

# EQUA Index: Cabin air quality ratings

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March 2019

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# EMISSIONS ANALYTICS

# Emissions Analytics' credentials

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- International testing and ratings organisation
- Founded in 2011
- Headquartered in the UK
- Operations in UK, Germany, USA and South Korea
- Focused on on-road testing and data analysis
- Largest commercially available database of real-world emissions data
- Works with researchers, regulators, OEMs, Tier 1/2 suppliers, fuel and chemical companies, fleets, consumer media

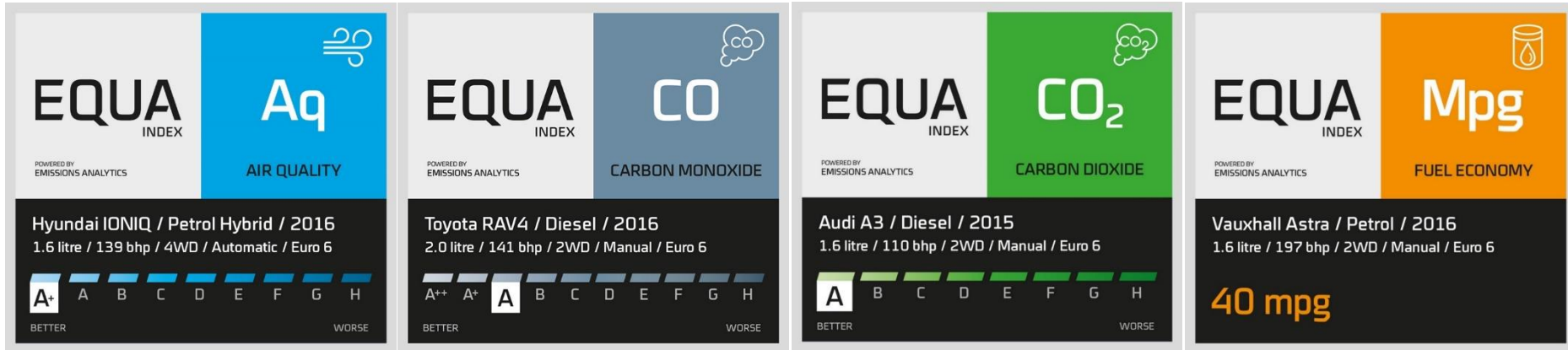


# Key activities

- Over 2000 passenger cars tested
- ~50 light commercial vehicles tested
- Heavy-duty commercial vehicles tested
- Agricultural equipment tested in service
- Newly-launched programme testing non-road mobile machinery, including generators, construction equipment
- Waterborne vessel testing commenced



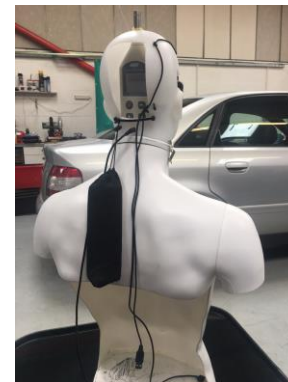
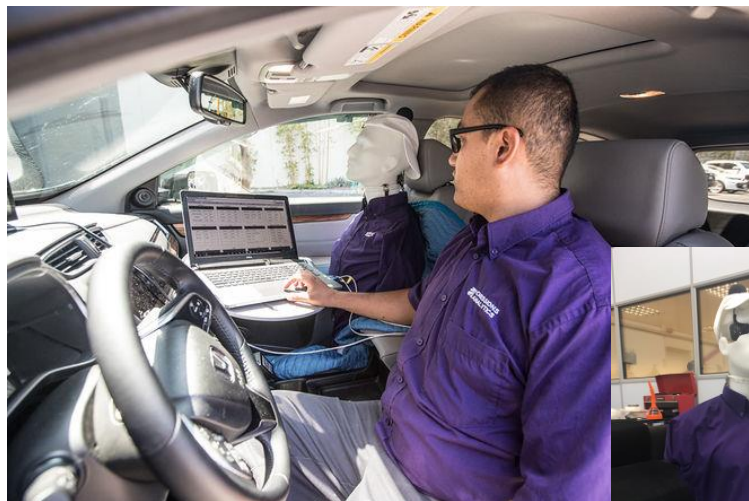
# Comparative data with EQUA Index



# IN-CABIN AIR QUALITY

# “PIMS”

Pollution in-cabin measurement system: PN (15nm), CO<sub>2</sub>, CO, NO<sub>2</sub>, VOCs



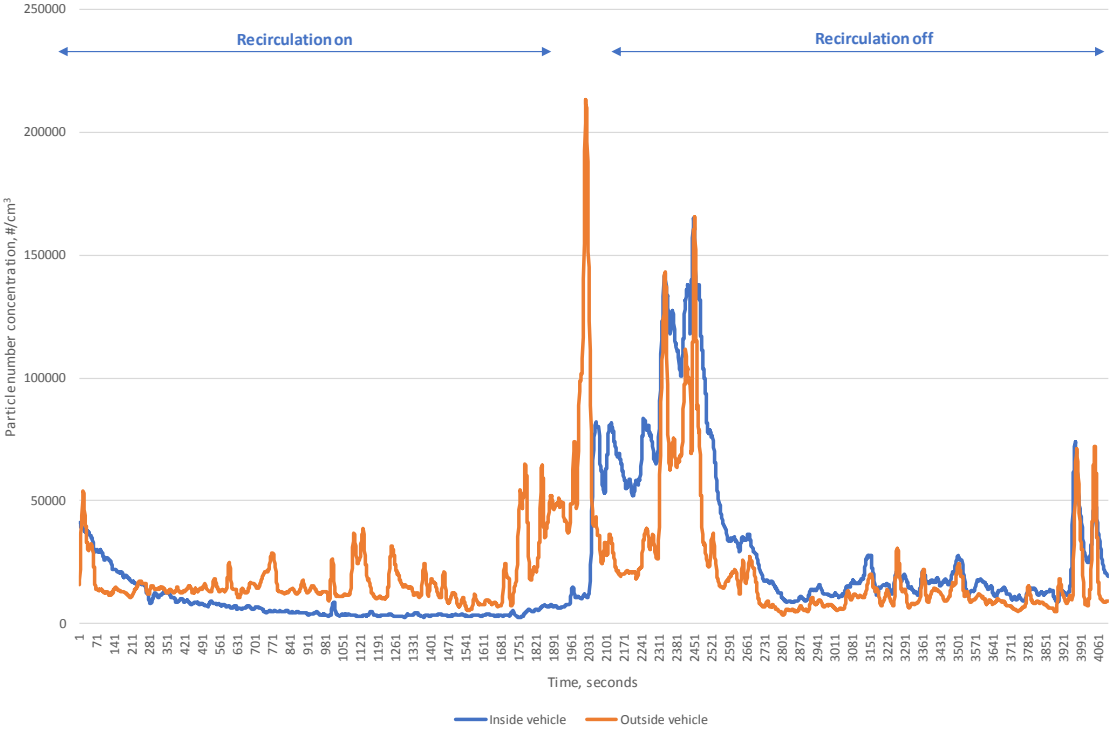
# Health and legal background

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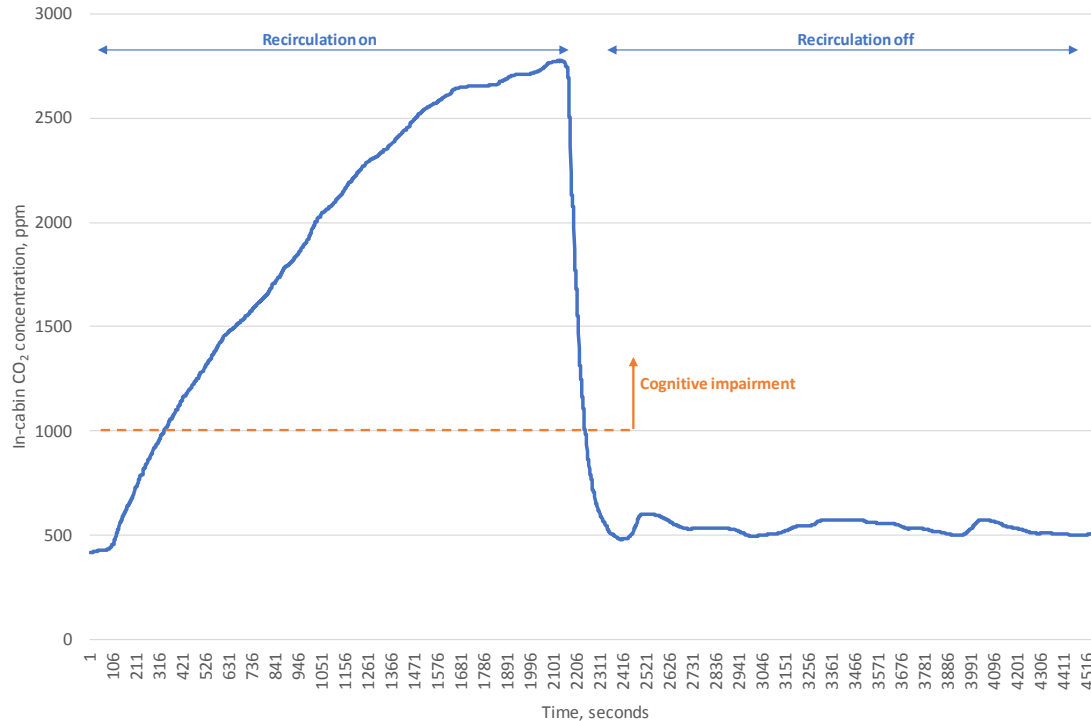
- “...each increase of 10 micrograms per cubic meter in annual exposure to PM<sub>2.5</sub> ... was associated with an increase in all-cause mortality of 7.3%...” – *New England Journal of Medicine*, 2017
- “...ultrafine PM which comprises the smallest fraction of fine PM ... may be disproportionately toxic...” – *Atmospheric Environment*, 2014
- Background CO<sub>2</sub> ~400ppm; measured background around roads 450-500ppm
- Cognitive impairment starts around 1000ppm
- CO<sub>2</sub> emitted as “greenhouse gas” becomes noxious pollutant in confined space
- Many vehicles count as workplaces and are subject to legal or regulatory criteria



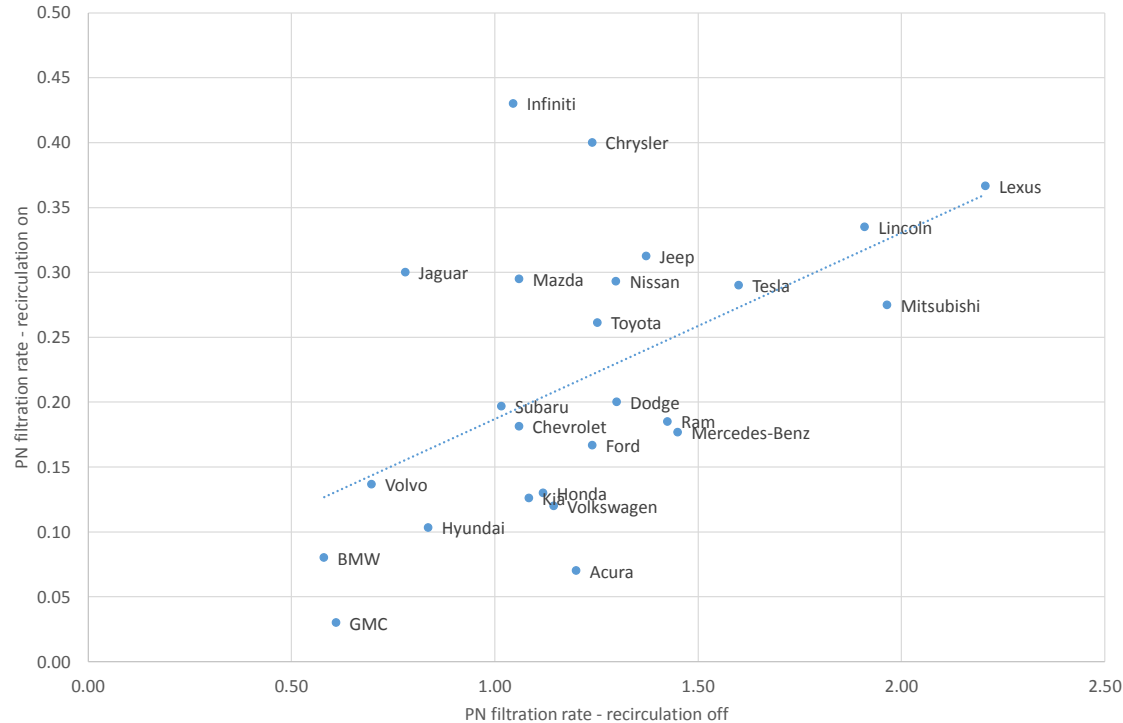
# Particle infiltration



# In-cabin CO<sub>2</sub> build-up

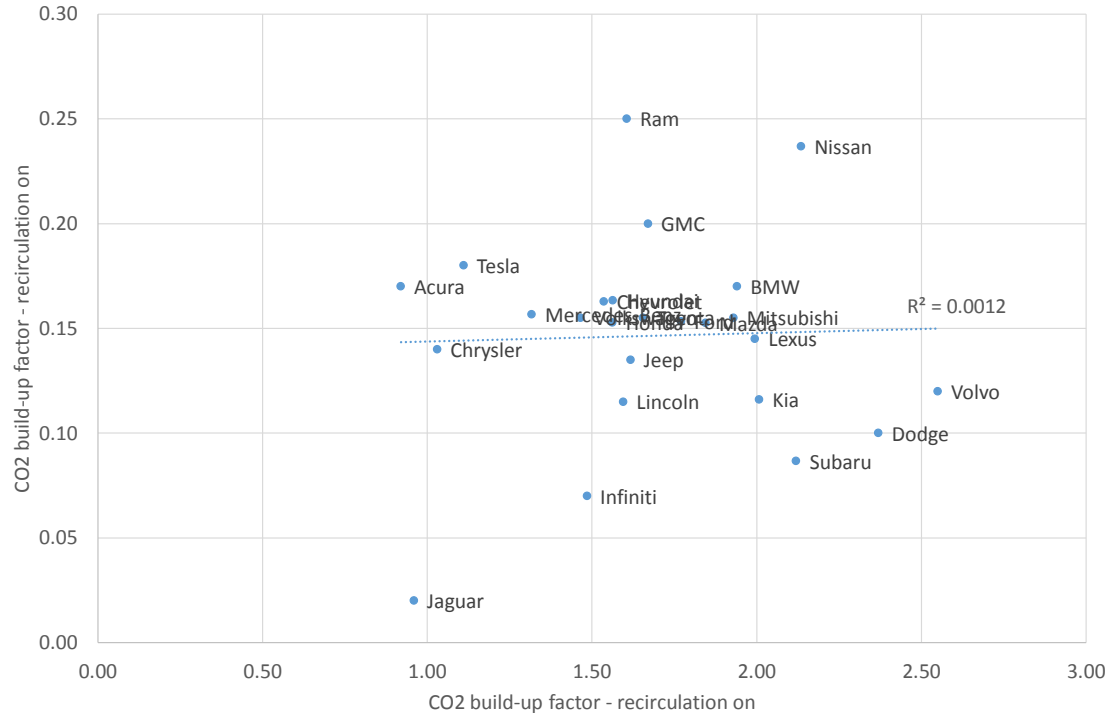


# PN filtration rates



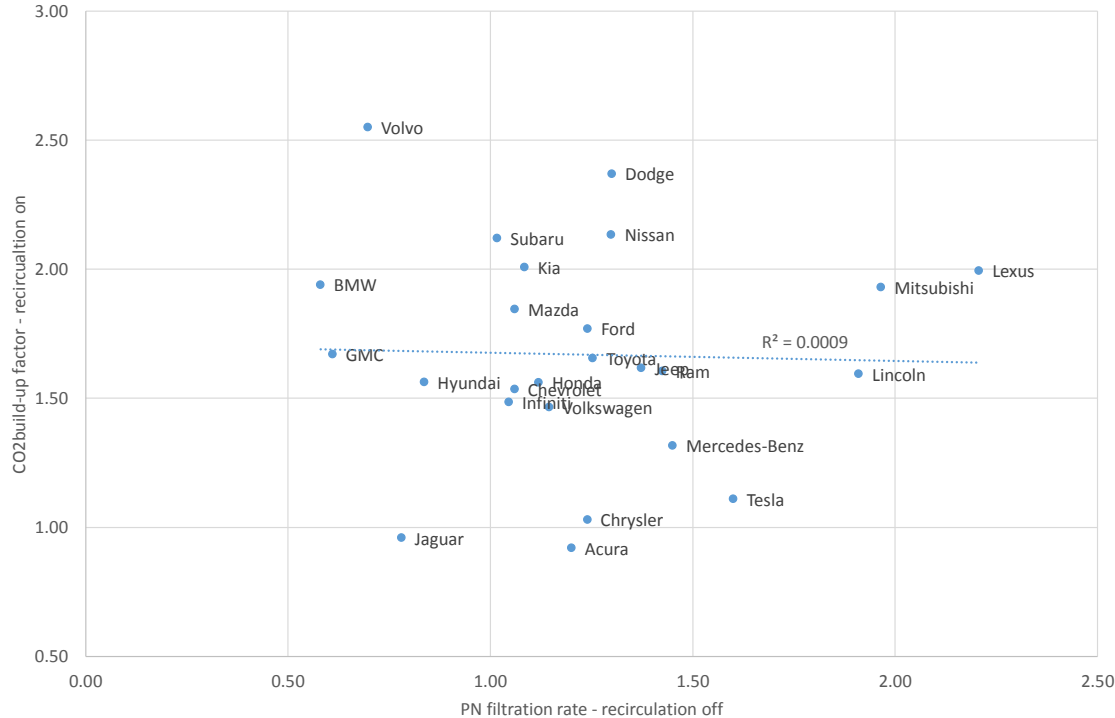
- Integrated ratio of inside to outside PN concentration over cycle
- Fresh air mode often sees average cabin concentration higher than ambient
- Correlation suggests recirculated air is (partly) filtered
- Or some filtered fresh air is allowed in even under recirculation

# CO<sub>2</sub> build-up rates



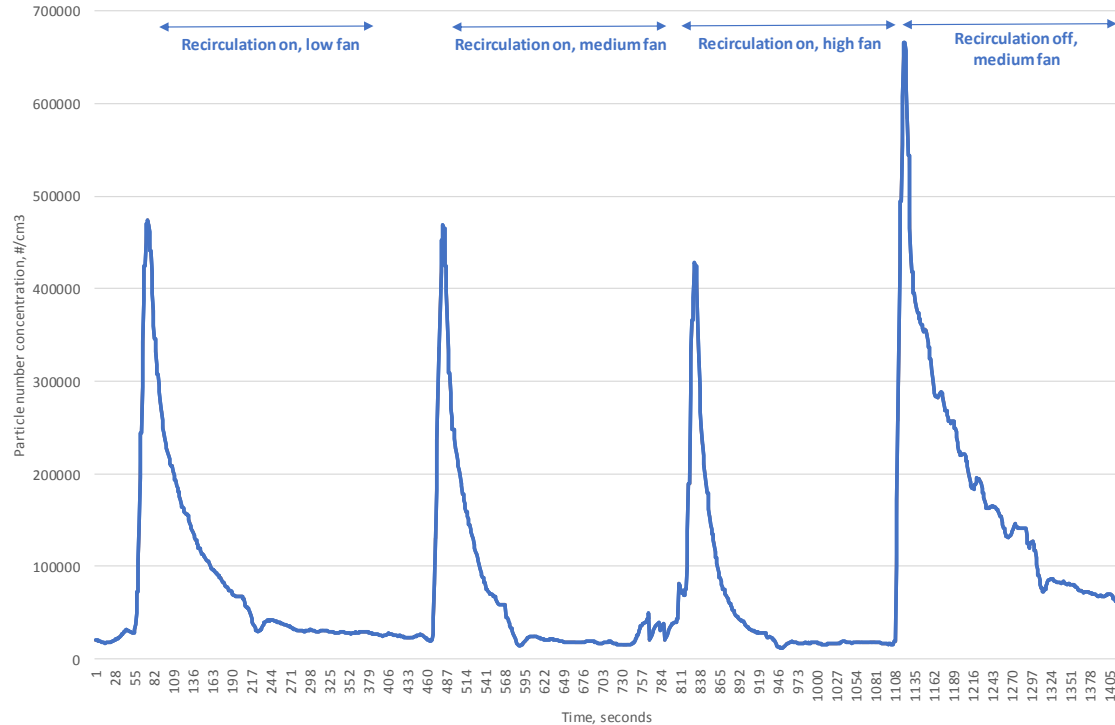
- Increase factor from test baseline
- Zero = no increase
- Worst cases CO<sub>2</sub> more than trebles over ~30 minute test
- No correlation between recirculation modes
- Jaguar I-Pace the best performing model

# CO<sub>2</sub> vs PN



- Driver choice between PN from fresh air mode and CO<sub>2</sub> build-up from recirculation mode
- No correlation suggests no trade-off – independent design decisions
- Trade-off is more likely on design cost

# Air exchange rate

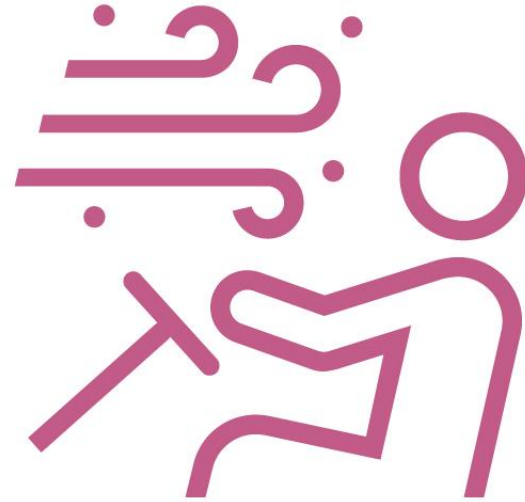


# Effect of fan speed and AC

Fan speed/AC	PN reduction	CO <sub>2</sub> reduction
Low fan, AC off	0.47	0.82
Medium fan, AC off	0.35	0.76
High fan, AC off	0.29	0.72
Medium fan, AC on	0.55	1.00

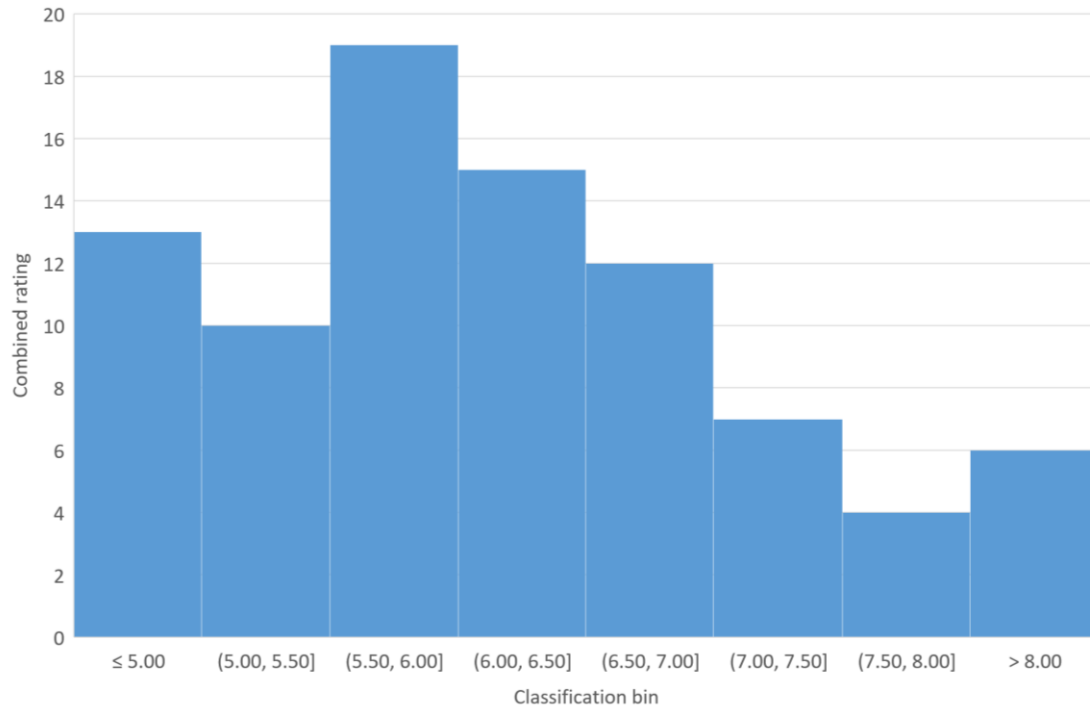
**EQUA**

**CABIN AIR  
QUALITY**





# Overall HVAC ratings



- Proposed classification scale
- Combination of PN and CO<sub>2</sub> air quality indices
- Low values are better
- A to H scale
- Repeatability +/-15%