

PIMS

vehicle interior
air quality testing

 **EMISSIONS
ANALYTICS**

Vehicle Interior Air Quality Real-world and laboratory testing

2023

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Our Belief

When it comes to the pursuit of emissions reduction, we believe in the power of clarity, transparency and integrity. With real-world data we can meet emissions challenges – instilling trust and confidence in our industry partners and public.

It's with our commitment and independence we are able to make a significant contribution toward positive change and to achieve enduring results.

Overview

- Founded in 2011
- Headquartered in the UK
- Operations in UK, Germany, USA and South Korea
- Independent testing house specialising in real-world emissions testing
- Over 2,500 vehicles/machines tested across passenger, commercial and off-road
- Largest commercially available database of real-world emissions data
- We work with regulators, OEMs, Tier 1/2 suppliers, fuel and chemical companies, fleets, consumer media
- Chair of EU CEN Workshops 90 and 103



The challenge

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Background

- Whilst exhaust emissions is strictly regulated, air quality standards in our vehicles is far less stringent – particularly in real-world conditions
- For over a decade, Emissions Analytics has specialised in real-world exhaust emissions testing across applications from cars to tug boats
- Based upon this expertise and adopting similar established measurement technologies, we have developed techniques and methods to test vehicle interior air quality (VIAQ) in real-world conditions
 - ✓ Ultrafine particulate ingress
 - ✓ CO₂ build-up
 - ✓ VOCs from interior materials
 - ✓ Diagnosis of malodours

Growing awareness and concern



Air pollution more harmful to children in cars than outside, warns top scientist

Exclusive: Walking or cycling to school is better for children's health as cars are 'boxes collecting toxic gases' says David King

- **Opinion: Smoking in cars is banned. But children still inhale toxic fumes in backseats**



BREATH ON THE ROADS Motorists still breathe in lethal toxins during heavy traffic despite built-in air pollution filters, claim scientists

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CLEAN AIR FOR ALL

Drivers of greenest cars exposed to the dirtiest air

Cyclists 'exposed to less air pollution than drivers' on busy routes

Study shows people in cars and buses spend longer in toxic air, as do walkers on main roads



Car cabin pollution scare prompts calls for new air conditioning rules



Journal of Transport & Health

Volume 26, September 2022, 101365



Personal air pollution exposure during morning commute car and active transport journeys

Conclusions

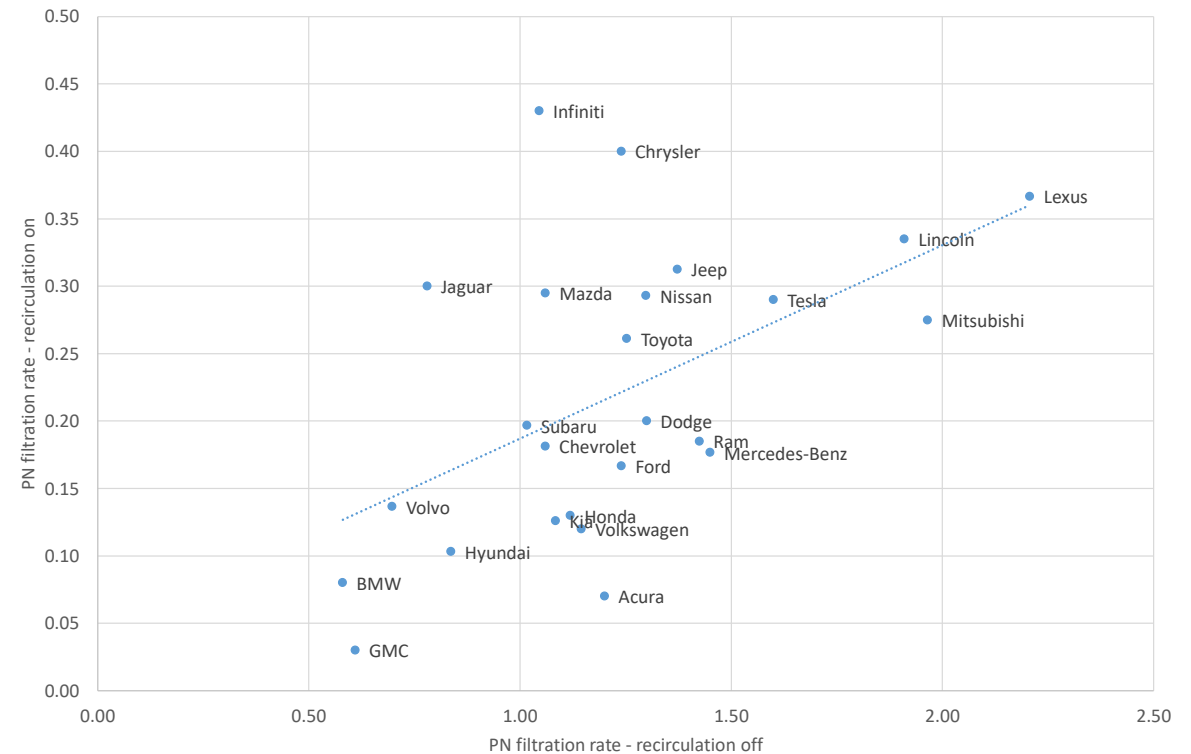
Concentrations of air pollutants in cars can be considerably higher than concentrations faced by active travellers. Commuters sitting in cars can both miss the benefits of physical activity and be exposed to higher levels of NO₂ than in active transport, which is particularly important in countries like the UK with NO_x exceedances.



The Air Inside Our Car Is More Dangerous Than The Outside Air

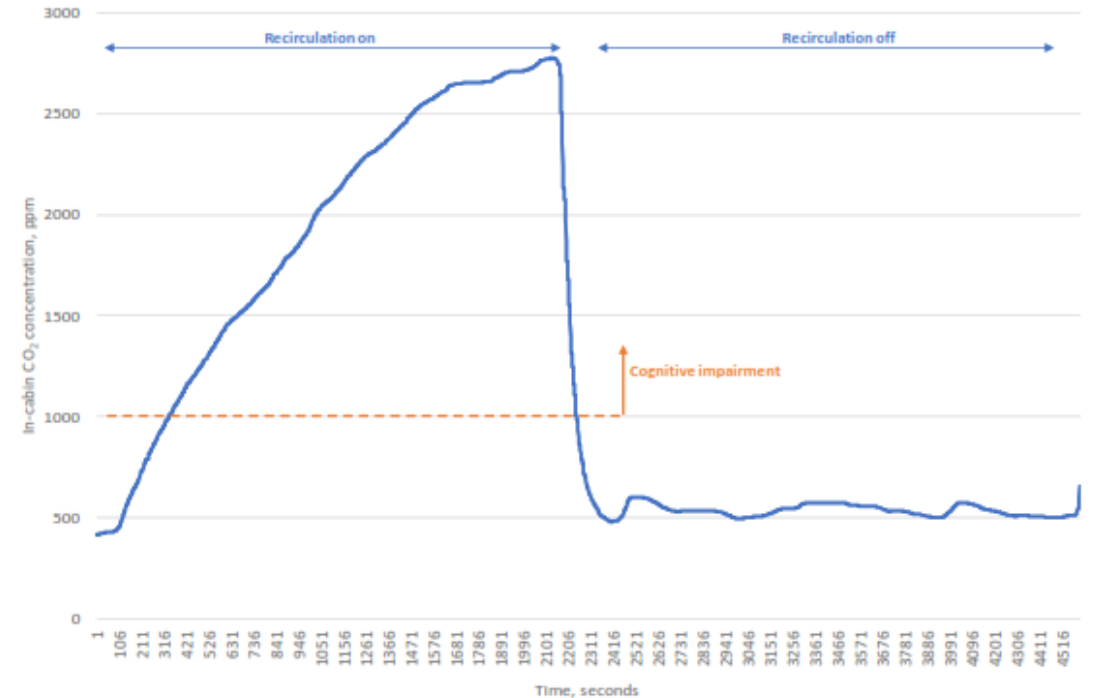
PN filtration efficiency variance

- Emissions Analytics independently tested over a hundred vehicles in Europe and USA
- As expected, without stringent regulation, the efficacy of vehicles air filtration varies wildly as demonstrated in this chart
- The Y Axis the percentage of ultrafine particles entering the vehicle with recirculation on.
- The X Axis the percentage of ultrafine particles entering the vehicle with recirculation off



CO₂ accumulation

- Chart shows the impact of activating recirculation to 'improve' air quality causes CO₂ accumulation
- Background CO₂ ~400ppm
- Measured background around roads 45–500ppm
- Cognitive impairment begins at 100ppm
- CO₂ emitted becomes a noxious pollutant in a confined environment
- Many vehicles count as a workplace and are subject to legal or regulatory criteria



Measurement capabilities

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Real-world VIAQ Measurement

- Measurements: CO, CO₂, particulates (15 nm ~ 2.5µm)
- 1hz measurements are taken via two separate sets of test equipment sampling the interior and exterior simultaneously
- Interior NO₂ measurement
- Semi and Volatile Organic Compounds measurement and identification

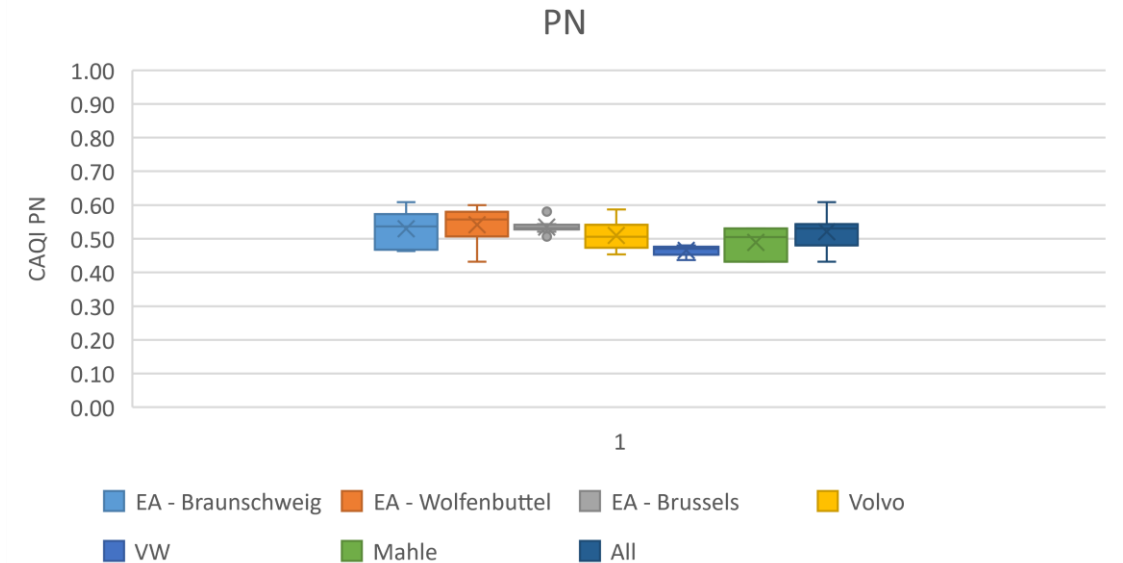


CEN VIAQ Testing Methodology

- In the absence of regulation, no standardised method existed to measure real-world particulate ingress and CO₂ accumulation
- Under the guidance of European Committee for Standardisation, CEN workgroup 103 established to develop a test method
- Two year process involving academia, vehicle manufacturers, HVAC technology specialists and testing houses including, Emissions Analytics
- In 2022 CWA 17934:2022 established
- By standardising data collection, vehicles can be compared in a transparent, consistent and concise manner, and allow the aggregate of data from multiple sources

Repeatable real-world PN testing

- Particulate ingress based upon simultaneous measurement of interior and exterior
- Exterior, ambient, particulate pollution is constantly changing and varies greatly depending upon the local environment.
- Could this be measured in real-world conditions with repeatable results?
- Yes - the chart shows results from tests across 6 different cities by CEN workgroup stakeholders measuring particulate number ingress



Applications for CWA 17934:2022

- Enables the comparison of vehicles, including their heating and ventilation (HVAC) systems and filter technology
- Different versions or calibrations of the HVAC of the same vehicle can be compared
- Alternative air-intake filters on the same vehicle can be compared
- Exposure levels can be compared to air quality or occupational health limits or guidelines

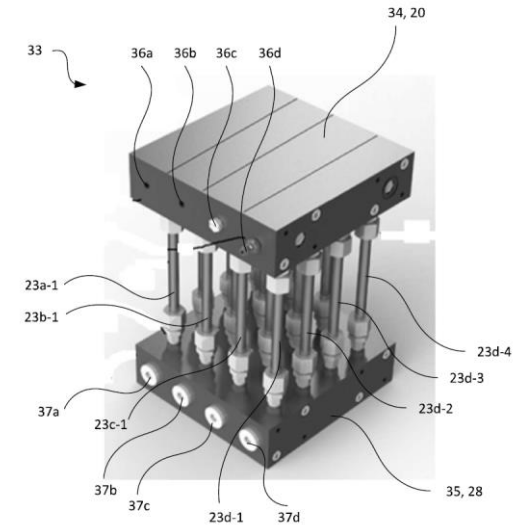
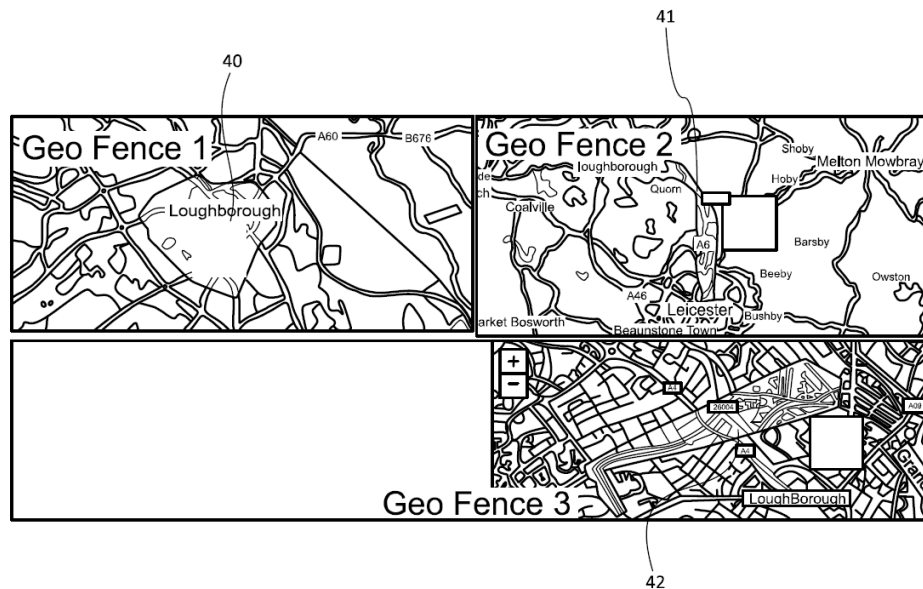
A high-angle, front-facing view of a luxury car's interior. The car features light-colored leather seats with a diamond-quilted pattern, a black steering wheel, and a dashboard with multiple air vents and a central display. The interior is illuminated with blue ambient lighting. A semi-transparent blue banner is overlaid across the upper right portion of the image, containing the text 'VOC analysis' and 'ASSURED | INDEPENDENT | RESPONSIVE'.

VOC analysis

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Integrated VOC sampling

- Cabin air pumped to a series of sample tubes
- Geofencing enables samples to be targeted whilst the vehicle is on route
- Real-world samples analysed using advanced gas chromatography



Laboratory capabilities

- Two-dimensional gas chromatography with mass spectrometry and HPLC
- INSIGHT flow modulator from SepSolve Analytical for separation
- BENCH-TOF time-of flight mass spectrometer
- Thermal desorption tube & DNPH sampling from Markes International



Materials analysis

- Materials increasing must comply with regulations and private requirements of buyers such as automotive companies
- Going beyond minimum requirements minimise the chance of unexpected health effects or malodours
- Combinations of materials in real-world conditions need testing
- GCxGC coupled with TOF-MS can achieve exceptional separation, identification and quantitation of volatile organic compounds



Relevant standards

- VDA 278
- ISO 12219: Interior air of road vehicles
- ASTM D5116
- ASTM D6670
- ASTM D7143
- ASTM WK21341

Benchmarking database

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Database process

Independently source vehicle

Test on standardised normal cycle:
urban, rural, motorway

Vehicles tested with recirculation on/off, low –
high fan, static filtration test

Top-line results, analysis, raw data and meta data
added to database within 48 hours

Database scope

- Separate passenger car databases for EU and US
- Over 150 cars tested
- Vehicles rented, typically <5,000 mileage, therefore new filters
- Cabin filter make and model recorded
- PN and CO₂ data only
- All test and meta data is owned by Emissions Analytics and available for corporate access

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Assured

Emissions testing in real-world conditions brings challenges that experience anticipates and expertise overcomes. We deliver.

Independent

Objectivity and candour are the driving forces in all our work, so you know the facts.

Responsive

We're fast on our feet so we can conduct emissions testing when and where we're needed.

Thank you.

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