Future Policy for Motor Vehicle Emission Reduction (Fourteenth Report)

Overview

Main Points of Future Policy for Motor Vehicle Emission Reduction (Fourteenth Report)

According to the results of the study by the Expert Committee on Motor Vehicle Emissions under the Air, Noise, and Vibration Committee of the Central Environment Council, the Chairperson of the Central Environment Council submitted the report to the Minister of the Environment on August 20, 2020.

Main points of the report

(1) Measures to reduce PM (particulate matter) emissions from motor vehicles

・**<u>New introduction of the regulation to limit the particle number of PM</u>**
(PN regulation: Regulation of particle number)
*Currently only PM mass regulation

(2) Measures to reduce emissions from special motor[1] vehicles (forklifts, etc.)

・**<u>Add a transient mode test in consideration of the actual status of use</u>**
*Currently the steady-state mode tests with simple test conditions

・**<u>Strengthen regulation values (allowable maximum desired values)</u>**

(3) International harmonization of emission test methods for passenger cars, etc.

・**<u>Harmonization of test methods for vehicles with small output volume</u>**
*The test methods for general passenger cars, etc. are already harmonized.

<New standards (excerpt)>

(i) Measures to reduce PM (introduction of PN regulations)

Vehicle Type	Allowable maximum desired value	Application start time
Diesel heavy-duty vehicles	6.0×10^{11} particles/kWh	By the end of 2023
Gasoline passenger cars (direct injection)	6.0×10^{11} particles/km	By the end of 2024

(ii) Measures to reduce emissions from special motor vehicles

<table>
<tr><th>Vehicle Type</th><th colspan="2">Allowable maximum desired value</th><th>Application start time</th></tr>
<tr><td rowspan="3">(Gasoline/ LPG special motor vehicles) Rated output of 19 kW or more but less than 560 kW</td><td>CO</td><td>15.0 g/kWh</td><td rowspan="3">By the end of 2024</td></tr>
<tr><td>HC</td><td>0.6 g/kWh</td></tr>
<tr><td>NOx</td><td>0.3 g/kWh</td></tr>
</table>

1

1. Measures to Reduce PM (Particulate Matter) Emissions from Motor Vehicles

・Since it is difficult to strengthen the current PM mass regulation due to the measurement accuracy limit, it is appropriate to introduce the regulation of PM particle number (PN), which is correlated with the PM mass and allows for more sensitive measurement, for further PM reduction.
・In view of the fact that the environmental standards for $PM_{2.5}$ are not met in some areas, it is appropriate to make the allowable maximum desired values for PN regulation as strict as technically feasible to apply them as soon as possible. Considering technological developments trends at home and abroad and the period of time required for automobile manufacturers to develop technologies, the details of each item are shown in the table below.

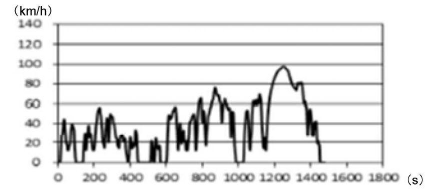
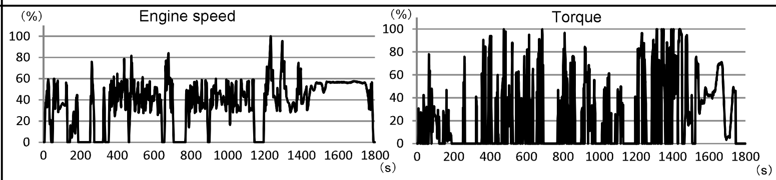
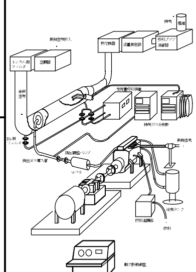
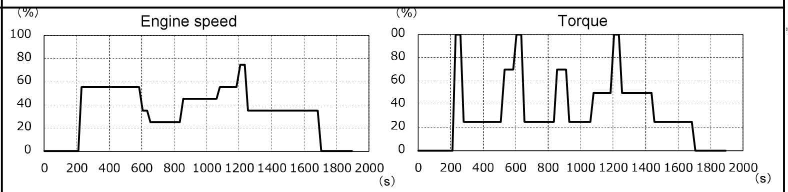
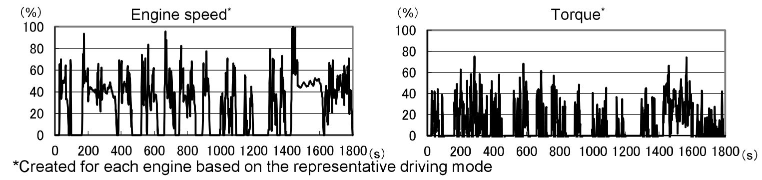
<table>
<tr><th colspan="2">Vehicle type</th><th>Fuel type</th><th>Allowable maximum desired value</th><th>Test method (test mode)</th><th>Application start time</th></tr>
<tr><td colspan="2">Passenger cars</td><td rowspan="4">Gasoline[*1]
Diesel</td><td rowspan="4">6.0×10^{11} particles/km</td><td rowspan="4">WLTC[*2]
(3 phases)</td><td rowspan="7">By the end of 2023
(for diesel-fueled motor vehicles)

By the end of 2024
(for gasoline-fueled motor vehicles)</td></tr>
<tr><td rowspan="6">Trucks/buses</td><td>Light freight vehicles</td></tr>
<tr><td>Light-weight vehicles
(GVW≦1.7 t)</td></tr>
<tr><td>Medium-weight vehicles
(1.7 t＜GVW≦3.5 t)</td></tr>
<tr><td rowspan="3">Heavy-duty vehicles
(3.5 t＜GVW)</td><td rowspan="2">Diesel</td><td>6.0×10^{11} particles/kWh</td><td>WHTC[*3]</td></tr>
<tr><td>8.0×10^{11} particles/kWh</td><td>WHSC[*4]</td></tr>
<tr><td>Gasoline[*1]</td><td>6.0×10^{11} particles/kWh</td><td>JE05[*5]</td></tr>
</table>

*1: Limited to direct injection type
*2 : WLTC (Worldwide Light duty Test Cycle) Worldwide harmonized test cycles for passenger cars, etc.
*3: WHTC (Worldwide Harmonized Transient Cycle) Worldwide harmonized transient test cycle for diesel heavy-duty vehicles
*4: WHSC (Worldwide Harmonized Steady state Cycle) Worldwide harmonized steady-state test cycle for diesel heavy-duty vehicles
*5: Transient test method for gasoline heavy-duty vehicles developed based on the actual running conditions of motor vehicles in Japan

2

(Reference) Test Mode

Vehicle type		Test method (test mode)	Test cycle	
passenger cars		WLTC (3 phases)		 Test by chassis dynamometer
Trucks/buses	Light freight vehicles			
	Light-weight vehicles (GVW≦1.7 t)			
	Medium-weight vehicles (1.7 t ＜GVW≦3.5 t)			
	Heavy-duty vehicles (3.5 t ＜GVW)	WHTC		 Test by engine bench
		WHSC		
		JE05	 *Created for each engine based on the representative driving mode	

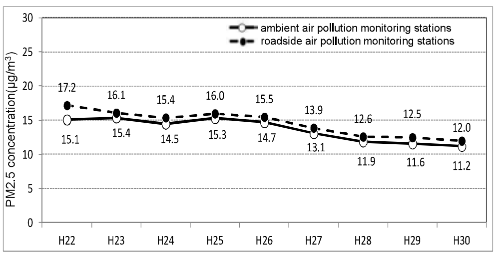
3

(Reference) State of Air Quality, etc. in Relation with Fine Particulate Matter

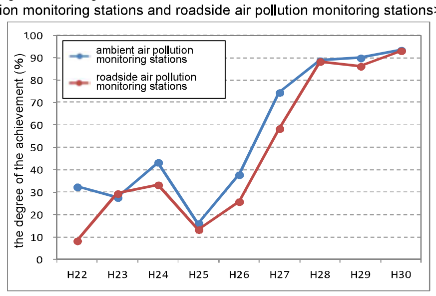
- The annual averages of $PM_{2.5}$ concentrations at all the monitoring stations **have been gradually decreasing since 2013**.
  The annual averages measured by ambient air pollution monitoring stations and roadside air pollution monitoring stations were 11.2 μg/m³ and 12.0 μg/m³ respectively.
- The environmental standard* achievement rate in the fiscal year 2018 was **93.5% at ambient air pollution monitoring stations** and **93.1% at roadside air pollution monitoring stations**.
  The rate was improved at both monitoring stations compared to in the fiscal year 2017.
- The total emissions of $PM_{2.5}$ as primary particles in the fiscal year 2015 was 59,000 tons.
  Of these, emissions from motor vehicles were 10,000 tons.

*Environmental standards concerning fine particulate matter: The annual average should be 15 μg/m³ or less and the daily average should be 35 μg/m³ or less.

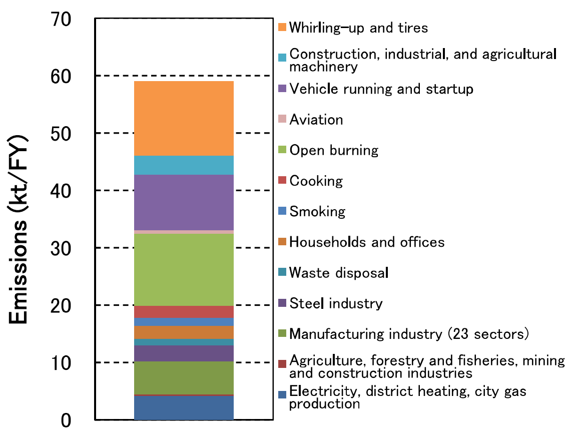
<Changes in annual averages of fine particulate matter>



<Changes in the degree of the achievement of environmental standards at ambient air pollution monitoring stations and roadside air pollution monitoring stations>



<Emissions of $PM_{2.5}$ (primary particles) by emission source (FY 2015)>



Note: Emissions from ships are excluded as they include emissions outside Japanese territorial waters and their boundary is different from the boundaries of other emission sources.

4

(Source: Report on the commissioned work to develop a $PM_{2.5}$ emission inventory and emission source profile in the fiscal year 2018 (March 2019))

(Reference) Example of Control Technology to Reduce PM

Mechanism of PM Emissions from Gasoline Direct Injection Vehicles and Control Technology

[Mechanism of PM Emissions]

- Since fuel is injected directly into the combustion chamber in the case of direct injection, the mixing time for fuel and air is shorter compared to port injection.
  This tends to cause the air-fuel mixture to become uneven, making some sections of the air-fuel mixture too rich, which leads to incomplete combustion and possible increase in PM emissions.
- Occasionally in cold start conditions, fuel adheres onto the piston top surface and produces PM.

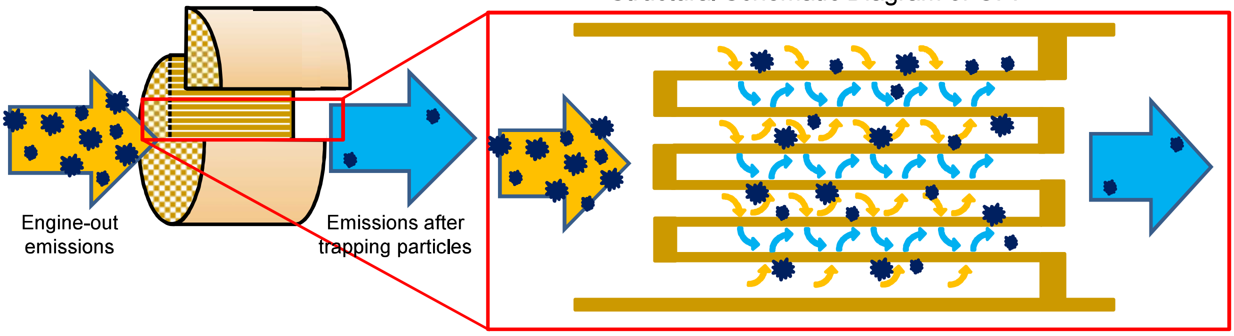
[Control Technology]

Take measures to improve combustion and collect PM with filters as with diesel vehicles.

PM Measures by Using Filters

Gasoline Particulate Filter（GPF）

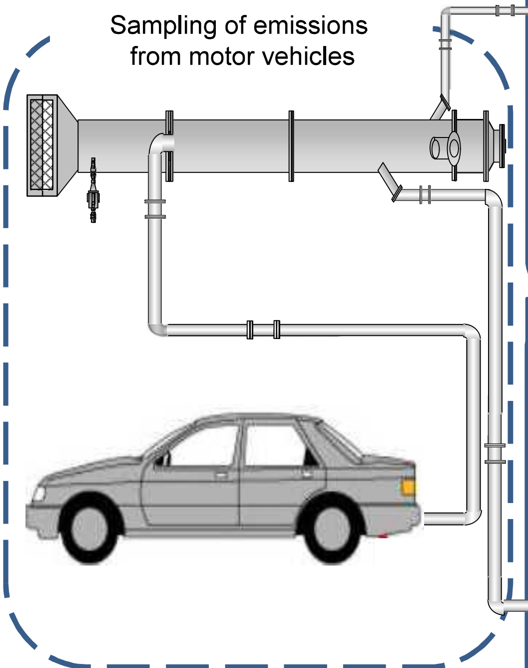
Structural Schematic Diagram of GPF



*The combustion temperature of gasoline vehicles is higher than that of diesel vehicles. Therefore, when PM is accumulated in the filter, natural regeneration occurs by burning PM during fuel cut due to deceleration. However, additional measures are necessary when the temperature required for PM combustion is not achieved or when sufficient amount of oxygen is not secured for combustion, such as during continuous low-speed driving.

5

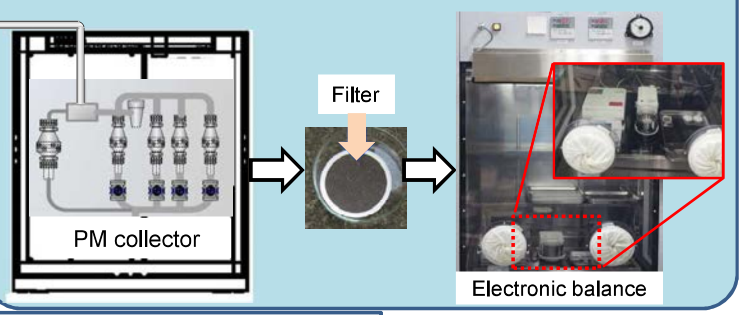
(Reference) PM Measurement Methods



Conventional Method

Mass Method

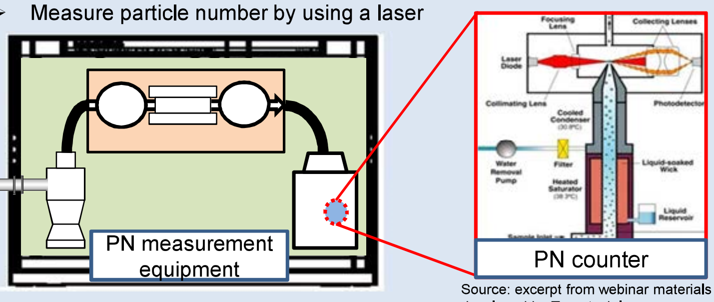
- Measure the mass of the particles trapped in the filter with a balance



Method to be introduced this time

Particle number measurement method (PN measurement method)

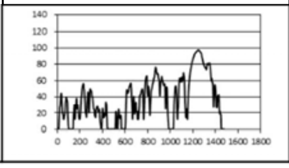
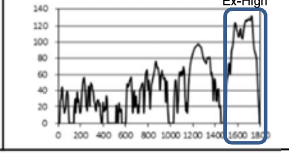
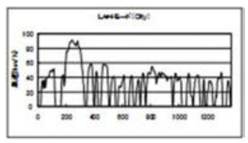
- Measure particle number by using a laser



Source: excerpt from webinar materials developed by Transtech Inc.

(Reference) Trends in PN Regulations Overseas

Comparison of PM regulations in different countries (from passenger cars to medium-weight vehicles)

		Japan (2018 standard)	Europe (2017 standard)	the U.S. (2020 standard)
Gasoline Vehicles				
Emission regulation value	PM (g/km in countries except the U.S., g/mile in the U.S.)	0.005 (direct injection)	0.0045 (direct injection)	0.003 - 0.01* (Adopting 0.001 from 2025 onward)
	PN (particles/km)	—	6.0×10^{11} (direct injection)	—
Diesel Vehicles				
Emission regulation value	PM (g/km in countries except the U.S., g/mile in the U.S.)	0.005	0.0045	0.003 - 0.01* (Adopting 0.001 from 2025 onward)
	PN (particles/km)	—	6.0×10^{11}	—
Test method		**Common to gasoline and diesel vehicles**	**Common to gasoline and diesel vehicles**	**Common to gasoline and diesel vehicles**
		WLTP (3 phases excluding Ex-High phase)	WLTP (4 phases including Ex-High phase)	Unique test method
				

*: Since several regulation values and sales proportion of vehicles in compliance with PM standards for each model year are set, automobile manufacturers are required to sell vehicles that comply with each of the standard values according to this proportion.
(Note) In Europe, PM particle number (PN) regulations were introduced in 2011 for diesel vehicles and in 2014 for gasoline direct injection vehicles.

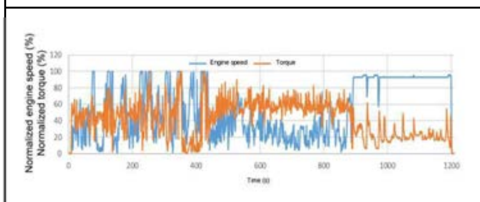
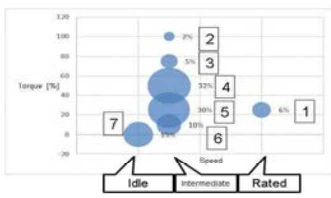
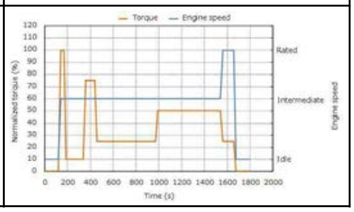
7

2. Measures to Reduce Emissions from Special Motor Vehicles (Forklifts, etc.)

- Although C2 mode (7-mode) which is a steady-state mode is adopted for gasoline /LPG special motor vehicles, it is appropriate to introduce LSI-NRTC which is a transient mode used in Europe and the U.S., in order to properly evaluate emission reduction measures commensurate with the actual use of these vehicles.
- As some engines generated more emissions when tested in 7-mode than in LSI-NRTC, it is appropriate to continue to use 7-mode and to select either 7-mode or 7M-RMC equivalent to 7-mode.
- Considering technological developments trends at home and abroad and the period of time required for automobile manufacturers to develop technologies, it is appropriate to adopt the below allowable maximum desired values and application start time.
- In line with the above, it is appropriate to prohibit the release of blow-by gas into the atmosphere as with other vehicle types.

Vehicle type	Fuel type	Allowable maximum desired value		Test method (test mode)	Application start time
Special motor vehicles (with a rated output of 19 kW or more but less than 560 kW)	Gasoline LPG	CO	15.0 g/kWh	Transient: LSI-NRTC* and Steady-state: 7-mode or 7M-RMC	By the end of 2024
		HC	0.6 g/kWh		
		NOx	0.3 g/kWh		

* LSI-NRTC : Large Spark Ignition engines Non-Road Transient Cycle
Test method for gasoline/LPG special motor vehicles created based on the actual use of these vehicles
The U.S. : adopted for special motor vehicles with a rated output of more than 19 kW but less than 560 kW, Europe: adopted for special motor vehicles with a rated output of more than 19 kW but less than 56 kW

Test method		
LSI-NRTC	7-mode	7M-RMC
		

8

3. International Harmonization of Emission Test Methods for Passenger Cars, etc.

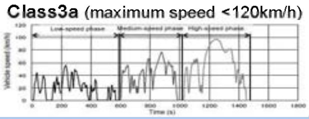
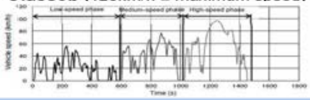
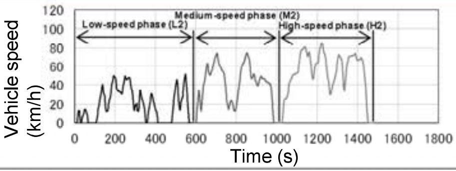
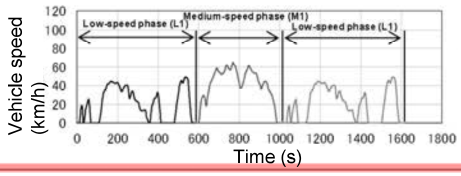
Background to Introduction

- The United Nations is developing the UN Regulations on WLTP (UNR-WLTP) based on the Global Technical Regulations (GTR15).
- In order to harmonize with the UNR-WLTP and enable mutual recognition, it is necessary to introduce Class 1 and Class 2 test cycles.
- There are almost no Class 1 or Class 2 vehicles in Japan (The impact on the domestic environment is limited.)

Results of Study

Introduce Class 1 and Class 2 test cycles to enable mutual recognition and adopt test cycles according to the same PMR (W/kg) and maximum speed (km/h) as in the UNR-WLTP as shown in the table below.

UNR-WLTP Vehicle Classification and Test Cycles

PMR*1	Class		
34<PMR	**Class3a** (maximum speed <120km/h) 	**Class3b** (120km/h ≤ maximum speed) 	Adopted in the 12th Report
22<PMR≦34	**Class2**		The 14th Report [Cycles to be adopted] ・Class2: L2 + M2 + H2 (excluding Ex-high phase*2) ・Class1 : L1＋M1+L1 *2 Can be excluded depending on the needs of member countries. [Allowable maximum desired value] Same values as current values for Class 3a and 3b [Application start time] Applied in conjunction with the adoption of the UNR-WLTP in Japan
PMR≦22	**Class1**		

*1 PMR: Power to Mass Ratio (W/kg)

9

4. Future Issues for Discussion Summarized by the Expert Committee on Motor Vehicle Emissions

Issues identified as priority items in the Fourteenth Report

- **Measures for fine particulate matter, etc.**
  Consideration of the lowering of the detectable lower limit of PN measurement method under consideration at the UN (from 23 to 10 nm in particulate diameter)
- **Measures for brake dust and tire dust**
  Consideration of test methods to measure brake dust and tire dust under consideration at the UN
- **Measures to reduce emissions from special motor vehicles**
  Strengthening of the measures to reduce emissions from special motor vehicles with a rated output of 19kW or more but less than 560kW (including the introduction of PN regulations)

- Measures to reduce fuel evaporative emissions
- Review of regulations on idling emissions
- Introduction of on-road inspections, etc.
- Introduction of low-temperature tests and high-temperature tests
- Measures to reduce emissions from gasoline/LPG heavy-duty vehicles
- Fuel property effects on emissions
- Measures on other non-regulated substances

10

List of Members of the Air, Noise, and Vibration Committee, Central Environment Council

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	Yuko Sakita	Journalist and environmental counselor
	Yumiko Sato	Professor, Faculty of Regional Development Studies, Otemon Gakuin University
	Yukari Takamura	Professor, Institute for Future Initiatives, The University of Tokyo
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	Haruo Ishida	Professor Emeritus, Division of Policy and Planning Sciences, Faculty of Engineering, Information and Systems, University of Tsukuba
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	Iwao Okochi	Vice Chairman, Environment and Energy Committee, The Japan Iron and Steel Federation
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	Hiroyuki Kimura	Chairman, Environment & Public Safety Committee, Petroleum Association of Japan
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Yasuhiko Taniguchi	Head Director, Environmental Management and Technology Center
Mitsuhiro Tsue	Professor, School of Engineering, The University of Tokyo
Hiroshi Nitta	Honorary Fellow, National Institute for Environmental Studies
Tatsuya Morishita	Professor, Department of Prime Mover Engineering, School of Engineering, Tokai University
Takashi Yano	Professor Emeritus, Kumamoto University
Makiko Yamagami	Senior Researcher, Nagoya City Environmental Science Research Institute

* As of August 19, 2020

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Temporary member	Mitsuhiro Tsue	Professor, School of Engineering, The University of Tokyo	○
Expert member	Hajime Ishii	Executive Director, National Agency for Automobile and Land Transport Technology	○
Expert member	Masakazu Iwamoto	Professor Emeritus, Tokyo Institute of Technology Professor Emeritus, Hokkaido University	
Expert member	Akira Obuchi	Visiting Researcher, Engine Combustion and Emission Control Group, Research Institute for Energy Conservation, Department of Energy and Environment, National Institute of Advanced Industrial Science and Technology	
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Expert member	Kazuhiko Sakamoto	Professor Emeritus, Saitama University	
Expert member	Masahiro Shioji	Professor Emeritus, Kyoto University	○
Expert member	Nobuaki Takubo	Director, Department of Traffic Science, National Research Institute of Police Science, National Police Agency	
Expert member	Kenji Tsuchiya	Executive Director, Japan Automobile Research Institute	

Note: The circle (○) indicates members of the working committee that developed the draft report, etc. under the Expert Committee.

*As of June 1, 2020