Informal document **VIAQ-25-03**

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

Teams meeting, November 9th 2022

Chair: Andrey KOZLOV, Russian Federation

Co-Chair: Inji PARK, The Republic of Korea

Secretary: Andreas WEHRMEIER, BMW

ToR for the Third Stage

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, NO_2, SO_2, O_3 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.

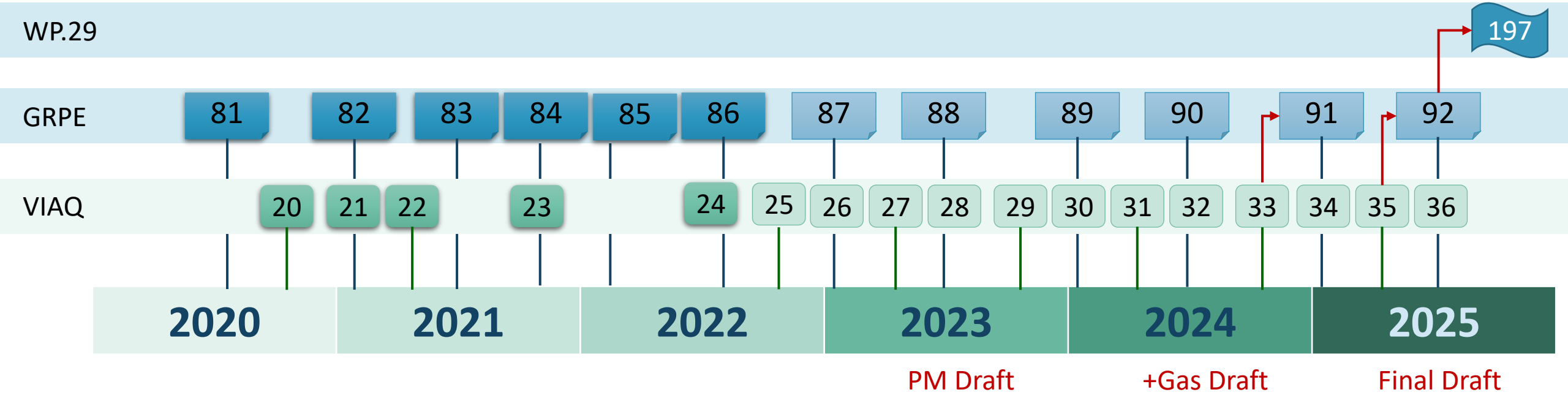
(d) Develop a draft for test procedures in a recommendation.

VIAQ IWG Meetings

➢ 24th VIAQ IWG Meeting

- Webex, 24th May 2022
- Half a day

Timeline



Data collection → Analysis of existing test procedures → Tests by VIAQ IWG members → **Developing of harmonized test procedure**

Stage 3. Phase 1

Stage 3. Phase 2

Information presented last meeting

Company	Presenter Name	Document Title	Document No.
Freudenberg Filtration Technologies	Ulrich Stahl	Influence of the Cabin Air Filter Age on the Pressure Loss and the Indoor Air Quality	VIAQ-24-04
UTAC/ESTACA	Nadir Hafs	The bubble: a dedicated platform for car cabin air pollution measurements	VIAQ-24-05
ACEA/CLEPA	Markus Michael, Andreas Wehrmeier	Statement of ACEA and CLEPA on CEN WS 103 draft document	VIAQ-24-06
NAMI	Andrey Kozlov	The group feedback analysis regarding to test methodology, conditions, equipment	VIAQ-24-07

Discussion of working items

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

Feedback from:

CEN/WS 103*	OICA Members	CLEPA (EU Association of Supplier)	UTAC/ESTACA (Paris saclay)	Korea Automobile Testing & Research Institute	CabinAir Sweden AB
CEN	OICA	CLEPA	UTAC	Korea	CabinAir

The full text feedback tables are in the document VIAQ-23-09

*CEN/WS 103 items from the document "Real drive test method for collecting vehicle interior air quality data" // Doc. CEN/WS 103 N. 34, 2022

Working items

1. Vehicle Category (agreed)

Category 1-1

Working items

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?

Working items

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 test must be primarily conducted on city roads and urban locations
- Road condition: Paved streets
- Windows, doors, sunroof or convertible soft top must be closed at all times. Heated or cooled seats should not be used.
- The vehicle shall have been driven at least 50 km in the seven days prior to the start of the test, to ensure that the vehicle has been in regularly use prior to the test and not left unused for a long period.
- When cleaning the vehicle prior to testing, only a damp cloth should be used. Fragrances and air fresheners should be avoided.
- There should the driver and one passenger present in the vehicle for the duration of the test. All outer clothing of the driver 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

On the base of EU requirements for urban part of RDE*:

- Vehicle speeds lower than or equal to 60 km/h
- The average speed (including stops) of the urban driving part of the trip should be between 15 and 40 km/h
- The start and the end point of a trip shall not differ in their elevation above sea level by more than 100 m
- Altitude lower or equal to 700 meters above sea level
- The minimum distance of operation shall be 16 km

The group decided to add to urban part of the test also urban motorway part

Task: Test conditions for urban and urban motorway driving must be clearly defined

*Requirements regarding: Commission Regulation (EU) 2017/1151

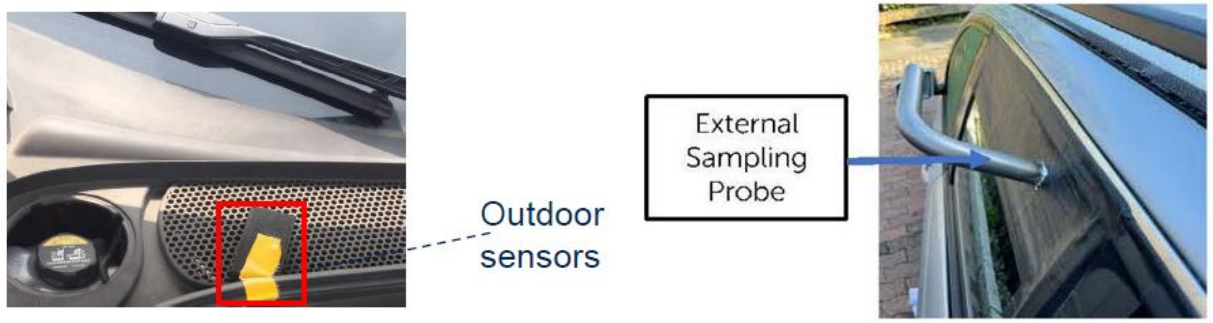
6. Sampling Points/Sampling Lines

1. The interior sampling point should be a head-height between the front headrests

2. The external sampling point should be (alternatively)
   2.1. As close as reasonably possible to the ventilation air intake. Sampling should be isokinetic
   2.2. A forward-facing, horizontally oriented sampling probe securely mounted to minimize vehicle aerodynamic influences, at least 5 cm from the vehicle surface

3. The sampling lines to the analyzer that is designed to minimize particle losses from 10 nm to 2.5 μm. The sampling lines should be constructed of materials to minimize electrostatic particle losses (for example, conductive materials) and sized to minimize inertial and/or diffusional particle losses

Task: External sampling position must be further defined. Sampling lines maximal length and minimal diameter must be defined



7. Background air pollution level

$PM_{2.5}$ concentration: > 15 µg/m^3 (regarding 24-hour mean values of WHO Air quality guideline)

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

8. Cabin air filter age

HVAC filter age:

- New, OEM-approved
- OEM-approved filter used for 3000 km

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

After filter was replaced with a new one the car should then be driven on the road for a minimum of 100 km before starting the test.

Task: Make a round robin test to see influence on filter age and define milage diapason

Working items

9. PM and gas components to be Measured

$PM_{2.5}$
NO
NO_2
CO_2

Optionally:

PN
small fraction PM (0.1-1 µm)
PM_{10}
CO
tVOC
PAH
NH_3
O_3

Tasks:
1. Substantiate inclusion of PN to list of measured components taking into account modern tendences to ambient and interior air quality requirements
2. Investigate the influence of fluctuation of external concentration of CO_2 in ambient air to interior concentration of CO_2 (do we need to measure external CO_2 simultaneously with internal)

Working items

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

Task: Further check realistic values for measured concentration diapason and time resolution

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 $\mu g/m^3$.

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 ppm ±20 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)

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

14. HVAC Modes

HVAC system settings:

- For Automatic mode: temperature 22˚C,
  if possible adjust manually: fan speed 50%/medium
- For manual mode: fan speed 50%/medium,
  temperature 50%/medium, fresh air mode
- Air conditioning switched OFF
- Ventilation flaps fully open and directed straight ahead
- If a vehicle has manufacturer-installed air quality sensors, these should be left in the predominant mode

Task: Investigate the influence of fan speed to measurements results and necessity to set not fan handle position, but air flow value through HVAC (e.g. 200 m^3/h)

15. Test Procedure

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

List of tasks

Working Item	Tasks
5. Test Conditions	Test conditions for urban and urban motorway driving must be clearly defined
6. Sampling Points/Sampling Lines	External sampling position must be further defined. Sampling lines maximal length and minimal diameter must be defined
7. Background air pollution level	The group need to set background levels to all measured components (regarding item 9)
8. Cabin air filter age	Make a round robin test to see influence on filter age and define milage diapason
9. PM and gas components to be Measured	1. Substantiate inclusion of PN to list of measured components taking into account modern tendences to ambient and interior air quality requirements 2. Investigate the influence of fluctuation of external concentration of CO_2 in ambient air to interior concentration of CO_2 (do we need to measure external CO_2 simultaneously with internal)
11. Test equipment requirements	Further check realistic values for measured concentration diapason and time resolution
13. Test Modes	Investigate the necessity and validity of laboratory test inclusion to test procedure
14. HVAC Modes	Investigate the influence of fan speed to measurements results and necessity to set not fan handle position, but air flow value trough HVAC (e.g. 200 m^3/h)
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

Next VIAQ IWG Meetings

- **26th VIAQ IWG Meeting (TBD)**
  - Geneva, Switzerland, January, 2023
  - Half a day
- **27th VIAQ IWG Meeting (TBD)**
  - Paris, France, May, 2023
  - Two days