Ultrafine Particles (UFP) in the Vicinity of Gatwick.

1. Reigate and Banstead BC first measured ultrafine particle concentrations in the vicinity of Gatwick in December 2011. As reported to the steering group in June 2012 airports had been identified as a significant source of ultrafine particulate pollution[1,2] i.e. particles that are under 0.1 µm in aerodynamic diameter, and that a large proportion of these particles were generated during take-off with the resulting 'spike' in ultrafine particles detected at least 600 m from the airport based on studies at Los Angeles Airport (LAX).

2. As research over the past 10 to 15 years has continually indicated that the finer combustion derived particle fractions, including particles under 0.1 µm in (aerodynamic) diameter, tend to have the biggest biological effects it was agreed at that time that any further work in this area would be reported back to the steering group.

3. As has been mentioned previously in reports to the steering group research around Schiphol Airport[3] suggests children suffer more respiratory complaints on days with high exposures to ultrafine particles, while researchers in Canada[4] found a significant association between ultrafine particle exposure in general and an increase in incidence of brain tumours in adults. Further work[5] has also been undertaken in California around Los Angles International Airport which has also found an increased risk of brain cancer associated with airport related ultrafine particles.

4. Additional work on ultrafine particles was undertaken by the Council in 2018 and 2019, following a successful bid by Kings College, Imperial College, and Leicester University funded initially by the Medical Research Council and then by Reigate and Banstead in conjunction with Leicester University.

5. This work demonstrated that residents on the Horley Gardens Estate were exposed to particle concentrations comparable to, or greater than, those measured next to a 6 lane road in central London (Marylebone Road) especially when winds were off airport, and that the average size of those particles was generally much smaller than that seen in London.

6. The Council first approached DEFRA in 2012 about funding a long term monitoring site for ultrafines on the Gardens Estate, given the potential high exposure in an otherwise normal residential housing estate. However, it was not until 2024 that DEFRA agreed to fund equipment for the RG1 monitoring station and include this station on the UK Particle Concentrations and Numbers Network. The site in Horley is only the 4th such site in the UK looking at both the particle number and the size of the ultrafine particles.

[1] Zhu, Y. *et al.* (2011) Aircraft emissions and local air quality impacts from take off activities at a large International Airport Atmospheric Environment v.45 pp.6526 – 6533. https://doi.org/10.1016/j.atmosenv.2011.08.062
[2] Hsu H.-H. *et al.* (2012) The Relationship Between Aviation Activities and Ultrafine Particulate Matter Concentrations Near a Mid-Sized Airport. Atmospheric Environment v.50 pp.328 – 337. https://doi.org/10.1016/j.atmosenv.2011.12.002
[3] Janssen, N.A.H. *et al.* (2019) Research into the health effects of short-term exposure to ultrafine particles in the vicinity of Schiphol Airport. RIVM report 2019-0084 https://www.rivm.nl/en/bibcite/reference/323511
[4] Weichenthal, S. *et al.* (2020) Within-City Spatial Variations in Ambient Ultrafine Particle Concentrations and Incident Brain Tumors in Adults. *Epidemiology* v.31(2) pp.177-183. https://doi.org/10.1097/ede.0000000000001137
[5] Wu, A. *et al.* (2021) Association between Airport-Related Ultrafine Particles and Risk of Malignant Brain Cancer: A Multiethnic Cohort Study. *Cancer Res.* v.81(16) pp.4360–4369. doi: 10.1158/0008-5472.CAN-21-1138

Ultrafine Particles: 2025 Monitoring Results.

7. With the equipment installed in late 2024, 2025 represents the first full year of monitoring on the Gardens Estate for this pollutant. As can be seen from Table 1 residents' exposure towards the centre of the Gardens Estate is comparable to that kerbside of a 6 lane highway in Central London (Marylebone Road), and considerably higher than the London Background site which the Gardens Estate more closely resembles.

Site	Distance from Source.	Data Capture (%)	Mean Particle Count (Particles / cm^3)
London – Background (Honor Oak)	n/a	74 %	8,678
RG1 Horley	350 m A23 / 610 m Airport	89 %	18,912
London – Kerbside (Marylebone Road)	1.5 m	77 %	18,794
RG1 Horley (Southerly winds only)	As above	As above	34,489
Honor Oak Park and Marylebone Road SMPS data for direct comparison to Horley SMPS data.			

Table 1: Mean Particle Number Concentrations in 2025 on the Horley Gardens Estate (RG1) and comparable London Sites.

8. The key difference between the Horley site and the London Kerbside site is that while the average concentrations over the year are similar between the two sites, the ultrafines concentration at the London site is fairly constant over the year, while the average at the Horley site 'masks' significant variations in exposure.

9. As can be seen in Table 2 (and the bottom row of Table 1), when winds are from a southerly direction i.e. off airport, the pollutant exposure in Horley Gardens is double that seen at the London kerbside site, and up to 4 times that seen when winds are from the north or east in Horley.

Wind Direction	Hours	Mean Particle Count (Particles / cm^3)	No. Hours 'High'
North	162	7,884	9
East	2954	7,275	96
South (from the airport)	2849	34,489	1,477
West	1753	14,253	392

Table 2: Mean Particle Number Concentrations by Wind Direction - RG1 Horley 2025.

10. While winds from the west (SW to NW) show elevated concentrations compared to the northerly and easterly directions, albeit still less than half the concentrations from the south, it is worth noting that this average concentration includes some high concentrations from a SW to WSW direction i.e. in effect off airport.

11. At present there are no UK or EU limit values for ultrafine particles, and the WHO are unable to give a guideline value due to the limited research to date in this area driven in part by the limited monitoring to date. However, the WHO have defined what can be regarded as:

    a. 'High' concentrations - more than 10 000 particles / cm^3 (24-hour mean) or more than 20 000 particles / cm^3 (1-hour).

    b. 'Low' concentrations – less than 1000 particles / cm^3 (24-hour mean).

12. Using the WHO methodology on the 2025 data (Table 3) indicates that the number of hours 'High' on the Horley Gardens Estate is around a factor of 10 higher than a comparable setting in London (Honor Oak), but lower than that seen kerbside in London. The comparable annual average concentrations at Horley and Marylebone Road but the higher number of days and hours 'High' at Marylebone Road reflects the more consistent level of exposure at the London kerbside site compared to Horley.

Site	**Distance from Source**	**Days of valid Data Capture**	**Mean Particle Count (Particles / cm^3)**	**Days 'High' (daily mean)**	**No. of hours 'High' in period**	**No. Days with min. of 1 hour 'High'**
London – Background (Honor Oak)	n/a	264	8,678	87	180	71
RG1 Horley	350 m A23 / 610 m Airport	321	18,912	177	1988	202
London – Kerbside (Marylebone Road)	1.5 m	268	18,794	237	2786	260

Note: The number of hours 'High' at the Horley site is greater here than in Table 2 as there is missing wind data for some of the 'High' hours in Table 2.

Table 3: Comparison of London Background and Roadside monitoring to Residential Monitoring in Horley using WHO guidelines.

13. While the number of hours 'High' in Horley is lower than that at the kerbside site in London, when levels are 'High' in Horley the level of exposure in that hour is on average higher than in London.

14. It is also important to note that the hours 'High' in Horley are not just clustered in a small number of days, but over 55 % of the days in 2025 resulted in residents being exposed to 'High' pollution for at least one hour per day.

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Abbreviations and Definitions.

m^3	cubic metre.
mg	milligram (1 thousandth of a gram).
ng	nanogram (1 billionth of a gram).
ng/m^3	nanogram(s) per cubic metre
ng m^{-3}	nanogram(s) per cubic metre, This scientifically is the correct form to use rather than ng/m^3, though either can be used.
nm	nanometre (1 billionth of a metre or 1 millionth of a millimetre)
PM	Particulate Matter.
PM_{10}	Essentially particles under 10 µm in diameter. Officially defined as the size fraction below 10µm in aerodynamic diameter, which has a cut off point at 50% of the particles which are 10µm in aerodynamic diameter.
$PM_{2.5}$	Essentially particles under 2.5 µm in diameter.
UFP	Ultrafine particles. Generally refers to particles under 0.1 µm (100 nm). Where measured in a regulatory setting the particle range is 10 nm to 100nm
µg	microgram (1 millionth of a gram).
$µg/m^3$	microgram(s) per cubic metre
µg m^{-3}	microgram(s) per cubic metre, This scientifically is the correct form to use rather than $µg/m^3$, though either can be used.
µm	micrometre (1 millionth of a metre or 1 thousandth of a millimetre).
WHO	World Health Organisation.

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