Future Policy for Motor Vehicle Emission Reduction

(Fourteenth Report)

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Expert Committee on Motor Vehicle Emissions,
Air, Noise, and Vibration Committee
Central Environment Council

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1. Introduction

1.1 Background to motor vehicle emission regulation in Japan and history of discussions at the Central Environment Council

Motor vehicle emission controls, aimed at further improvement of air quality in Japan, began in 1966 with the adoption of a regulation limiting the concentration of carbon monoxide (hereinafter referred to as “CO”) emissions from ordinary-sized motor vehicles[*1] and small-sized motor vehicles[*2] using gasoline for fuel. Since then, the country has successively enhanced controls on motor vehicle emissions, taking into account the state of air pollution, technological developments trends, and trends in overseas regulations. Currently, regulations are implemented by fuel type, such as gasoline, liquefied petroleum gas (hereinafter referred to as “LPG”) , and diesel, and by category of motor vehicle, such as ordinary-sized motor vehicles, small-sized motor vehicles, light motor vehicles[*3], motorcycles*[4], motor-driven cycles*[5], and special motor vehicles.[*6]

With regard to the motor vehicle emission reduction measures taken in recent years, it was in May 1996 that the Director-General of the Environment Agency sent a request to the Central Environment Council to formulate recommendations for Future Policy for Motor Vehicle Emission Reduction (inquired in May 1996). In response, deliberations were held within the Air Environment Committee (present-day Air, Noise, and Vibration Committee) of the Central Environment Council, as well as the Expert Committee on Motor Vehicle Emissions established under the Air Environment Committee.

Among the above categories, for motorcycles and motor-driven cycles (hereinafter referred to as “two-wheeled vehicles”), emission regulations have been implemented since October 1998 on the basis of the Interim Report (compiled by the Central Environment Council in October 1996). In addition, the 2006 Regulation have been implemented since October 2006 based on the Sixth Report (compiled by the Central Environment Council in June 2003), with more stringent regulation values on CO, hydrocarbons (hereinafter referred to as “HC”), and nitrogen oxides (hereinafter referred to as “NOx”). Furthermore, the worldwide harmonized test cycles (Worldwide Motorcycle emissions Test Cycle, hereinafter referred to as “WMTC”),[*7] which were

established at the World Forum for Harmonization of Vehicle Regulations of the United Nations Economic Commission for Europe (hereinafter referred to as “UN-ECE/WP29”) with the participation of Japan, have been introduced on the basis of the Eleventh Report (compiled by the Central Environment Council in August 2012) since October 2012, and the allowable maximum desired values for emissions specified by WMTC have been adopted since October 2016. Emission regulation values will be more stringent in December 2020 based on the Thirteenth Report (compiled by the Central Environment Council in May 2017).

For emissions from gasoline- and LPG-fueled ordinary-sized, small-sized, and light motor vehicles (hereinafter referred to as “gasoline/LPG vehicles”), the 2005 Regulation and the 2007 Regulation, or so-called New Long-Term Regulations, have been implemented since October 2005 based on the Fifth Report (compiled by the Central Environment Council in April 2002). In addition, for gasoline/LPG vehicles equipped with in-cylinder direct injection lean-burn gasoline engines in which occlusion type NOx reduction catalysts are used (hereinafter referred to as “lean-burn direct injection vehicles”), the 2009 Regulation, or so-called “Post New Long-Term Regulations,” have been enforced since October 2009 on the basis of the Eighth Report (compiled by the Central Environment Council in April 2005), which newly introduced emission regulation values on particulate matter (hereinafter referred to as “PM”). Subsequently, anticipating the spread of bio-ethanol fuels, the regulation has been implemented since April 2012 based on the Tenth Report (compiled by the Central Environment Council in July 2010) on the quality of motor vehicle fuels, such as 10-volume percent bio-ethanol-blended gasoline subject to so-called E-10 fuel standards, and on emissions from motor vehicles running on these fuels. Furthermore, the Twelfth Report (compiled by the Central Environment Council in February 2015) recommended the adoption of a global technical regulation (hereinafter referred to as “gtr”) on the Worldwide harmonized Light vehicles Test Procedure (hereinafter referred to as “WLTP”)[*9] established for gasoline/LPG vehicles and diesel vehicles excluding heavy-duty vehicles (hereinafter referred to as “passenger cars, etc.”) by UN-ECE/WP29 with the participation of Japan and the introduction of the Worldwide

Light-duty Test Cycle (hereinafter referred to as “WLTC”),[*10] which was adopted in October 2018. The Thirteenth Report recommended the introduction of PM emission regulations on all vehicles equipped with in-cylinder direct injection gasoline engines including vehicles equipped with in-cylinder direct injection gasoline engines in which combustion takes place at the theoretical air fuel ratio where a three-way catalyst can be used (hereinafter referred to as “stoichiometric direct injection vehicles”), which will be enforced in December 2020.

For emissions from diesel-fueled ordinary-sized and small-sized motor vehicles (hereinafter referred to as “diesel vehicles”), the New Long-Term Regulations have been implemented since October 2005 on the basis of the Fifth Report. The Post New Long-Term Regulations have been enforced since October 2009 on the basis of the Eighth Report, which strengthened the emission regulation values on NOx and PM. Moreover, for diesel vehicles with a gross vehicle weight exceeding 3.5 tons (hereinafter referred to as “diesel heavy-duty vehicles”), the Tenth Report recommended that it was appropriate to strengthen the allowable maximum desired value for NOx in 2016 as well as to introduce the Worldwide Harmonized Transient Cycle (WHTC) [*12] and the Worldwide Harmonized Steady state Cycle

(WHSC),[*13] both of which are part of the Worldwide harmonized Heavy Duty Certification (WHDC)[*11] for diesel heavy-duty vehicles established by UN-ECE/WP29 with the participation of Japan. The test cycles have been adopted since October 2016. Further, the Tenth Report recommended that it was appropriate to introduce a worldwide harmonized standard for measures in conditions other than a testing mode which is representative of the driving in the market above, or so-called “off-cycle” (Off-Cycle Emission; hereinafter referred to as “OCE”),[*14] and to introduce more advanced on-board diagnostic (OBD) systems.[*15] In addition, as measures on emissions from vehicles in use, durability distance targets largely exceeding past levels have been implemented starting with vehicles compliant with the 2002 Regulation (New Short-Term Regulations), based on the Third Report (compiled by the Central Environment Council in December 1998). Furthermore, on the basis of the Ninth Report (compiled by the Central Environment Council in January 2008), the method of measuring PM

emissions was changed from the one based on black smoke contamination measuring equipment to the one using an opacimeter[*16] for vehicles after implementing the Post New Long-Term Regulations, and allowable maximum desired values were set out. Additionally, for diesel vehicles with a gross vehicle weight of 3.5 tons or less, as with their gasoline/LPG counterparts, WLTC, etc. was introduced based on the WLTP-gtr, and has been applied since October 2018.

For diesel-fueled special motor vehicles (hereinafter referred to as “diesel special motor vehicles”),[*17] emission regulation has been implemented since October 2003 based on the Second Report (compiled by the Central Environment Council in November 1997) and the Fourth Report (compiled by the Central Environment Council in November 2000). Further, emission regulation has been tightened since October 2006 on the basis of the Sixth Report. Moreover, the Ninth Report recommended enhancing regulation values in two phases, i.e., firstly from 2011 and then from 2014, and replacing the emission test cycle with Non Road Transient Cycle (hereinafter referred to as “NRTC”)[*18] and so on. Based on the above, the 2011 Regulation which set allowable maximum desired values in accordance with the engine rated output were implemented in phases between October 2011 and October 2013, and subsequently the 2014 Regulation have been implemented since October 2014. As well, based on the Eleventh Report, the method of measuring PM emissions was changed from the one based on black smoke contamination measuring equipment to the one using an opacimeter since the 2014 Regulation, and it was determined that discussions would be held for harmonization with the blow-by gas[*20] measures set out in the worldwide standard for non-road mobile machinery (hereinafter referred to as “NRMM”)[*19] established by UN-ECE/WP29. The Eleventh Report also suggested that either the conventional C1 mode (8-mode) or the new test mode (Ramped Modal Cycle; hereinafter referred to as “RMC”)[*21] could be selected to ensure harmonization with the NRMM standard for the steady-state test cycle.

1.2 Standpoints in discussions of motor vehicle emission reduction measures

Motor vehicles are developed, certified, and produced in each country and region.

Therefore, automobile manufacturers provide different specifications for each destination in order to comply with regulations of various countries including Japan.

If emission test methods are harmonized internationally, the design specifications for motor vehicles can be unified, which will promote standardization of parts, reduce development period and production costs, thus lead to the widespread of new technology for reducing emissions. Needless to say, it will also help research and development of emission reduction technology. Thus, automobile manufacturers have been expecting the international harmonization of emission test requirements around the world.

Furthermore, it is considered that promoting the international harmonization of emission test methods is very useful for Japanese automobile manufacturers to ensure international competitiveness while maintaining the world's highest level of environmental technology. Given the situation, as described in 1.1, the Ninth, Tenth, Eleventh, and Twelfth Reports suggested that emission test methods should be harmonized internationally through the adoption of the worldwide-harmonized test cycles and other measures for diesel special motor vehicles, diesel heavy-duty vehicles, two-wheeled vehicles, passenger cars, etc., and such methods are being introduced one by one.

The Thirteenth Report suggested that in terms of measures for Particulate Matter 2.5 (hereinafter referred to as "$PM_{2.5}$"),[*22] the conventional measurement method under the PM regulations was based on the measurement of the mass of the particles trapped in the filter, thus the regulation values could not be reduced significantly due to inadequate measurement accuracy. Therefore, the introduction of regulations for PM particle number (hereinafter referred to as "PN") should be considered on diesel vehicles and gasoline direct injection vehicles while taking into account the degree of the achievement of environmental standards in Japan and the actual status of PM emissions.

According to the Thirteenth Report by Expert Committee, regarding gasoline- or LPG-fueled special motor vehicles (gasoline/LPG special motor vehicles),[*23] it is considered that the government should consider reviewing the test cycles currently in

place (C2 mode), introducing a transient cycle and taking measures to reduce blow-by gas.

In addition, it is necessary to consider test cycles applied to low-powered passenger cars, etc. to further promote the international harmonization of emission test methods.

The Expert Committee held in-depth discussions mainly on the above subjects and reached the conclusion stated in Section 2 regarding measures for fine particulate matter, and that stated in Section 3 regarding measures to reduce emissions from special motor vehicles, and that stated in Section 4 regarding international harmonization of emission test methods for passenger cars, etc. The Committee also summarized its opinion about the future policy for motor vehicle emission reduction in Section 5.

2. Measures for Fine Particulate Matter, etc.

2.1 State of air quality in relation with fine particulate matter

Regarding measures for particulate matter, Japan established environmental standards in 1973, defining particles with a particle size of 10 μm or less that floated in the air for relatively long periods of time and were inhaled into the respiratory system as suspended particulate matter (SPM), and has been taking comprehensive measures to protect the air environment. Recently, there has been growing concern about the impact of fine particulate matter with a diameter of 2.5 μm or less ($PM_{2.5}$) among the suspended particulate matter, as it can penetrates deep into the respiratory system and various harmful components are absorbed or attached on the surface of the particles. With regard to the health effects of exposure to $PM_{2.5}$, a number of scientific findings in epidemiology and toxicology showed that it, as a whole, had certain influence on human health, including respiratory diseases, circulatory diseases, lung cancer, etc. Therefore, environmental standards have been implemented on $PM_{2.5}$ since September 2009, and a nation-wide infrastructure is currently under development to measure its concentration.

The annual average concentration (hereinafter referred to as “annual average”) has 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/m^3 and 12.0 μg/m^3 in the fiscal year 2018, respectively. Also, the achievement of environmental standards in the fiscal year 2018 was 93.5% (765 among 818 valid monitoring stations) for ambient air pollution monitoring stations, and 93.1% (216 among 232 valid monitoring stations) for roadside air pollution monitoring stations.

The contribution of cross-border air pollution to $PM_{2.5}$ concentrations in Japan is declining, indicating that the contribution of domestic sources is relatively increasing. The contribution ratio of domestic sources to $PM_{2.5}$ concentrations in Japan varies by region, but in general, fixed sources and the automobile sector mainly contribute to $PM_{2.5}$ concentrations. Therefore, it is necessary to take comprehensive measures not only for the automotive sector, but also for fixed sources, etc.

2.2 Background to regulations on particulate matter in Japan

Since most of the particles of PM emitted from motor vehicles are 2.5 μm or smaller in diameter, a steady execution of the existing emission regulations is directly effective for the reduction of $PM_{2.5}$. In Japan, PM regulations on diesel vehicles were introduced for the first time by the Short-Term Regulations in 1993. Moreover, some lean-burn direct injection gasoline vehicles equipped with an occlusion type NOx reduction catalyst were found to emit an equivalent or a greater amount of PM compared to diesel vehicles equipped with a diesel fine particulate removal device (diesel particulate filter; hereinafter referred to as “DPF”).*[24] Therefore, based on the above, it was suggested in the Eighth Report that the allowable maximum desired value for PM emissions should be set only for lean-burn direct injection vehicles equipped with an occlusion type NOx reduction catalyst at the same level as that of diesel vehicles to reduce their PM emissions, and the regulation has been implemented since 2009. Moreover, the PM emissions from stoichiometric direct injection vehicles are greater in volume than the PM emissions from diesel passenger cars*[25] on which the regulation has been implemented already. Therefore, it was suggested in the Thirteenth Report that the allowable maximum desired value for PM emissions should be set for stoichiometric direct injection vehicles at the same level as those of diesel vehicles and lean-burn

direct injection vehicles to reduce their PM emissions, and the regulation will be implemented in December 2020.

2.3 Background to regulations on particulate matter in the United Nations, etc.

In the United Nations, the PM regulations for heavy-duty vehicles (including gasoline vehicles) and for diesel vehicles have been set forth in the UN Regulation No.49 02 Series enforced in 1992 and in the UN Regulation No.83 01 Series enforced in 1992, respectively. In addition, as for the UN Regulation No.83 06 Series enforced in 2010, PM regulations were set forth on gasoline direct injection vehicles (including stoichiometry direct injection vehicles) in the UN regulation at the same level as the PM regulations on diesel vehicles. In line with these moves to revise the UN Regulations, PM regulations similar to the UN Regulation have been implemented in Europe.

On the other hand, as the conventional mass method has a limitation in the level of measurement, an informal working group was established under the Working Party on Pollution and Energy (GRPE) of UN-ECE/WP29 to examine, consider, and evaluate a new measurement method that would complement or replace the conventional mass method, with the participation of Japan, the United States and Europe. As a result, it was concluded that the PN measurement method would be a superior alternative to the mass method for future regulations and was specified in the UN Regulation.

In response, in Europe, the PN regulations have been introduced since 2011 for diesel vehicles (excluding heavy-duty vehicles) and since 2012 for diesel heavy-duty vehicles. In addition, they have been introduced since 2014 for gasoline direct injection passenger cars and since 2015 for gasoline direct injection small-sized commercial vehicles.

On the other hand, the United States has announced a plan to substantially strengthen the PM regulations with the mass method since 2025, while paying close attention to the consideration of a new measurement method in the United Nations, and is currently considering how to improve the accuracy of the mass method.

2.4 Technology for reducing PM emission from vehicles, etc.

PM emissions from diesel vehicles, which used to be distinctively high, were greatly reduced by the introduction of DPFs in the 1990s. DPF is a device that traps PM by making the exhaust gas pass through a porous filter, etc. Whenever a certain amount of PM accumulates in the filter, the filter temperature is raised to oxidize and remove the PM.

In vehicles equipped with conventional fuel injection (port injection) gasoline engines, fuel and air are mixed before entering the combustion chamber. This allows for sufficient mixing time to attain an evenly mixed air-fuel mixture, which results in extremely low PM emissions. On the other hand, in direct injection vehicles where fuel is directly injected into the combustion chamber, fuel collides with the wall of the combustion chamber and the mixing time for air and fuel is shorter compared to port injection gasoline vehicles, which causes some of air-fuel mixture to become uneven This makes 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, injected fuel adheres onto the piston top surface and produces PM through pool fire.[*26] In Europe, to comply with the PN regulations mentioned in Section 2.3, gasoline particulate filters (GPF)[*27] similar to those used in diesel vehicles are put into practical use for gasoline vehicles, in addition to the measures to improve engine combustion. Since gasoline vehicles have higher exhaust gas temperatures than diesel vehicles, they can oxidize and remove PM accumulated in the filter during normal driving. When the exhaust gas temperature is low due to special driving conditions, such as repeated low-speed driving in a low-temperature environment, it is necessary to oxidize and remove PM by raising the filter temperature, just like diesel vehicles. As for gasoline vehicles where combustion takes place at the theoretical mixture ratio, there is basically no oxygen in the exhaust gas, and when fuel cut during deceleration generates a surplus of oxygen, oxygen is provided to the GPF to oxidize the accumulated PM. Therefore, if the amount of oxygen required for oxidation cannot be secured due to continuous low speed driving, etc., it is necessary to take measures to supply the GPF with oxygen necessary for PM oxidation, such as cutting fuel and

introducing secondary air.

2.5 Consideration of PM emission measurement

As the conventional measurement method under the PM regulations is based on the measurement of the mass of the particles trapped in the filter, the regulation values cannot be reduced significantly due to inadequate measurement accuracy. On the other hand, the PN measurement method, which removes the volatile components of PM and counts the number of particles, enables more accurate measurement. As mentioned in Section 2.3, Europe has introduced stringent regulations that are difficult to be evaluated by conventional measurement method, and the PN regulations (which cover particles with a diameter 23 nm or more) have been introduced as the use of particulate filters, etc. with high trapping efficiency allows compliance with the regulations. In addition, other countries except Europe have already adopted PN regulations.

According to the results of research conducted by the Ministry of the Environment up to the fiscal year 2019, there is a certain degree of correlation between PM mass and PN. If the current PN regulation values in Europe are converted to PM mass, the emissions will be about one-tenth of the current PM mass regulation values. Therefore, it is appropriate to introduce PN regulations for diesel vehicles and vehicles equipped with in-cylinder direct injection gasoline engines, since the introduction of PN regulations can significantly reduce PM emissions.

2.6 Allowable maximum desired values for emissions and application start time

With regard to the emission test methods including emission test cycles when introducing PN regulations in accordance with the policy described in Section 2.5, it is appropriate to apply WHDC including WHTC and WHSC to heavy-duty vehicles (JE05 mode[*28] to gasoline heavy-duty vehicles) and WLTP including WLTC to passenger cars, etc.

It is appropriate to make the allowable maximum desired values as strict as feasible, based on the degree of the achievement of the environmental standards for $PM_{2.5}$ and

technological developments trends at home and abroad, as shown in Attached Tables 1 and 2.

With regard to the application start time, it is appropriate to commence the application by the end of 2024 for gasoline vehicles and by the end of 2023 for diesel vehicles, in consideration of the period of time required for automobile manufacturers to develop technologies, etc.

3. Measures to Reduce Emissions from Special Motor Vehicles

3.1 Test cycles for special motor vehicles

Japan regulates emissions from special motor vehicles with an engine output of 19 kW or more but less than 560 kW. Based on the Sixth Report, C2 mode (7-mode), which is a steady-state mode, has been adopted for gasoline/LPG special motor vehicles since 2007. On the other hand, based on the Ninth Report, NRTC, which is a transient test cycle, has been introduced for diesel special motor vehicles since 2011 in addition to C1 mode (8-mode), which is a steady-state mode, and the RMC mode, which is can be selected instead of C1 mode (8-mode), has been introduced since 2014 on the basis of the Eleventh Report.

A three-way catalyst is mainly used to reduce emissions from gasoline/LPG special motor vehicles, and feedback control is implemented to always maintain an appropriate air-to-fuel ratio by measuring the residual oxygen concentration in emissions with an O_2 sensor to achieve a high cleaning rate. As the current test cycle for gasoline/LPG special motor vehicles is a steady-state cycle, it cannot take into consideration time delay in catalyst temperature caused by transient use and the deterioration of the performance of the three-way catalyst due to unsteady nature of emissions flowing into the catalyst. Therefore, it may not properly evaluate emission reduction measures commensurate with the actual use of the vehicles. For this reason, it is also appropriate to introduce a transient cycle as a test cycle for the regulations for gasoline/LPG special motor vehicles in the next term.

3.2 Transient modes, etc. for gasoline/LPG special motor vehicles in the U.S. and

Europe

As for the transient modes for gasoline/LPG special motor vehicles introduced in other countries, the U.S. has introduced the Large Spark Ignition engines Non-Road Transient Cycle (LSI-NRTC).[*37] In Europe, LSI-NRTC and NRTC have been adopted for gasoline/LPG special motor vehicles with a rated output of less than 56 kW and for gasoline/LPG special motor vehicles with a rated output of 56 kW or more, respectively.

In terms of steady-state cycles, either C2 mode (7-mode) or 7M-RMC can be selected in the U.S. In Europe, C2 mode (7-mode) and C1 mode (8-mode) have been introduced for gasoline/LPG special motor vehicles with a rated output of less than 56 kW and for gasoline/LPG special motor vehicles with a rated output of 56 kW or more, respectively. Based on the above, discussions were held on whether or not it was appropriate to introduce these transient modes in Japan as well.

3.3 Consideration of introduction of transient modes, etc. for gasoline/LPG special motor vehicles

Japan developed test cycles based on the actual use of gasoline/LPG special motor vehicles (JTC)[*38] and conducted a comparative test of emissions between JTC and the transient modes introduced in other countries. As a result, NRTC is not considered to be appropriate as a test cycle for gasoline special motor vehicles due to its high output ratio[*39] and higher emissions values compared to LSI-NRTC. In addition, comparison of emissions results from LSI-NRTC and JTC showed that there was a high correlation between the two test cycles in terms of NOx emissions, with LSI-NRTC giving higher emission values (g/kWh) than JTC.

Based on these results, it is expected that air quality will be improved and worldwide harmonization of emission test cycles will be promoted when LSI-NRTC is used as an emission test cycle in Japan. Consequently, it is appropriate to introduce LSI-NRTC shown in Attached Figure 1 as a transient cycle of the test method in the emission regulation for special motor vehicles in the next term.

In terms of steady-state cycles, C1 mode (8-mode) is not considered to be appropriate as a test cycle for gasoline/LPG special motor vehicles due to its high

output ratio and higher emissions values compared to C2 mode (7-mode). It is appropriate to continue to adopt the current C2 mode (7-mode) as some engines generated more CO and HC emissions (g/kWh) in the current C2 mode (7-mode) than in LSI-NRTC.

Furthermore, the emissions measured in 7M-RMC met the current regulation values for all substances and were similar compared to emissions measured in C2 mode (7 mode). In light of the above, from the viewpoint of international harmonization of technical standards, it is appropriate to introduce 7M-RMC shown in Attached Figure 1 in addition to C2 mode (7-mode) in terms of steady-state tests and to allow for selection between C2 mode (7-mode) and 7M-RMC at the time of the emission certification test.

3.4 Allowable maximum desired values for emissions and application start time

Based on the policy described in Section 3.3, the allowable maximum desired values when introducing LSI-NRTC and 7M-RMC are as shown in Attached Table 3, and it is appropriate to adopt them by the end of 2024.

3.5. Measures to reduce blow-by gas

The release of blow-by gas into the atmosphere has been prohibited for ordinary-sized, small-sized, and light motor vehicles, motorcycles, motor-driven cycles, and diesel special motor vehicles, excluding certain types of vehicles. On the other hand, regulations to ban the release of blow-by gas into the atmosphere are not currently introduced for gasoline/LPG special motor vehicles.

A survey of the technologies introduced in recent gasoline special motor vehicles showed that it was technologically possible to prohibit the release of blow-by gas into the atmosphere. Therefore, it is appropriate to prohibit the release into the atmosphere of blow-by gas emitted from gasoline/LPG special motor vehicles with a rated output of 19 kW or more but less than 560 kW.

With regard to the application start time, it is appropriate to adopt it by the end of 2024, in conjunction with the adoption of the allowable maximum desired values for

emissions, as described in the Section 3.4.

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

4.1 Trends in international harmonization of emission tests, etc.

In terms of the test method for passenger cars, etc. in Japan, WLTC developed by UN-ECE/WP29 with the participation of Japan has been adopted since October 2018, as described in Section 1.1. Vehicles to which WLTC is applied are divided into three categories based on the value of the maximum power output of a vehicle divided by the vehicle mass in an unladen state (running order)[*40] (Power to Mass Ratio, hereinafter referred to as “PMR”). They are classified as Class 1, Class 2 and Class 3 in ascending order of PMR, with 22 W/kg and 34 W/kg as the borderlines. Class 3 vehicles are divided into 2 subclasses according to their maximum speed: Class 3a vehicles with a maximum speed of less than 120 km/h and Class 3b vehicles with a maximum speed of 120 km/h or more. Base on the above, different test cycles are applied to each class of vehicle. Among these test cycles, Japan has introduced only test cycles applied to Class 3a and Class 3b vehicles, which were developed based on the actual situation of vehicle running in Japan. In terms of the test cycles applied to Class 1 and Class 2 vehicles, Japan has not introduced the relevant test cycles until now, as there is almost no actual vehicle driving data in japan and test cycles for these vehicles have been developed taking into account the actual vehicle driving data in other countries where most vehicles are low-powered and travel at low speed.

On the other hand, UN-ECE/WP29 is now considering the development of a UN Regulation on WLTP as a new international standard. When the UN Regulation is adopted by Japan and is subject to mutual recognition, it is necessary to introduce not only the test cycles applied to Class 3a and Class 3b vehicles, but also the test cycles applied to Class 1 and Class 2 vehicles. Therefore, from the viewpoint of international harmonization of technical standards, it is necessary to consider whether to introduce test cycles applied to Class 1 and Class 2 vehicles.

4.2 Consideration of introduction of test cycles applied to WLTC Class 1 and Class 2

vehicles

The maximum speed, average speed, and maximum positive acceleration for the test cycles are set higher for Class 2 vehicles than for Class 1 ones, higher for Class 3a and Class 3b vehicles than for Class 2 ones. The average speed is set higher for Class 3b vehicles than for Class 3a ones.

The test cycle applied to Class 1 vehicles consists of a low-speed phase, a medium-speed phase and an additional low-speed phase. The test cycles applied to Class 2, Class 3a and Class 3b vehicles consist of a low-speed phase, a medium-speed phase, a high-speed phase and an extra-high-speed phase. However, the extra-high-speed phase can be excluded at the option of the contracting parties, and in fact, Japan has not adopted it in the test cycles applied to Class 3a and Class 3b vehicles.

A survey was conducted about the presence of Class 1 and Class 2 vehicles in Japan, and found that there were no such vehicles among new vehicles on sale in Japan. Therefore, the impact of the test cycle change on the environment is considered to be very limited.

On the other hand, the introduction of test cycles applied to Class 1 and Class 2 vehicles would allow for the adoption of the UN Regulation, which would reduce the burden on automobile manufacturers and enable more efficient implementation of environmental measures.

Based on the above, the test cycles applied to WLTC Class 1 and Class 2 vehicles as shown in Attached Figure 2 should be introduced in Japan, and test cycles by vehicle type as in the UN Regulation should be applied as well. The test cycle applied to Class 1 vehicles shall consist of a low-speed phase, a medium-speed phase, and an additional low-speed phase, and the test cycle applied to Class 2 vehicles shall consist of a low-speed phase, a medium-speed phase, and a high-speed phase, as with the test cycles applied to Class 3a and Class 3b vehicles.

4.3 Application start time

Based on the policy described in Section 4.2, it is appropriate to introduce a test cycle applied to WLTC Class 1 vehicles and a test cycle applied to WLTC Class 2

vehicles for passenger cars, etc. with a PMR not exceeding 22 W/kg, and for passenger cars, etc. with a PMR exceeding 22 W/kg but not exceeding 34 W/kg, respectively and to adopt the test cycles by vehicle type as in the UN Regulation in conjunction with the adoption of the UN Regulation on WLTP.

5. Future Policy for Motor Vehicle Emission Reduction

It is necessary to continue to take measures to reduce vehicle emissions to improve the air quality in Japan. In doing so, it is expected that the issues described in Section 5.1 and the international harmonization of technical standards in Section 5.2 will be discussed in consideration of balancing low emission technologies and fuel-efficient technologies, in addition to future regulatory effects, technological developments trends, and contribution to emissions, and that the related measures described in Section 5.3 will be further promoted to complement the measures.

5.1. Issues to be considered in the future

5.1.1 Measures for fine particulate matter, etc.

Currently, discussions are being held in UN-ECE/WP29 on whether to reduce the lower limit of detection range of the PN measurement method from the current value of 23 nm to 10 nm in particulate diameter. In addition, the revision of the test method is being discussed based on the results of round-robin tests[*41] to improve the accuracy of the measurement method including a diameter of 23 nm. Japan should continue to participate in and contribute to the activities of the United Nations by sharing its knowledge on the actual status of emissions in Japan, etc. with UN-ECE/WP29, and discuss revisions to the test method, etc. considering Japan's environment and impact of vehicle emissions

5.1.2 Measures for brake dust and tire dust

In addition to the emissions from exhaust pipes, PM emissions from motor vehicles also include fine particles caused by the wear of brakes and tires. As PM in exhaust pipe emissions has been decreasing due to improved combustion, DPFs, and other factors, the relative ratios of brake dust and tire dust to the overall PM emissions are

on the rise. In addition to holding discussions on the strengthening of exhaust pipe emissions, UN-ECE/WP29 is therefore working to establish the test methods for brake dust and tire dust. In particular, test methods for brake dust are studied in detail at various research institutes. The United Nations has agreed to develop test methods for that by 2021. As round-robin tests using the test methods are scheduled to be conducted in the future, Japan should also actively participate in and contribute to the development of international standards by cooperating in the round-robin tests and sharing the findings gained through surveys, etc. in Japan with UN-ECE/WP29.

5.1.3 Measures to reduce fuel evaporative emissions

With regard to fuel evaporative emissions during parking, fuel evaporative gas will be emitted from vehicles due to breakthrough of the adsorption canister[*42] especially when a vehicle is parked for a long time. Since three-day parking tests result in better cost-effectiveness than two-day parking tests with the parking realities in Japan taken into account, the number of days for the parking test will possibly be increased to three days in the future so that vehicles can be parked for longer periods of time without emitting fuel vapors. In recent years, instead of installing a canister with larger capacity, the adoption of an airtight fuel tank is becoming more popular especially for hybrid vehicles, etc. in which purging is difficult. The valve opening pressure for the vent valve is set sufficiently high on vehicles with airtight tanks to prevent vapor emissions from the tanks even in a high temperature environment. While grasping the latest technological developments such as canisters with larger capacity and airtight tanks, the Japanese government should also actively participate in and contribute to the reviewing of international standards by sharing survey findings, etc. with UN-ECE/WP29.

Moreover, regarding the temporary emissions of fuel vapors that occur depending on the internal pressure of the tank when the fuel cap is opened (hereinafter referred to as “puff loss”), vehicles with airtight tanks have a mechanism to suppress these emissions, for which discussions are being held to establish test methods under international standards. On the other hand, discussions are not being held for the puff

loss emissions from vehicles equipped with conventional tanks. It is believed that even the puff loss from vehicles with conventional tanks can be reduced by opening the valve between the tank and the canister prior to opening the fuel cap. Therefore, while taking into account the amount of puff loss emissions from vehicles with conventional tanks and the costs required for implementing measures, discussions should be held on the establishment of standards for these emissions in addition to the strengthening of the number of days for the parking test as described above, with the perspective of international harmonization of technical standards.

5.1.4 Review of regulations on idling emissions

With regard to regulations on idling emissions, the abolition of the HC regulation and the strengthening of the regulation on four-wheeled vehicles were put on agenda for discussion in the Thirteenth Report. With regard to the former issue, field surveys of HC and CO emissions in Japan showed no correlation between CO and HC emissions, and therefore a conclusion of abolishing the HC regulation was not reached.

On the other hand, the strengthening of regulations on four-wheeled vehicles should be discussed, based on the current status of reviewing the reclassification of UN regulations on emissions, while accurately assessing the movements in the future and reevaluating the actual emissions and the development of measuring instruments and their spread.

5.1.5 Introduction of on-road inspections, etc.

In September 2015, the diesel passenger cars and other vehicles manufactured by Volkswagen (VW) were found to be using illegal software. Specifically, the diesel vehicles sold by VW in Europe, the United States, and other regions had illegal software installed which activated the emission reduction device only when driven in certain running modes on the test bench for new-vehicle inspection. On the other hand, the software stopped or weakened the emission reduction device in on-road conditions.

In response to this scandal, from October 2015, discussions were held on the reviewing, etc. of the emission test methods for diesel passenger cars and other

vehicles in the “Investigative Committee for Reviewing the Inspection Methods for Diesel Passenger Cars in Response to Illegal Emission Control” (a committee jointly established by the Ministry of Land, Infrastructure, Transport and Tourism and the Ministry of the Environment). The final summary published on April 20, 2017 recommended that it was appropriate to introduce the guidelines for safety control and on-road inspections in 2022. In response to this, the relevant laws and regulations were amended in March 2018 and will be enforced in October 2022.

Based on the introduction of PN regulations as described in Section 2, the necessity of introducing PN regulations for on-road inspections should be discussed in the future, including field surveys, etc., from the viewpoint of international harmonization of technical standards.

Moreover, it is appropriate to review the calculation methods, including the emission intensity used in calculating the overall emissions, by making corrections based on the postulation of real-life driving, etc.

5.1.6 Introduction of low-temperature tests and high-temperature tests

In UN-ECE/WP29, discussions are currently being held on whether to include low-temperature tests and high-temperature tests in WLTP, in addition to the conventional emission tests under the normal temperature. The test methods for low-temperature tests will be established by 2021. As the low-temperature tests and high-temperature tests are effective measures to reduce emissions in the actual use conditions of the vehicles in combination with the on-the-road inspections and the guidelines for safety control described in Section 5.1.5, the Japanese government should also actively participate in and contribute to the reviewing of international standards and discuss the necessity of introducing those tests by conducting field surveys, etc.

5.1.7 Measures to reduce emissions from gasoline/LPG heavy-duty vehicles

At present, regarding gasoline- or LPG-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 3.5 tons(excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less)

(hereinafter referred to as “current gasoline/LPG heavy-duty vehicles”), the allowable maximum emission values specified by the Post New Long-Term Regulations (2009 Regulation) are applied to the emission values measured in the JE05 mode.

After the introduction of WLTC, as with the current gasoline/LPG heavy-duty vehicles, JE05 mode rather than the current JC08 mode will be used for the emission measurement of gasoline/LPG passenger cars (limited to those with a riding capacity of 10 people and a gross vehicle weight exceeding 3.5 tons). The allowable maximum emission values specified by the Post New Long-Term Regulations (2009 Regulation) will be applied to the emission values measured in the JE05 mode.

Regarding both of the above vehicle types (gasoline- or LPG-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 9 people or less), hereinafter collectively referred to as “gasoline/LPG heavy-duty vehicles”), it is necessary to consider introducing off-cycle emission measures and OBD II as well as strengthening the emission regulations, including the introduction of cold start tests as needed. For this consideration, the state of air pollution by gasoline/LPG heavy-duty vehicles, contribution of their emissions, and trends in technological developments should be taken care of.

5.1.8 Measures to reduce emissions from special motor vehicles

As for special motor vehicles, the regulations applied to them differ according to the rated output of an engine, so it is necessary to consider measures that will be necessary in the future according to each category.

(1) Special motor vehicles with a rated output of 19 kW or more but less than 560 kW

For special motor vehicles with a rated output of 19 kW or more but less than 560 kW, it is necessary to consider strengthening the emission regulation for them as necessary, taking into account the state of air pollution, contribution of their emissions, technological developments trends, and international trends.

Particularly with regard to measures to reduce fine particulate matter, it is necessary to consider the required measures, including the PN regulations introduced for vehicles

other than special motor vehicles, as the contribution of special motor vehicles to PM emissions is expected to increase.

(2) Special motor vehicles with a rated output of less than 19 kW and 560 kW or more

Special motor vehicles with a rated output of less than 19 kW and 560 kW or more are currently not subject to any emission regulation. It is recommended that the government consider the introduction of emission regulation for them as necessary, taking into account the state of air pollution, contribution of their emissions, technological developments trends, international trends, the effects of the designation system for construction machinery by emission type implemented by the MLIT, study on emissions from general-purpose diesel engines below 19 kW voluntarily conducted by the Japan Land Engine Manufacturers Association, and so on.

5.1.9 Effect of fuel properties on emissions

In Japan, the oil demand peaked in 1999 and has been declining since then, due to the declining population and various energy-saving efforts. In addition, Sophisticated Methods of Energy Supply Structures has been enforced to meet the decreasing demand for heavy fuel oil A, B and C[*43] and to use them for motor fuel. Given this situation, the residue oil generated in the refining process at refineries (such as heavy oil left over from the crude oil refining process) has been decomposed and mixed with gasoline or diesel for effective use. It has been pointed out that motor fuel mixed with decomposed residue oil has an effect on fine particulate matter and PN in emissions, by the impact assessment of the use of decomposed motor fuel on vehicles, etc. (JATOP III report: May 9, 2018) conducted by the Japan Petroleum Energy Center.

Biofuels effective in fighting global warming include, in addition to fuel mixed with up to 10 volume% of bioethanol for gasoline vehicles, biodiesel fuels used by diesel vehicles (diesel with content of 5.0 mass% or less of fatty acid methyl ester synthesized from fats and oils of biomass). The use of these fuels must meet the quality stipulated by the Act on the Quality Control of Gasoline and Other Fuels (Act No. 88 of 1976). Diesel vehicles, in particular, are made for diesel as fuel, and given emission reduction devices are more sophisticated than before, with the tightening of emission regulations.

Therefore, the use of bio-mixed diesel with content of more than 5.0 mass% of fatty acid methyl ester may change the combustion characteristics of the engine, affect the purification capacity of the emission reduction system and increase the amount of emissions. In light of the above, the Ministry of Land, Infrastructure, Transport and Tourism has established guidelines on points to note, etc. for fuels, modifications, inspection and maintenance in order to ensure the safety of diesel vehicles in using such fuels in test and research, and has provided advice and warnings. Consequently, when using such fuels, it is necessary to investigate the effect of fuel properties on emissions and to consider measures based on the results.

5.1.10 Measures on other non-regulated substances

Among volatile organic compounds (hereinafter referred to as “VOC”) discharged from motor vehicles, those subject to regulation are HC and hydrocarbons excluding methane (CH_4), (NMHC), but their effects on air quality vary depending on the hydrocarbon component. It is therefore desirable, regarding non-regulated hazardous air pollutants[*44] discharged from motor vehicles, to develop infrastructure to assess the amount of emissions from motor vehicles by developing measuring methods and improving measuring accuracy and to take necessary measures based on information collected. In doing so, it is also necessary to assess the effects of engine technologies, after-treatment technologies, and qualities of fuel and lube oil on the amount of toxic air pollutants emitted from motor vehicles.

In discussing the policy for motor vehicle emission reduction, care should be taken so as to prevent the increase of not only carbon dioxide (CO_2), which is a greenhouse gas, but also such other compounds as methane (CH_4) and nitrous oxide (also known as dinitrogen monoxide, N_2O).

5.2 Leading the international harmonization of technical standards for motor vehicle emission reduction

In promoting motor vehicle emission reduction, it is essential to take into account the air environment in Japan and take measures adapted to real-world running conditions

of motor vehicles in Japan. On the other hand, as the globalization of the automobile industry progresses, international harmonization of motor vehicle emission reduction measures offers an effective means to reduce cost and time for development of emission reduction technologies and to promote their wide implementation.

Therefore, in studying each of the issues to be considered described in Section 5.1, it is desirable for the public and private sectors to continue to work together to promote the international harmonization of technical standards so that Japan can take the lead in it, bearing in mind the globalization of the automobile industry and maintaining the world's most stringent level of emission regulation.

5.3 Measures, etc. related to policy for motor vehicle emission reduction

5.3.1 Promoting a comprehensive policy for motor vehicle emission reduction

(1) Measures taken under the Act on Special Measures for Total Emission Reduction of NOx and PM

Regarding the progress and future plans of measures established in accordance with the Basic Policy for Areawide Total Pollutant Load Control under the Act Concerning Special Measures for Total Emission Reduction of Nitrogen Oxides and Particulate Matter from Automobiles in Specified Areas (Act No. 70 of 1992, hereinafter referred to as “Automobile NOx/PM Act”), the Comprehensive Policy on Motor Vehicle Emissions Subcommittee summarized an interim review in the fiscal year 2016. This review suggested the need to further promote effective actions, such as individual measures that are highly effective in reducing emissions, promotion of next-generation motor vehicles, action plans for eco-driving, facilitation of traffic flow, and suppression of traffic demand. The review also suggested the need to narrow down the regions, out of the specified areas designated by the Act, that require implementation of measures to achieve the environmental targets by the fiscal year 2020 through the use of the numerical calculation technique, etc., and to consider and implement necessary measures in these regions. It is essential that a comprehensive policy for motor vehicle emission reduction will be promoted by taking effective measures with the cooperation of related governmental bodies based on the review

results and close observation of the situation.

(2) Encouraging regular check and maintenance and vehicle inspection

In the future, it is important to keep making vehicles in use maintain good performance of their emission reduction devices, by encouraging users to practice regular check and maintenance and have periodical inspection (safety inspection) as prescribed in the Road Transport Vehicle Act (Act No. 185 of 1951) and by checking the function of emission reduction devices and inspecting fuel quality in guidance and control on the streets (street inspection).

Inspections using the OBD system, including inspections of exhaust emission control devices, are scheduled to start in 2024 for new models manufactured after 2021. Since the inspections are expected to contribute to maintaining good performance of the emission reduction devices, it is important to continue to specifically discuss the implementation of the inspections.

Furthermore, it is desirable to urgently consider the introduction of random sampling surveillance of vehicles in use, including the necessity of such surveillance, based on international trends in Europe, the United States and other countries.

(3) Promoting eco-friendly driving practice

Eco-friendly driving practice, such as avoiding sudden acceleration/deceleration and idling stop (driving practice to reduce environmental burden) is effective not only for CO_2 reduction but for emission reduction as well. Moreover, since vehicles with the idling stop function or other eco-driving support functions have been put to practical use, it is desirable to continue the promotion of action plans and measures to spread eco-driving and related technologies in cooperation with relevant ministries and agencies and concerned bodies that comprise the Eco-Drive Promotion Liaison Committee, etc.

5.3.2 Promotion of eco-friendly motor vehicles

To further improve air quality and fight global warming, it is important to promote eco-

friendly motor vehicles, such as next-generation motor vehicles and low-emission, fuel-efficient vehicles. It is therefore desirable to promote measures to support eco-friendly motor vehicles on an ongoing basis, such as tax benefits as well as subsidies at the time of purchase.

In addition, reducing vehicle emissions is generally in conflict with improving fuel efficiency, for example, like the relationship between NOx reduction performance of diesel vehicles and fuel consumption performance. Accordingly, it is hoped that automobile manufacturers will be promoted to develop these technologies at the same time.

It goes without saying that Life Cycle Assessment (LCA) will have to be taken into account in the future when considering environmental performance.

5.3.3 Assessing the state of air quality and forecasting the effects of improvement

With the enhancement of motor vehicles emission regulations and comprehensive policy for motor vehicle emission reduction, it becomes more and more important to accurately assess the effect of past measures and forecast the effects of measures to be taken in the future for the formulation and implementation of new measures. In doing so, it is necessary to sort out and update the emission inventory of $PM_{2.5}$, NOx, VOC, etc. and clarify the mechanism of generation of $PM_{2.5}$, photochemical oxidants, and other pollutants. It is therefore desirable to create a system to assess the effects of various measures on improved air quality along the road, etc. at the sources of emissions. Moreover, the reproducibility of long-term trends in numerical simulation models for air quality has been confirmed, and improvements are being made to the stage of assessing the effects of measures to reduce NOx, VOC and others substances on the reduction of photochemical oxidant concentrations, etc. and considering additional measures. Their further utilization and improvement are desired.

Also, in order to formulate effective environmental measures, it is desirable to consider the possibility of utilizing vehicle information including location information through information and communications technology.

5.3.4 Continuous assessment of the costs and effects of measures

When introducing a new emission reduction measure for motor vehicles, it is important to continuously assess the actual cost required for the measure as well as the effects on emission reduction and air quality improvement so that the data can be utilized in discussing future measures.

5.3.5 Research system improvement and securing of human resources for motor vehicle emission reduction

In discussing the policy for motor vehicle emission reduction such as the assessment of trends in emission reduction technologies, international trends in emission regulations, establishment of measuring methods for emissions, and examining the amount of time necessary for technological development, it is essential to utilize expert knowledge, research results, and other data obtained from neutral research institutions. Especially at these research institutions, it is desirable to develop sufficient testing systems and secure human resources, including testing facilities that are appropriate for the importance of measures for motor vehicles, which comprise the core industry of Japan.

5.4 Measures responding to changes in environment surrounding motor vehicles

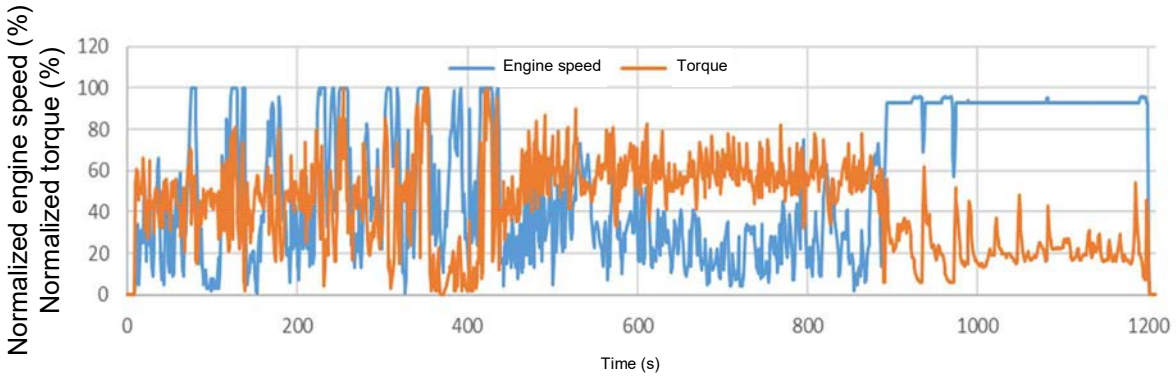
It is recognized that the air quality in Japan has been steadily improving due to the past measures to reduce motor vehicle emissions, and the air quality standards are generally achieved, except for photochemical oxidant concentrations. On the other hand, the environment surrounding motor vehicles is expected to continue to change significantly due to the advancement of information and communications technology, the proliferation of highly motorized vehicles, the advancement of automated driving, car sharing, and MaaS[*45], and the introduction of unconventional maximum speed limit on expressways in the infrastructure sector in connection with social trends such as declining birthrate, aging population and the global decarbonization trend.

It is expected that automobile manufacturers will work on the development of technologies to reduce emissions and improve fuel efficiency as measures against air

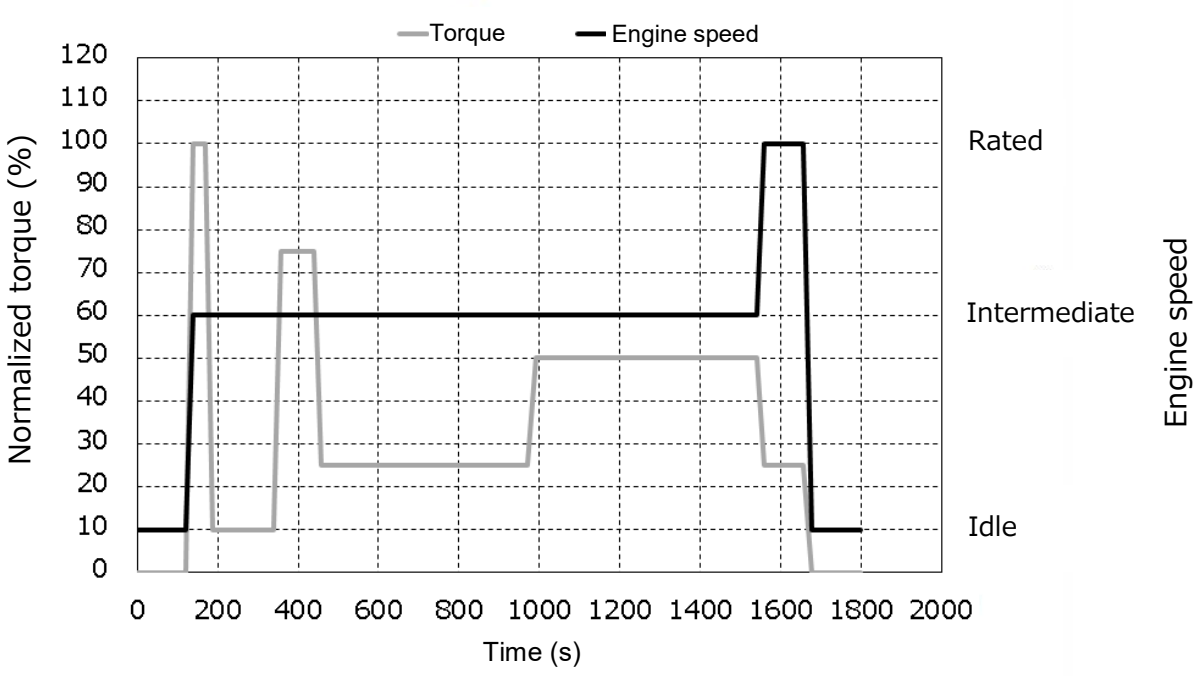
pollution and global warming, and maintain and develop the superiority of Japanese technologies in the global community, while responding to these major social changes.

Attached Figure 1

Exhaust pipe emission test cycle for gasoline/LPG special motor vehicles



LSI-NRTC (Large Spark Ignition engines Non-Road Transient Cycle)

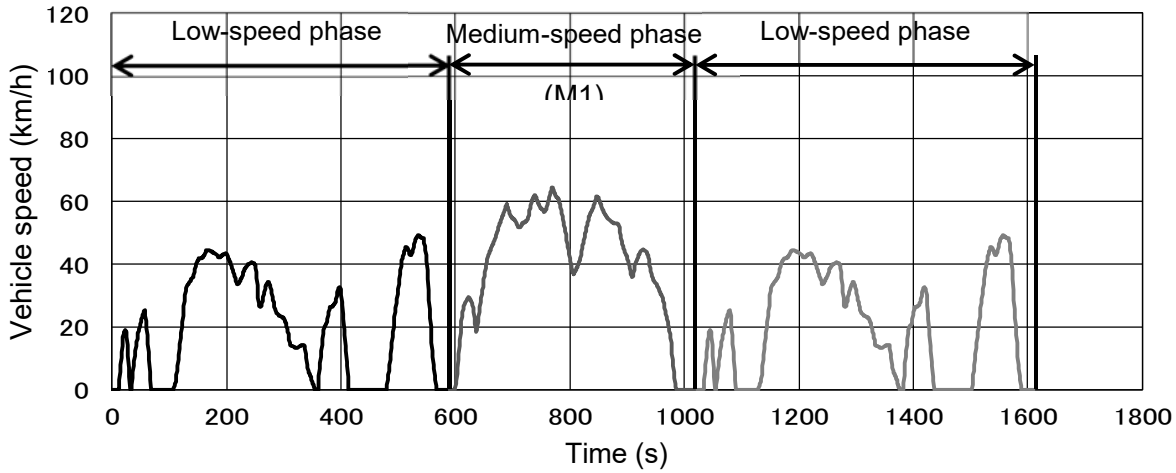


7M- RMC（7M Ramped-Modal Cycle）

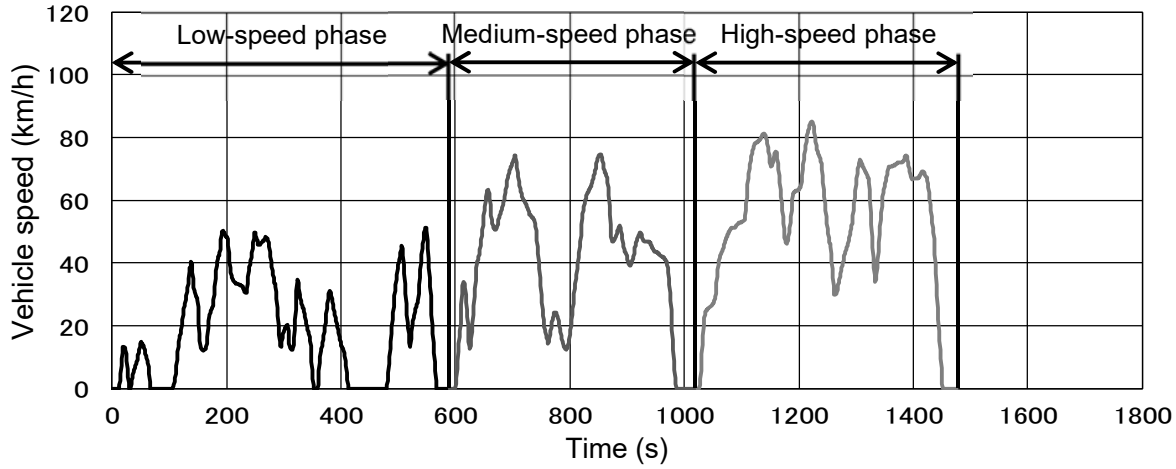
Attached Figure 2

Exhaust pipe emission test cycle for passenger cars, etc.

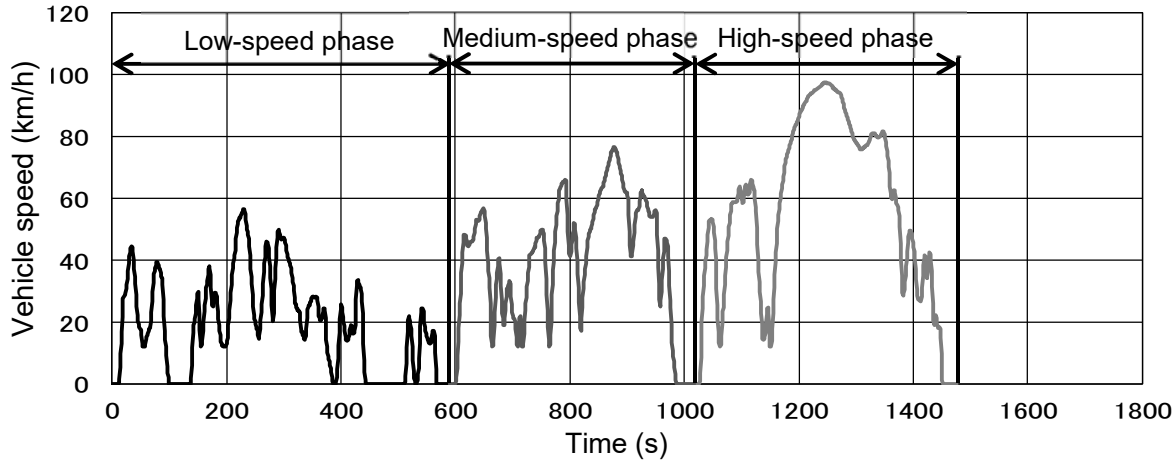
● Test cycle (i)



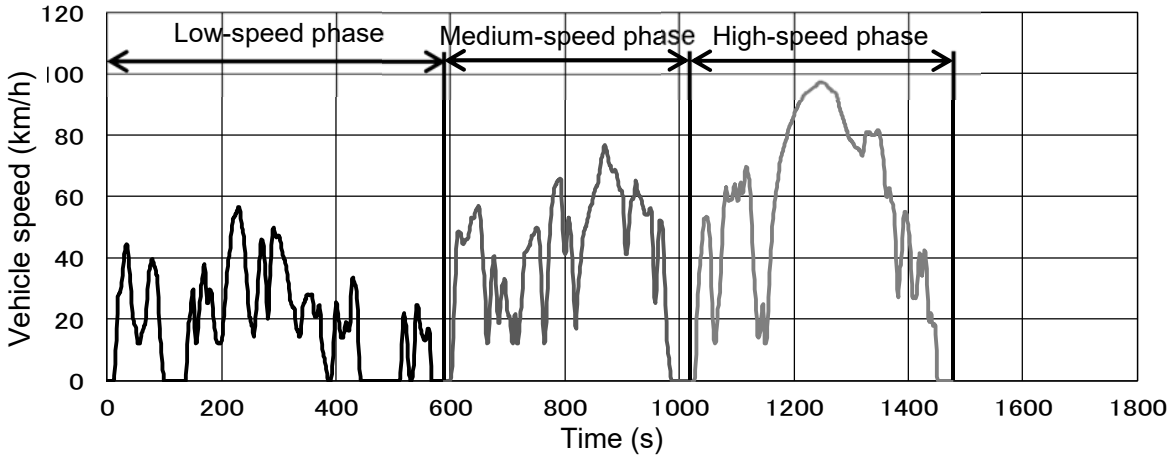
● Test cycle (ii)



● Test cycle (iii)



● Test cycle (iv)



*Note: The test cycle is determined for each type of vehicle as follows:

<table>
<tr><th colspan="3">Vehicle type</th><th>Test cycle</th></tr>
<tr><td rowspan="5">Gasoline/LPG passenger cars
Gasoline/LPG light-freight vehicles
Gasoline/LPG light-weight vehicles
Gasoline/LPG medium-weight vehicles
Diesel passenger cars
Diesel light-weight vehicles
Diesel medium-weight vehicles</td><td colspan="2">Vehicles with a PMR not exceeding 22 W/kg</td><td>Test cycle (i)</td></tr>
<tr><td colspan="2">Vehicles with a PMR exceeding 22 W/kg but not exceeding 34 W/kg</td><td>Test cycle (ii)</td></tr>
<tr><td rowspan="2">Vehicles with a PMR exceeding 34 W/kg</td><td>Vehicles with a maximum speed of less than 120 km/h</td><td>Test cycle (iii)</td></tr>
<tr><td>Vehicles with a maximum speed of 120 km/h or more</td><td>Test cycle (iv)</td></tr>
</table>

Test cycle (i): a test cycle applied to Class 1 vehicles in WTLP-gtr

Test cycle (ii): a test cycle applied to Class 2 vehicles in WTLP-gtr (excluding the extra-high-speed phase)

Test cycle (iii): a test cycle applied to Class 3a vehicles in WTLP-gtr (excluding the extra-high-speed phase)

Test cycle (iv): a test cycle applied to Class 3b vehicles in WTLP-gtr (excluding the extra-high-speed phase)

Attached Table 1

Allowable Maximum Desired Values for Emissions from Gasoline Direct Injection Vehicles

Vehicle type (Note 1)	Allowable maximum desired value (average)
	PN
Gasoline/LPG passenger cars[*29] (Note 2) **Gasoline/LPG light-freight vehicles**[*30] (Note 3) **Gasoline/LPG light-weight vehicles**[*31] (Note 4) **Gasoline/LPG medium-weight vehicles**[*32] (Note 5)	6.0×10^{11} [particles/km]
Gasoline/LPG heavy-duty vehicles[*33] (Note 6)	6.0×10^{11} [particles/kWh]

(Note 1) Limited to vehicles equipped with in-cylinder direct injection gasoline engines

(Note 2) Gasoline- or LPG-fueled ordinary-sized, small-sized, and light motor vehicles exclusively used for carrying passengers and having a riding capacity of 10 people or less (excluding those with a riding capacity of 10 people and a gross vehicle weight exceeding 3.5 tons, as well as two-wheeled vehicles).

(Note 3) Gasoline- or LPG-fueled light motor vehicles (excluding those exclusively used for carrying passengers, as well as two-wheeled vehicles)

(Note 4) Gasoline- or LPG-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight of 1.7 tons or less (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

(Note 5) Gasoline- or LPG-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 1.7 tons but not exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

(Note 6) Gasoline- or LPG-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 9 people or less, as well as two-wheeled vehicles)

Attached Table 2

Allowable Maximum Desired Values for Emissions from Diesel Vehicles

Vehicle type	Allowable maximum desired value (average)
	PN
Diesel passenger cars (Note 1) **Diesel light-weight vehicles***34 (Note 2) **Diesel medium-weight vehicles***35 (Note 3)	6.0×10^{11} [particles/km]
Diesel heavy-duty vehicles*36 (Note 4)	6.0×10^{11} [particles/kWh] (limited to WHTC)
	8.0×10^{11} [particles/kWh] (limited to WHSC)

(Note 1) Diesel-fueled ordinary-sized and small-sized motor vehicles exclusively used for carrying passengers and having a riding capacity of 10 people or less (excluding those with a riding capacity of 10 people and a gross vehicle weight exceeding 3.5 tons, as well as two-wheeled vehicles)

(Note 2) Diesel-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight of 1.7 tons or less (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

(Note 3) Diesel-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 1.7 tons but not exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

(Note 4) Diesel-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

Attached Table 3

Allowable maximum desired values for exhaust pipe emissions from gasoline/LPG special motor vehicles

Vehicle type	Allowable maximum desired value (average)		
	CO	HC	NOx
Gasoline/LPG special motor vehicles (Note 1)	15.0 g/kWh	0.6 g/kWh	0.3 g/kWh

(Note 1) Limited to gasoline- or LPG-fueled special motor vehicles with a rated output of 19 kW or more but less than 560 kW

Glossary

*1Ordinary-sized motor vehicles

Defined in Article 2 of the Regulation for Enforcement of the Road Transport Vehicle Act (Ministry of Transport Order No. 74 of 1951, hereinafter referred to as the “Regulation”). Motor vehicles other than small-sized and light motor vehicles and large-sized and small-sized special motor vehicles. Motorcycles are not included.

*2Small-sized motor vehicles

Defined in Article 2 of the Regulation. Motor vehicles of 4.70 m or less in length, 1.70 m or less in width, and 2.00 m or less in height, other than light motor vehicles, large-sized special motor vehicles, and small-sized special motor vehicles. (In cases of motor vehicles powered by an internal combustion engine (excluding diesel-fueled motor vehicles and motor vehicles powered only by natural gas), limited to those whose engine displacement is 2.00 l or less).

*3Light motor vehicles

Defined in Article 2 of the Regulation. Motor vehicles of 3.40 m or less in length, 1.48 m or less in width, 2.00 m or less in height, and 0.660 l or less in engine displacement, excluding large-sized special motor vehicles and small-sized special motor vehicles.

*4Motorcycles

Two-wheeled small-sized motor vehicles and light motor vehicles (excluding those with an engine displacement of 0.125 l or less) as defined in Article 2 of the Regulation. Light motorcycles are defined as those of 2.50 m or less in length, 1.30 m or less in width, and 2.00 m or less in height, and 0.250 l or less in engine displacement. All other motorcycles are classified as small-sized motorcycles.

*5Motor-driven cycles

Defined in Article 2, paragraph 3 of the Road Transport Vehicle Act, of which an engine displacement is specified in Article 1 of the Regulation. Among two-wheeled vehicles, those with an engine displacement of 0.125 l or less (0.050 l or less for all others). Of these vehicles, those with an engine displacement of 0.050 l or less are classified as Class 1 motor-driven cycles and others are classified as Class 2 motor-driven cycles.

*6Special motor vehicles

Large-sized special motor vehicles and small-sized special motor vehicles defined in Article 2 of the Regulation. They include vehicles of special structure such as bulldozers, forklifts, and agricultural tractors. Of these, small-sized special motor vehicles are those of 4.70 m or less in length, 1.70 m or less in width, 2.80 m or less in height and a maximum speed of 15 km/h or less. (For some motor vehicles including agricultural tractors, there is no limitation on size, but the maximum speed is less than 35 km/h.)

*7WMTC [Worldwide Motorcycle emissions Test Cycle]

Worldwide harmonized test cycles defined in the “Worldwide Harmonized Motorcycle Emissions Certification Procedure”, which was established by UN-ECE/WP29 with the participation of Japan based on the “Agreement Concerning the Establishing of Global Technical Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles” (hereinafter referred to as “1998 Agreement”).

*8PM [Particulate Matter]

Abbreviated name for particulate matter. PM emitted from motor vehicles is divided broadly into black smoke and sulfate, and SOF (Soluble Organic Fraction).

*9WLTP [Worldwide harmonized Light vehicles Test Procedure]

A worldwide harmonized test method for determining the levels of emissions and fuel consumption of passenger cars established by UN-ECE/WP29 with the participation of Japan based on the 1998 Agreement. In addition to the Worldwide Light-duty Test Cycles (WLTC) for passenger cars and other vehicles, the WLTP defines the cold start test, the weight of vehicles at the time of testing, etc.

*10WLTC [Worldwide Light-duty Test Cycle]

Worldwide harmonized test cycles specified in the International Worldwide harmonized Light vehicles Test Procedure (WLTP) for passenger cars, etc.

*11WHDC [Worldwide harmonized Heavy Duty Certification]

A worldwide harmonized test method for determining the levels of emissions of diesel heavy-duty vehicles established by UN-ECE/WP29 with the participation of Japan based on the 1998 Agreement. It defines these test cycles, Worldwide Harmonized Transient Cycle (WHTC), Worldwide Harmonized Steady state Cycle (WHSC), etc.

*12WHTC [Worldwide Harmonized Transient Cycle]

A transient test cycle, as defined by the Worldwide harmonized Heavy Duty Certification (WHDC) for diesel heavy-duty vehicles, that represents real world driving.

*13WHSC [Worldwide Harmonized Steady state Cycle]

A steady-state cycle conducted under engine operating conditions equivalent to those of WHTC, as defined by the Worldwide harmonized Heavy Duty Certification (WHDC) for diesel heavy-duty vehicles.

*14OCE [Off-Cycle Emission]

An emission reduction measure for conditions other than those prescribed by the worldwide harmonized official test cycles established by the UN-ECE/WP29 with

the participation of Japan based on the 1998 Agreement. To verify the amount of emissions in driving conditions other than the officially prescribed test cycles, it defines additional emission tests based on WNTE (World Harmonized Not to Exceed).

*15OBD system [On-Board Diagnostics System]

A kind of a self-diagnostic device, onboard failure diagnostic system that monitors the engine for system anomaly. OBD systems are classified into two types: those which monitor for disconnection or other failures and high-level OBD systems (OBD-II) which detect the performance degradation, etc., of emission reduction devices with various sensors.

*16 Opacimeter

A test instrument that projects light through emissions sampled from the exhaust pipe and measures how much the emissions are contaminated by PM (light absorption coefficient [m^{-1}]) from the permeability of emissions

*17Diesel special motor vehicles

Diesel-fueled large-sized special motor vehicles and small-sized special motor vehicles

*18NRTC [Non-Road Transient Cycle]

A transient test cycle for emissions from the engines of diesel special motor vehicles established by EU and the U.S. NRTC is defined as a transient test cycle in the worldwide standard for diesel non-road mobile machinery (NRMM) established by UN-ECE/WP29 with the participation of Japan based on the 1998 Agreement.

*19NRMM [Non-Road Mobile Machinery]

A worldwide harmonized test method for determining the levels of emissions from

diesel special motor vehicles established by UN-ECE/WP29 with the participation of Japan based on the 1998 Agreement. It defines the transient test cycle for emissions from the engines of diesel special motor vehicles (Non-Road Transient Cycle, NRTC), etc.

*20Blow-by Gas

Mixed gas containing the combustion gas, which leaked into the crankcase through piston ring gaps, etc., mist of the lubricant in the crankcase, and air. Regulations have been introduced for two-wheeled vehicles, passenger cars, heavy-duty vehicles, and diesel special motor vehicles.

*21RMC [Ramped Modal Cycle]

One of the steady-state cycles defined in NRMM-gtr. As opposed to C1 mode which first measures emissions at eight measuring points and then calculates the amount of emissions by obtaining the weighted average, RMC measures emissions by continuously sampling them throughout the test cycle just like NRTC.

*22$PM_{2.5}$ [Particulate Matter 2.5]

Fine particulate matter suspended in the air, as sampled after a device removes particles larger than 2.5 μm by 50%. As a whole, $PM_{2.5}$ has certain influence on respiratory diseases, circulatory diseases, lung cancer, etc.

*23Gasoline/LPG special motor vehicles

Gasoline- or LPG-fueled large-sized special motor vehicles and small-sized special motor vehicles

*24DPF [Diesel Particulate Filter]

A system to remove diesel fine particulate matter which collects PM in the emissions from motor vehicles through a filter installed in the exhaust system of the engine and removes them with electric heating wires and catalysts. Those with

catalysts are called continuous regeneration type DPF.

*25Diesel passenger cars

Diesel-fueled ordinary-sized and small-sized motor vehicles exclusively used for carrying passengers and having a riding capacity of 10 people or less (excluding those having a riding capacity of 10 and with a gross vehicle weight exceeding 3.5 tons, as well as two-wheeled vehicles)

*26Pool fire

Liquid surface combustion which occurs when fuel injected into the cylinder at the time of a cold start of an engine adheres to the wall and upper surface of the piston as a liquid film and reacts with hot gas after combustion

*27GPF [Gasoline Particulate Filter]

A gasoline particulate filter designed to trap and remove PM in emissions from a direct injection gasoline engine

*28JE05 mode

Abbreviated name for an engine-based emission test method introduced in conjunction with regulations based on the New Long-Term Targets. A test mode in which a representative driving mode based on the actual running conditions is determined by converting to engine speed and load depending on individual engines. This conversion is calculated from the engine and vehicle specifications, as well as gear shift positions and transmissions, to reflect the engine speed and load used by the individual engines.

*29Gasoline/LPG passenger cars

Gasoline- or LPG-fueled ordinary-sized, small-sized, and light motor vehicles exclusively used for carrying passengers and having a riding capacity of 10 people or less (excluding those with a riding capacity of 10 people and a gross vehicle

weight exceeding 3.5 tons, as well as two-wheeled vehicles).

*30Gasoline/LPG light-freight vehicles

Gasoline- or LPG-fueled light motor vehicles (excluding those exclusively used for carrying passengers, as well as two-wheeled vehicles)

*31Gasoline/LPG light-weight vehicles

Gasoline- or LPG-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight of 1.7 tons or less (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

*32Gasoline/LPG medium-weight vehicles

Gasoline- or LPG-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 1.7 tons but not exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

*33Gasoline/LPG heavy-duty vehicles

Gasoline- or LPG-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

*34Diesel light-weight vehicles

Diesel-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle of 1.7 tons or less (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

*35Diesel medium-weight vehicles

Diesel-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 1.7 tons but not exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

*36Diesel heavy-duty vehicles

Diesel-fueled ordinary-sized and small-sized motor vehicles with a gross vehicle weight exceeding 3.5 tons (excluding those exclusively used for carrying passengers and having a riding capacity of 10 people or less, as well as two-wheeled vehicles)

*37LSI-NRTC [Large Spark Ignition engines Non-Road Transient Cycle]

Test cycle for gasoline/LPG special motor vehicles. It is used as a transient test cycle for engines with an output of less than 56 kW in Europe and as a transient test cycle for full power engines in the U.S.

*38JTC [Japan Transient Cycle]

A transient cycle for investigation based on the measurement patterns shown in Annex A.5 “Fuel consumption of engine vehicles” of JIS D6202-2011 “Forklift trucks - Standard form of specification” selected as a cycle that simulates the actual operations of forklift trucks, which account for almost all of gasoline/LPG special motor vehicles used in Japan.

*39Output ratio

The ratio of average power when defining as average power the average value of the products per second of engine speed and torque normalized to the rated value

*40Unladen state (running order)

Unoccupied and unladen state fully loaded with fuel, coolant, and lubricant, and

equipped with all tools and accessories (including a spare tire) specified by automobile manufacturers as standard equipment. In this case, loading the full volume of fuel means loading 90% or more of the total fuel capacity of the fuel system. This is different from the “vehicle weight.”

*41Round-robin tests

A test for examining the reliability, etc. of a measuring method or measurement equipment conducted by assigning the same vehicles and measurement equipment to multiple testing institutions

*42Canister

A container filled with activated carbon that is installed in gasoline vehicles to suppress fuel evaporative emissions. Fuel evaporative emissions that fill the fuel tank are adsorbed into activated carbon, and are desorbed by letting a portion of air supplied to the engine pass through while the vehicle is running, and then are burned in the engine.

*43Heavy fuel oil

Distillation residue or mixture of distillation residue and diesel fraction, made into a product by adjusting viscosity, residual carbon, sulfur content, or pour point, according to its use. According to kinematic viscosity, it is roughly classified into three: heavy fuel oil A, B, and C.

*44Hazardous air pollutants

Hazardous air pollutants are defined in Article 2, paragraph 15, of the Air Pollution Control Act as “a substance that is likely to harm human health if it is ingested continuously and that causes air pollution.” The Future Policy on Hazardous Air Pollutants (Second Report) (compiled by the Central Environment Council in October 1996) listed 234 substances as those which were likely to be hazardous air pollutants and designated 22 of them as top priority substances that were highly

harmful for human health. Later, the Ninth Report (compiled by the Central Environment Council in October 2010) reviewed them to 248 substances and 23 substances, respectively.

*45MaaS [Mobility as a Service]

The integration of various forms of transportation services into a single mobility service accessible on demand

Reference: Society of Automotive Engineers of Japan, Japanese-English Dictionary of Automotive Terms, etc.