages of implementation of the Directive. It is vital that the public, the Member States and the Commission have as much information as possible on the likely magnitude of problems and on trends. It is stressed that when data are reported it must always be clear whether the data were obtained by using the reference method, by using a method for which equivalence has been shown, by using a correction factor which has been properly demonstrated to be acceptable, or by the interim solution of applying a default correction factor to data from an existing instrument.

The Group also determined some general principles by which Member States can identify particulate exceedences which result from natural events, and provide justification to the Commission that a natural event was the source and origin of the exceedence.

The Working Group remit was very specific and was designed to produce a pragmatic working solution to a relatively short term problem. The Group recognised therefore that while the Report should be technically acceptable, it was not appropriate to produce a report which aimed at complete scientific rigour. There is still much work underway in the development of measurement methods for particles and this report should be seen as an initial response to an immediate problem. It will be necessary to revisit these issues as our scientific understanding develops and as CEN undertakes further work on monitoring particulate matter and on demonstrating equivalence. This will be important for review of the implementation of Directive 1999/30 in 2003 .

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1. INTRODUCTION AND BACKGROUND

The Air Quality Framework Directive 1996/62/EC(1) establishes a framework under which the EU will set limit values or target values for specified ambient air pollutants. These values would be set out in subsequent Daughter Directives; Directive 1999/30/EC(2) is the first such Daughter Directive and addresses four pollutants, one of which is particulate matter.

Directive 99/30/EC sets out the methodology for assessment of PM_{10} concentrations by use of a reference method for sampling and measurement, as described in CEN Standard EN12341(3). At the same time, the Directive adopts an approach to PM_{10} measurement which has been used for other pollutants whereby Member States may use any other candidate instruments or techniques which the Member State can demonstrate give results equivalent to the reference method, or display a consistent relationship to the reference method.

At the meeting of the Air Quality Steering Group on 3/4 July 2000, DG Environment reported briefly on the Venice Workshop on Monitoring Particulate Matter(4), organised for Member States to report progress towards implementing the monitoring requirements for PM set out in Directive 1999/30/EC. An earlier Workshop in London, 13/14 October 1999, heard presentations from many Member States on their progress on measurement methods, other than reference methods, to implement the Directive 1999/30/EC.

It was clear from both Workshops that many Member States were undertaking considerable programmes of work on intercomparison of measurement methods for PM_{10} with a view to determining whether methods, other than the reference method set out in Directive 1999/30/EC, can be used. There was also much useful work being done on measurement methods for $PM_{2.5}$.

At the same time a number of problems were identified at the Venice Workshop.

- Firstly, most non-gravimetric methods in use at present tend not to produce results equivalent to the reference method.
- Secondly, there was no emerging consensus on whether correction factors, or correction equations, could be developed for non-gravimetric methods and if they were applied, whether corrections should be universal or site specific.
- Thirdly, some Member States may not have completed their intercomparison work before the date on which they should begin monitoring PM_{10} and $PM_{2.5}$ under Directive 1999/30/EC.

Clearly these problems must be solved. There are promising developments within some Member States and from manufacturers. But in the meantime there is a danger that almost no data and public information will be available in the crucial early stages of implementation of the Directive.

- Finally, whilst the Directive acknowledges that exceedences in particulate matter concentrations could be due to natural events it requires Member States to report such exceedences and to justify their conclusion as to the cause of such exceedences.

Therefore, the Commission proposed that the Working Group on Particulate Matter should reconvene to summarise progress so far and determine whether it would be possible to draft guidance and advice for Member States on particle monitoring under Directive 1999/30/EC in order that useable data should be available in the short term. As with the previous Group the Commission asked Germany and United Kingdom to co-chair the Working Group. Membership of the Working Group is given in Annex A.

The Commission made clear it was essential that the Working Group received as much information as possible from all Member States who could provide it to the Group. In addition, technical experts from each country and from other interested parties should have the opportunity to discuss any draft guidance in depth. Lastly, the Commission considered that the Working Group's members should not have a commercial or similar interest in any particular type of monitoring equipment.

To meet these objectives, the Commission proposed that the Group should prepare a draft report for discussion in detail with all interested stakeholders at a further Workshop on PM Monitoring, prior to submission to the Air Quality Steering Group in February 2001.

The Working Group was asked to provide the guidance for those Member States using measurement methods other than the reference method where these have not been demonstrated to produce results equivalent to the reference method, and was also asked to consider guidance for monitoring and reporting Natural Events, as defined in Directive 1999/30/EC.

The Terms of Reference and Timetable for the Working Group, were agreed at the Air Quality Steering Group meeting on 11/12 September 2000. They are set out in Annex B.

This Report aims to assist Member States by providing guidance on how best they might meet the legal obligations under Directive 1999/30/EC to measure concentrations of PM_{10} in ambient air by common methods in order to make information on those concentrations readily available to the Commission, the public and other appropriate organisations.

The Working Group remit was very specific and was designed to produce a pragmatic interim working solution to a relatively short term problem. The Group recognised therefore that while the Report should be technically acceptable, it was not appropriate to produce a report which aimed at complete scientific rigour. There is still much work underway in the development of measurement methods for particles and this report should be seen as an initial response to an immediate problem. It will be necessary to revisit these issues as our scientific understanding develops and as CEN undertakes further work on monitoring particulate matter and on demonstrating equivalence. This will be important for review of the implementation of Directive 1999/30 in 2003 .

2. LEGAL CONSIDERATIONS

The objectives of Directive 1999/30/EC are described in Article 1 of the Directive. They include the need to assess concentrations of the four pollutants, covered by the Daughter Directive on the basis of common methods and criteria, and ensure that adequate information on the concentration of each pollutant is made available to the public.

Specifically, Article 5 sets out the need for Member States to take measures necessary to ensure that concentrations of PM_{10} in ambient air do not exceed the limit values laid down elsewhere in that Directive. The same Article goes further to describe that where limit values for PM_{10} are exceeded owing to concentrations of PM_{10} in ambient air due to natural events, which result in concentrations significantly in excess of normal sources, Member States shall inform the Commission and provide justification to demonstrate that such exceedences are due to natural events.

In addition, Article 8 sets out the requirements that Member States shall ensure up-to-date information is made available to the public as well as other appropriate organisations on ambient concentrations of particulate matter, updated on at least a daily basis.

From 19 July 2001 Member States must employ measurement programmes which meet the requirements of Directive, requiring them to report information on exceedences of limit values for PM_{10}, within 9 months of the end of each calendar year and make that information available to the public. Thus, whilst 19 July is the mandatory date for commencement of monitoring and measurement, such a programme would only provide 5 month's data within the calendar year. Consequently, the Commission encouraged Member States to begin monitoring on 1 January 2001 in order to meet the requirement for reporting one calendar year's data within 9 months of the end of 2001.

Member States who have been using EN12341 reference method instruments, or candidate instruments alongside reference instruments, for a reasonable period of time may be in a position to meet their obligations for reporting data and making it widely available. Explanations of what constitutes a reasonable period of time are discussed in Chapter 3.

The problems identified at the Venice Workshop, and which the Working Group were asked to address, relate mainly to those Member States who have not started equivalence monitoring or who have only begun monitoring and will not have sufficient data for proper comparison to a reference method. These Member States will be unable to report ratified data to the Commission in a manner which meet the needs of the Directive, nor will they be able to make information available to the public.

There is a further point that Annex IX of Directive 1999/30/EC states that the reference method for sampling and measurement of PM_{10} is based on gravimetric techniques. This is a time consuming procedure, and potentially more expensive than the use of continuous, automatic instruments. Thus, whilst continuous instruments offer the better advantage for reporting updated information to the public on daily means, as required under Article 8 of the Directive, they are inconsistent with Annex IX. Therefore, the Working Group was also asked to address this inconsistency.

The Working Group stress that their Report has the status of guidance. As such, it is not mandatory but has been adopted by the Air Quality Steering and if Member States adopt the approaches recommended by the Working Group, that should in the opinion of the Group be acceptable to the Commission. If Member States choose not to follow the recommendations of the Working Group they will have to justify their approach and demonstrate its validity to the Commission.

In addition, and because Member States have used instruments they feel best fitted to their purposes, this Report uses data acquired from a variety of instruments. It is stressed that the inclusion of any instrument or technique for measuring ambient suspended particulate matter, other than reference instruments, in the data set does not imply endorsement of that instrument by either the Commission or the Working Group. The inclusion of a particular instrument or manufacturer is not an acceptance by the Commission that the instrument meets criteria for candidate equivalence.

It is also worth noting that whilst the Directive states that mass concentrations of the gaseous pollutants should be referenced to 20^0C and 101.3kPa, there is no such explicit statement for the particulate pollutants PM_{10} or lead. The issue was discussed at the Air Quality Steering Group where it was agreed that the interpretation of the Directive on this point was that measurements should be made, and reported, at ambient temperatures and pressure, rather than at 20^0C.

3. THE REFERENCE METHODS

Directive 1999/30/EC cites European Standard EN12341 for details on the reference method for sampling and measurement of PM_{10}. This Standard also specifies a test protocol for comparing results from a candidate PM_{10} sampler with a reference PM_{10} sampler in a field test. Award of reference equivalence applies only to the range of conditions under which the field tests were conducted. Therefore, by carrying out the field tests covering a wide range of relevant ambient parameters it is assumed that equivalence holds good for prevailing conditions within European countries.

EN12341 states that the reference measuring methodology shall consist of a PM_{10} sampling inlet directly coupled with a filter substrate and a regulated flow device followed by gravimetric mass determination of that collected particulate matter.

The Standard refers to three devices which might be used:

- Low Volume system: the LVS-PM-10 sampler
- High Volume system: the HVS PM-10 sampler
- Superhigh Volume System: the WRAC-PM10 sampler (Wide Range Aerosol Classifier)

Precise details of the methodology are not discussed here and the reader is referred to the original EN12341 document for further information.

The WRAC system is usually referred to as the primary Standard, and the HVS and LVS as field standards. However, no distinction is made between these three methods for the purposes of Working Group's Report. Thus, the term 'reference method', used in this Report, could refer to any of these three methods.

It should be noted that EN12341 also makes clear that any method based on the same principle as the three methods identified above, that is a PM10 inlet directly coupled to a filter substrate and the regulated flow control followed by gravimetric mass determination of the collected PM, will be recognised as "EN12341 equivalent".

EN12341 also describes a range of factors which must be met in order to determine reference equivalence of candidate instruments. These factors include descriptions of field test sites, variety of aerosol composition, differing geographical locations, a range of seasons and meteorological conditions, data treatment and handing, as well as quality assurance and quality control procedures for filter weighing and statistical analysis.

Again the reader is referred to EN12341 for the full description of test procedures.

It should be noted that EN12341 deals with candidate reference methods in its discussion of equivalence and does not deal with equivalence of commonly employed automated systems such as β-attenuation and oscillating mass balance methods. The use of automated methods alongside reference instruments under conditions and parameters described in the Directive 1999/30/EC and EN12341 will provide a relationship to reference methods through intercomparison measurements.

However, it is important to note that CEN has recently begun to address the question of procedures to demonstrate equivalence between the reference methods described in EN12341 and candidate methods which Member States may wish to use in the ambient monitoring. In advance of this work being finalised (which may take more than one year) this Report should serve as guidance.

4. MEMBER STATES INTERCOMPARISON MEASUREMENTS OF CONTINUOUS INSTRUMENTS WITH THE REFERENCE METHOD:- A STRUCTURED APPROACH

As discussed in Chapter 1 the Working Group developed a structured approach, setting out guidance on best practice which would enable Member States using methods which have not yet been demonstrated as equivalent to the reference method to plan or to review their procedures for their own intercomparison studies and to establish factors or equations by which they may relate the results of their continuous measurements to the reference procedures.

The following approach describes a recommended set of principles which Member States should adopt as far as practicable in carrying out their own intercomparison exercises with reference methods. It is stressed that this approach represents guidance, based on the expert judgement of the WG. In the event that Member States have not carried out these studies before the first reporting deadline, Chapter 5 deals with interim default procedures which can be used.

- 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. These conditions might, for example, be an urban background site and an industrial or kerbside site. The conditions should also include amongst other things, climatic factors as described in Directive 1999/30/EC and EN12341.
- 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. This can be done, for example, by running intercomparison measurements of candidate and reference instruments at more than one site and comparing results.
- 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 one location. It would be advisable to use significantly more than this minimum number of data points in order to cover a wider range of climate and particle source conditions than might occur during one month.
- The correlation between candidate and reference instruments is regarded as valid if the regression or determination coefficient, $r^2 \geq 0.8$ and the intercept $\leq 5 \mu g/m^3$. It is stressed that the fulfilment of these and other criteria does not necessarily mean that the slope of the regression between candidate analyser and the reference method is 1:1. It simply means that the data can be used to determine the relationship between the two methods.
- Since results of the intercomparison tests depend critically on technical details including: heating of the monitoring device or inlet system; the sampling head; the

temperature of the air stream or inlet tube; the calibration; any temperature/pressure adjustment, it is essential that comprehensive documentation of all measurement parameters is prepared and retained. The correction factor or equation derived should only be applied to the candidate instrument operated in the same way.

- If the correction factors/equations of the two seasons are equal, or almost equal, a uniform correction factor/equation for the whole year may be applied. A measure for the tolerable differences between seasonal factors/equations can be derived from the overall measurement uncertainty of 25% given in Annex VIII of the Directive 1999/30/EC, for daily means. For simplicity, it might be considered that this uncertainty can be allocated in roughly equal parts between systematic bias and random variations. The Working Group proposes that if the difference between daily means in the range of the limit value, corrected with the two seasonal factors/equations, lies within ±10% then the daily means corrected with the two seasonal factors/equations can then be regarded as equal and a single factor can be applied throughout all seasons. At the same time, the Working Group agreed that Member States or Regions are free to use any other factors they choose, but they must be able to justify the arguments to support their decisions. The Working Group chose not to be too prescriptive on determination of factors but their derivation may include approaches such as Y=aX + b; Y=aX; the mean ratio of daily means over the study period. Whatever the approach taken the Working Group stress the need for Member States to provide justified arguments for their decisions.
- If seasonal correction factors/equations are necessary (differences of corrected daily means >±10%) it is recommended that interpolation through moving averages of the factors/equations are used to avoid discontinuities in the time series when changing from season to season. An approach to this is suggested in Annex C although, as with determination of factors, the Working Group stress that Member States develop their own methodology which they subsequently agree with the Commission.. Alternatively, a Member State might use the more stringent factor/equation throughout the year; this would be easier for network operation and management as well as erring on the safe side for reporting.
- The intercomparison should cover the range of concentrations expected to be found. Correction factors or equations should not normally be applied outside the range tested, unless there is good evidence of linearity.
- Therefore, the Member State or Region should check for linearity of the correction factors/equations. If the relationship is non-linear it is recommended that a correction equation is applied rather than a correction factor.
- 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.
- Where a Member State is proposing corrections applicable at locations near those in a neighbouring Member State, it should liaise with the other Member State to ensure, as far as practicable and appropriate, the consistency of the corrections in the two areas.

- Full and accurate documentation of both the candidate and reference instrumentation used is essential (i.e. full model/serial number, date of manufacture, temperature of inlet, etc) as is a full description of the monitoring locations, time periods, and other relevant information.

- All raw data collected should be retained for a suitable period consistent with the principles of good data quality management.

The procedure described above should be regarded as a potentially interim strategy until improved instruments are available which sample a fraction of the ambient aerosol similar to that sampled by the gravimetric reference method.

For example, there are developments in progress on a new generation of automated instruments fitted with dryers to reduce water content of the samples thereby allowing measurements to be made at lower temperatures. This new generation is expected to contain losses of volatiles to within 10%. In addition, other new equipment, such as β gauge and micro-balance instruments, is being developed; these too are expected to contain losses to less than 10%.

However, this performance will have to be demonstrated in future measurement programmes and until such demonstration has been made the Working Group has proposed the procedures set out above.

5. DEFAULT CORRECTION FACTORS

In setting the Working Group's Terms of Reference the Commission recognised that some Member States might not have started any programme of equivalence or inter-comparison measurements, or had only a few data from limited geographical locations and field test conditions. In this event Member States may not have been able to agree corrections to their automatic data before they have to report data to the Commission as required by the Daughter Directive.

Consequently, the Working Group was asked to consider whether default factors or equations could be determined which allowed Member States to correct their data to a common standard and acceptable to the Commission for reporting purposes. However, in agreeing the Terms of Reference the Air Quality Steering Group stressed that the use of default factors did not remove the statutory obligations to report data as described in Chapter 2. Thus, those Member States who are pursuing reference measurement and/or equivalence monitoring with appropriate quality control/quality assurance protocols applied to their data in accordance with the guidance in Chapter 4 of this report do not need to consider default factors.

Default factors have been developed specifically for a defined set of purposes: that is where Member States have no other mechanism by which to report their measured data to the Commission or make information available to the public.

In order to develop default factors/equations the Working Group called for information from all Member States carrying out reference measurement or equivalence monitoring. This information was to be supplied through a questionnaire, set out in Annex D.

The information provided is set out in Annex E from which it will be seen that the Working Group had access to data from a range of instruments, geographical locations and measurement periods. (It should be noted that data were also received from Switzerland in addition to Member States that these data were used in the analysis). In assessing all these data and noting in particular the range of sampling periods and the scatter in the data, the Group agreed it was essential to define criteria by which to select the most appropriate data for analysis in order to determine default equations or factors. It should be stressed that these were screening criteria to enable default procedures to be developed and are not the same as those proposed in Chapter 4 for demonstrating equivalence.

Substantive amounts of data were received only for β-gauge and oscillating micro-balance methods and thus only these have been analysed. The data were of variable quality and in order to screen out data with large scatter the Working Group agreed a series of criteria which it used as guidance for selection. These criteria were:

- There should be at least 30 days continuous data measurement in any given period (e.g. summer or winter)
- Data have been compared with EN 12341 or a proven equivalent instrument
- Only regression equations having $r^2 \geq 0.8$
- Data with a regression equation constant >5 (b from y=ax+b) in absolute values were rejected.

- Only period means >10µgm^{-3} would be used.

Figures 1 and 2 show the intercomparison results of the selected studies fulfilling the above criteria. In addition, it is noted that data from the Madrid-Berlin-Birmingham study, co-ordinated by the JRC, Ispra, (from end 1995 to mid-1996) were also included; the Working Group reasoned that whilst the data were only for a period of 25 days, they were the only set which included data providing a direct relationship with the WRAC instruments.

The following conclusions were reached from the evaluation of the results of the field intercomparison tests.

For both the Tapered Element Oscillating Micro-balance (TEOM) instrument and β-gauge data there was considerably more scatter in the regression slopes of all countries data than there was in the ratios of the mean reference method PM_{10} to the mean candidate PM_{10} in each period. Accordingly, the Group decided to concentrate its analysis on the period means for each method (where period mean is taken to be the average concentration of PM_{10} over a measurement period e.g. summer or winter).

In taking this decision the Group was well aware that there is more scatter in daily means than in seasonal means and that applying correction factors derived from seasonal means may result in either an under-, or overestimate of daily means. Furthermore, the Group recognised that underestimation for higher daily means may be greater if the correlation is non-linear. However, the Group was working towards an interim, pragmatic solution which was both easy to apply, and acceptable to the Commission, for reporting data.

TEOM instrumentation

Figure 1 (top and middle) plots the period mean values of PM_{10} obtained with reference gravimetric equipment versus TEOM instrumentation obtained in different intercomparison exercises. (For clarity it should be noted that each point in Figure 1 represents a mean PM_{10} concentration over a measurement period in a country. Period means are taken from Annex D).

The overall data show an underestimation of TEOM measurements of around 16% on average, i.e. REFERENCE=TEOM*1.19, (reciprocal =0.840) of the PM_{10} gravimetric values (see Figure 1 top). However, if regressions are obtained separately for the different regions from Europe, it becomes evident that there is a wide range of factors from REFERENCE=TEOM*1.27 (reciprocal =0.787) obtained in the French tests to REFERENCE=TEOM*1.09 (reciprocal =0.917) in the Spanish tests (see Figure 1 middle).

This range of factors may be due to the different aerosol composition present in the different regions. It has been known for some time that the underestimation of TEOM measurements is due to the loss of semi-volatile compounds during the heating of the inlet or sample chamber. Thus, a high proportion of mineral dust or primary anthropogenic particulates may account for a lower loss since the content of semi-volatile phases is considerably higher in the secondary particle load.

The differences in temperature between ambient air and the heated devices may account also for the different correction factors obtained under different micro-climates or seasonal conditions. Thus, for a given site a clear seasonal variation of the correction factor is demonstrated. Figure 1 (bottom) shows that most of the winter tests performed in Northern and Central Europe sites show an important TEOM underestimation, correction factors in the range of 1.25 (reciprocal =0.80) to 1.3 (reciprocal =0.769), whereas the tests performed in other seasons tend to show lower mass losses, and lower correction factors, commonly in the range 1.0 to 1.1 (reciprocal =0.909). This is probably due to the differences in seasonal temperature between ambient air and the TEOM heating system. It must be pointed out that two winter tests performed in UK and Spain yielded factors close to 1.0. In these cases, a high mineral load in PM_{10} probably accounts for a low loss of semi-volatile phases, even in winter conditions.

Some of these factors may also be due to different conditions of the reference instruments such as different temperatures of the sampling head and inlet system. It has been demonstrated that losses of semi-volatile aerosols can also occur in unheated parts of the reference system, for example during warm and sunny periods.

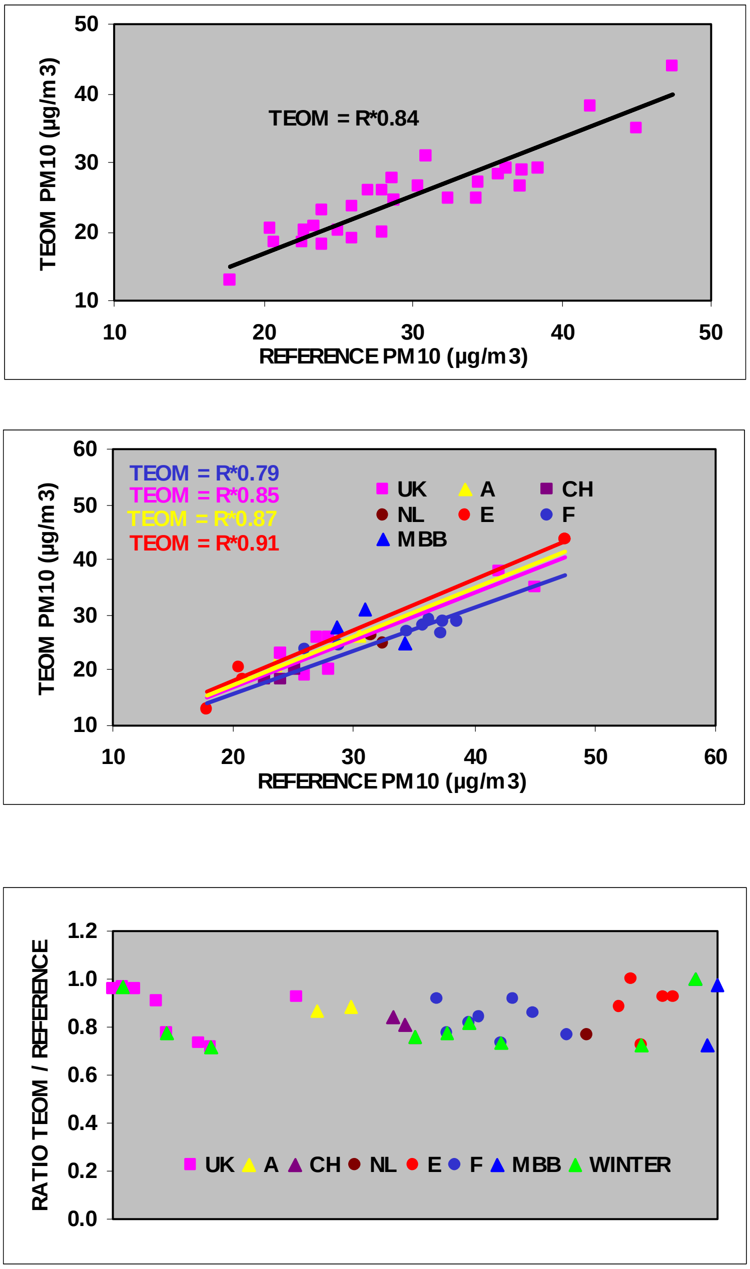


Figure 1. Results of field intercomparison studies with TEOM instrumentation with EN12341 gravimetric reference equipment (or equivalent) performed in different European countries (A, Austria, CH, Switzerland, E, Spain, F, France, NL, The Netherlands, UK, United Kingdom), the intercomparison performed in Madrid, Birmingham and Berlin (MBB). In addition, triangles in the bottom figure indicate intercomparison results obtained in winter periods.

BETA (β) -instrumentation

Figure 2 (top and middle) plots the mean values of PM_{10} obtained with reference gravimetric equipment versus β-instrumentation obtained in different intercomparison exercises. The overall data show an underestimation of β-measurements of around 13%, i.e. REFERENCE=BETA*1.15, (reciprocal =0.870) of the PM_{10} gravimetric values (see Figure 2 top). However, if this regression is split by obtaining factors for the different regions from Europe, it becomes evident that the following factors are deduced from the major intercomparison exercises (see Figure 2 middle):

- A factor of REFERENCE=BETA*1.04 (reciprocal =0.961) was obtained using the data from the experiments carried out in Denmark, Finland, Spain and Switzerland, independently of the season when these were carried out.
- A factor of REFERENCE=BETA*1.30 (reciprocal =0.769) was obtained from the German and Austrian tests carried out in the winter season, whereas the tests carried out in non-winter periods at these sites yielded a similar factor to the one obtained in the other European sites.

This range of factors may be due to the different heating systems of the sampling inlets. Thus, from the reported data with the equipment used in Denmark, Finland, Spain and Switzerland there is only a slight underestimation of β-gauges with respect to the reference gravimetric methods, even in the winter periods. Consequently, it is evident that during these experiments, the loss of semi-volatile compounds was very low, probably due to the absence of inlet heating or to other instrumental reasons. However, in the tests performed in Germany and Austria in winter, and from one of the tests in the Netherlands in the same season, a high proportion of semi-volatile compounds were lost with the subsequent underestimation of β-measurements with respect to the reference methods. As for the TEOM results, a factor close to 1.0 was obtained in non-winter measurements from Austria and Germany. Therefore, the inlet heating is probably the major cause of the winter underestimation of β-measurements.

Another parameter which contributes to the range of factors encountered in different networks may be the different basis of the calibration of instruments. Some networks have used the calibration foil delivered by the manufacturer which is based purely on quartz dust. Other networks may have applied a calibration foil with an internal calibration factor of 1.15, (reciprocal =0.870) also delivered by the manufacturer. Because of the lack of corresponding data these ambiguities could not be resolved by the Working Group.

The results obtained evidenced a clear seasonal variation of the correction factor (Figure 2 bottom), with a winter β underestimation (correction factors in the range of 1.3 {0.769}) and non-winter factors close to 1.0 for the German and Austrian tests. This seasonal variation is probably induced by the loss of semi-volatile matter due to the different seasonal temperature contrast between ambient air and the inlet heating system used in Austria and Germany. However, the good fit between β-measurements and reference measurements (factors close to 1.0) obtained in the other European experiments, performed under very different micro- and macro-environments, indicate probably that the heating system (if applied) or other characteristics β-attenuation instruments are not inducing a loss of semi-volatile material. Consequently, although the performance of intercomparison tests is highly encouraging for all types of automatic measurements, in the case of β-instruments these are exceptionally important given the high influence of the measurement conditions used in each particular site.

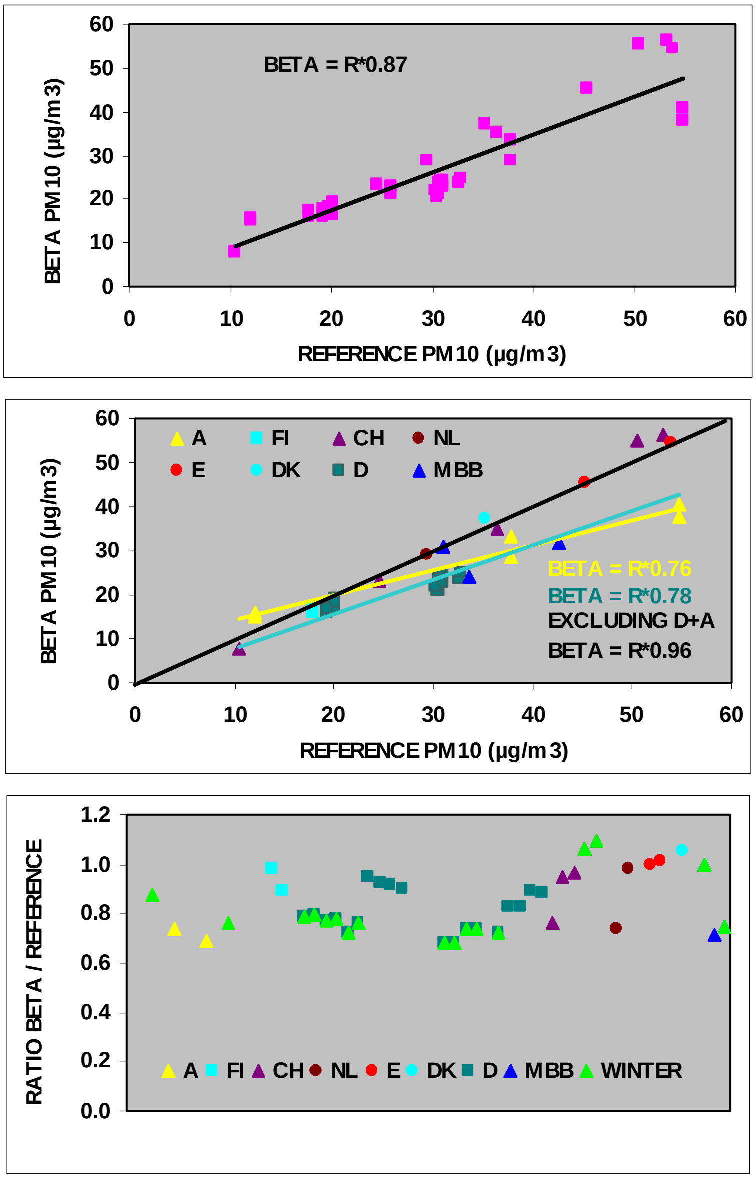


Figure 2. Results of field intercomparison studies with BETA gauges with EN12341 gravimetric reference equipment (or equivalent) performed in different European countries (A, Austria, CH, Switzerland, D, Germany, DK, Denmark, E, Spain, F, France, NL, The Netherlands), an intercomparison performed at Madrid, Birmingham and Berlin (MBB). In addition, triangles in the bottom figure indicate intercomparison results obtained in winter periods.

Working Group Conclusions

The Group recognised that there was scatter in the pooled results from the various countries. Therefore, prescribing one default factor as a mean or median of these data might run the risk of underestimating PM_{10} concentrations. The Group felt therefore that a factor nearer the extreme of the distribution of period mean ratios would be more appropriate. The Group felt that it was important to include this level of safety, bearing in mind that the default factor would be used in advance of the Member State having carried out its own intercomparison exercises. The Group accordingly concluded that a **default correction factor of 1.3** could be applied to measurement data from both TEOM instruments and equipment measuring by β-attenuation techniques. (Although not used in deriving the factor, it is interesting to note that this is approximately the mean plus one standard deviation of the distribution of the ratios of the period means).

The Working Group agreed that this single factor could be applied to both daily averages and to annual means. At the same time the Working Group stressed that in choosing to use this factor a Member State accepts and recognises the uncertainty resulting from the Group's analysis of limited data sets and range of locations and seasons from which the data are taken. The Working Group also stresses that whilst it decided to use the ratios of seasonal mean values to derive the default factor, it would not recommend that this should be done in Member States' own intercomparison exercises discussed in the previous Chapter.

Therefore, the Group agreed that it would recommend that a Member State use this single default factor for reporting under Directive 1999/30/EC, in advance of having carried out their own intercomparison exercises and established their equivalence procedure with the Commission. At the same time the Group stresses that this factor should only be used until such time as procedures in Chapters 3 or 4 can be developed and that a Member State should begin measurement and monitoring in accordance with either of those Chapters as soon as possible. Once this has been done and the Member State has agreed with the Commission the corrections appropriate to its own conditions, it no longer needs to use the 1.3 default factor.

6. CHECKING COMPLIANCE WITH THE LIMIT VALUE FOR SUSPENDED PARTICULATE MATTER UNDER DIRECTIVE 80/779/EC USING PM_{10} MEASUREMENTS

Article 9 (5) of Directive 1999/30 allows Members States to employ PM_{10} measurement stations as one means of assessing concentrations of suspended particulate matter for the purpose of demonstrating compliance with the limit values for TSP laid down in Directive 80/779. For the purpose of demonstrating compliance, the data must be multiplied by a factor of 1.2.

This assumes the use of the reference method or a method that produces equivalent results to measure PM_{10}. If a Member State is using a method which requires use of a PM_{10} correction factor to produce equivalent results to the reference method it must apply the PM_{10} correction factor BEFORE applying the TSP factor of 1.2. For example, if the PM_{10} correction factor is 1.3, then TSP is calculated as:

TSP = measured data x 1.3 x 1.2

If this is not done the reported values for TSP from this site would always be lower than reported values for PM_{10}. Clearly this would not be correct,

7. METHODOLOGY FOR THE EVALUATION OF THE IMPACT OF NATURAL EVENTS ON PM_{10} LEVELS

Article 5.4, Directive 1999/30/EC, provides a derogation in cases where the limit values for PM_{10} are exceeded owing to concentrations of PM_{10} in ambient air due to natural events which result in concentrations significantly in excess of normal background levels from natural PM_{10} sources. In these cases, the Article states that "Member States shall provide the necessary justification to demonstrate that such exceedences are due to natural events". Article 2 of the first Daughter Directive defines natural events as "volcanic eruptions, seismic activities geothermal activities, wild-land fires, high-wind events or the atmospheric re-suspension or transport of natural particles from dry regions".

Furthermore, rural background stations in Southern Europe are characterised by a seasonal distribution of exceedences of the PM_{10} limit value with modes in the spring-summer periods. These higher summer PM_{10} levels contrast with the typical seasonal pattern of urban and industrial environments. This difference may be due to higher natural particulate input as a consequence of one or more of the following factors:

a) low rainfall (low particulate scavenging potential)
b) the intensive atmospheric convective dynamics (induced by the high insolation) occurring mainly in spring and summer (favouring re-suspension),
c) the possible higher frequency of African air mass intrusions.

It is recognised that Northern Europe Member States experience similar problems and also face long range transport pollution from other sources such as secondary aerosols and photo-chemically formed particles.

The Terms of Reference asked the Working Group to consider whether guidance could be developed to assist Member States who might need to provide justification demonstrating that exceedences were due to natural events. Since natural events may have a local origin (re-suspension) or an external origin, (long range transport of mineral dust from dry regions, volcanic activity), the Working Group developed the following three strategies as alternative options to detect these different origins. Papers on daily mean exceedences of particulate matter from long range transport and natural events were presented to the Workshop in Venice by Spain and United Kingdom. It should be noted that the Working Group was helped extensively by Spain in the development of the strategies described in Chapter 6.

This Chapter describes a series of techniques and research tools which could be used to identify the contributions of natural events to measured PM_{10} levels. It should be stressed that this guidance is not meant to suggest that Member States should use all of these techniques, nor that detailed research level data need to be submitted to the Commission for all days. Member States should use those techniques which are appropriate and sufficient for the circumstances of natural events which they are investigating. There may be other techniques which Member States might wish to use and, provided these can be substantiated, Member States are of course free so to do.

The Working Group stressed that data on natural events were an important source of knowledge and that information of such events should be clearly reported and made freely available as a contribution towards understanding the phenomena.

Strategy 1: Detection of natural events due to long range transport of mineral dust such as Sahara air mass intrusions

It is well known that high Sahara and Sahel dust air mass intrusions occur in Europe. Although these events are detected with a higher frequency in the Mediterranean domain, Central and Northern Europe are also sporadically influenced by these events. The Sahara or Sahel dust is made up of mineral particles (mainly, calcite, iron oxide, quartz and clay minerals) which differ considerably, in composition and grain size, from anthropogenic particles. Although a large proportion of this dust is made up by particles coarser than 10 microns, the high dust load associated with these events accounts for the impact on PM_{10} (particulate matter finer than 10 microns) measurements. In some parts of the EU territory, such as the Canary Islands, PM_{10} levels may remain up to about 10 times the limit value for several consecutive days during Saharan dust intrusion events. Identification of such events is easy for these Member States. However, by the time that Saharan dust plumes reach Northern European region, the dispersion processes and the interference with the local particulate load may mask the easy detection of the events.

Objective of the method

The objective of this method is to identify high PM_{10} events, exceeding the PM_{10} daily limit values (50µg/m^3), caused by natural particulate inputs produced by long range transport events such as Sahara or Sahel air mass intrusions.

Procedure

1. Identify particulate peaks in the PM_{10} time series.
2. Compile information from simultaneous time series of different monitoring stations of the network and from a rural/remote/EMEP area (reference series) close to the monitoring site.

3. Compare the PM_{10} series for those events with high PM_{10} levels and identify a list of coincident high PM_{10} peaks. A daily collection of the results of the TOMS measurements of aerosol index and of the SKIRON model (Kallos et al., 1997) has to be performed to evaluate the possible Sahara/Sahel influence on the PM10 levels. This information of TOMS index may be obtained for the previous day at http://jwocky.gsfc.nasa.gov. Information is supplied in detail for Europe in graphs which may be downloaded from ftp://jwocky.gsfc.nasa.gov/pub/tmp/meduse The daily dust load and 72 hr forecast ,maps over Europe deduced from SKIRON are available daily from http://forecast.uoa.gr.

4. Backwards trajectory analysis using isentropic meteorological models using 3 to 7 days backwards transport periods may help to support the long transport input of PM_{10}. The Hysplit model (Draxler, 1994) is suitable for this analytical process; it is a relatively easy to operate and it may be downloaded free of charge from the NOAA web site (ftp://www.arl.noaa.gov/pub/models). The 15 days meteorological data files needed to run the model can be downloaded from ftp://www.arl.noaa.gov/pub/archives/fnl/, free of charge, during one subsequent month or purchased from National Climatic Data Centre services in USA. The results of the analysis may be validated with the synoptic charts, available at: http://www.ecmwf.int/or at http://pcarx2.am.ub.es/infomet/arxiu/avn.

5. If the daily information from TOMS, SKIRON or the backwards trajectory models has been stored, a simple check of the TOMS and SKIRON mapping of the plume of Sahara/Sahel dust for the selected days, or the backwards trajectory analysis, will confirm the Sahara/Sahel influence. In order to attribute the high PM_{10} levels to a Sahara particulate input, the PM_{10} levels recorded at the reference station during the high particulate events will have to represent a high proportion of the PM_{10} levels recorded at the monitoring site. In the case of the exceedences of the PM_{10} limit values, the comparison of the reference and the monitoring site will help to support the justification that the limit value would not have been exceeded without this long range transport event.

   It is important to note that the meteorological data (for the back-trajectories calculations and ECWMF charts) and the forecast SKIRON are available at internet only for a few days. Thus, it is necessary to down load the meteorological files and to run the forecast SKIRON every day in order to store data for the later study of the PM_{10} time series.

With the methodology described, the major long range dust transport events may be detected but alternatively, the following strategies may also be able to identify these events:
(a) Since the anthropogenic particulate load occurs mainly in the fraction finer than 2.5 microns, ($PM_{2.5}$), the presence of a large proportion of 2.5-10 micron particles indicates the influence of natural particulate sources. Therefore, if simultaneous TSP or $PM_{2.5}$ measurements are performed in urban areas, the proportions of PM_{10} in TSP or $PM_{2.5}$ in PM_{10} will considerably decrease when Sahara/Sahel dust events occur. However, it should be noted that this relationship is not valid for areas under the influence of primary particulate emissions (mining, tiling, demolition, cement and ceramic manufacture) since the grain size of the particulate emissions are very similar to that of the natural dust load.

(b) The use of a reference station may be substituted by chemical mass balance of the major components of PM_{10} for the days exceeding the limit value. Given that Sahara/Sahel dust is made up mainly of quartz, calcite, dolomite and clay minerals, the direct analysis of Ca, Al_2O_3, Fe_2O_3, K, Mg, and the indirect determination of Si ($2*Al_2O_3 = SiO_2$) and CO_3^{2-}($1.5*Ca + 2.5*Mg = CO_3^{2-}$) allows the determination of the mineral load supplied by the Sahara input. If this load is subtracted from the total PM_{10}, and the limit value is not exceeded, it can be inferred that the natural input is responsible for the exceedence.

Further, detailed information on this procedure can be obtained from the following references:

- Seasonal evolution of atmospheric suspended particles around a coal-fired power station: TSP levels and source origins. Atmospheric Environment, 32, 11, 1963-1978 (1998). QUEROL X., ALASTUEY A., LOPEZ-SOLER A., PLANA F. PUICERCUS J.A, MANTILLA E., MIRO J.V.; ARTIÑANO B.

- Saharan dust contribution to PM10 and TSP levels in Southern and Eastern Spain. Atmospheric Environment (In Press, 2001). RODRIGUEZ S., QUEROL X., ALASTUEY A., KALLOS G. and KAKALIAGOU O.
- Assessment of airborne particulate matter in Spain in response to the new EU-directive. Atmospheric Environment (In Press, 2001). ARTIÑANO B., QUEROL X., SALVADOR P., RODRIGUEZ S., ALASTUEY A.
- The regional weather forecasting system SKIRON: an overview. KALLOS, G., KOTRONI, V., LAGOUVARDOS, K. Proceedings of the symposium on regional weather prediction on parallel computer environments, 1997, University of Athens, Greece, pp. 109-122.
- Hybrid Single-Particles Lagrangian Integrated Trajectories. Version 3.2, Draxler R.R. (1994). NOAA-ARL.
- Monitoring of PM10 and PM2.5 ambient air levels around primary anthropogenic emissions. Atmospheric Environment 35, 845 – 858. QUEROL X., ALASTUEY A, RODRIGUEZ S., PLANA F., MANTILLA E., and RUIZ CR.

Strategy 2: Detection of natural events due to local re-suspension

Atmospheric suspended particles from dry areas in Southern Europe have a higher mineral load when compared with Central and Northern Europe. This differentiation is not exclusive to Europe, since a number of studies have shown a similar differentiation between the Eastern and Western coasts of USA. A number of causes are thought to account for this higher mineral load:

a) poor soil cover allows re-suspension of soil particles;
b) low rainfall accounts for a low particulate scavenging potential,
c) intense atmospheric convective dynamics (induced by the high insolation) occurring mainly in spring and summer, favouring re-suspension.

Given that the physical and chemical characteristics of natural re-suspended particles differ considerably in most of the cases from the anthropogenic particles, both chemical and physical measurements may allow identification of high particulate events induced by local re-suspension processes.

Objective of the method

The objective of this method is to identify high PM_{10} events caused by natural particulate inputs due to local re-suspension of soil particles.

Procedure

If re-suspension processes are expected to increase the PM_{10} levels in a given monitoring site, it is recommended to develop chemical mass balances procedures. This analysis should be carried out for at least one year (around 75 samples homogeneously distributed throughout a year) to determine the periods of influence and to demonstrate the high proportion of the natural load on the PM_{10} levels. The direct analysis of Ca, Al_2O_3, Fe_2O_3, K, Mg, Ti and P and the indirect determination of Si ($2*Al_2O_3 = SiO_2$) and CO_3^{2-}($1.5*Ca + 2.5*Mg = CO_3^{2-}$) allows the determination of the mineral load. If this load is subtracted from the total PM_{10} mass concentration and the limit value is not exceeded, it can be inferred that the natural input is responsible for the exceedence. In urban background stations, levels of SO_4^{2-}, NO_3^-, NH_4^+ and non mineral C (organic C) shall represent the anthropogenic load, whereas the levels of Cl^-, Na^+ and marine SO_4^{2-} and Mg^{2+} (both determined indirectly from the Na^+ levels) shall represent the marine aerosol load.

Once the importance of the re-suspended particulate load is demonstrate by a source apportionment analysis, the following steps may be applied in the subsequent years to identify further re-suspension events.

1. Identify particulate peaks in the PM_{10} time series.

2. Compile information from simultaneous time series obtained in different monitoring sites of the network and from a rural/remote/EMEP area (reference series) close to the monitoring site.

3 Compare the PM_{10} reference series from those events with high PM_{10} levels in the time series and identify a list of coincident high PM_{10} peaks. Lower concentrations of

particulate pollutants are expected in spring and summer, than in autumn and winter, as a consequence of the higher atmospheric dispersion conditions and the lower emission rates. Therefore, any high PM$_{10}$ events occurring in spring and summer may have a higher natural input than those occurring in winter.

4 Obtain simultaneous measurements of TSP and/or PM$_{10}$and PM$_{2.5}$ levels in the reference and the monitoring sites. Mineral fractions of re-suspended soil particles are mainly in the coarse range (larger than 2.5 microns). Consequently, if the proportion of PM$_{2.5}$ in PM$_{10}$, or in TSP for a high PM$_{10}$ event recorded in both the reference and the monitoring stations, is very low (<50 %wt), then possible re-suspension processes may account for the high PM$_{10}$ values. However, it is important to note that the absence of anthropogenic primary PM$_{10}$ emission sources (ceramic, mining, cement) has to be demonstrated since these sources emit particles mainly in the 2.5 to 10 micron range.

Further, detailed information on this procedure can be obtained from the following references:

- Source assessment of particulate pollutants measured at the southwest European coast. Atmospheric Environment, 30, 19, 3309-3320 (1996). PIO C:A:, CASTRO L.M., CERQUEIRA M. A., SANTOS I.M., BELCHIOR F., SALGUEIRO M.L.
- Comparative RECEPTOR MODELLING STUDY OF AIRBORNE PARTICULATE POLLUTANTS IN Birmingham (United Kingdom), Coimbra (Portugal) and Lahore (Pakistan). Atmospheric Environment, 31, 3309-3321 (1997). HARRISON R.M., SMITH D.J.T., PIO C.A. and CASTRO L.M.
- Spatial and temporal variations in PM10 and PM2.5 source contributions and comparison to emissions during the 1995 integrated monitoring study Atmospheric Environment, 33, 4757-4773 (1999). MAGLIANO K.L., HUGHES V.N., CHINKING, L.R., COE D.L., HASTE T.L., KUMAR N., LURMANN F.W.
- Monitoring of PM10 and PM2.5 ambient air levels around primary anthropogenic emissions. Atmospheric Environment 35 5 848 – 858). QUEROL X., ALASTUEY A., RODRIGUEZ S., PLANA F., MANTILLA E. and RUIZ C.R.
- Seasonal evolution of atmospheric suspended particles around a coal-fired power station: Chemical Characterization. Atmospheric Environment, 32, 4, 719-731 (1998). QUEROL X., ALASTUEY A., LOPEZ-SOLER A., PLANA F. PUICERCUS J.A, RUIZ C.R., MANTILLA E., JUAN R.

Strategy 3: Detection of natural events due to volcanic, seismic events or wild fires

In addition to long range transport and re-suspension processes, other natural events such as volcanic, seismic and wild fire events may induce sporadically high PM_{10} levels in EU Member States. The detection of any of these events by one Member State is enhanced by similar detection in other Members States. Furthermore, the presence of gaseous tracers at air monitoring stations throughout the affected Member States should also help to determine the timing of these events more precisely.

Objective of the method

The objective of this method is to demonstrate that a high PM_{10} event is caused by natural particulate inputs due to volcanic, seismic events or wild fire.

Procedure

1. Identify particulate peaks in the PM_{10} time series.

2. Compile information on a simultaneous time series from a rural/remote/EMEP area (reference series) relevant to the monitoring site.

3. Compare the PM_{10} series from those events with high PM_{10} levels and identify a list of coincident high PM_{10} peaks.

4. Compile a list of volcanic, seismic events or wild fires occurring during the time series.

5. Compare the time distribution of these events with that of the coincident high PM_{10} peaks and review information on gaseous tracers for volcanic (SO_2) or wild fires (NO_x and CO) to confirm the relationship between these events and the PM_{10} peaks in the reference station.

6. Modelling of the dispersion of plumes from volcanic events and wild fires may also demonstrate the relationship of PM_{10} limit value exceedences and these natural events.

ANNEX A

Membership of the Working Group

Chairmen	Peter Bruckmann Martin Williams
Secretariat	John Stealey
Members	Lynne Edwards Stefan Jacobi Duncan King Duncan Laxen François Mathé Ton van der Meulen Finn Palmgren Xavier Querol Emile de Saeger

ANNEX B

Terms of Reference

- To obtain information from Member States about work carried out to compare the different methods for measuring particulate matter and to summarise the results.

- To draft advice on demonstrating equivalence with the aim of helping Member States fulfil the requirements of Directive 1999/30/EC.

- To advise on any difficulties and, if necessary, to suggest practical solutions during the first stage of implementation of Directive 1999/30/EC.

- To draft recommendations for the development of correction factors or correction equations which may be applied to data obtained by measurement methods, for $PM_{10,}$ other than the reference method set out in Directive 1999/30/EC in order to produce equivalent results.

- To draft recommendations in respect of default factors which might be applied by Member States who have not completed intercomparison tests in time for implementation of the Directive.

Natural Events

The Group should also consider whether it is advisable to draft advice on demonstrating that exceedences of limit values for PM_{10} are due to natural events, and if so, whether it is feasible to do so within the two planned meetings. It should be noted that the Venice Workshop agreed that results presented by Spain and the UK were sufficient to demonstrate the influence of long range transport, and that this work will be published.

The Commission asked the Working Group to gather information, review the data and produce its draft recommendations, in order to report to the Air Quality Steering Group meeting, scheduled for 12 – 13 February 2001.

ANNEX C:

INTERPOLATION OF SEASONAL CORRECTION FACTORS/EQUATIONS

In cases where seasonal factors/equations need to be applied (where the differences of corrected daily means are >±10%) it is recommended that moving averages of the factors/equations are used to avoid a discontinuity or 'step change' in the time series when changing from one season to the next.

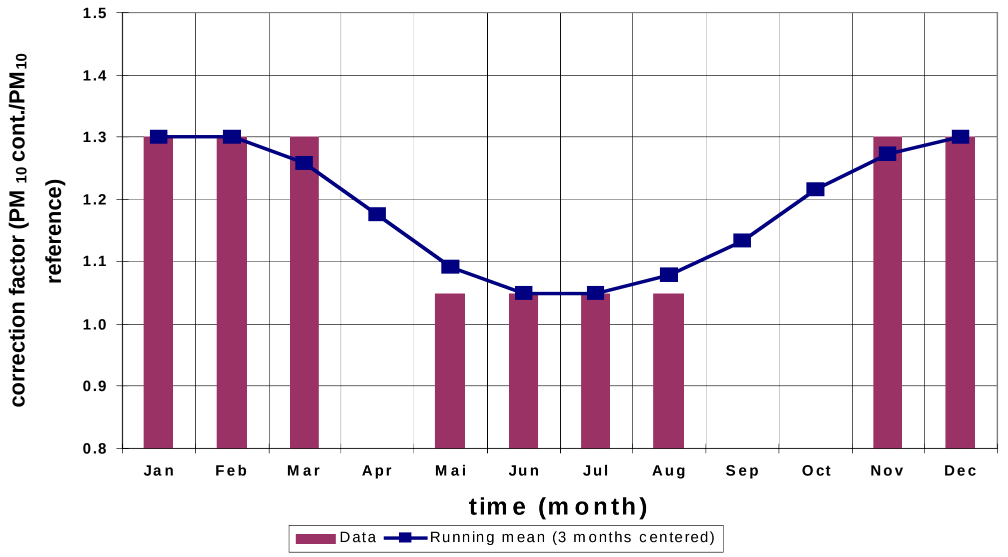
The method for interpolating the data depends upon whether a correction factor or a correction equation is being applied. Examples of how interpolation may be carried out in each case are provided below.

Seasonal Correction Factors

Where a seasonal ***correction factor*** is applied, it is recommended that the 3-month moving average is calculated, based upon the month centred. For example, the correction factor for March is calculated by averaging the factors for February, March and April; the correction factor for April is calculated by averaging the factors for March, April and May.

Example: An example is shown plotted in Figure 1. Correction factors were determined from monitoring in 9 months of the year, and are shown plotted as histogram bars. The 'winter' correction factor is 1.3, whilst the 'summer' factor is 1.05. The effect of applying a moving average provides a smooth transition in the correction factor across the year.

Figure 1: Interpolation of seasonal correction factors



Seasonal Correction Equations

Where a seasonal ***correction equation*** is applied, it is not possible to calculate the moving average in the manner described above. Instead, a 3-month moving average is derived from weighting of the equations, based upon the month centred.

Example: In this example, it is assumed that 30 days monitoring were carried out in January and July. The correction equation determined in January is assumed to be representative of the winter season (October to March), and the equation in July of the summer season (April to September). The equations are assumed to be as follows:

Winter (October to March): $y = 1.24x + 3.684$
Summer (April to September): $y = 1.12x + 1.963$

Where y is the ‘corrected’ PM_{10} concentration, and x is the measured PM_{10} concentration as determined by the candidate automatic sampler.

The derivation of the correction factors for each month are described in the table below:

Month	**Calculation of weighted mean**	**Correction Equation**
January	Weighted average of Dec-Feb	$y = 1.24x + 3.684$
February	Weighted average of Jan-Mar	$y = 1.24x + 3.684$
March	Weighted average of Feb-Apr	$y = (2*(1.24x + 3.684)+ (1.12x + 1.963))/3$
April	Weighted average of Mar-May	$y = (1.24x + 3.684)+ (2*(1.12x + 1.963))/3$
May	Weighted average of Apr-Jun	$y = 1.12x + 1.963$
June	Weighted average of May-Jul	$y = 1.12x + 1.963$
July	Weighted average of Jun-Aug	$y = 1.12x + 1.963$
August	Weighted average of Jul-Sep	$y = 1.12x + 1.963$
September	Weighted average of Aug-Oct	$y = (1.24x + 3.684)+ (2*(1.12x + 1.963))/3$
October	Weighted average of Sep-Nov	$y = (2*(1.24x + 3.684)+ (1.12x + 1.963))/3$
November	Weighted average of Oct-Dec	$y = 1.24x + 3.684$
December	Weighted average of Nov-Jan	$y = 1.24x + 3.684$

ANNEX D

Questionnaire Table

1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference	7 Regression Equation

8. Number of Exceedences (50ug/m3 24hr mean) Candidate	9. Number of Exceedences (50ug/m3 24 hr mean) References	10 r^2 value & sample size	11 Modifications to Instrument	12 STP or Ambient	13 Modifications to data	14 Other analysis

Key to Questionnaire

1. Site Classification: Describe monitoring site e.g. roadside, background urban, rural.

2. Member State Candidate Instrument: Describe type of instrument(s) selected by Member State and being tested for equivalence measurement technique e.g. gravimetric, automatic, β attenuation, housing conditions e.g. inside or outside a housing, air conditioning and temperature control.

3. Reference Instrument: specify the type of reference instrument against which intercomparison is being made and equivalence of the candidate instrument is being sought, as stated in EN 12341.

4. Season & Period; Describe test period e.g. summer or winter and provide dates of each period.

5. Seasonal Mean for Candidate: the mean PM_{10} mass concentration values for each of the seasonal periods described.

6. Seasonal Mean for Reference: the mean PM_{10} mass concentration values for each of the seasonal periods described.

7. Number of Exceedences for Candidate: state number of fixed 24 hour periods where concentration is > 50 $\mu g/m^3$

8. Number of Exceedences for Reference: state number of fixed 24 hour periods where concentration is > 50 $\mu g/m^3$

9. Regression equation: the mathematical values for the regression analysis carried out. Please give as x axis = reference instrument; y axis = candidate instrument

10. r^2 value and sample size: the numerical value for the regression coefficient and the sample size on which it is based.

11. Modifications to the candidate instrument: describe any modifications which may have been made to the instrument such as removal of air flow heating units, temperature of inlet, etc.

12. STP or ambient: are data corrected to STP or to ambient conditions.

13. Modifications to data: have data been modified to force regression line through the origin. If so what mathematical analysis has been carried out to achieve this result.

14. Other Analysis: is regression analysis the preferred technique for demonstrating equivalence or have other measurement options, for example calculating the ratio of candidate instrument measurement to reference instrument measurement been investigated and used.

Short narrative of useful points.

It would help the WG if you have found any particular approaches to gathering data, maintenance of instruments or ideas about good practice in your programme which have helped the quality and reliability of data acquisition and analysis. The WG would like to take advantage of promulgating and sharing any ideas which Member States have used in their intercomparison studies.

Please add any short notes you feel are relevant and may help others who have not reached the same level of progress in their intercomparison work.

ANNEX E Data Sets Submitted to the Working Group

AUSTRIA

	1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference:	7 Regression Equation
1	Kerbside	TEOM, all temperatures 40°C, inside airconditioned container	LVS Kleinfilter, outside	24.3.00 - 3.5.00	43,66	54,76	y=0,853x-1,82
2	Industrial	above	above	18.5.00 - 19.6.00	24,22	25,89	y=0,912x+0,54
3	Commercial	above	above	8.2.00 - 10.3.00	36,44	37,88	y=0,877x+3,01
4	Suburban background	above	above	13.7.00 - 30.8.00	18,06	12,08	y=0,931x+6,97

	8. Number of Exceedences (50ug/m3 24hr mean) Candidate	9. Number of Exceedences (50ug/m3 24 hr mean) References	10 r^2 value & sample size	11 Modifications to Instrument	12 STP or Ambient	13 Modifications to data	14 Other analysis
1	12	21	0,9110 (N=36)	none	20°C, 1013 hPa	none	none
2	0	0	0,7818 (N=32)	none	20°C, 1013 hPa	none	none
3	6	7	0,9426 (N=31)	none	20°C, 1013 hPa	none	none
4	0	0	0,8748 (N=47)	none	20°C, 1013 hPa	none	none

	1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference:	7 Regression Equation
1	Kerbside	FH62IN inside airconditioned container, 40°C inlet temparature	LVS Kleinfilter, outside	24.3.00 - 3.5.00	40,57	54,76	y=0,882x-6,59
2	Industrial	as above	above	18.5.00 - 19.6.00	22,86	25,89	y=0,954x-1,91
3	Commercial	as above	above	8.2.00 - 10.3.00	33,26	37,88	y=0,859x+0,42
4	Suburban background	as above	above	13.7.00 - 30.8.00	15,77	12,08	y=0,898x+4,89

	8. Number of Exceedences (50ug/m3 24hr mean) Candidate	9. Number of Exceedences (50ug/m3 24 hr mean) References	10 r^2 value & sample size	11 Modifications to Instrument	12 STP or Ambient	13 Modifications to data	14 Other analysis
1	9	21	0,9782 (N=36)	none	20°C, 1013 hPa	none	none
2	0	0	0,6886 (N=32)	none	20°C, 1013 hPa	none	none
3	5	7	0,9773 (N=31)	none	20°C, 1013 hPa	none	none
4	0	0	0,8725 (N=48)	none	20°C, 1013 hPa	none	none

	1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean **Candidate**	6. Season or Period Mean **Reference:**	7 Regression Equation
1	Kerbside	FH62IR, inside airconditioned container, 40°C inlet temparature	LVS Kleinfilter, outside	24.3.00 - 3.5.00	37,94	54,76	y=0,816x-5,54
2	Industrial	as above	above	18.5.00 - 19.6.00	21,09	25,89	y=0,786x+0,39
3	Commercial	as above	above	8.2.00 - 10.3.00	28,75	37,88	y=0,759x-0,19
4	Suburban background	as above	above	13.7.00 - 30.8.00	14,97	12,08	y=0,851x+4,66

	8. Number of Exceedences (50ug/m3 24hr mean) Candidate	9. Number of Exceedences (50ug/m3 24 hr mean) References	10 r^2 value & sample size	11 Modifications to Instrument	12 STP or Ambient	13 Modifications to data	14 Other analysis
1	6	21	0,9784 (N=36)	none	20°C, 1013 hPa	none	none
2	0	0	0,7235 (N=32)	none	20°C, 1013 hPa	none	none
3	2	7	0,9793 (N=31)	none	20°C, 1013 hPa	none	none
4	0	0	0,8718 (N=48)	none	20°C 1013 hPa	none	none

Additional information on data from Austria

- 4 sites have been tested, 1,2,3 in Austrian agglomerations
- The number of samples is very small at each site, it is planned to revisit the site in different seasons
- 2 Kleinfiltergeräte are used, alternating as sampling starts and stops at midnight
- All gravimetric instruments use filters of the same type and manufacturer: glassfibre with organic binder
- Studies are currently underway to examine reasons for the differences in the gravimetric methods, it seems that the Kleinfiltergeräte give a systematic underestimation compared to the other ones, specially the Digitel: this has been cleared, the Digitel head was wrongly labeled (PM10 for 30m³/h flow) but contained nozzles for 64 m³/h, so data are skipped.
- There is strong evidence that the 2 PM10 inlets (US-EPA) of the Partisol have slightly different cut off characteristics, also this data are skipped; the same PM10 head as for the FH monitors are now used.
- the number of decimals used in the table for period mean and regression equation is due to calculation of these numbers (and the example given)

Parallel measurements with 2 LSV Kleinfilter, 2 Digitel and one Partisol near to the Agency are underway to the end of the year.

DENMARK

Data submitted by Denmark were not in the format of the Questionnaire, described in Annex C. However, information was made available to the Working Group and thus that information is included in this Report.

- PM_{10} gravimetric (average 35.19 µg/m^3) v PM_{10} β Absorption (average 37.12 µg/m^3)

  $r^2 = 0.93$

  $y = 1.20x - 5.18$

- PM_{10} gravimetric (average 35.20 µg/m^3) v TSP gravimetric (average 47.50 µg/m^3)

  $r^2 = 0.83$

  $y = 1.35x - 0.10$

Danish data of gravimetric results and the β gauge results are from the same filters sampled by an ADAM sampler. They are also compared to the TSP data which shows a ratio of TSP/PM_{10} of 1.35.

FINLAND

	1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference	7. Regression Equation
1	Vallila Kerbside	LVS Kleinfiltergerat2	LVS Kleinfiltergerat1	Autumn (8/9/00 – 26/9/00)	17.5	17.9	y=1.0137x+0.1631
2	Vallila Kerbside	TEOM – inside temperature 50°C	LVS Kleinfiltergerat1	Autumn (8/9/00 – 26/9/00)	16.4	17.9	y=0.7391x+3.1618
3	Vallila Kerbside	Eberline FH 62 I-R 1	LVS Kleinfiltergerat1	Autumn (8/9/00 – 26/9/00)	17.5	17.9	y=0.8385x+2.5308
4	Vallila Kerbside	Eberline FH 62 I-R 2	LVS Kleinfiltergerat1	Autumn (8/9/00 – 26/9/00)	16.0	17.9	y=0.7665x+2.27
5	Vallila Kerbside	Virtual Impactor	LVS Kleinfiltergerat1	Autumn (8/9/00 – 26/9/00)	16.3	17.9	y=1.0133x-1.8178
6	Vallila Kerbside	Dekati-Impactor	LVS Kleinfiltergerat1	Autumn (8/9/00 – 26/9/00)	17.0	17.9	y=0.9656x-0.3117

	8. Number of Exceedences (50 µg/m^3 24 hr mean) Candidate	9. Number of Exceedences (50 µg/m^3 24 hr mean) Reference	10. r^2 value & Sample size	11. Modifications to Instrument	12. STP or Ambient	13. Modifications to data	14. Other Analysis
1	0	0	0.9979 (N=17)	None	STP	Regression not forced through ”0”	None
2	0	0	0.9705 (N=18)	None	STP	Regression not forced through ”0”	None
3	0	0	0.9603 (N=18)	None	STP	Regression not forced through ”0”	None
4	0	0	0.9615 (N=18)	None	STP	Regression not forced through ”0”	None
5	0	0	0.9694 (N=18)	None	Ambient	Regression not forced through ”0”	None
6	0	0	0.9945 (N=18)	None	Ambient	Regression not forced through ”0”	None

Additional information on data from Finland

1. Site description:

The sampling site is located in downtown Helsinki (60°13’N, 24°58’E), Finland, at a distance of 14 m from a road with an average daily traffic of about 13 000 vehicles. The air was collected on a roof of the station, 3.5 m above the ground.

2. Candidate Instrument:

- TEOM (inside temperature 50°C), Eberline FH 62 I-R 1 and Eberline FH 62 I-R 2 were inside the station.
- Virtual Impactor and Dekati-Impactor were on the roof of station and both techniques are based on the gravimetric technique

4. Season & Period:

Measurements were started on 8th September, 2000 and will be continue up to the end of October, 2000. Next measurement period (also 2 months) will be carried out on spring, 2000.

FRANCE

French measurements: HVS PM10 Andersen vs. TEOM PM10

1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference:	7 Regression Equation
Traffic site	TEOM – inside individual shelter - 50^0C inlet temperature	HVS - Graseby-Andersen (EN12341)	(06/05/98 – 02/09/98)	23,6	26	Y = 0,7741 X + 3,467
Traffic site	TEOM – inside individual shelter - 50^0C inlet temperature	HVS - Graseby-Andersen (EN12341)	(12/10/98 – 31/03/99)	29	38,5	Y = 0,6266 X + 4,867
Traffic site	TEOM – inside individual shelter - 50^0C inlet temperature	HVS - Graseby-Andersen (EN12341)	(01/04/99 – 18/06/99)	26,9	36,4	Y = 0,5974 X + 5,1398
Urban site with traffic influence	TEOM – inside big shelter - 50^0C inlet temperature	HVS - Graseby-Andersen (EN12341)	(06/09/99 – 07/03/00)	27	34,4	Y = 0,6517 X + 4,6323
Urban site with traffic influence	TEOM – inside big shelter - 50^0C inlet temperature	HVS - Graseby-Andersen (EN12341)	(06/04/00 – 24/08/00)	28,2	35,8	Y = 0,601 X + 6,6839

8. Number of Exceedences (50ug/m3 24hr mean) Candidate	9. Number of Exceedences (50ug/m3 24 hr mean) References	10 r^2 value & sample size	11 Modifications to Instrument	12 STP or Ambient	13 Modifications to data	14 Other analysis
0	0	0,8807 (N=44)	None	STP	If Regression forced through "0" Y = 0,9 X (r^2=0,8562)	Mean ratio TEOM/HVS = 0,913 ± 0,07
4	18	0,835 (N=82)	None	STP	If Regression forced through "0" Y = 0,731 X (r^2=0,807)	Mean ratio TEOM/HVS = 0,779 ± 0,121
1	7	0,7836 (N=34)	None	STP	If Regression forced through "0" Y = 0,7259 X (r^2=0,7437)	Mean ratio TEOM/HVS = 0,75 ± 0,11
5	8	0,8957 (N=56)	None	STP	If Regression forced through "0" Y = 0,7544 X (r^2=0,8666)	Mean ratio TEOM/HVS = 0,813 ± 0,119
2	8	0,9344 (N=38)	None	STP	If Regression forced through "0" Y = 0,7455 X (r^2=0,8646)	Mean ratio TEOM/HVS = 0,84 ± 0,147

FRANCE: HVS DIGITEL DA80 PM10 vs. TEOM PM10

1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference:	7 Regression Equation
Traffic site	TEOM – inside individual shelter - 50^{0}C inlet temperature	HVS - Digitel DA80 PM10 (EN12341)	(12/10/98 – 10/12/98)	29,2	33,6	Y = 0,5219 X + 11,652
Traffic site	TEOM – inside individual shelter - 50^{0}C inlet temperature	HVS - Digitel DA80 PM10 (EN12341)	(22/01/99 – 01/05/99)	26,6	37,2	Y = 0,6093 X + 4,014
Traffic site	TEOM – inside individual shelter - 50^{0}C inlet temperature	HVS - Digitel DA80 PM10 (EN12341)	(02/09/99 – 22/12/99)	24,6	28,8	Y = 0,688 X + 4,7565
Urban site with traffic influence	TEOM – inside big shelter - 50^{0}C inlet temperature	HVS - Digitel DA80 PM10 (EN12341)	(03/02/00 – 02/03/00)	22,9	28,8	Y = 0,5852 X + 5,9962
Urban site with traffic influence	TEOM – inside big shelter - 50^{0}C inlet temperature	HVS - Digitel DA80 PM10 (EN12341)	(06/04/00 – 28/08/00)	29,2	36,3	Y = 0,6234 X + 6,606

8. Number of Exceedences (50ug/m3 24hr mean) Candidate	9. Number of Exceedences (50ug/m3 24 hr mean) References	10 r^2 value & sample size	11 Modifications to Instrument	12 STP or Ambient	13 Modifications to data	14 Other analysis
0	2	0,5969 (N=25)	None	STP	If Regression forced through "0" Y = 0,8189 X (r^2=0,3714)	Mean ratio TEOM/HVS = 0,929 ± 0,21
2	18	0,9029 (N=82)	None	STP	If Regression forced through "0" Y = 0,702 X (r^2=0,8785)	Mean ratio TEOM/HVS = 0,735 ± 0,08
3	10	0,9469 (N=77)	None	STP	If Regression forced through "0" Y = 0,8117 X (r^2=0,9061)	Mean ratio TEOM/HVS = 0,913 ± 0,15
0	2	0,9206 (N=23)	None	STP	If Regression forced through "0" Y = 0,7665 X (r^2=0,8192)	Mean ratio TEOM/HVS = 0,827 ± 0,11
4	13	0,9126 (N=54)	None	STP	If Regression forced through "0" Y = 0,7655 X (r^2=0,8518)	Mean ratio TEOM/HVS = 0,856 ± 0,14

GERMANY

	1. Site	2. Candidate Instrument y	3. Reference Instrument x	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference	7. Regression Equation y = b • x + a
1	suburban, modest industrial influence	DHA-80	KFG (1) (Typ: GS050/3-C)	18/05/98 - 30/09/98	21.7	21.4	y = 0,92x + 2,01
2	suburban, modest industrial influence	DHA-80	KFG (2) (Typ: GS050/3-C)	18/05/98 - 30/09/98	21.6	21.2	y = 1,00x + 0,37
3	suburban, modest industrial influence	FH 62 I-N (1)	KFG (1) (Typ: GS050/3-C)	18/05/98 - 30/09/98	19.2	20.2	y = 0,88x + 1,39
4	suburban, modest industrial influence	FH 62 I-N (1)	KFG (2) (Typ: GS050/3-C)	18/05/98 - 30/09/98	17.9	19.3	y = 0,87x + 1,19
5	suburban, modest industrial influence	FH 62 I-N (2)	KFG (1) (Typ: GS050/3-C)	18/05/98 - 30/09/98	18.2	19.8	y = 0,75x + 3,25
6	suburban, modest industrial influence	FH 62 I-N (2)	KFG (2) (Typ: GS050/3-C)	18/05/98 - 30/09/98	17.4	19.4	y = 0,76x + 2,75
7	suburban, modest industrial influence	FH 62 I-R (1)	KFG (1) (Typ: GS050/3-C)	18/05/98 - 30/09/98	16.7	20.1	y = 0,79x - 0,94
8	suburban, modest industrial influence	FH 62 I-R (1)	KFG (2) (Typ: GS050/3-C)	18/05/98 - 30/09/98	16	19.3	y = 0,80x + 0,57
9	suburban, modest industrial influence	FH 62 I-R (2)	KFG (1) (Typ: GS050/3-C)	18/05/98 - 30/09/98	18	20.2	y = 0,81x + 1,68
10	suburban, modest industrial influence	FH 62 I-R (2)	KFG (2) (Typ: GS050/3-C)	18/05/98 - 30/09/98	17	19.3	y = 0,80x + 1,46

	8. Number of Exceedences (50µg/m^3 24hr mean) Candidate	**9. Number of Exceedences (50µg/m^3 24hr mean) Reference**	**10. r^2 value & sample size**	**11. Modifications to Instrument**	**12. STP or Ambient**	**13. Modifications to data**	**14. Other analysis**
1	1	1	0,93 (n=64)	none	ambient	Grubbs test for outliers	none
2	1	1	0,89 (n=47)	none	ambient	Grubbs test for outliers	none
3	2	0	0,85 (n=61)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
4	1	0	0,85 (n=46)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
5	1	0	0,81 (n=53)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
6	1	0	0,83 (n=45)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
7	2	0	0,84 (n=62)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
8	1	0	0,89 (n=46)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
9	0	0	0,85 (n=61)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
10	0	0	0,84 (n=46)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none

	1. Site	2. Candidate Instrument y	3. Reference Instrument x	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference	7. Regression Equation y = b • x + a
11	suburban, modest industrial influence	DHA-80	KFG (1) (Typ: GS050/3-C)	05/10/98 - 31/05/99	29.5	30.1	y = 1,00x - 0,70
12	suburban, modest industrial influence	DHA-80	KFG (2) (Typ: GS050/3-C)	05/10/98 - 31/05/99	29.5	30	y = 1,00x - 1,39
13	suburban, modest industrial influence	FH 62 I-N (1)	KFG (1) (Typ: GS050/3-C)	05/10/98 - 31/05/99	24.5	31	y = 0,80x - 0,63
14	suburban, modest industrial influence	FH 62 I-N (1)	KFG (2) (Typ: GS050/3-C)	05/10/98 - 31/05/99	24.4	30.8	y = 0,80x - 0,23
15	suburban, modest industrial influence	FH 62 I-N (2)	KFG (1) (Typ: GS050/3-C)	05/10/98 - 31/05/99	23.8	30.8	y = 0,76x + 0,22
16	suburban, modest industrial influence	FH 62 I-N (2)	KFG (2) (Typ: GS050/3-C)	05/10/98 - 31/05/99	23.7	30.6	y = 0,76x + 0,09
17	suburban, modest industrial influence	FH 62 I-R (1)	KFG (1) (Typ: GS050/3-C)	05/10/98 - 31/05/99	20.9	30.7	y = 0,70x - 0,89
18	suburban, modest industrial influence	FH 62 I-R (1)	KFG (2) (Typ: GS050/3-C)	05/10/98 - 31/05/99	20.8	30.5	y = 0,71x - 0,85
19	suburban, modest industrial influence	FH 62 I-R (2)	KFG (1) (Typ: GS050/3-C)	05/10/98 - 31/05/99	22.9	31	y = 0,78x - 1,33
20	suburban, modest industrial influence	FH 62 I-R (2)	KFG (2) (Typ: GS050/3-C)	05/10/98 - 31/05/99	22.8	30.8	y = 0,78x - 1,35

	8. Number of Exceedences (50µg/m^3 24hr mean) Candidate	**9. Number of Exceedences (50µg/m^3 24hr mean) Reference**	**10. r^2 value & sample size**	**11. Modifications to Instrument**	**12. STP or Ambient**	**13. Modifications to data**	**14. Other analysis**
11	11	14	0,98 (n=102)	none	ambient	Grubbs test for outliers	none
12	11	12	0,98 (n=98)	none	ambient	Grubbs test for outliers	none
13	11	16	0,91 (n=97)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
14	11	14	0,93 (n=94)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
15	12	16	0,91 (n=101)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
16	12	14	0,92 (n=98)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
17	11	15	0,94 (n=97)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
18	11	13	0,95 (n=94)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
19	13	16	0,92 (n=100)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none
20	13	14	0,93 (n=97)	Candidate: sampling line heated (40 cm, 50°C) and completely insulated inside the station	ambient	Grubbs test for outliers	none

	1. Site	2. Candidate Instrument y	3. Reference Instrument x	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference	7. Regression Equation y = b • x + a
21	suburban	DHA-80 (1)	KFG (1) (Typ: LVS3)	20/01/98 - 15/01/99	32.8	33	y = 1,00x - 0,02
22	suburban	DHA-80 (1)	KFG (2) (Typ: LVS3)	20/01/98 - 15/01/99	33.9	34.2	y = 0,98x + 0,39
23	suburban	DHA-80 (2)	KFG (1) (Typ: LVS3)	20/01/98 - 15/01/99	33.9	34.2	y = 0,98x + 0,39
24	suburban	DHA-80 (2)	KFG (2) (Typ: LVS3)	20/01/98 - 15/01/99	33.5	33.5	y = 0,99x + 0,48
25	suburban	FH 62 I-R (1)	KFG (2) (Typ: LVS3)	07/01/99 - 01/07/99	21.3	29.7	y = 0,59x + 3,73
26	suburban	FH 62 I-R (2)	KFG (2) (Typ: LVS3)	07/01/99 - 01/07/99	21.8	30.3	y = 0,63x + 2,72
27	suburban, modest industrial influence	DHA-80 (1)	KFG (1) (Typ: GS050/3-C)	25/10/95 - 27/02/96	53.9	55.2	y = 1,03x - 3,03
28	suburban, modest industrial influence	DHA-80 (1)	KFG (2) (Typ: GS050/3-C)	25/10/95 - 27/02/96	53.9	55.2	y = 1,04x - 3,35
29	suburban, modest industrial influence	DHA-80 (2)	KFG (1) (Typ: GS050/3-C)	25/10/95 - 27/02/96	53.3	55.4	y = 0,99x - 1,52
30	suburban, modest industrial influence	DHA-80 (2)	KFG (2) (Typ: GS050/3-C)	25/10/95 - 27/02/96	53.3	55.4	y = 1,00x - 2,16
31	suburban, modest industrial influence	FH 62 I-N (1)	DHA-80	04/11/98 - 30/04/99	23.6	32.6	y = 0,72x + 0,08
32	suburban, modest industrial influence	FH 62 I-N (2)	DHA-80	04/11/98 - 30/04/99	24.9	32.8	y = 0,68x + 2,57

	8. Number of Exceedences (50µg/m^3 24hr mean) Candidate	**9. Number of Exceedences (50µg/m^3 24hr mean) Reference**	**10. r^2 value & sample size**	**11. Modifications to Instrument**	**12. STP or Ambient**	**13. Modifications to data**	**14. Other analysis**
21	10	10	0,99 (n=191)	none	STP	Grubbs test for outliers	none
22	33	34	0,99 (n=197)	none	STP	Grubbs test for outliers	none
23	33	34	0,99 (n=197)	none	STP	Grubbs test for outliers	none
24	30	31	0,99 (n=198)	none	STP	Grubbs test for outliers	none
25	0	4	0,77 (n=52)	Candidate: sampling line heated (80 cm, 40°C) and completely insulated inside the station	STP	Grubbs test for outliers	none
26	1	6	0,81 (n=55)	Candidate: sampling line heated (80 cm, 40°C) and completely insulated inside the station	STP	Grubbs test for outliers	none
27	35	39	0,98 (n=73)	none	STP	Grubbs test for outliers	none
28	36	39	0,98 (n=74)	none	STP	Grubbs test for outliers	none
29	34	36	0,97 (n=69)	none	STP	Grubbs test for outliers	none
30	36	38	0,97 (n=72)	none	STP	Grubbs test for outliers	none
31	12	28	0,98 (n=172)	Candidate: sampling line heated (40 cm, 40°C) and completely insulated inside the station	STP	Grubbs test for outliers	none
32	11	28	0,95 (n=172)	Candidate: sampling line heated (40 cm, 40°C) and completely insulated inside the station	STP	Grubbs test for outliers	none

Additional information on data from GERMANY

These results were gained during a federal campagne ("Exchange of experience on PM10- / PM2,5-measurements") in 1998/1999. Intercomparison exercises were carried out by: *Hessian Agency for the Environment and for Geology* (HLUG): No. 1-20; station: Wiesbaden, *State Agency for the Environment North Rhine Westfalia* (LUA NRW): No. 21-26; station: Essen and *Company for Environmental Monitoring and Surveys Ltd.* (UMEG): No. 27-32; station: Karlsruhe).

IRELAND

	1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference:	7 Regression Equation
1	Roadside	Osiris laser instrument	Opsis (Adams) Sampler with US inlet	Autumn/Winter (1/9/99 – 14/12/99)	40.2	28.9	y=1.4232x-0.928
2	Industrial	Osiris laser instrument	Opsis (Adams) Sampler with US inlet	Summer (8/6/00 – 25/7/00)	26.9	36.8	y=0.6683x+2.3306
3	Urban background	Osiris laser instrument	Opsis (Adams) Sampler with US inlet	Winter (19/1/00 - 28/3/00)	46.8	41.3	y=1.0734x+2.5208
4	Urban background	Osiris laser instrument	Opsis (Adams) Sampler with US inlet	Spring/Summer (3/2/00 – 31/7/00)	29.1	24.7	y=1.131x

MADRID – BERLIN – BIRMINGHAM

1. Site	2. Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean	6. Regression Equation	7 r^2 value & sample size	8. Modifications to Instrument	9. STP or ambient	10. Modifications to data	11 Other Analysis
Madrid Urban background	TEOM 1400	WRAC	Winter 1996	~31 µg/m3	1.00x + 3.83	0.95 n = 22		STP		
Madrid Urban background	Environment MP 101 (Beta)	WRAC	Winter 1996	~ 31 µg/m3	1.00x + 0.39	0.97 n = 28		STP		
Berlin Urban highway	TEOM 1400	Andersen High Volume	Spring/ summer 1996	~ 34 µg/m3	0.64x + 2.98	0.84 n = 64		STP		
Berlin Urban highway	Environment MP 101 (Beta)	Andersen High Volume	Spring/ summer 1996	~ 34 µg/m3	0.64x + 2.34	0.92 n = 68		STP		
Birmingham Urban industrial	TEOM 1400	Partisol Low Volume (1 m^3/h)	Summer/ autumn 1997	~ 29 µg/m3	0.72x +4.4	0.92 n = 30		STP		
Birmingham Urban industrial	BAM (Beta)	Partisol Low Volume (1 m^3/h)	Autumn 1996	~ 36 µg/m3	0.89x + 3.0	0.89 n = 20		STP		
Birmingham Urban industrial	Eberline FH62 (Beta)	Partisol Low Volume (1 m^3/h)	Winter 1997	~ 43 µg/m3	0.70x + 4.3	0.82 n = 33		STP		FH62: 45°C heated sampling head

Eberline FH62 (β) 45^0C heated sampling head.

NETHERLANDS

	1. Site	2. Candidate	3. Reference instrument	4. Season & Period	5. Period Mean Candidate (µg/m^3)	6. Period Mean Reference (µg/m^3)	7. Number of measurements >50 µg/m^3 24h mean Candidate:
1	Rural (Biest / Houtakker)	TEOM Inside housing (10°C-25 °C) Inlet 50 °C	LVS- Kleinfiltergerät Derenda	Winter-Spring Feb-May1999	26.31	31.45	2
2	Rural (Biest / Houtakker)	ß-attenuation FH62 I-N Inside housing (20°C-25 °C) Inlet 50 °C	LVS- Kleinfiltergerät Derenda	Winter-Spring Feb-May1999	28.87	29.42	2
3	urban/ roadside (Utrecht)	TEOM Inside housing (10°C-35 °C) Inlet 50 °C	LVS- Kleinfiltergerät Derenda	Autumn-Winter Sep-Dec 1999	24.72	32.35	0
4	urban/ roadside (Utrecht)	ß-attenuation FH62 I-N Inside housing (10°C-35 °C) Inlet 50 °C	LVS- Kleinfiltergerät Derenda	Autumn-Winter Sep-Dec 1999	22.95	31.00	1

	8. Number of measurements >50 µg/m^3 24h mean Reference:	9. **Regression Equation**	10. r^2 value & n sample size	11. Modifications	12. STP or ambient	13. Modifications to data	14. Other analysis
1	4	$y = 0.687 x + 4.8$	0.7154 (n = 43)	---	STP	---	
2	4	$y = 0.867 x + 3.4$	0.9091 (n = 43)	25h filterchange	STP	First hour after filterchange skipped	
3	5	$y = 0.627 x + 4.5$	0.8866 (n = 49)	---	STP	---	
4	5	$y = 0.711 x + 0.9$	0.9173 (n = 51)	25h filterchange	STP	First hour after filterchange skipped	

Filter changes at 25 hrs on β-attenuation FH 62 I-N.

SPAIN

	1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean **Candidate**	6. Season or Period Mean **Reference:**	7 Regression Equation
1	Barcelona-Madrid-Monagrega (Traffic-urban and rural, coastal and continental)	DIGITEL-DHA80	GRASEBY	February to September 1999	40.3	42.3	y = 0.986*x-1,321
2	Barcelona-Madrid-Monagrega-Onda (Rural, traffic-urban and industrial)	MCV-PM1025	GRASEBY	March to September 1999	39.5	38.2	y =1.072*x-1,425
3	Sants-Tarragona (Traffic-urban and Industrial)	MCV-PM10/CAV	GRASEBY	January to May 2000	48.3	44.5	y =1.041x + 1.996
4	Madrid Traffic-urban-roadside	TEOM- inside housing 50ºC inlet temp.	GRASEBY	August to September 1999	43.0	43.0	y =1.172x –6.63
5	Monagrega Rural background	TEOM- inside housing 50ºC inlet temperature	DIGITEL-DHA80*	March 1999 to July 2000	18.4	20.8	y =0.969x – 1.627
5A	Monagrega Rural background	TEOM- inside housing 50ºC inlet temp.	DIGITEL-DHA80*	Summer- March to October 1999	20.5	20.5	y =1.027x – 0.266
5B	Monagrega Rural	TEOM- inside housing 50ºC	DIGITEL-DHA80*	Winter- November 1999 to April 2000	12.9	17.8	y =0.766x – 0.769

	background	inlet temp.					
5C	Monagrega Rural background	TEOM- inside housing 50ºC inlet temp.	DIGITEL-DHA80*	Summer - May to July 2000	26.2	29.9	y =1.231x –10.86
6	Barcelona (L'H) Traffic-urban	Beta attenuation - inside housing 50ºC inlet temp.	DIGITEL-DHA80*	March to June 2000	45.3	45.4	y =0.843x +7.018
7	Barcelona, Madrid, Monagrega, Onda Traffic-urban, rural, industrial	GRIMM 1108, Laser-monitor	DIGITEL-DHA80*	January 1999 to June 2000	43.1	45.4	y =0.955x –0.259
8	Bilbao Traffic-urban	TEOM- inside housing 50ºC inlet temp.	GRASEBY	March 1999 to May 2000	43.8	47.5	y=0.885x+1.876
9	Bilbao Traffic-urban	TEOM- inside housing 50ºC inlet temp.	Low vol PM10 reference	March 1999 to May 2000	43.8	47.5	y=0.885x+1.922
10	Barcelona (Sants) Traffic-urban	Beta attenuation - inside housing 50ºC inlet temp	MCV PM10 CAV	February to July 2000	54.6	53.9	y =0.888x+6.652

	8. Number of Exceedences (50ug/m3 24hr mean) Candidate	9. Number of Exceedences (50ug/m3 24 hr mean) References	10 r^2 value & sample size	11 Modifications to Instrument	12 STP or Ambient	13 Modifications to data Forced through “0”	14 Other analysis Ratio candidate/reference
1	12	12	0.98 (N=50)	None	***ambient***	y = 0,959*x (r^2 = 0.98)	0.955
2	12	11	0.99 (N=42)	None	***ambient***	y = 1.041*x (r^2 =0.99)	1.035
3	12	9	0.98 (N=32)	None	***ambient***	y = 1.076x (r^2 = 0.98)	1.086
4	6	4	0.89 (N=24)	None	***ambient***	y = 1.028x (r^2 = 0.88)	1.063
5	0	0	0.82 (N=129)	None	***ambient***	y = 0.90x (r^2 = 0.81)	0.885
5A	0	0	0.90 (N=64)	None	***ambient***	y = 1.02*x (r^2 =0.90)	1.001
5B7	0	0	0.80 (N=60)	None	***ambient***	y = 0.73x (r^2 = 0.80)	0.722
5C8	0	0	0.92 (N=17)	None	***ambient***	y = 0.84x (r^2 = 0.84)	0.877
6	12	11	0.93 (N=36)	None	***ambient***	y =0.966x (r^2 = 0.90)	0.998
7	58	61	0.91 (N=180)	None	***ambient***	y = 0.951x (r^2 = 0.94)	0.950
8	9	13	0.91 (N=32)	None	***ambient***	y = 0.918x (r^2 = 0.91)	0.925
9	9	13	0.91 (N=32)	None	***ambient***	y = 0.904x (r^2 = 0.90)	0.923
10	23	22	0.87 (N=46)	None	***ambient***	y = 0,987x (r^2 = 0.862)	1.039

Additional information on data from Spain.

Location and type of the monitoring stations and instruments utilised for PM10 measurements

NAME	X UTM	Y UTM	HEIGHT (msnm)	TYPE
Catalunya				
Barcelona (	432460	4586170	24	Traffic-Urban
L'Hospitalet	426080	4580470	28	Traffic-Urban
Tarragona	348300	4553400	41	Industrial-Traffic
Endesa-Teruel				
Monagrega	727898	4536235	605	Rural background

Madrid	**long**	**lat**		
Escuelas Aguirre	03 40 52 W	40 25 32 N		Traffic-Urban
Comunidad valencia				
Onda	00 15 43 W	39 57 43 N	167	Urban-Industrial Tile primary emissions
Bilbao				
	03 00 52 W	43 21 22 N	16	Traffic-Urban

2. Instrumentation

Candidate samplers

Manual PM10 samplers:

- DIGITEL DHA80 (30 m^3 h^{-1})
- PM10-MCV-PM1025 (40 m^3 h^{-1})
- PM10-MCV-PM10/CAV (68 m^3 h^{-1})

All the manual samplers are outside housing

Automatic PM10 monitors:

- TEOM R&P1400AB
- BETA FAG FH-62I-N

- All this automatic instruments are inside housing with 50ºC inlet temperature.

Reference samplers

- GRASEBY-ANDERSEN, high volume sampler (68 m^3 h^{-1})
- Low volume IND LVS3 PM10
- *DIGITEL DHA80: is not a reference equipment in the sense of EN 1234/1, but the equivalence with the HVS Graseby reference equipment has been demonstrated previously

3. Filters

Filters used for the inercomparison were:
Quartz filters Schleicher and Schuell QF20
Filters were previously stabilised in a disecator at ambient temperature

SWITZERLAND

	1. Site	2. Member State/Candidate Instrument	3. Reference Instrument	4. Seasons & Period
1	Aarau, downtown area, near traffic (50 m distance)	TEOM 1400 ab 50°C inlet temp., enclosure temp. 40°C	Digitel HVS DHA-80	April 1998 - Febr. 1999 (all seasons) Remarks: dependence on air temperature. T (average) > 15° (summer): coefficient TEOM(HIV~1 T (average) < 5° (winter): coefficient TEOM/HIV~0.6 spring, autumn: coefficient TEOM/HIV~0.8-0.9

	5. Seasons or Period Mean Candidate	6.Season or Period Mean Reference	7. Regression Equation	8. Number of Exceedences (50 $\mu g/m^3$ 24 hr mean) Candidate	9. Number of Exceedences (50 $\mu g/m^3$ 24 hr mean) References
1	20.2	25.1	Y=0.57x+6.0	5	31

	10. r^2 value & sample size	11. Modifications to Instrument	12. STP or Ambient	13. Modifications to data	14. Other analysis
1	0.83 (N=334)	none	STP	Regression not forced through "0"	multivariate linear regression (suitable for summer) multivariate logarithmic regression (suitable for winter) variables: TEOM, T, rH, NO_X

	1. Site	2. Member State/Candidate Instrument	3. Reference Instrument	4. Seasons & Period
2	Winterthur, downtown near traffic (10 m)	TEOM 1400 ab 50°C inlet temp., 40°C enclosure temp.	HVS Digitel DHA-80	autumn 25.9.-27.10.1998

	5. Seasons or Period Mean Candidate	6.Season or Period Mean Reference	7. Regression Equation	8. Number of Exceedences (50 µg/m³ 24 hr mean) Candidate	9. Number of Exceedences (50 µg/m³ 24 hr mean) References
2	18.3	22.6	$y = 0.72x+2.00$	0	1

	10. r² value & sample size	11. Modifications to Instrument	12. STP or Ambient	13. Modifications to data	14. Other analysis
2	0.96 (N=30)	none	STP	Regression not forced through "0"	none

	1. Site	2. Member State/Candidate Instrument	3. Reference Instrument	4. Seasons & Period
3	Davos, urban background	Eberline FH62I-R sampling line heated to 30°C (on 1.5 m)	HVS Digitel outside station	Jan. - March 1999 (winter)

	5. Seasons or Period Mean Candidate	6.Season or Period Mean Reference	7. Regression Equation	8. Number of Exceedences (50 µg/m³ 24 hr mean) Candidate	9. Number of Exceedences (50 µg/m³ 24 hr mean) References
3	7.9 (low concentrations)	10.4	y = 0.95x-1.88	0	0

	10. r² value & sample size	11. Modifications to Instrument	12. STP or Ambient	13. Modifications to data	14. Other analysis
3	0.92 (N=44)	none	STP	Regression not forced through "0"	none

	1. Site	2. Member State/Candidate Instrument	3. Reference Instrument	4. Seasons & Period
4	Zürich, kerbside	Eberline FH62I-R (β-gauge) sampling line heated to 30°C (45 cm)	HVS Digitel Quarz fibre filter	a) summer 1.5. - 23.6.1998 b) summer 1.7. - 31.8.1998 c) winter 20.11.1198 - 14.1.1999 d) winter 15.1. - 28.2.1999

	5. Seasons or Period Mean Candidate	6.Season or Period Mean Reference	7. Regression Equation	8. Number of Exceedences (50 $\mu g/m^3$ 24 hr mean) Candidate	9. Number of Exceedences (50 $\mu g/m^3$ 24 hr mean) References
4	a) 23.2 b) 35.1 c) 56.4 d) 55.2	a) 24.5 b) 36.4 c) 53.2 d) 50.5	a) y=1.19x-3.36 b) y=0.95x+0.81 c) y=1.18x-5.82 d) y=1.16x-3.28	no data	no data

	10. r^2 value & sample size	11. Modifications to Instrument	12. STP or Ambient	13. Modifications to data	14. Other analysis
4	a) 0.92 (N=44) b) 0.96 (N=54) c) 0.99 (N=55) d) 0.98 (N=44)	none	ambient	Regression not forced through "0"	none

	1. Site	2. Member State/Candidate Instrument	3. Reference Instrument	4. Seasons & Period
5	Zürich, urban background	a) TEOM 1400a 50° inlet temp. b) TEOM 1400a 30° inlet temp.	HVS Digitel DHA-80	a) year (8/96 - 7/97) b) year (1/98 - 12/98) winter, high conc.: TEOM 60 % HVS summer, low conc.: TEOM ~ 100 % HVS

	5. Seasons or Period Mean Candidate	6.Season or Period Mean Reference	7. Regression Equation	8. Number of Exceedences (50 µg/m³ 24 hr mean) Candidate	9. Number of Exceedences (50 µg/m³ 24 hr mean) References
5	a) 18.2 (TEOM 50°C) b) 20.2 (TEOM 30°C)	a) 24.0 b) 22.7	a) y=0.60x+3.85 b) y=0.74x+3.47 better correspondence with TEOM 30°	no data	no data

	10. r^2 value & sample size	11. Modifications to Instrument	12. STP or Ambient	13. Modifications to data	14. Other analysis
5	a) 0.87 (N=128) b) 0.86 (N=166)	b) TEOM 30° inlet temp.	STP	Regression not forced through "0"	none

	1. Site	2. Member State/Candidate Instrument	3. Reference Instrument	4. Seasons & Period
6	rural	TEOM 1400B 50° inlet temp., enclosure temp. 40°	HVS Digitel DH80	winter (4.2. - 4.3.1998)

	5. Seasons or Period Mean Candidate	6.Season or Period Mean Reference	7. Regression Equation	8. Number of Exceedences (50 µg/m³ 24 hr mean) Candidate	9. Number of Exceedences (50 µg/m³ 24 hr mean) References
6	no data	no data	a) TEOM= 0,7 HVS b) TEOM + NH_4NO_3= 0.94 HVS	no data	no data

	10. r² value & sample size	11. Modifications to Instrument	12. STP or Ambient	13. Modifications to data	14. Other analysis
6	a) 0.86 b) 0.98	b) analysis of NH_4NO_3 on HVS filters	ambient	-	Regression can be significantly improved by adding NH_4NO_3 levels

UNITED KINGDOM

	1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference:	7 Regression Equation
1	Kerbside	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Summer (03/06/99 – 30/09/99)	38 µgm^{-3}	42 µgm^{-3}	Y=0.7975x+4.4938
2	Kerbside	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Winter (01/10/99 – 31/03/00)	35 µgm^{-3}	45 µgm^{-3}	Y=0.6764x+4.9516
3	Kerbside	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Summer (01/04/00 – 16/08/00)	33 µgm^{-3}	50 µgm^{-3}	Y=0.3176x+16.565
4	Urban B'kgrd	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Summer (27/05/99 – 30/09/99)	19 µgm^{-3}	26 µgm^{-3}	Y=0.5667x+4.2932
5	Urban B'kgrd	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Winter (01/10/99 – 31/03/00)	20 µgm^{-3}	28 µgm^{-3}	Y=0.5902x+2.9435
6	Urban Bk'grd	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Summer (01/04/00 – 15/08/00)	20 µgm^{-3}	31 µgm^{-3}	Y=0.4185x+6.8929
7	Rural	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Summer (28/05/99 – 30/09/99)	16 µgm^{-3}	17 µgm^{-3}	Y=0.4245x+8.6309
8	Rural	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Winter (01/10/99 – 31/03/00)	13 µgm^{-3}	17 µgm^{-3}	Y=0.3617x+7.3839
9	Rural	TEOM – inside housing 50^{0}C inlet temp	LVS - Kleinfiltergerat	Summer (01/04/00 – 10/08/00)	15 µgm^{-3}	19 µgm^{-3}	Y=0.2758x+9.8551

	1. Site	2. Member State Candidate Instrument	3. Reference Instrument	4. Season & Period	5. Season or Period Mean Candidate	6. Season or Period Mean Reference:	7 Regression Equation
10	Industr'l	TEOM – inside housing 50^0C inlet temp	LVS - Kleinfiltergerat	Summer (19/08/99 – 30/09/99)	23 μgm^{-3}	24 μgm^{-3}	Y=0.9616x+0.0414
11	Industr'l	TEOM – inside housing 50^0C inlet temp	LVS - Kleinfiltergerat	Winter (01/10/99 – 31/03/00)	26 μgm^{-3}	27 μgm^{-3}	Y=0.9315+0.3895
12	Industr'l	TEOM – inside housing 50^0C inlet temp	LVS - Kleinfiltergerat	Summer (01/04/99 – 09/08/00)	23 μgm^{-3}	24 μgm^{-3}	Y=0.7352+4.8743
13	City Centre	TEOM – inside housing 50^0C inlet temp	LVS - Kleinfiltergerat	Winter (02/12/99 – 31/03/00)	18 μgm^{-3}	20 μgm^{-3}	Y=0.602x+5.7831
14	City Centre	TEOM – inside housing 50^0C inlet temp	LVS - Kleinfiltergerat	Summer (01/04/00 – 12/07/00)	26 μgm^{-3}	28 μgm^{-3}	Y=0.874x+1.5559

	8. Number of Exceedences (50ug/m3 24hr mean) Candidate	**9. Number of Exceedences (50ug/m3 24 hr mean) References**	**10 r^2 value & sample size**	**11 Modifications to Instrument**	**12 STP or Ambient**	**13 Modifications to data**	**14 Other analysis**
1	9	15	0.8512 (n=81)	None	STP	Regression not forced through “0”	None
2	18	53	0.8139 (n=141)	None	STP	Regression not forced through “0”	None
3	15	28	0.4358 (n=63)	None	STP	Regression not forced through “0”	None
4	0	6	0.8623 (n=86)	None	STP	Regression not forced through “0”	None
5	0	9	0.8391 (n=118)	None	STP	Regression not forced through “0”	None
6	0	9	0.7716 (n=68)	None	STP	Regression not forced through “0”	None
7	0	0	0.3905 (n=68)	None	STP	Regression not forced through “0”	None
8	0	0	0.4754 (n=143)	None	STP	Regression not forced through “0”	None
9	0	8	0.3725 (n=102)	None	STP	Regression not forced through “0”	None
10	1	0	0.9335 (n=18)	None	STP	Regression not forced through “0”	None
11	7	9	0.9582 (n=86)	None	STP	Regression not forced through “0”	None
12	1	4	0.8241 (n=66)	None	STP	Regression not forced through “0”	None
13	0	1	0.6445 (n=77)	None	STP	Regression not forced through “0”	None
14	4	7	0.9005 (n=70)	None	STP	Regression not forced through “0”	None

Additional information on data from UK

- Results shown cover only concentrations where both TEOM and LVS are less than 100 µg/m^3. Where either instrument has registered a fixed 24-hour concentration greater than this value, data have been removed from the regression analysis.

- The sites are located accordingly:
  Kerbside (records 1-3) – Marylebone Road
  Urban Background (records 4-6) – Thurrock
  Rural (records 7-9) – Harwell
  Industrial (records 10-12) – Port Talbot
  City Centre (records 13 and 14) – Glasgow

- For each of the locations listed above, results for seasonal periods broadly defined as ‘Summer’ and ‘Winter’ are given and which cover April – Sept., and Oct.- March, respectively. Specific dates are given for each period in order to indicate exact monitoring periods.

- The data analysis has been carried out on data gathered from both instruments where a full 24-hour monitoring period has been carried out.

- Data gathered from the national network from the TEOM’s at each site have been fully ratified up to, and including, the second quarter of 2000. Consequently, the results covering the period ‘Summer’2000 should be treated as provisional.

References:

1. Council Directive 1996/62/EC of 27 September 1996. On ambient air quality assessment and monitoring.

2. Council Directive 1999/30/EC of 22 April 1999. Relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air.

3. European Standard EN 12341. Final draft July 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.

4. Workshop on Particulate Matter Monitoring. Venice Italy 12 – 13 June 2000. http://192.167.230.2/meetings/venice2000/