

Description of Japan RDE methodology

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Outline of Japan's RDE

Scope

- Diesel vehicles having a gross weight of 3.5t or less
- Diesel powered passenger cars having a capacity of 9 or less people

Method and Requirement

[will be described later]

Schedule of Introduction for RDE in Japan

- New Type Approval Vehicle : October 2022
- Continuous Production Vehicle : October 2024

- RDE method shall be able to detect whether result of chassis-dynamometer test reflects on real driving correctly or not.
- The Japan's RDE method is based on EC's , but it is slightly modified considering different real world driving conditions and different phase of WLTC between Japan and Europe.
- Therefore, we modified these factors in align with driving conditions in Japan.

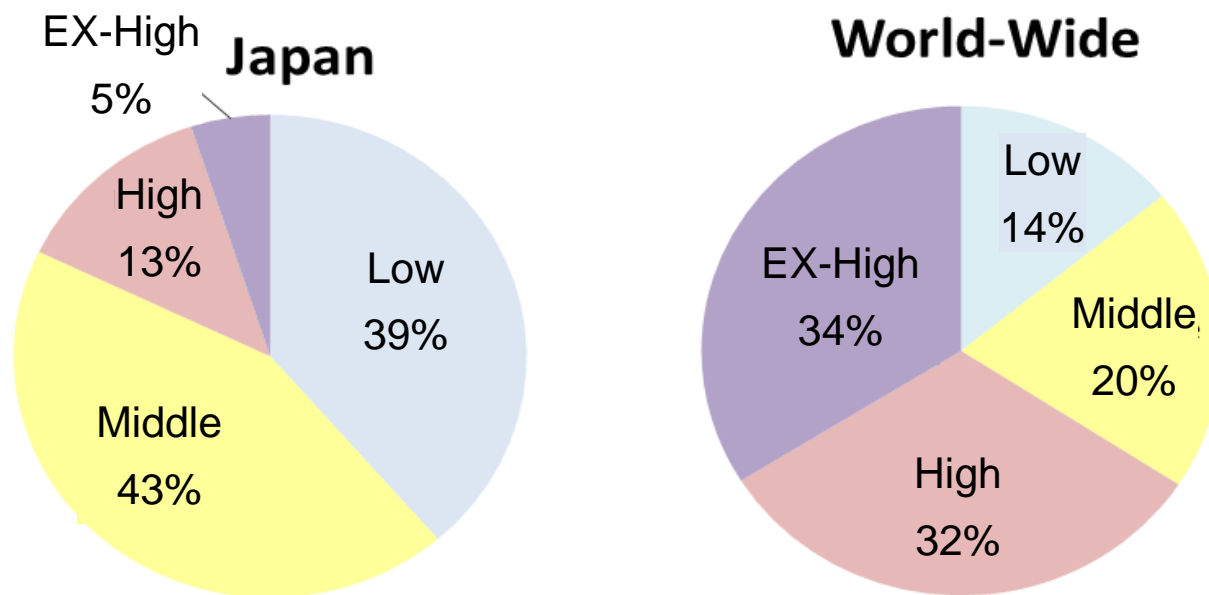
- Japan are using 3 phases in WLTP.
- The average speed and max speed are greatly different between 3 phases and 4 phases.
- Based on these differences, Japan modified some factors slightly.

Main differences between WLTC 3 phases and 4 phases

	3 phases	4 phases
Average Speed	36.6 km/h	46.5 km/h
Ratio of Idling Time	15.4 %	13.0 %
Max Speed	97.4 km/h	131.3 km/h
Max Acceleration	5.7 km/h/s	5.7 km/h/s
RPA	0.167	0.152
Driving Time	1477 s	1800 s
Total Mileage	15.01 km	23.27 km

- The traffic speed in Japan's real driving tends to be slow compared with World-Wide.
- Especially, the ratio of driving speed at 60km/h or less ("Low" + "Middle") is very high.
- Since the speed limit of Japan's motorway is less than 100km/h in most sections, the proportion of "EX-High" is low.

Traffic rate of Japan and World-Wide

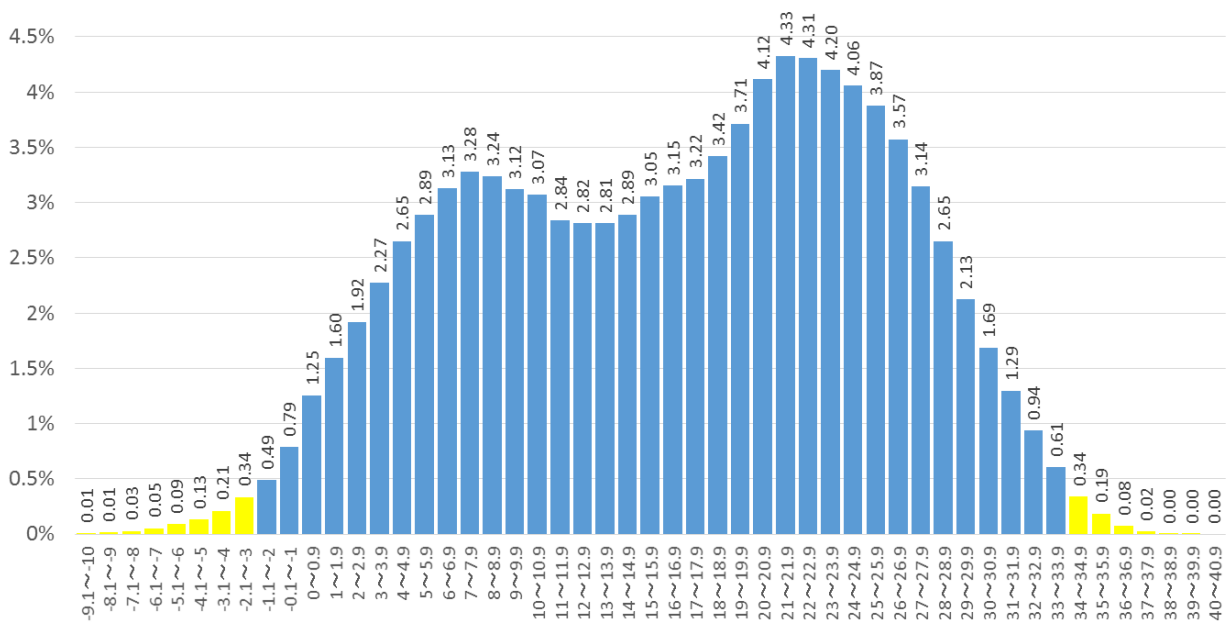


- The speed thresholds are 60km/h, 80km/h, 110km/h.

Weather Conditions

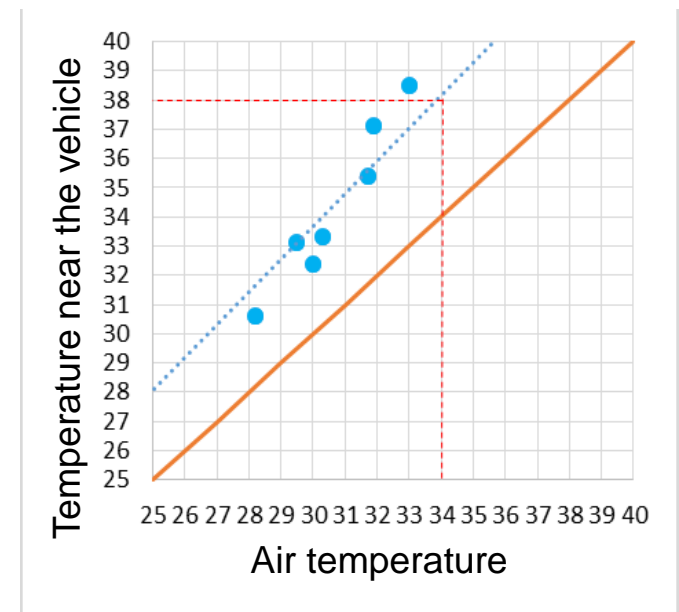
- Japan is somewhat hotter than Europe.
- 98% of the traffic in Japan is between -2 to 34°C, calculating from traffic frequency distribution weighted by traffic volume, time and temperature, excluding upper and lower 1%.
- In summer, the temperature near the vehicle increase about 4°C.

Average traffic volume for every air temperature (2012-2016)



• Yellow area is about 1% (low temperature and high temperature, respectively)

Increased temperature on the road



Detail of Japan's RDE method

- Japan's RDE is basically the same structure and method as EC's RDE.

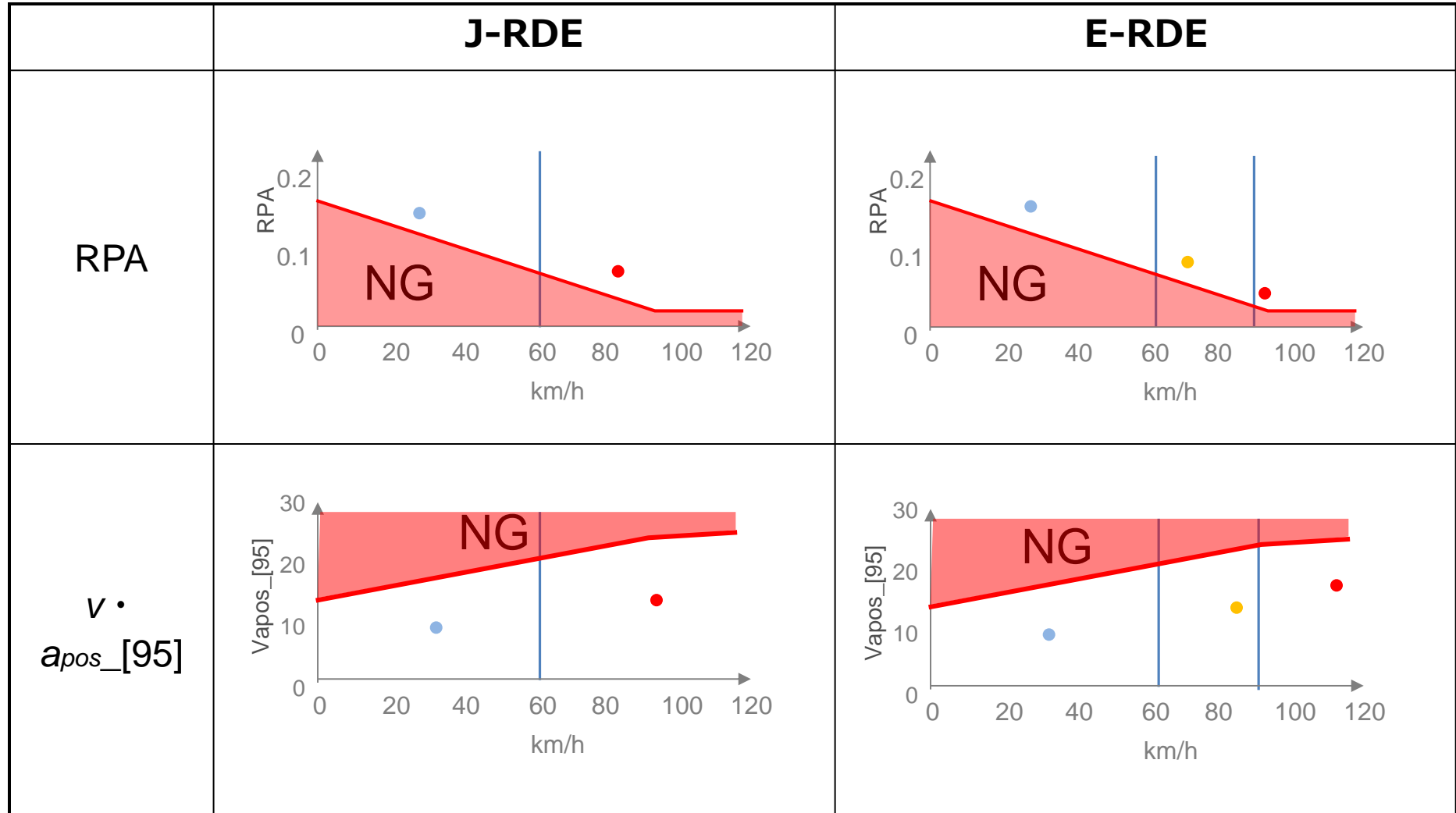
Japan's RDE method

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| 1. Scope | Appendix 1 Test Procedure for Exhaust Emission with PEMS |
| 2. Definitions and Abbreviations | Appendix 2 Specification and Calibration of PEMS and Signals |
| 3. General Requirements | Appendix 3 Validation of PEMS a Non-Traceable Exhaust Mass Flow Rate |
| 4. Special Requirements | Appendix 4 Determination of Emissions |
| 5. Test Conditions | Appendix 5 Verification of Trip Dynamic Conditions by Moving Average Window |
| 6. Running Requirement | Appendix 6 Verification of Overall Trip Dynamic State |
| 7. Driving requirement | Appendix 7 Procedure to Determine Cumulative Positive Elevation Gain of Trip |
| 8. Lubricating Oil, Fuel and Reagent | Appendix 8 Verification of Trip Conditions of OVC-HEV and Calculation of Final On-Road Emissions |
| 9. Emission Amount of Exhaust Emission and Evaluation of Running | |

- Based on difference of WLTP phases, Japan modified some of factors slightly as below.

	J-RDE			E-RDE		
Vehicle speed and Consist	Routes	Speed [km/h]	Consist [%]	Routes	Speed [km/h]	Consist [%]
	Urban/Rural	$V \leq 60$	40-65	Urban	$V < 60$	29-44
				Rural	$60 < V < 90$	23-43
	Motorway	$60 < V$	35-55	Motorway	$90 < V$	23-43
Window speed characteristics	$V < 50$:urban/rural speed $50 \leq V$:motorway speed			$V < 45$:urban speed $45 \leq V < 80$:rural speed $80 \leq V < 145$:motorway speed		
CO ₂ characteristic curve reference points	P1 : Same as E-RDE P2 : Same as E-RDE P3 : —			P1: $v_{p1}=18.882\text{km/h}$ (Average Speed of the Low Speed phase of the WLTP cycle) P2: $v_{p2}=56.664\text{km/h}$ (Average Speed of the High Speed phase of the WLTP cycle) P3: $v_{p3}=91.997\text{km/h}$ (Average Speed of the Extra High Speed phase of the WLTP cycle)		

Different respects between J – E WLTP phases



- Based on difference of real driving condition, Japan modified some of factors slightly as below.

	J-RDE	E-RDE
Order	1.Urban/Rural 2.Motorway	1.Urban 2.Rural 3.Motorway
Ambient conditions Altitude	0~1000m(700m) (Moderate altitude)	0 ~1300m(700m) (Moderate altitude)
temp	-2°C(0)~38°C(35) (Moderate temp)	-7 °C(0)~ 35°C(30) (Moderate temp)
Average speed (urban driving part)	—	15 ~ 40 km/h
Max speed	—	145km/h
Motorway speed	—	Cover range : 90 ~ at least 110 km/h Velocity : Above 100 km/h for at least 5 minutes.
Test track	Available	—

- Based on difference of regulation and concept, Japan modified some of factors slightly as below.

	J-RDE	E-RDE
Measurement items	<p>NO_x, CO₂</p> <p><i>Note: Japan doesn't regulate PN under the chassis-dynamometer test and on road test.</i></p>	NO _x , PN, CO ₂
Fuel	Basically same as E-RDE (If it exceed criteria, the reference fuel defined in Annex 3 of GTR15 may be used for second RDE test.).	The fuel, lubricant and reagent (if applicable) used for RDE testing shall be within the specifications issued by the manufacturer for vehicle operation by the customer.
If a part of the test is performed outside of ambient conditions	It is basically the test may be invalid. However, it can be made valid if the CF value conforms to limit.	The test shall be invalid.

Thank you for your attention!