

Comparison between VIAQ M.R.3 and Korean Green NCAP, and Next steps

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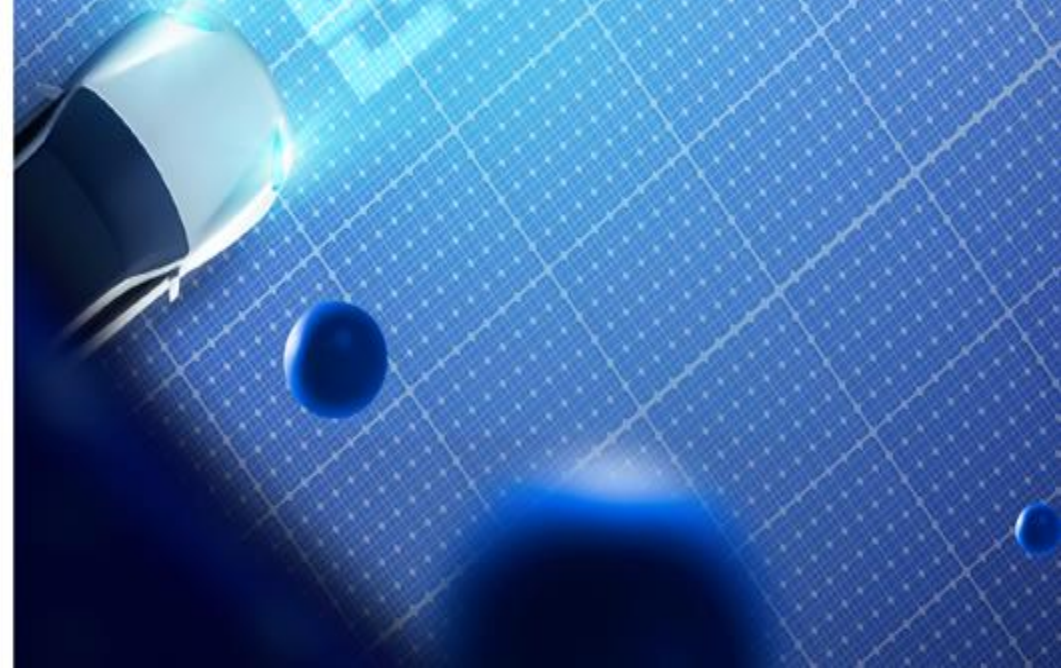


PART

Introduction

- 1 Development of Korean VIAQ Evaluation Technology
- 2 Presentation Overview of VIAQ-28-04

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1

Development of Korean VIAQ Evaluation Technology

Development of Korean VIAQ Evaluation Technology



Funding



Ministry of Land, Infrastructure and Transport

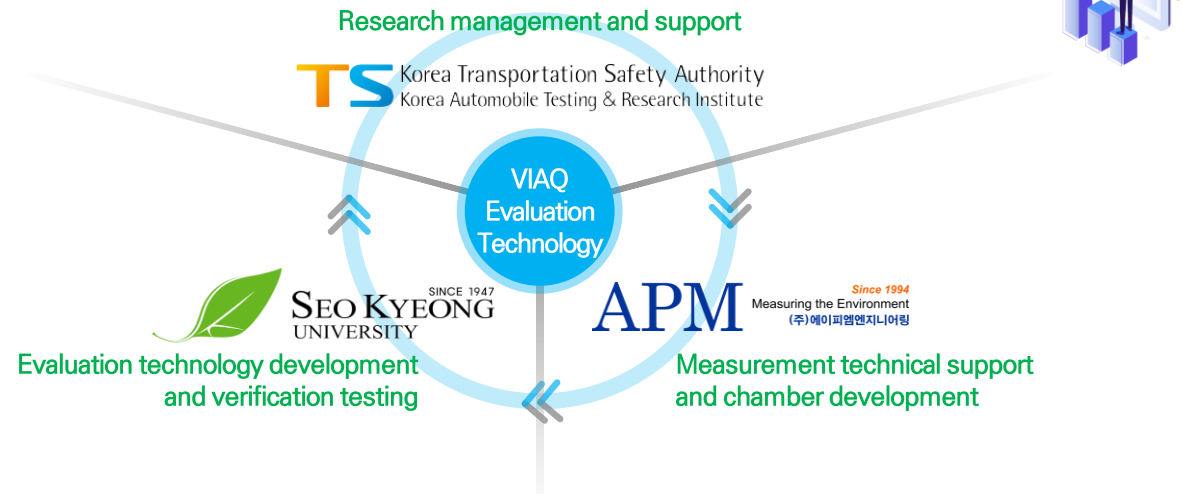


Korea Agency for Infrastructure Technology Advancement

Research Period

2023. 04. 01. ~ 2026. 12. 31. (45months)

Research Overview



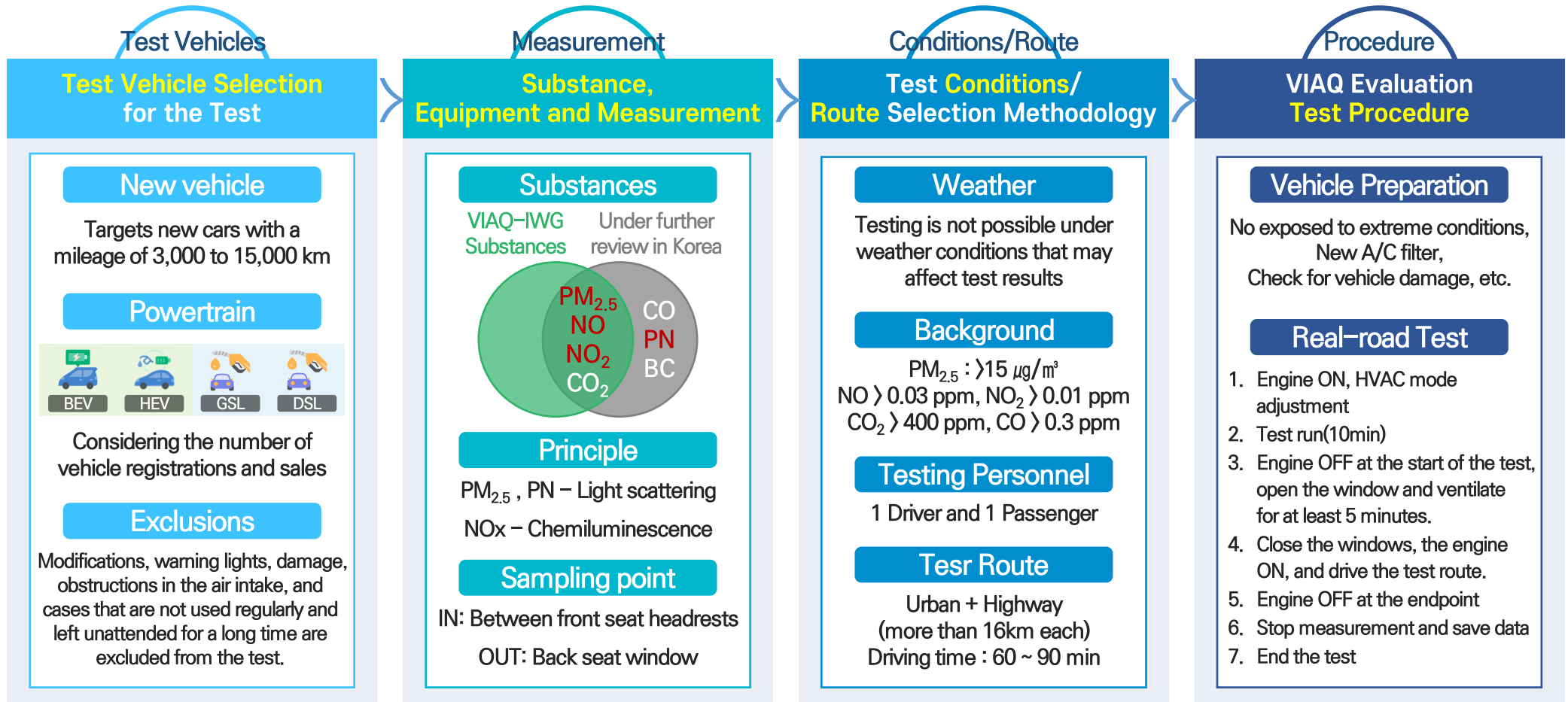
Final Goal

Development of standardized VIAQ evaluation technology and the chambers for laboratory test

2 Presentation Overview of VIAQ-28-04

Real road driving test method for the evaluation of VIAQ

✓ An evaluation concept was established by reflecting on the contents confirmed at the VIAQ-IWG 27th meeting and the actual situation of the Republic of Korea.



2 Presentation Overview of VIAQ-28-04

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 $> 1.0 \mu\text{m}$ were mainly observed rather than large size particles.
- ✓ Particles $> 1.0 \mu\text{m}$ 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, NO₂, NO_x

- ✓ Regardless of whether indoor or outdoor, NO concentration was higher than NO₂ concentration.
- ✓ In DSL and GSL test, NO concentration continued to increase slightly in RC mode.
- ✓ The increase in indoor NO_x concentration due to the increase in outdoor NO_x concentration is not immediate.

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

II

PART

VIAQ M.R.3 and Korean Test Procedure

- 1 Requirements for the test vehicle
- 2 Requirements for the test apparatus,
instrument and equipment
- 3 Test procedure, test mode, and test conditions

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1 Requirements for the test vehicle

- ☑ The Korean research team has **set the criteria for test vehicles as new cars with a mileage range of 3,000 to 15,000 km.**
- ☑ However, obtaining vehicles that satisfy this mileage requirement through short-term leasing has proven to be challenging, leading to the exploration of viable solutions.

Clause	VIAQ M.R.3	Korean Green NCAP	Compliance with M.R.3
7.1	Test vehicles should only be new vehicles from serial production. Used vehicles are not included. The selection of vehicles should be based on a worst case to minimize testing cost. For the purpose of emissions entering into the cabin with outside air equipment for air purification is only allowed in the test cars if it is serial equipment.	A survey of Korea’s domestic vehicle production and sales identified the most sold vehicles from the past three years (2021~2023) as representative models for testing. Four powertrain types (BEV, HEV, GSL, DSL) are selected as the focus for testing. The testing protocol includes using short-term leased vehicles to cover a wide array of vehicle types.	Complied
7.2	The new vehicle should have been run in for between 3,000 and 15,000 km and have age more than one month.	The reliance on short-term leased vehicles has led to challenges in securing vehicles that meet all the required criteria, particularly regarding mileage. Plans are in place to seek assistance from vehicle manufacturers to either secure new cars that meet these criteria or to negotiate a possible relaxation of these requirements.	To be complied
7.3	General inspection of the test vehicle should be performed before testing.	A comprehensive vehicle inspection is performed before testing.	Complied
7.5	The test vehicle should be equipped with OEM-approved cabin air filter artificially aged to 3,000 km. The filter aging procedure – TBD If the model of vehicle of the OEM has no filter in its definition, the vehicle shall be tested with this procedure without an additional filter.	Korean tests utilize new filters.	To be complied

2 Requirements for the test apparatus, instrument, and equipment

- ☑ A method for external air sampling through the windows of the second-row seats behind the driver has been developed.
- ☑ This approach offers advantages over traditional sampling from the HVAC system's air intake, and further testing is planned to demonstrate its effectiveness.

Clause	VIAQ M.R.3	Korean Green NCAP	Compliance with M.R.3
8.1	<p>Test substances. During the tests concentrations of substances listed below should to be measured:</p> <p>(a) Fine particulate matter (PM_{2.5}) inside and outside vehicle cabin;</p> <p>(b) Nitrogen monoxide (NO) inside and outside vehicle cabin;</p> <p>(c) Nitrogen dioxide (NO₂) inside and outside vehicle cabin;</p> <p>(d) Carbon dioxide (CO₂) inside vehicle cabin only.</p>	<p>Measurements are taken for PM_{2.5}, NO, NO₂ and CO₂. Additional measurements for PN conducted.</p> <p>※ The proposal to include CO in the list of test substances faces opposition.</p>	<p>Planning additional measurements for PN</p>
8.2.1 to 8.2.2	<p>The interior sampling point should be a head-height between the front headrests. Sampling tube should be directed to the rear of the vehicle.</p> <p>The external sampling point should be as close as reasonably possible to the ventilation air intake.</p>	<p>In compliance with M.R.3, internal air sampling points are set up at the head height of the driver and front passenger, aimed towards the back seats.</p> <p>Contrary to M.R.3, external sampling points are arranged through the rear seat windows, using pipes and hoses designed for steady air intake and exhaust to facilitate the sampling of external air quality.</p>	<p>Planning further tests on external air sampling point locations</p>
8.2.3	<p>The sampling lines to the analyser should be:</p> <p>(a) As short as possible</p> <p>(b) Line lengths must be identical and not more than 2 m</p> <p>(c) As straight as possible</p> <p>(d) with few bendings as possible</p> <p>(e) with no sharp bendings;</p> <p>(f) made of antistatic materials for particles measurement</p> <p>(g) made of PTFE for gases measurement</p> <p>(h) with diameter compatible to measurement equipment, usually 6 mm or 8 mm</p>	<p>This setup ensures the capability for external air quality sampling through a system of pipes and hoses designed for consistent air intake and exhaust. A bypass pump installed within the vehicle supports the intake and expulsion of external air.</p>	<p>Planning further tests on external air sampling point locations</p>
8.3	<p>For fine particles (PM_{2.5}): optical particle counter</p> <p>For nitrogen oxides (NO, NO₂): non-dispersive ultra-violet chemiluminescent detector, and for NO₂: iterative cavity-enhanced differential optical absorption spectroscopy.</p> <p>For carbon dioxide (CO₂): non-dispersive infra-red detector.</p>	<p>Measurements for PM_{2.5}, NO, and NO₂ are conducted in accordance with M.R.3.</p> <p>For PN : optical particle sizer</p>	<p>Complied</p>
8.4 to 8.8	<p>Test substance concentration measurement limits.</p> <p>Additional measurement equipment, etc.</p>	<p>In accordance with M.R.3.</p> <p>However, the detection limit for PN is to be determined.</p>	<p>Planning to present additional information for PN</p>

3 Test procedure, test mode, and test conditions

Clause	VIAQ M.R.3	Korean Green NCAP	Compliance with M.R.3
9.1	Take out cabin air filter and replace by new artificially aged one. Check vehicle for tightness(sealings, windows, doors, trunk, roof) Before testing substance concentration, the measurement equipment and sampling system should be placed inside the test vehicle and warmed up ahead of the test start time in accordance with the equipment manual.	In accordance with M.R.3.	Complied
9.2	Ambient temperature in the range from +5°C to +25°C Relative humidity from 40% to 80% Atmospheric pressure from 85 to 110 kPa Weather condition should be: no rain, no fog, no snow, no standing water on the road	In accordance with M.R.3. However, planning to propose changing the ambient temperature range from -5°C to +40°C for testing in all seasons in Korea	Planning to present additional information
9.3.1	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).	In accordance with M.R.3.	Complied
9.3.2	Background air pollution level: PM _{2.5} should be not less than 15 µg/m ³ and not more than 500 µg/m ³ . NO, NO ₂ , CO ₂ : TBD	In accordance with M.R.3.	Partially complied, Planning to present additional information on NO, NO ₂ .
9.3.7	The trip shall consist of approximately 55 per cent urban and 45 per cent expressway speed bins. ‘Approximately’ shall mean the interval of ±25 per cent points around the stated percentages. The urban speed bin can never be less than 40 per cent of the total trip distance.	According to M.R.3, two driving routes have been designated, covering both urban and highway scenarios, with total distances of 35 km and 38 km, respectively.	Complied
9.3.8 to 9.3.13	Urban-Expressway speed bins and trip duration	In accordance with M.R.3.	Complied
9.4	Vehicle conditioning	In accordance with M.R.3.	Complied
9.5	HVAC system settings	In accordance with M.R.3.	Complied
9.6	Real driving test procedure	In accordance with M.R.3.	Complied

●●● The intention is to conduct **a comparative presentation for clauses 10 to 12** after Korea has completed extensive and repeated testing. ●●●

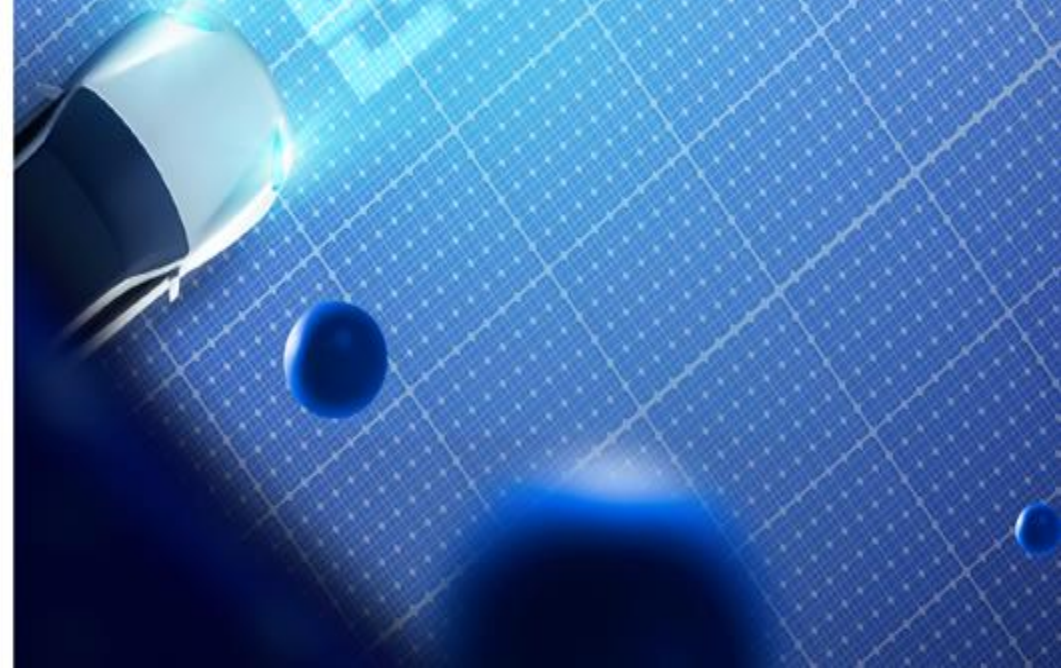


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Next Steps

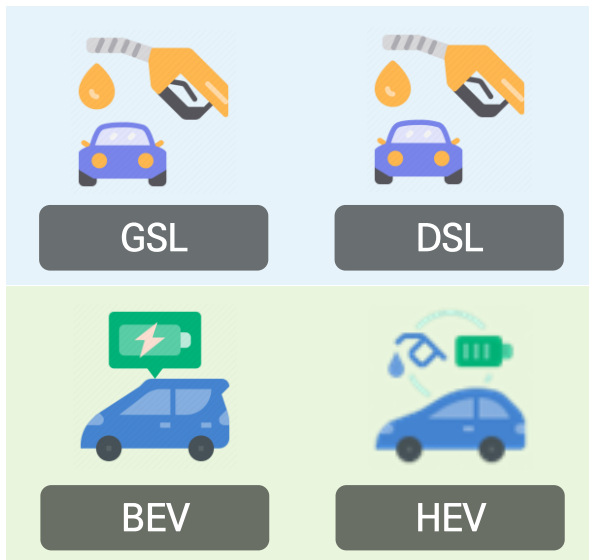
- 1 2024 Testing Plan
- 2 Testing of External Sampling Point Locations
- 3 Proposal for External Air Concentration Conditions

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1 2024 Testing Plan

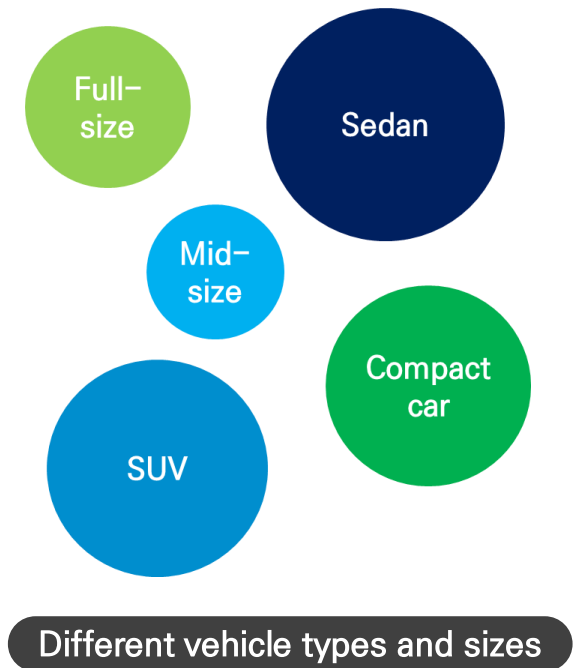
- ✓ The objective is to enhance the variety of test data, covering different vehicle types and sizes, seasonal variations, and repeat tests.
- ✓ The strategy includes building a diverse dataset for four types of powertrains (GSL, DSL, HEV, BEV), targeting a range of vehicle models and sizes.
- ✓ Seasonal tests are planned to reflect the varying levels of atmospheric pollution, with repeat testing aimed at ensuring the data's reliability and neutrality.



4 types of powertrains



Seasonal tests

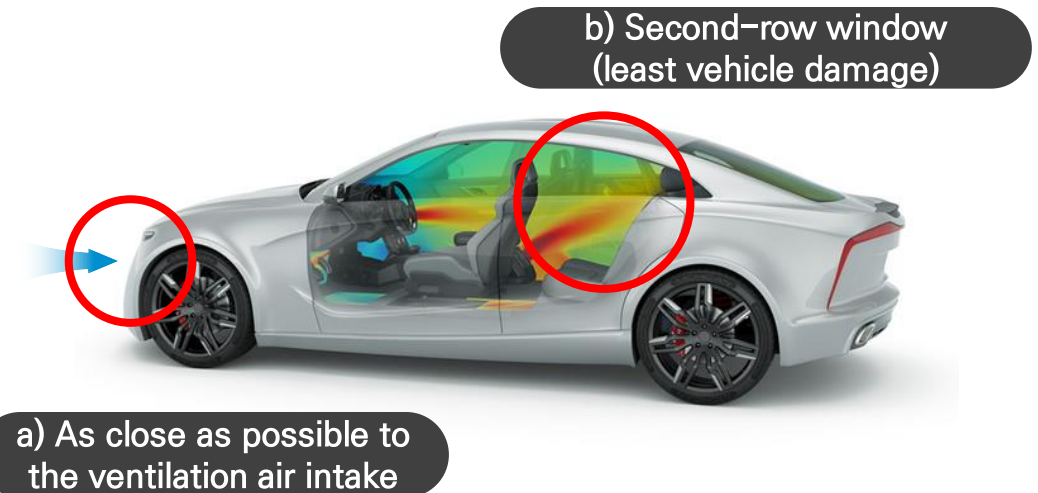


Different vehicle types and sizes

2 Testing of External Sampling Point Locations

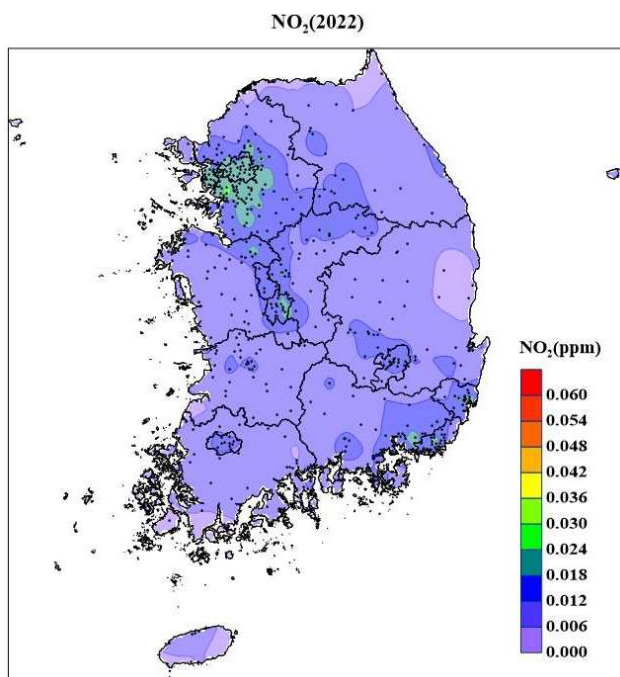
- ✓ The task involves reviewing and selecting suitable locations for external air sampling points.
- ✓ Discussions regarding the Korean research team's views on external air sampling points have occurred in VIAQ meetings and Korea's internal meetings.
- ✓ Plans are in place to assess the differences in data based on the external air sampling point locations, either near the ventilation air intake or at the second-row window, using actual tests or CFD analysis.

The outdoor air inlet and vent line



3 Proposal for External Air Concentration Conditions

- ✓ Efforts are underway to review and propose standards for external air concentration.
- ✓ The draft currently specifies levels for PM_{2.5} in external air concentration.
- ✓ Leveraging real-road test data from the Korean research team and surveying atmospheric pollution levels internationally, there is a plan to propose global standards for NO, NO₂ and CO₂.



Annual average NO₂ Concentration in Korea (2022)

Annual average air pollutant concentration by country (2021)

Year	Country	PM ₁₀ (μg/m ³)	PM _{2.5} (μg/m ³)	NO ₂ (ppm)	SO ₂ (μg/m ³)
2021	Korea(Seoul)	38	20	0.024	0.003
	US(LA)	33	13.8	0.025	0.000
	France(Paris)	19	12	0.012	-
	UK(London)	16	11	0.014	0.000
	China	54	30	0.012	0.003

(Air Korea: <http://airkorea.or.kr>)

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Thank you

