Ultrafine Particles from aviation (UFPs)

What are UFPs?

Particulate Matter (PM) describes solid and liquid particles in the air that are typically classified by their size, for example $PM_{2.5}$ and PM_{10} (particles smaller than 2.5 and 10 micrometers respectively)[1].

Ultrafine particles (UFPs) are the smallest category of PM, having a diameter less than 0.1 micrometers. UFPs tend to make up a small fraction of particle mass but a large proportion of the number of particles in the air. UFPs are emitted from all combustion processes, such as burning coal in industry or fuels for transport. Road vehicles are the major urban source, although UFPs from aircraft can disperse tens of kilometres from airports. Sulphur in fuels contributes to the presence of UFPs, with kerosene having a much higher sulphur content than road fuels. It is thought that UFPs from aviation have different compositions than road-sourced UFPs.

UFP regulation

$PM_{2.5}$ and PM_{10} are frequently monitored for health impacts, but there are no limits specific to UFPs anywhere in the world (UFP as a subset of PM may be a strong influence in the correlation between concentration and health impact). For PM, EU regulations and World Health Organization (WHO) guidance are stricter than UK limits.

Air quality limits (year set)	**$PM_{2.5}$** ($\mu g/m^3$)	**PM_{10}** ($\mu g/m^3$)
UK (2010)	20	40
England 2030 (2026 non-binding)	10	N/A
EU by 2030 (2024)	10	20
WHO (2021)	5	15

Why aren't UFPs more tightly regulated?

Whilst there is a significant body of evidence on the effects of UFP exposure, WHO deemed this insufficient to set guideline levels due to differences in methods which limited the comparability of studies. The actual measurement of UFPs is challenging and expensive, limiting the presence of monitoring, with around 10 sites currently operating in the UK.

WHO has four good practice statements for UFPs, focused on quantifying and monitoring UFP levels and improving exposure assessment. They also set low concentrations (24-hour mean) as < 1,000 particles/cm^3 and high concentrations as > 10,000 particles/cm^3 (24-hour) or 20,000 particles/cm^3 (1-hour). The evidence base around UFPs is improving, and the EU Air Quality Directive now includes specific requirements for UFP monitoring. DEFRA consulted on environmental targets in 2021 and concluded that the best approach was to focus on $PM_{2.5}$.

Aviation engine standards

A standard agreed by the International Civil Aviation Organization (ICAO) came into effect on 1 January 2023 which regulates how much non-volatile PM new types of aircraft engine can emit, a category of emissions largely made up of soot, which contains UFPs. Volatile UFP concentrations are

[1] Under the PM classification, all particles of a smaller category are included in the scope of larger categories. For example, $PM_{2.5}$ particles are counted under PM_{10}.

much higher than the non-volatile component and are not considered in this ICAO Standard. Similar standards are in place for new road vehicles in Europe, which is important as airport traffic is likely to be a significant contributor to local UFP concentrations.

Any benefits from regulation are likely to be wiped out as flight numbers rise, as noted by DEFRA's Air Quality Expert Group (AQEG): 'growth of air traffic is likely to cause increased UFP concentrations in the vicinity of airports, unless the fuel sulphur content is reduced'.

What impact do they have on public health?
UFPs contribute to the wider health risks from PM, although separating their exact toxicity from larger particles is challenging. UFPs may potentially present a higher health risk due to their small particle size, which both leads to increased total surface area (linked to toxicity) and deeper penetration into the lungs. Some studies have indicated associations between UFPs and issues with heart and lung function, diabetes, high blood pressure and dementia, but there is variability within the evidence.

What do we want to see?

- Further assessment of airport-related UFPs around the UK (including health impacts)

Baseline monitoring, especially given the push for airport expansion, is required to fully understand the extent of UFP emissions around UK airports. This is a key step for aviation in taking responsibility for reducing harmful pollutants and developing appropriate policy and targets in the future. Development of a measurement standard for UFPs around airports would be beneficial for this process. As this evidence base builds, it can be used to create a better picture of the health impacts associated with UFPs. Whilst several monitoring studies have been conducted around UK airports, there is yet to be a UK-based study on aviation UFPs and health outcomes. A wider national increase in measurement locations (e.g. following the 2024 EU Ambient Air Quality Directive) would be helpful in contextualising aviation UFPs. Publishing of provisional data close to real-time would add to the benefits of an improved monitoring network.

- Full consideration in planning decisions

UFPs continue to be largely overlooked within the planning system due to a lack of legal limits. At the recent Gatwick Airport expansion inquiry, the airport deemed it not possible to predict UFP concentrations, instead carrying out a qualitative assessment. Funding for UFP monitoring around Gatwick is also conditional on limits being written into law. The absence of regulatory limits and monitoring continue to be played against each other in a chicken and egg scenario that leaves UFPs unaccounted for in expansion approvals. There is growing momentum for including a proper assessment of UFPs within the Airport National Policy Statement (ANPS), which is currently being reviewed. In discussing Heathrow expansion in December, the London Assembly Environmental Committee recommended that: *'The government should ensure that the role of UFPs from aircraft is properly assessed and included as part of the government's tests for its ANPS, and ensure that there is a systematic process for measuring around Heathrow and other London airports.'*

- Regulatory proposals to limit and reduce

The body of evidence linking UFPs to negative health outcomes is growing. It would be sensible to take a precautionary approach by setting limits and reduction plans on airports. Specific measures to target UFPs are essential, with the DEFRA AQEG making it clear that, 'Policies and actions to control ambient $PM_{2.5}$ and PM_{10} will not always control UFP'.

- Hydrotreatment and use of alternative fuels

These offer two possible routes to 'cleaning up' jet fuel and reducing PM emissions. Hydrotreatment is a refinery process that reduces the impurities (e.g. sulphur and aromatics) in kerosene. Some alternative fuels may also produce fewer PM emissions. These solutions are not without their own problems (e.g. cost, certification and scale), and a better understanding of them is needed to weigh the benefits, co-benefits and potential costs.