

Revised PM₁₀ Air Quality Index for Reference Equivalent Data

From 1992 until recently the UK widely utilised the Tapered Element Oscillating Microbalance (TEOM) in order to monitor near-real time concentrations of PM₁₀ particulate matter. The human-health impacts of concentrations of this pollutant were assessed by the Committee on the Medical Effects of Air Pollutants (COMEAP), and a 1-10 air pollution index was defined for public information purposes.

COMEAP put a great deal of effort into defining the original index breakpoints based on TEOM PM₁₀ measurements¹, and the 1997 Statement explaining how this was done is on the COMEAP website. Part of the statement is reproduced here for clarity.

- Particulate matter is monitored in the UK as PM₁₀: i.e. particles generally less than 10 microns in diameter. A large number of epidemiological studies have shown that day-to-day variations in concentrations of particles are associated with adverse effects on health. These include increased daily deaths, increased admissions to hospital of patients suffering from heart and lung disorders, and a worsening of the condition of those with asthma. This evidence was reviewed in detail by COMEAP in the report "Non-Biological Particles and Health" published by DH in 1995.
- A remarkable feature of the evidence is that even at low concentrations of particles effects remain. Of course, as concentrations fall so effects decrease. In a specially commissioned study of the effects of air pollution in Birmingham, a city with a population of 1 million, it was shown that on a day when the concentration of particles rose from the annual average concentration of 25 µg/m³ to 50 µg/m³ (24 hour average), then one more admission to hospital for treatment of respiratory diseases might be expected. 50 µg/m³, 24 hour average concentration, was accepted by the Expert Panel on Air Quality Standards (EPAQS) as a lowest effect level and was recommended as the EPAQS air quality standard. EPAQS also advised that efforts should be made to reduce annual average concentrations of particles in the UK.

Because of the continuous relationship between concentrations of particles and effects on health a different approach to devising bands of air quality was advised by COMEAP. The following break points between bands were agreed: 50, 75 and 100 µg/m³. Thus the bands for TEOM PM₁₀ data were defined as:

- Less than 50 µg/m³ (running 24 hour average): "low" levels of air pollution.
- 50-75 µg/m³ (running 24 hour average): "moderate" levels of air pollution.
- 75-100 µg/m³ (running 24 hour average): "high" levels of air pollution
- More than 100 µg/m³: "very high" levels of air pollution.

Associated health effects advice for each of the bands is provided by COMEAP and published at <http://www.airquality.co.uk/standards.php#band> and elsewhere.

When Defra began reporting data to the European Commission as TEOM x 1.3 (then termed 'gravimetric equivalent') the PM₁₀ bandings were also multiplied by 1.3 to give:

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|---|-------------|
| • Less than 64 µg/m ³ (running 24 hour average): | "LOW" |
| • 65-96 µg/m ³ (running 24 hour average): | "MODERATE" |
| • 97-129 µg/m ³ (running 24 hour average): | "HIGH" |
| • More than 130µg/m ³ : | "VERY HIGH" |

¹ Time series studies in the literature use a variety of PM₁₀ measurement methods and the method used is not always clearly specified. UK studies are usually based on TEOM measurements.

For particulate monitors 'equivalence' is defined in terms of whether the candidate method is capable of fulfilling the Data Quality Objectives as specified in the First Daughter Directive, and strict equivalence criteria are set out. The UK Equivalence Programme for Monitoring Particulate Matter² has concluded that TEOM monitors do not meet the equivalence criteria and are therefore being phased out of the UK Automatic Urban and Rural Network (AURN). Local authorities have also been advised to replace TEOMs with "reference equivalent" monitors if their review and assessment for PM₁₀ shows concentrations close to or above the UK air quality objective, or if the old TEOM breaks down and requires replacement.

The current PM₁₀ air quality index for TEOM monitors is not directly transferable to other reference equivalent monitors and therefore requires updating.

The results of the PM₁₀ equivalence programme (carried out between November 2004 and January 2006) have been analysed to develop an equation relating old TEOM data to reference equivalent monitors as follows:

$$\text{Reference equivalent PM}_{10} = \text{TEOM} \times 1.3 - 2.2494$$

It has been accepted by COMEAP that on this basis the air quality index for PM₁₀ and breakpoints for "Low", "Moderate", "High" or "Very High" pollution can be assigned to old TEOMs or reference equivalent data as follows:

Banding	Index	PM₁₀ Running 24-hour mean (TEOM µg/m³)	PM₁₀ Running 24-hour mean (Reference Equivalent** µg/m³)
Low	1	0-16	0-19
	2	17-32	20-40
	3	33-49	41-62
Moderate	4	50-57	63-72
	5	58-66	73-84
	6	67-74	85-94
High	7	75-82	95-105
	8	83-91	106-116
	9	92-99	117-127
Very High	10	>100	>128

** For PM₁₀, Reference Equivalent refers to the measurement method found to be equivalent to CEN standard EN12341 for PM₁₀, and includes:

- gravimetric measurement using Partisol 2025;
- corrected TEOM (TEOMx1.3 – 2.249 or Volatile Correction Model (VCM) corrected TEOM (see www.volatile-correction-model.info/ for details));
- FDMS-TEOM;
- corrected BAM (BAM/1.211; or BAM_{ambient}/1.273);
- Opsis SM200 by beta; and
- corrected Opsis SM200 by mass ((SM200_{mass} – 1.286)/0.819).

The term Reference Equivalent is used to reflect the wider range of equivalent methods available for use in the UK monitoring networks, as a result of the UK 2006 Equivalence Testing Programme, than was reflected by the previous term, 'Gravimetric Equivalent'. Details of the UK Equivalence Testing Programme can be found at www.airquality.co.uk/archive/reports/cat05/0606130952_UKPMEquivalence.pdf.

² Harrison, D, et al., (2006) UK Equivalence Programme for Monitoring of Particulate Matter http://www.airquality.co.uk/archive/reports/cat05/0606130952_UKPMEquivalence.pdf

All local authorities and other organisations are advised to update their air quality websites and reporting to incorporate this revised PM₁₀ index as soon as possible.

The UK Air Quality Archive and National Air Quality websites for Wales Scotland and Northern Ireland will adopt these changes from Monday August 3rd 2009.