

The compliance challenge from measuring PM₁₀ concentrations

Correction factors can make all the difference

The First Air Quality Daughter Directive (1999/30/EC) establishes limit values for ambient concentrations of sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter (PM₁₀) and lead. This includes a 24-hour PM₁₀ compliance limit that entered into force in January 2005. This provision limits to 35 the number of exceedance days above a daily average concentration of 50 µg/m³. It was not long into that year before a number of Member States were expressing great concerns over their ability to meet this requirement at many of their measuring sites. At some locations the whole of January 2005 were exceedance days. The reaction to this was felt in a number of arenas, not least in the ongoing debate in the Council and Parliament over the finalisation of the Ambient Air Quality Directive which will ultimately replace the First Daughter Directive¹. There has been much discussion over the implications of these compliance problems for the new Directive. In this article we explore the key issue of the measurement protocol that has undoubtedly contributed to these problems in a number of Member States.

With regard to the measurement methods required to demonstrate compliance, the Directive sets forth a 'Reference Method' for each of the four main pollutants covered. However, other measurement methods are permitted provided they are demonstrated to give results equivalent to the reference method. In recognition of the difficulties in measuring particulate concentrations in ambient air (especially continuous measurement), the requirements for demonstrating equivalence to the reference method for PM₁₀ are more extensively covered in the Directive viz:

'A Member State may use any other method which it can demonstrate gives results equivalent to the reference method or any other method which the Member State

*concerned can demonstrate displays a consistent relationship to the reference method. In that event, the results achieved by that method must be corrected by a relevant factor to produce results equivalent to those that would have been achieved by using the reference method.'*²

Since the finalisation of the Directive, the most common alternative measurement method to the reference method, installed by Member States in establishing their measurement networks, is the TEOM (Tapered Element Oscillating Microbalance). This device provides essentially continuous measurement (at least down to hourly values) of PM₁₀ concentrations. Due to its design, some particulate matter is lost prior to measurement (due to vibration and the heating) resulting in 'under-measurement' of actual concentrations. However, through the use of suitable correction factors, equivalence to the reference method can apparently be achieved. These correction factors are affected by the nature of the PM that is being measured and have therefore to be determined locally.

It is on this very question of 'what constitutes an appropriate correction factor?' that significant debate has taken place over the past several years. Some Member States have applied correction factors of unity, while others have used factors of 1.4 or higher.

The European Environment Agency, through the European Topic Centre on Air and Climate Change (ETC/ACC), have studied the variability in the use and magnitude of correction factors across the Union and reported their findings in a technical Paper, *PM₁₀ measurement methods and correction factors in AIRBASE: 2004 Status Report*³.

¹ *This Directive, COM(2005) 447 final, will in fact replace the first three Daughter Directives.*

² *Council Directive 1999/30/EC, 22 April 1999 Relating to Limit Values for Sulphur Dioxide, Nitrogen Dioxide and Oxides of Nitrogen, Particulate Matter and Lead in Ambient Air: Annex IX, Section IV.*

³ *ETC/ACC Technical paper 2005/6, Frank de Leeuw, December 2005.*

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In this brief Article we explore the implications of this divergence in approach to the application of correction factors. In doing so we have drawn on the information provided in the ETC/ACC technical paper and on the comprehensive measurement data available in AIRBASE⁴. For the reporting year of 2004 (the latest data available in AIRBASE at the time of the study), AIRBASE included data on more than 1800 PM₁₀ measuring stations in the European Union. All these data were utilised in this study.

The available information on the correction factors (including whether the data reported to AIRBASE includes such a correction or not) allowed the 'as reported' concentration data in AIRBASE to be adjusted to assess the implications of various common 'correction factor scenarios' on the level of compliance with PM₁₀ limit values.

For example, if the reported 24-hour average PM₁₀ concentration was 40 µg/m³ and the 'correction factor' used for that station was unity, when exploring the

implications of a common correction factor of 1.3, the 'corrected' concentration was calculated as 52 µg/m³. Against the 24-hour limit value of 50 µg/m³ this would result in a 'non-exceedance' day becoming an exceedance day. Conversely, in exploring the 'no correction factor' case, at a site where a correction factor of 1.2 was used with a reported 24-hour average concentration of 60 µg/m³, the adjusted concentration would be 50 µg/m³, moving the exceedance day to a non-exceedance day.

Base Case (as reported in AIRBASE)

The first case explored used the 'as reported to AIRBASE' data for 2004. The results are given in Figure 1 which shows the percentage of measuring stations in each Member State with exceedances above the limit values. The annual mean limit value being 40 µg/m³, the number of exceedances above the threshold of 50 µg/m³ daily mean is limited to 35 per year.

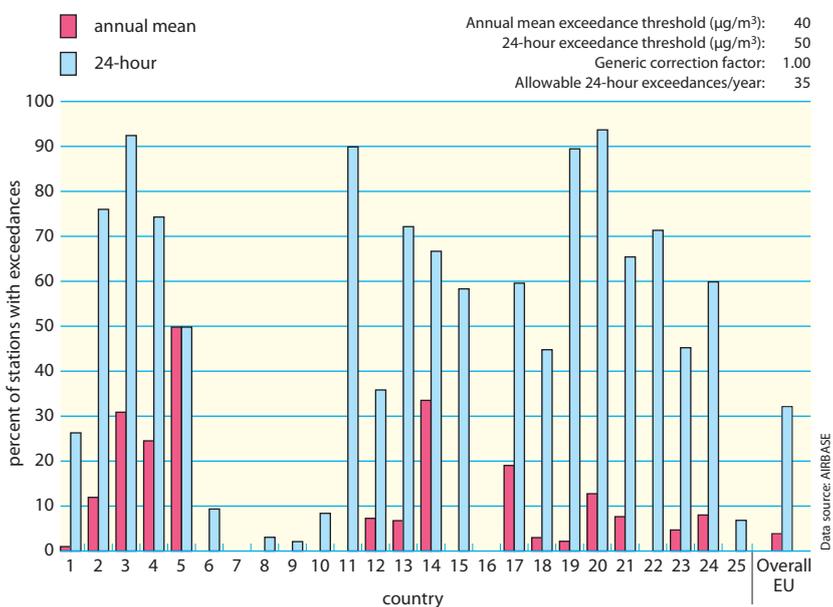
Figure 1 shows that in this 'Base Case', in many Member States, this 35-day maximum above the 50 µg/m³ threshold for the 24-hour average concentration is widely exceeded. Although the 24-hour limit did not enter into force until 2005, this '2004 Picture' anticipates the widespread reporting of exceedances by individual Member States that occurred the following year. In the overall EU some 32% of measuring stations show exceedances of the 24-hour limit. In some individual Member States this increases to more than 75%. Figure 1 also indicates the 24-hour limit is substantially more difficult to comply with than the annual mean limit value of 40 µg/m³ with less than 5% of stations in the EU exceeding this latter limit.

The 'No Correction' to measurements case

Figure 2 shows how this picture changes if all the 'as reported' measured data are adjusted back to a correction factor of unity. Of course in Member States where a correction factor was not applied in the 'as reported' data to AIRBASE, or in situations where the measurement stations utilise the reference method (correction

⁴ AIRBASE is a comprehensive data base on measurement stations and measured concentrations in ambient air in Europe provide under the Exchange of Information Directive (97/101/EC). AIRBASE is maintained by the European Topic Centre on Air and Climate Change (ETC/ACC).

Figure 1 Exceedances of PM₁₀ limit values implied by the 'as reported' data in AIRBASE 2004



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factor of unity by definition), the situation is unchanged from that shown in Figure 1.

This said, with this adjustment to a common correction of 'unity', the 24-hour limit exceedance in the whole EU is reduced from 32% to some 27%. The situation in some Member States changes much more significantly. For example in 'Country 2' exceedances reduce from some 75% of stations to less than 10% and for the annual mean limit from some 12% to zero. This situation reflects the use of a relatively high correction factor in reported measurements from this country.

The 'Common Correction Factor of 1.3' case

Figure 3 depicts the compliance situation if a common 1.3 correction factor were to be used on non-reference method measurements and such corrected data reported into AIRBASE. Compared to the 'Base Case' (Figure 1), the compliance situation for both the 24-hour and annual mean limits significantly worsen. In the whole EU exceedances of the 24-hour limit rise from 32% to 50% of measuring stations; for the annual mean limit exceedances rise from 5% to 15% of measuring stations.

These 'compliance cases', derived from the processing of AIRBASE data, were designed to demonstrate the very significant impact of the present diversity of PM₁₀ measurement correction factors on the PM₁₀ compliance situation. It is not the purpose of this study to make any value judgement on what correction factors are appropriate in a given situation, this is a complex area since the 'particulate cocktail' varies both spatially and temporally. However, the results surely serve to highlight the urgent need to make further progress on the harmonisation of approaches across Member States to establish a level playing field for assessing compliance with current and future limit values (including those for PM_{2.5} in the new Ambient Air Quality Directive). On the one hand, the use of inappropriately high correction factors will continue to mask the very real progress expected from significant policy steps already taken and those currently under development as a follow up to the

Figure 2 Exceedances of PM₁₀ limit values if reported data into AIRBASE were adjusted back to a common 'correction factor' of unity

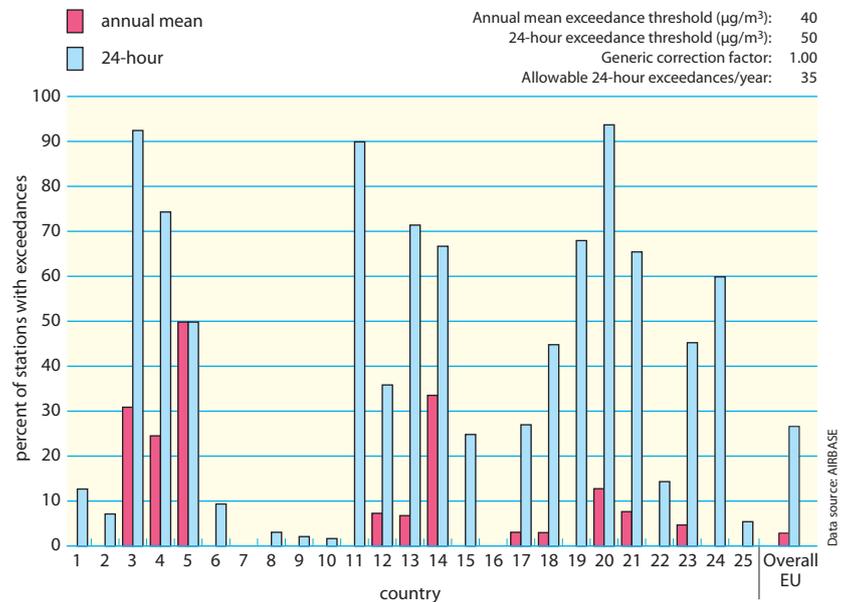
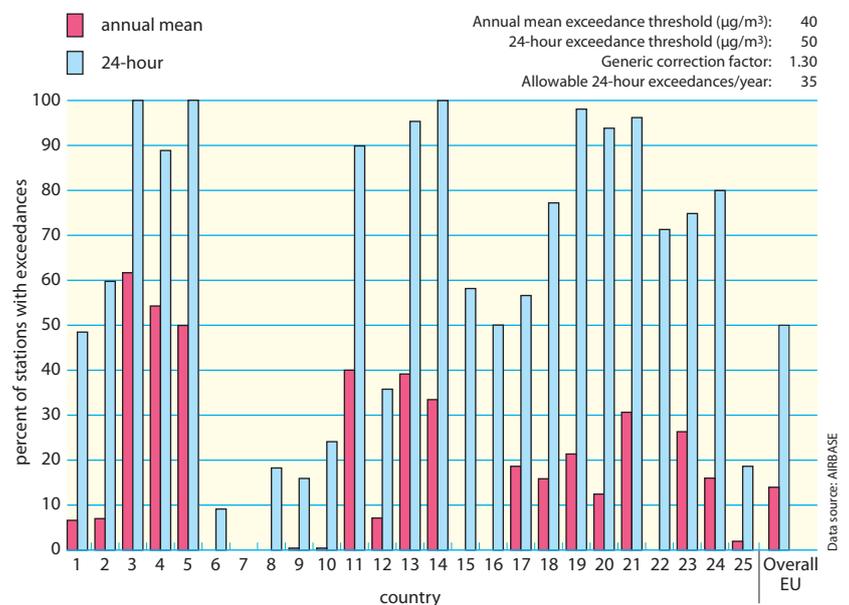


Figure 3 Exceedances of PM₁₀ limit values if reported data into AIRBASE were adjusted with a common correction factor of 1.3



Commission's Thematic Strategy on Air Pollution. On the other hand, use of an inappropriate correction factor will fail to provide the information necessary to inform future policy responses.