Informal document GRPE-90-35
90th GRPE, 8 – 12 January 2024
Agenda item 12

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

Geneva, 8 – 12 January, 2024

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.)

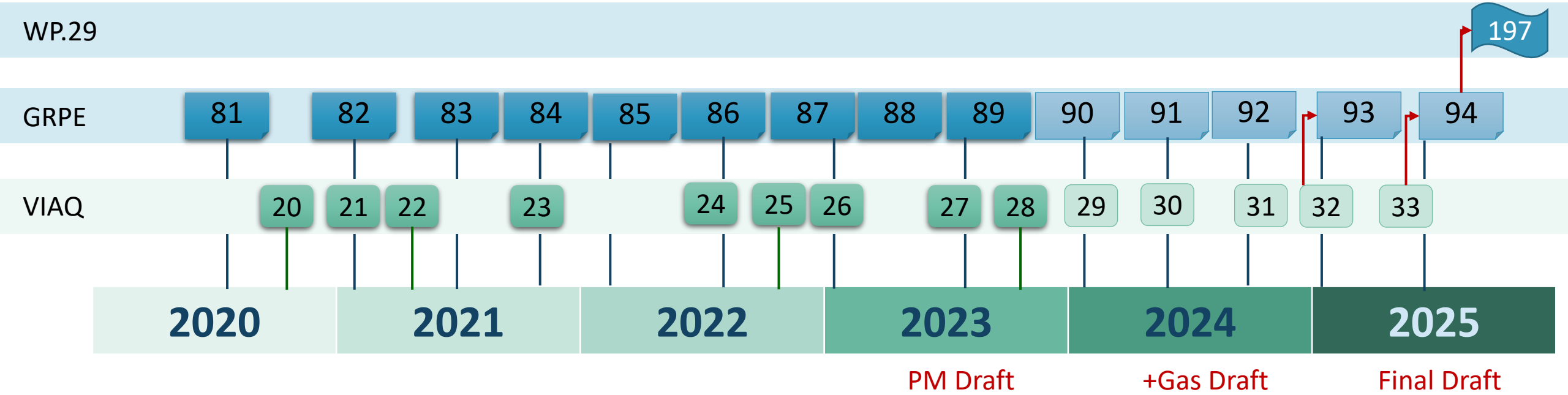
(c) Discuss the potential of air pollutants in the vehicle interior air with toxicologists.

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

VIAQ IWG Meetings since the last GRPE session

- **28th VIAQ IWG Meeting**
  - On-line meeting, 9th November, 2023
  - 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 28th meeting

Company	Presenter Name	Document Title	Document No.
KATRI Green NCAP	SungChul Seo	Analysis of Particles and gaseous pollutants measured in real road driving	VIAQ-28-04
Donny Detoxicology	Albert Donnay	Rethinking Carbon Monoxide inside Motor Vehicles	VIAQ-28-05
ESTACA	Nadir Hafs	Influence of tube length and type on mass concentration of fine particles with and without air flow around the probe	VIAQ-28-06
NAMI	Zinaida Bulycheva	Tendences of the content of nitrogen oxide and dioxide in the car interior air and the environment when operating on city highways during the “summer-autumn” season	VIAQ-28-07
Airlib Inc.	Herve Borrel	Map based real-time car service for reduction of in-cabin pollution	VIAQ-28-08
ARAI	Moqtik Bawase	Meteorological Data For India and for Pune Maharashtra	VIAQ-28-11

Discussion of working items

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. Ambient air concentration level ($PM_{2.5}$)
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

Draft of Part IV of the Mutual Resolution (M.R.3)

Draft document (VIAQ-27-04) and Template for comments (VIAQ-27-05) were sent to all VIAQ IWG members

We received comments from members (VIAQ-27-08):

- OICA
- CLEPA; Europe
- Palas; Germany
- MANN+HUMMEL GMBH; Germany
- Donnay Detoxicology LLC (DD); USA

In total about 80 comments

Draft of Part IV of M.R.3 on VIAQ

Draft document (GRPE-89-26) was presented on 89th session of GRPE

Contents

1. Purpose
2. Scope and application
3. Definitions
4. Abbreviations
5. General provisions
6. Normative references
7. Requirements for the test vehicle
8. Requirements for the test apparatus, instrument and equipment
9. Test procedure, test mode, and test conditions
10. Calculation, presentation of results, precision and uncertainty
11. Performance characteristics
12. Quality assurance/quality control

Annex 7. Test report of emissions entering to the vehicle cabin with outside air pollutants and the interior air cleaning efficiency

This Draft document was updated on the base of 27th meeting decisions (see VIAQ-28-09)

Proposals for Organizing of Interlaboratory Tests

Target: to check draft procedure for consistency, repeatability, reproducibility and accuracy in different laboratories and different conditions

Tasks are to check:

1. **Test procedure clarity and consistency**
2. **Repeatability and reproducibility of test results in different laboratories and different ambient, driving and air pollution level conditions**
3. **Test equipment requirements and applicability**
4. **Reliability of measurements (test methodology allows to achieve reliable results)**

As a result: to revise test procedure according to obtained checking results

Proposals for Organizing of Interlaboratory Tests

I stage

To carry out tests of different cars in different countries in different conditions to check firs of all test methodology clarity and consistency and repeatability of test results INSIDE THE SAME LABORATORY

Time schedule: June – October 2023

II stage

To carry out tests of the same cars in different countries to check firs of all reproducibility of test results obtained IN DIFFERENT LABORATORIES

Time schedule: April – October 2024

Proposals for Organizing of Interlaboratory Tests

Possible participants:

- **KATRI (Korea)**
- **ESTACA/UTAC (France)**
- **NAMI (Russian Federation)**
- **OICA (BMW)**
- **CLEPA**

Reporting:

Test results and comments to improve the test procedure could be reported to the VIAQ informal working group

Tests carried out by VIAQ members

I. **Analysis of Particles and gaseous pollutants measured in real road driving**
   KATRI (Korea)
   VIAQ-28-04

II. **Tendences of the content of nitrogen oxide and dioxide in the car interior air and the environment when operating on city highways during the “summer-autumn” season**
   NAMI (Russian Federation)
   VIAQ-28-07

Overview of Tests carried out by KATRI (VIAQ-28-04)

VIAQ IWG
Vehicle Interior Air Quality
Informal Working Group

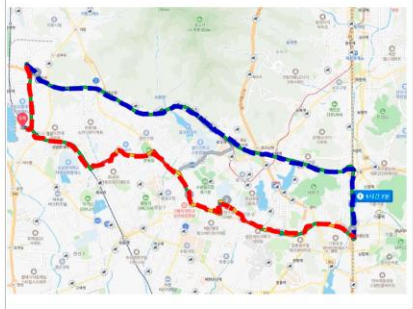
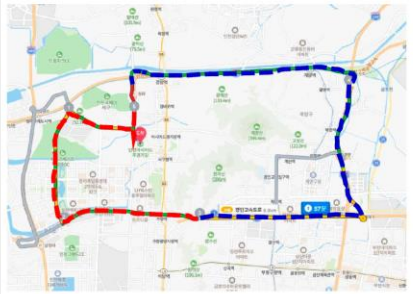
I. Analysis of Particles and gaseous pollutants measured in real road driving

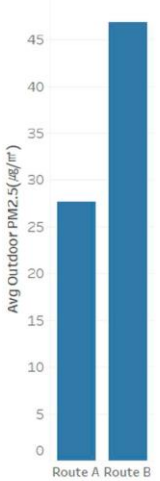
III. Test setup

2 Test Route

Setup of the real-road driving test route

- Selection of urban and highway routes in accordance with Korea's road traffic laws.
- Driving first on the urban route and then on the highway route. Each route is over 16km and the total route is more than 32km.

Item	A	B
Route		
City	Uiwang & Suwon, korea	Incheon, korea
Urban ■	21.7 km	16.5 km
Highway ■	16.3 km	18.5 km
Total	38.0 km	35.0 km



III. Test setup

3 Test Vehicle

Vehicle information used for the test

- Difficulties in securing new vehicles with a range of 3,000 ~ 15,000 km.
- Four types of powertrains(GSL, DSL, HEV, EV) were used for the test

Item	GSL	DSL	HEV * gasoline	EV
Vehicle				
Manufacturer	Hyundai	Hyundai	Hyundai	KIA
Type	SUV	SUV	Sedan	SUV
Model	Santafe 2.5	Santafe 2.2 AWD	Grandeur IG 2.4	EV6 2WD
Model year	2023	2021	2021	2023
Mileage (km)	12,590	69,324	48,338	29,299

Overview of Tests carried out by KATRI (VIAQ-28-04)

I. Analysis of Particles and gaseous pollutants measured in real road driving

III. Test setup

4 Measurement Setup

In-vehicle equipment installation

- Two units each of equipment equipment for simultaneous measurement of indoor and outdoor air($PM_{2.5}$, PN, NOx).
- Two power banks for power supply to the equipment.
- Data measured every second are merged through the program.
- The outdoor air inlet and vent line are secured through the back seat window on the driver's side.

Equipment installation in the vehicle

The outdoor air inlet and vent line

III. Test setup

4 Measurement Setup

Equipment detailed specifications

Item	TSI DUSTTRAK	TSI OPS	Serinus 40
			
Taget substance	Particle	Particle size	NO, NO_2, NOx
Measurement principle	90° light scattering	120° light scattering	Chemiluminescence
Range	0.001 ~ 400 ㎎/㎥	Particle : ~ 3,000 particles/㎤ Mass : 0.001 ~ 275,000 ㎍/㎥	0 ~ 20 ppm
Flow Rate	3.0 L/min	1.0 L/min	0.6 L/min

Overview of Tests carried out by KATRI (VIAQ-28-04)

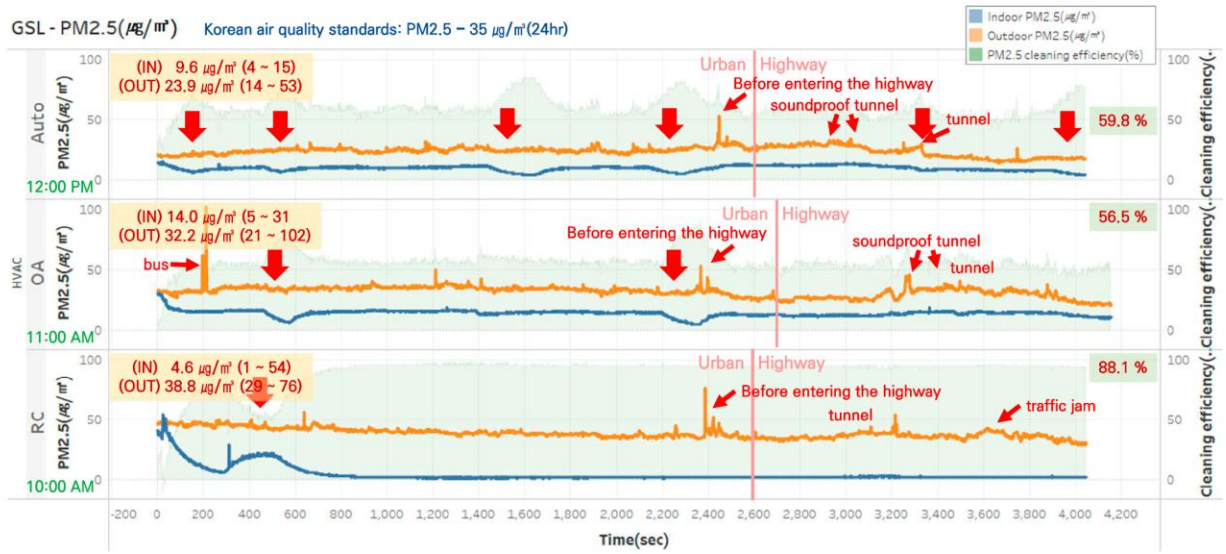
VIAQ IWG
Vehicle Interior Air Quality
Informal Working Group

I. Analysis of Particles and gaseous pollutants measured in real road driving

IV. Test results

1 $PM_{2.5}$(μg/m³) – GSL (Route A)

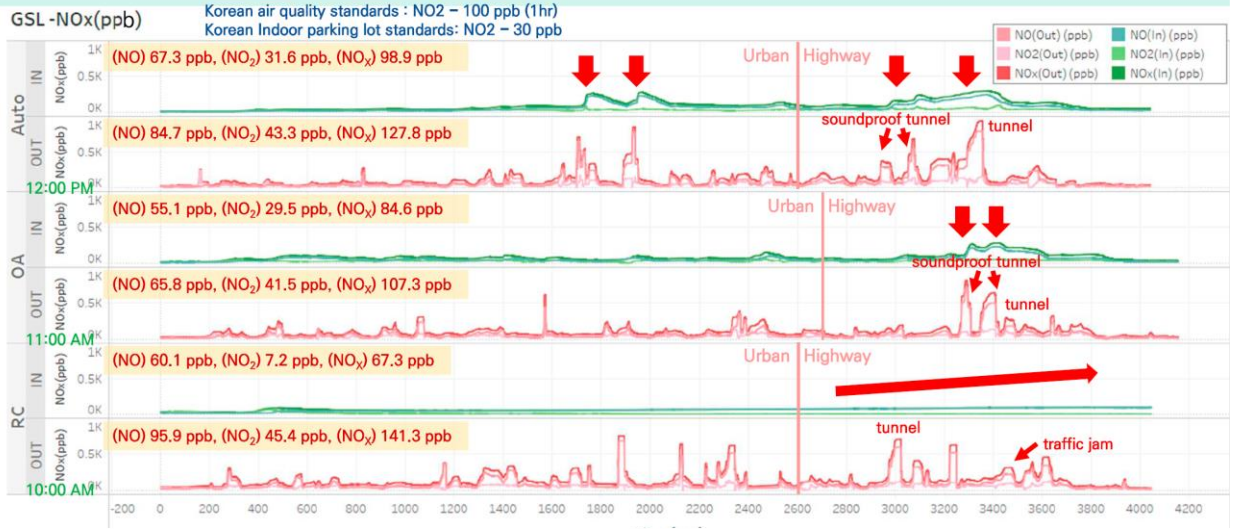
- Auto : Indoor concentration repeatedly increases and decreases depending on HVAC mode changes.
- OA : Highest average concentration. The decrease in some sections is due to checking the blocking function.
- RC : Lowest average concentration. Concentration temporarily increases at the beginning → due to the defogging function



IV. Test results

3 NOx(ppb) - GSL (Route A)

- Regardless of whether indoor or outdoor, NO concentration was higher than NO_2 concentration.
- Indoor NO concentration is lowest in OA and Indoor NO_2 was lowest in RC.
- OA & Auto : The concentration repeatedly increases and decreases.
- RC : The concentration of NO steadily increased.



Overview of Tests carried out by KATRI (VIAQ-28-04)

I. Analysis of Particles and gaseous pollutants measured in real road driving

V. Next steps

1 Conclusion

$PM_{2.5}$

- ☑ Indoor concentration repeatedly increases and decreases depending on HVAC changes in 'Auto' mode.
- ☑ Generally showing low average concentrations in RC.
- ☑ Conversely, in EV vehicles, OA mode showed the lowest average concentration, so additional tests and analysis are needed.

Particle Numbers

- ☑ Small size particles less than 〉 1.0 ㎛ were mainly observed rather than large size particles.
- ☑ Particles 〉 1.0 ㎛ most have been removed.
- ☑ In the DSL test, in which the outdoor $PM_{2.5}$ Conc. was low, the PN cleaning efficiency was high. So, the outdoor $PM_{2.5}$ Conc. on the test day may affect to results.

NO, NO_2, NOx

- ☑ Regardless of whether indoor or outdoor, NO concentration was higher than NO_2 concentration.
- ☑ In DSL and GSL test, NO concentration continued to increase slightly in RC mode.
- ☑ The increase in indoor NOx concentration due to the increase in outdoor NOx concentration is not immediate.

••• Additional tests in various conditions(vehicle models, powertrains, background concentrations, city, etc.) are needed. •••

Overview of Tests carried out by NAMI (VIAQ-28-07)

II. Tendences of the content of nitrogen oxide and dioxide in the car interior air and the environment when operating on city highways during the “summer-autumn” season

Test objects

1. Lada Granta - petrol
2. Nissan Pathfinder - diesel
3. Volkswagen Tiguan - diesel
4. Hyundai Ioniq - electric
5. Sampling line for outer air

Test equipment

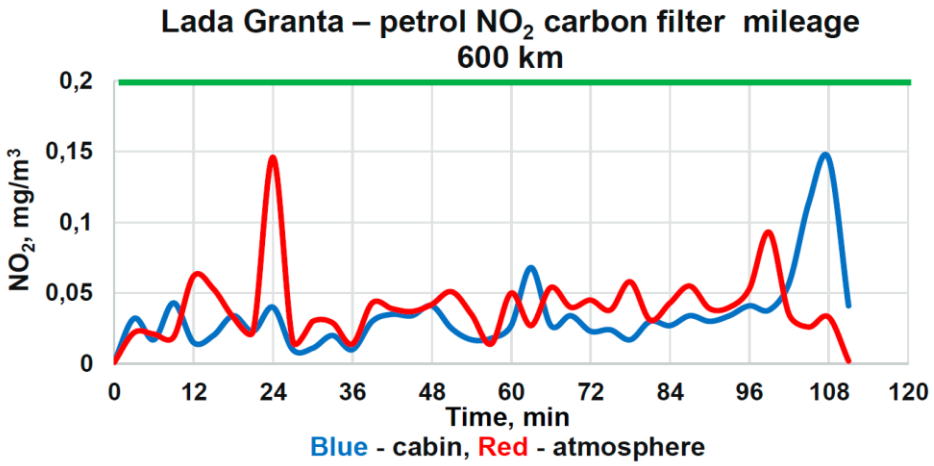
-NAMI-

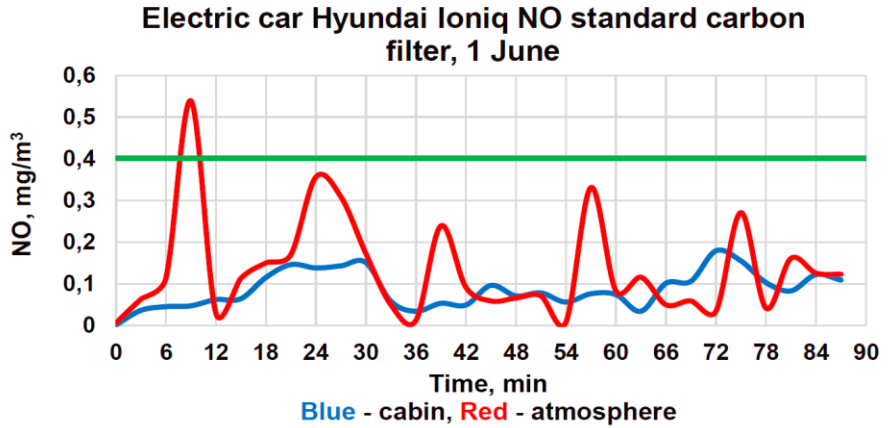
Two gas analyzers R-310 with chemiluminescent detector for measuring NO and NO2
Location in the cabin of tested car

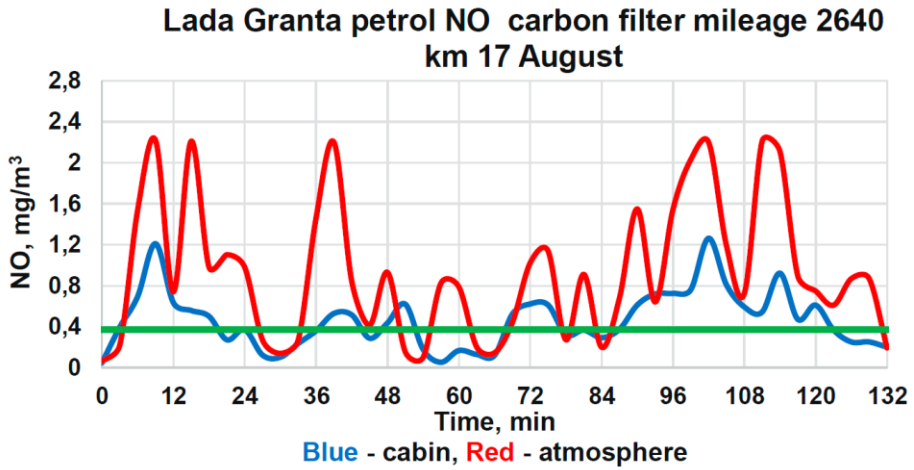
Vbox 3i Racelogic LTD for measuring distance, time, speed

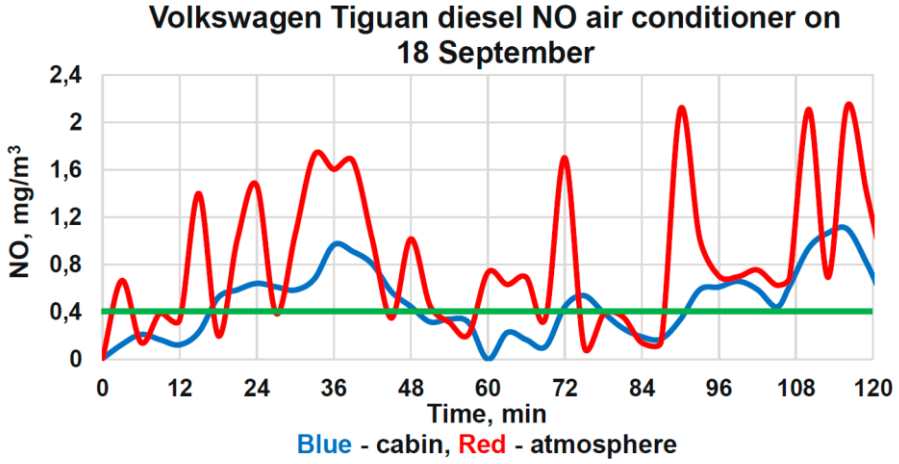
Overview of Tests carried out by NAMI (VIAQ-28-07)

II. Tendences of the content of nitrogen oxide and dioxide in the car interior air and the environment when operating on city highways during the “summer-autumn” season









Overview of Tests carried out by NAMI (VIAQ-28-07)

II. Tendences of the content of nitrogen oxide and dioxide in the car interior air and the environment when operating on city highways during the “summer-autumn” season

Conclusions

-NAMI-

1. Four cars with petrol, electric and diesel were tested according to a developed, approved driving cycle under heavy traffic conditions in season “summer-autumn”.
2. Test results have not depended on the seasons.
3. Significant amounts of NO and NO_2, were detected in cabin air at the level of 0.5…2.0 of limit value.
4. The concentrations of NO and NO_2 measured in the cabin air of the test vehicles in a clean atmosphere were practically equal to zero.
5. Electric car with zero emissions, is not safe for passengers and driver, since the content of pollutants (NO_2 and NO) in the car cabins was the same as at the car cabins with other types of powertrains (petrol, diesel): 0.5…2.0 of limit value and sometimes was higher than in the outside air.
6. It is necessary to include NO together with NO_2 to the list of test substances because the mechanism of their influence on the human body is different and cumulative effect of both oxides is possible inside the cabin:
   - NO - affects the hematopoietic system;
   - NO_2 - affects the respiratory system.

List of tasks

Working Item	Tasks
5. Test Conditions	Finalize urban speed limit (now 60 km/h; proposed 50 km/h)
6. Sampling Points/Sampling Lines	Investigate the influence of sampling line length to PM measurement accuracy
7. Ambient air concentration level	The group need to set background levels to all measured components (regarding item 9) $PM_{2.5}$ background concentration level agreed
8. Cabin air filter age	Define artificial filter aging procedure
9. PM and gas components to be Measured	Nitrogen Oxide inclusion to the scope have to be discussed
11. Test equipment requirements	Finalize specification for test equipment
14. HVAC Modes	Finalize HVAC modes for test procedure (proposed to add mode with recirculation ON)

Next VIAQ IWG Meetings

- **29th VIAQ IWG Meeting (TBD)**
  - On-line, 7th February, 2024
  - Half a day
- **30th VIAQ IWG Meeting (TBD)**
  - Geneva, Switzerland, May, 2024 (during 91th GRPE session 21-24 of May)
  - One day