

**Progress Report of the
VIAQ (Vehicle Interior Air Quality)
Informal Working Group**

GENEVA, January 10th 2023

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Terms of reference and rules of procedure for the IWG on Vehicle Interior Air Quality

Background. The group considered the inclusion in the scope of interior air pollutants from outside sources as a possible extension of the mandate at third stage. As an extension of the existing Mutual Resolution on VIAQ, this will take into account not only interior air emissions generated from interior materials and exhaust gases from the vehicle entering into the cabin but also outside air pollution sources. The list of outside air pollutions could include CO, NO, NO₂, SO₂, O₃ volatile organic compounds (VOC), aldehydes, aromatic and aliphatic hydrocarbons, particulate number (PN) and mass (PM) and microbiological substances, e.g. allergens, fungi, bacteria and viruses. As an extension of the existing Mutual Resolution on VIAQ, this will take into account not only interior air quality but also the air cleaning efficiency of the vehicle air handling & treatment system.

Objective. This proposal expands on the issues of the vehicle interior air quality, addressing outside air pollutants entering into the vehicle cabin and the interior air cleaning efficiency, to develop a test procedure in a recommendation by including Part 4 in the Mutual Resolution No. 3.

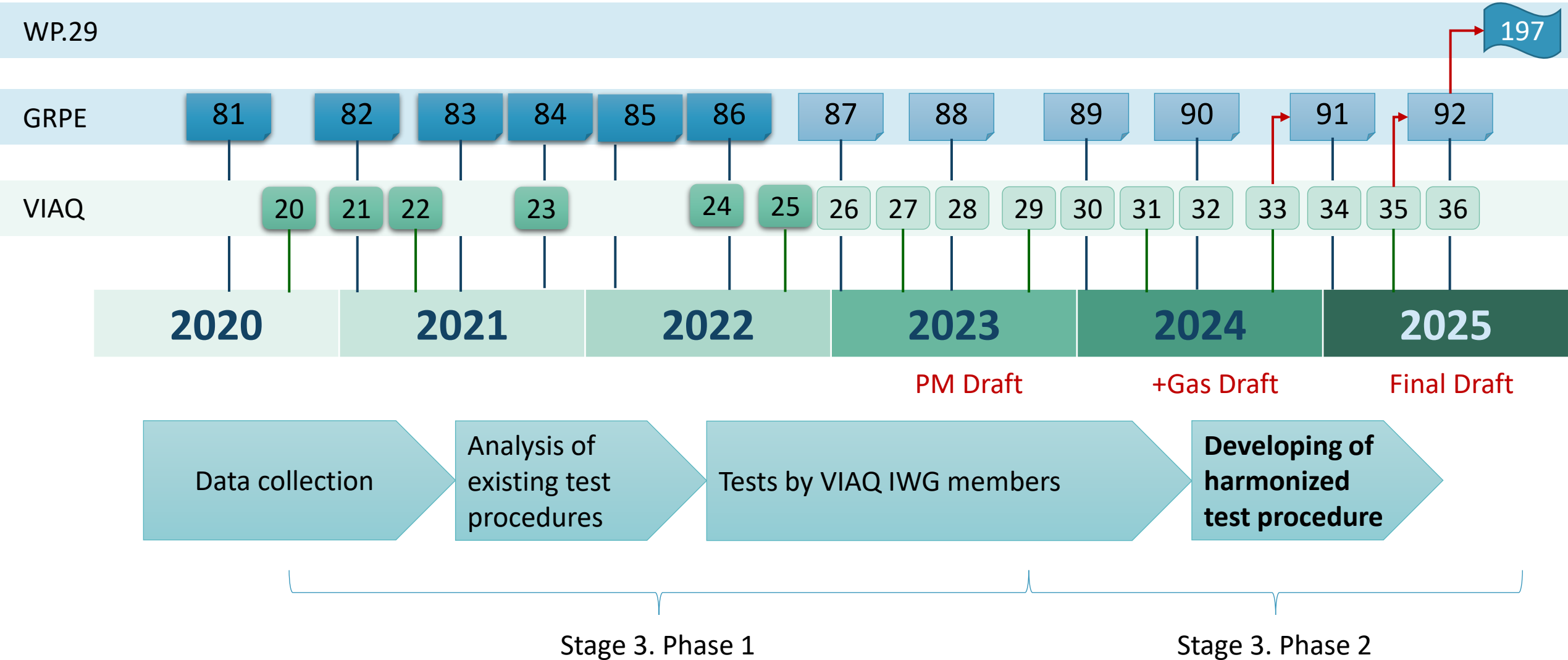
Scope and work items. Outside air pollutants entering into the vehicle cabin and their cleaning efficiencies

- (a) Collect the information and research data on relevant air pollutants and similar issues, and understand the current regulatory requirements with respect to vehicle interior air quality in different markets.
- (b) Review, assess and develop new test procedures suitable for the measurement methods of air pollutants entering into the vehicle cabin and their cleaning efficiencies (including test modes, sample collection methods and analysis methods, etc.)
- (c) Discuss the potential of air pollutants in the vehicle interior air with toxicologists.
- (d) Develop a draft for test procedures in a recommendation.

➤ **25th VIAQ IWG Meeting**

- Teams, 9th November 2022
- Half a day

Timeline



Information presented last meeting

Company	Presenter Name	Document Title	Document No.
KOTSA	Inji Park	Behavior of particulate matters measured in vehicle cabin during real driving conditions	VIAQ-25-04
Airlib	Herve Borrel	Improved in-cabin air quality with map-based air recirculation control	VIAQ-25-05
UTAC/ESTACA	Amine Mehel	Simultaneous in-cabin and on-road CO2 concentrations during on-board mobile measurements	VIAQ-25-06
NAMI	Andrey Kozlov	Test methodology development and repeatability assessment	VIAQ-25-07
UTAC/ESTACA	Nadir Hafs	The necessity of laboratory test in stabilized controlled atmosphere for vehicle in-cabin air quality full characterization	VIAQ-25-08
CLEPA	Markus Michael	Comments on UN VIAQ IWG 24th session	VIAQ-25-09 VIAQ-25-10

The purpose of this discussion was to formulate tasks for farther group activities and to develop harmonized PM measurement test method

The items

1. Vehicle Category
2. Criteria for excluding a vehicle from tests
3. Test Vehicle age/millage
4. Meteorological Conditions
5. Test Conditions
6. Sampling Points/Sampling Lines
7. Background air pollution level
8. Cabin air filter age
9. PM and gas components to be Measured
10. Measurement Methods
11. Test equipment requirements
12. Gas Analysers Calibration
13. Test Modes
14. HVAC Modes
15. Test Procedure
16. Test Protocol

1. Vehicle Category (agreed)

Category 1-1

2. Criteria for excluding a vehicle from tests (agreed)

Exclusion shall be based on a positive answer to any of the criteria below:

- ✓ Does the vehicle not have a full service history?
- ✓ Is there a Malfunction Indication Light showing on the vehicle instrument panel?
- ✓ Has the vehicle had unauthorised vehicle repairs?
- ✓ Has any part of the vehicle's heating and ventilation system replaced with non-original parts?
- ✓ Through visual inspection of the vehicle, are there any damaged ventilation system relevant components?
- ✓ Are there any obstructions to the vehicle air intake path?
- ✓ Is the vehicle not in overall safe operating condition?
- ✓ Is there any damage to the body of the vehicle, including but not limited to doors, windows and the rear?

3. Test Vehicle age/mileage (agreed)

Test vehicle age: more than one month

Test vehicle mileage: 3 000...15 000 km

4. Meteorological Conditions (agreed)

Weather condition:	no rain, fog, snow or standing water on the carriageway
Relative Humidity:	40...80%
Atmospheric pressure:	85...110 kPa
Temperature:	+5...+25°C

5. Test Conditions

- The VIAQ performance shall be demonstrated by testing vehicles on the road, operated over their normal driving patterns, conditions and payloads. The test shall be conducted on paved roads (e.g. off-road operation is not permitted).
- Windows, doors, sunroof or convertible soft top must be closed at all times. Heated or cooled seats should not be used.
- When cleaning the vehicle prior to testing, only a damp cloth should be used. Fragrances and air fresheners should be avoided.
- There should be the driver and one passenger present in the vehicle for the duration of the test. All outer clothing of the driver and passenger should be made of polyester to minimize particle generation from the driver. Clothing should cover both arms and legs.
- The occupants should avoid applying any fragrances or make-up prior to or during the test. Further, occupants should not have smoked for at least 24 hours before a test.

5. Test Conditions

- The trip shall consist of approximately 55 per cent urban and 45 per cent expressway speed bins. 'Approximately' shall mean the interval of ± 10 per cent points around the stated percentages. The urban speed bin however can be lower than 45 per cent but never be less than 40 per cent of the total trip distance.
- Urban speed bin is characterised by vehicle speeds lower than or equal to 60 km/h.
- Expressway speed bin is characterised by speeds above 60 km/h and up to 100 km/h.
- Local speed limits remain in force during a test, notwithstanding other legal consequences. Stop periods, defined by vehicle speed of less than 1 km/h, shall account for 6-30 per cent of the time duration of urban operation. Urban operation may contain several stop periods of 10 s or longer.
- The trip duration shall be between 30 and 60 minutes. The trip distance - TBD.
- The start and the end points of a trip shall not differ in their elevation above sea level by more than 100 m. In addition, the proportional cumulative positive altitude gain over the entire trip and over the urban operation shall be less than 1,200 m/100 km.

6. Sampling Points/Sampling Lines

1. The interior sampling point should be a head-height between the front headrests
2. The external sampling point should be as close as reasonably possible to the ventilation air intake.
3. The sampling lines to the analyzer should be:
 - as short as possible
 - line lengths must be identical and not more than 1 m
 - with few bendings as possible
 - with no sharp bendings
 - made of antistatic materials for particles measurement
 - made of PTFE for gases measurement
 - with diameter compatible to measurement equipment, usually 6 mm or 8 mm (outer diameter)

7. Background air pollution level

PM_{2.5} concentration should be not less than 30 µg/m³ and not more than 500 µg/m³

NO - TBD

NO₂ - TBD

CO₂ - TBD

Task: The group need to set background levels to all measured components (regarding item 9)

8. Cabin air filter age

HVAC filter age:

- OEM-approved filter artificially aged to 3000 km

If a vehicle is not installed with a filter by the OEM, the vehicle to be tested with no filter present.

Task: Define artificial filter aging procedure, if good procedure is available only take artificial aged filter

9. PM and gas components to be Measured

PM_{2.5}

NO

NO₂

CO₂ (Interior only)

Task: Check real NO₂ and NO concentration in outside air

10. Measurement Methods (agreed)

PM concentration	Optical particle counter
NO and NO ₂ concentration	Non-dispersive ultra-violet chemiluminescent detector
CO ₂ concentration	Non-dispersive infra-red

11. Test equipment requirements

PM _{2.5} concentration	0 to 0.5 mg/m ³
NO concentration	0 to 0.5 ppm
NO ₂ concentration	0 to 0.5 ppm
CO ₂ concentration	0 to 5,000 ppm

Time resolution: <2 s

CLEPA proposals:

Test Equipment suitable for mobile application

Test Equipment fulfils common safety regulations

Detection limit chosen as such to enable save measurement

Task: Prepare specification for test equipment

12. Gas Analysers Calibration (agreed)

Calibration and linearization of the equipment shall be performed according to manufacturer recommendations prior to the commencement of measurements.

After the equipment is installed in the vehicle, a dynamic calibration shall be performed. The dynamic calibration ensures that the paired instruments are measuring the same concentrations. The dynamic calibration should be run each time: before the test series; if there is a new or changes to an existing test equipment installation on a vehicle; and after the first test to ensure in correct measurement. For the purposes of this calibration test, a stainless steel Y-piece should be used to split the air from the exterior sample probe equally between the interior and exterior measurement instruments. At the end of the calibration, the Y-piece should be removed and the installation returned to the test configuration.

The dynamic calibration test should be run for at least 30 minutes and expose the vehicle to concentrations in the range defined in item 7. The Pearson correlation coefficient between the data points from each matched pair of measurement devices shall be calculated. For a valid calibration, the r^2 on all devices should be at least 0.98.

The drift of the zero response of the particle number instruments, defined as the mean response to HEPA filtered air at the inlet of the sampling line during a time interval of at least 30 seconds, shall be tested prior to each test and shall be less than $3 \mu\text{g}/\text{m}^3$.

The drift of the zero response of the carbon dioxide instruments, defined as the mean response to ambient air at the inlet of the sampling line during a time interval of at least 30 seconds, shall be tested prior to each test and shall be $413 \text{ ppm} \pm 20 \text{ ppm}$.

Annual calibration following supplier recommendation.

13. Test Modes

1. Real driving conditions (urban + urban motorway)
2. Laboratory test (see VIAQ-22-11, VIAQ-23-05, VIAQ-23-10, VIAQ-23-11, VIAQ-24-05, VIAQ-25-08)

Task: Investigate the necessity and validity of laboratory test inclusion to test procedure in the future

14. HVAC Modes

OICA proposals

HVAC settings should be as automatic as possible. However, some vehicles do not provide automatic settings, or automatic settings can be adjusted.

- A) Start to set HVAC to automatic. If vehicle does not have an automatic HVAC program or automatic settings can be adjusted follow the next steps:
- B) Set temperature to 22°C or 50% (medium) temperature setting
- C) Set fan speed to 50% (medium)
- D) Switch air conditioning: ON
- E) Switch ventilation flaps: fully open and directed straight ahead;
- F) Switch air quality sensors: ON
- G) Switch ionization: ON
- H) Do not use fragrance programs

Task: Create a test procedure how to set the HVAC mode depending on vehicle components/functions

15. Test Procedure (PM measurement)

1. Measure ambient air temperature, relative humidity, pressure and background air pollutants concentration.
2. Start the engine, adjust HVAC operation mode, switch on the PM analyzers and drive for at least 10 min.
3. Drive to the beginning of the test route, start PM analyzers, GPS logger.
4. Drive on the route urban and expressway parts.
5. Park the car, stop the PM measurement, GPS logger.
6. Switch off PM analyzer and the engine.
7. Save measurement protocols from PM analyzers and GPS track from logger to the computer.
8. Take another background measurement according to subclause 1. Vehicle real driving test is complete.

Task: To write draft test procedure and discuss in the next meetings

16. Test Protocol

The protocol contains

1. Vehicle information (type, variant, version, manufacturer, mileage, engine type, fuel type, filter type and date of installation...)
2. Test condition information (testing date, test locations, test time, test equipment...)
3. Reporting of test results (inside and outside concentrations measurement results, ventilation mode, ambient conditions, mean vehicle speed, test distance, altitude, filtering efficiency...)

Task: This item must further be updated, when test procedure will be finalized

Working Item	Tasks
7. Background air pollution level	The group need to set background levels to all measured components (regarding item 9)
8. Cabin air filter age	Define artificial filter aging procedure, if good procedure is available only take artificial aged filter
9. PM and gas components to be Measured	Check real NO2 and NO concentration in outside air
11. Test equipment requirements	Prepare specification for test equipment
13. Test Modes	Investigate the potential of laboratory test inclusion to test procedure in the future
14. HVAC Modes	Create a test procedure how to set the HVAC mode depending on vehicle components/functions
15. Test Procedure	To write draft test procedure and discuss in the next meetings
16. Test Protocol	This item must further be updated, when test procedure will be finalized

➤ **27th VIAQ IWG Meeting (TBD)**

- Paris, France, May, 2023
- Two days