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Agenda item 13

# Development of the Japan's RDE (Real Driving Emission) procedure

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Road Transport Bureau,
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Japan

# Background

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- In September 2015 in the United States, it was revealed that the manufacturer used defeat devices, which activates the emission control system during the certification test and deactivates the system during real driving.
- In response to this issue, MLIT, Japan set "Working Group of Reviewing Diesel Passenger Vehicle Test Procedures for Addressing Defeat Device Issue" composed by experts of diesel emission.
- The working group published a final report in April 2017 to introduce  the real driving emissions(RDE) test.

# Outline of Japan’s RDE

# Abstract of final report and Outline of RDE in Japan

## 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]

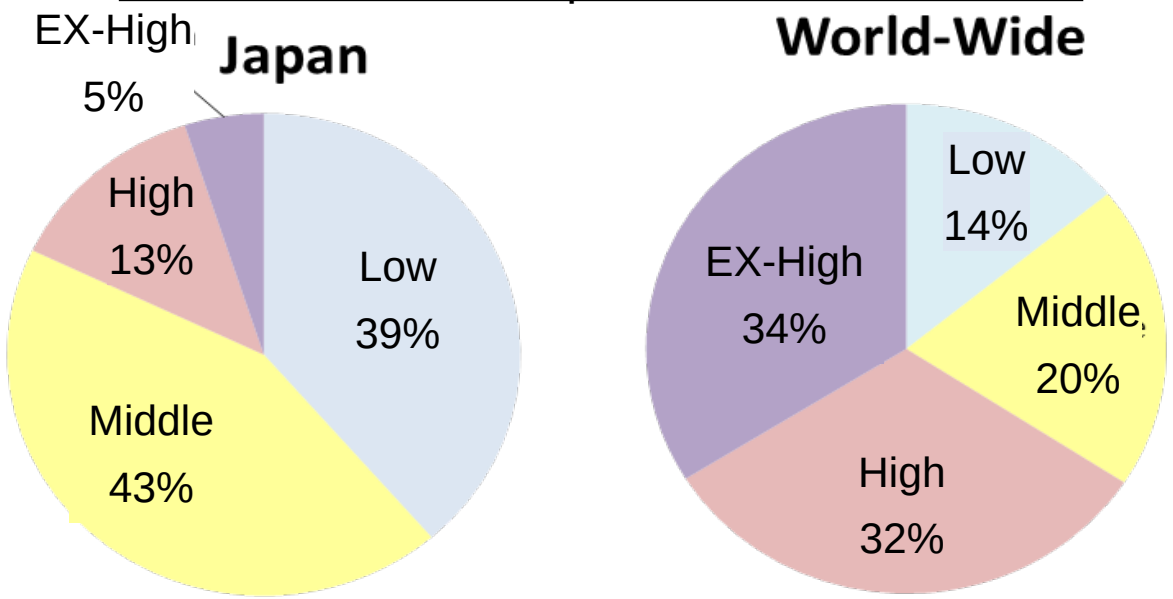
## Schedule of Introduction for RDE in Japan

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

# Concept of Japan's RDE method

- RDE method shall be able to check whether result of chassis-dynamometer test is effect on real driving correctly as well or not.
- The Japan's RDE method is based on EC's RDE method, but it is slightly modified by taking into consideration difference of real world driving conditions and adopted different phase of WLTC between Japan and Europe .
- Especially driving condition and speed threshold of Moving Average Window(MAW) and CF value under EC's RDE method are developed based on chassis-dynamometer test (WLTC) and real world driving conditions.
- Therefore, we modified these factors in align with driving conditions in Japan.

Traffic rate of Japan and World-Wide



# Detail of Modifying RDE method

# Modifying MAW method and CF value

## MAW(Moving Average Window) method

- We develop the MAW method in align with driving condition in Japan and 3 phases WLTC.
- We modify the EC's MAW method slightly as below.
  - Modifying threshold of speed from 45, 80km/h to 35, 50km/h
  - Modifying requirements of trip completeness to 10%
  - Modifying all $CO_2$ compensation factors to 1.1

## CF(Conformity Factor) value

- We checked the proper CF value with the lowest emission vehicle in Japan in 2016.
- In result, we got 2.0 as CF value under Japan driving condition.

# Modifying other factors (1)

- In addition to modifying MAW method and CF value, we checked other factors whether they are proper in Japan or not.
- In result, we modify some of them slightly as below.

| | Japan | EC |
|---|---|---|
| Measurement items | NOx, $CO_2$<br>*Note: Japan doesn't regulate PN under the chassis-dynamometer test and on road test.* | NOx, PN, $CO_2$ |
| Order | 1.Urban<br>2.Motorway | 1.Urban<br>2.Rural<br>3.Motorway |
| Stop periods (<1km/h) , Low speed | • No continuous 20minutes driving with less than 20km/h<br>• Test shall contain several stop periods of 10s or longer, and total stop periods is 7~36% of the time duration of urban.<br>• Every stop period doesn't exceed 300s | • Average speed of urban:15～40km/h<br>• Test shall contain several stop periods of 10s or longer, and total stop periods is 6~30% of the time duration of urban.<br>• Every stop periods doesn't exceed 300s |
| Motorway | Test shall contain more than 20% of the distance of motorway with more than 80km/h. | • Not exceed 145km/h<br>• above 100km/h at least 5min |

# Modifying other factors (2)

| | Japan | Europe |
|---|---|---|
| Time | (Same as EC) | 90-120 min |
| Altitude | Less than 1000m (the emissions are divided by 1.6 during higher than 700m) | Less than 1300m (the emissions are divided by 1.6 during higher than 700m) |
| Slope | (Same as EC) | • Altitude between start and end point shall not exceed 100m<br>• Cumulative positive altitude shall not exceed 1200m/100km |
| Mass | (Same as EC) | Paymass90% |
| Temperature | -2～38℃(the emissions are divided by 1.6 during -2～0℃, 35～38℃) | -7～35℃(the emissions are divided by 1.6 during -7～0℃, 30～35℃) |

# Summary

# Summary and Next stage of RDE method

## Summary

- Japan has a plan to introduce RDE regulation for some diesel vehicles from October 2022.
- When developing Japan's RDE method, we take into consideration the difference of real world driving conditions and adopted different phase of WLTC between Japan and Europe.
- In result, we modify MAW method, CF value and other factors.

## Next stage

- Since Japan's RDE method is based on 3 phase WLTC and can be introduced to same driving condition's countries, we can contribute to establish UN/GTR requirement as much as possible.

# Thank you for your attention!

# Reference

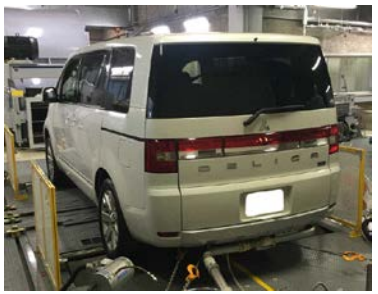
# Investigation for On-Road emission in Japan

We investigated the exhaust emissions from 8 diesel-powered passenger vehicles by chassis-dynamometer testing and on-road testing

Test Procedures

**1. Chassis-dynamometer testing**

- JC08
- WLTP
- 60km/h constant for 30 minutes etc.



Dynamometer Testing

PEMS

**2. On-road driving testing**

➢ Testing the vehicles with a PEMS in Urban, Rural and Motorway.

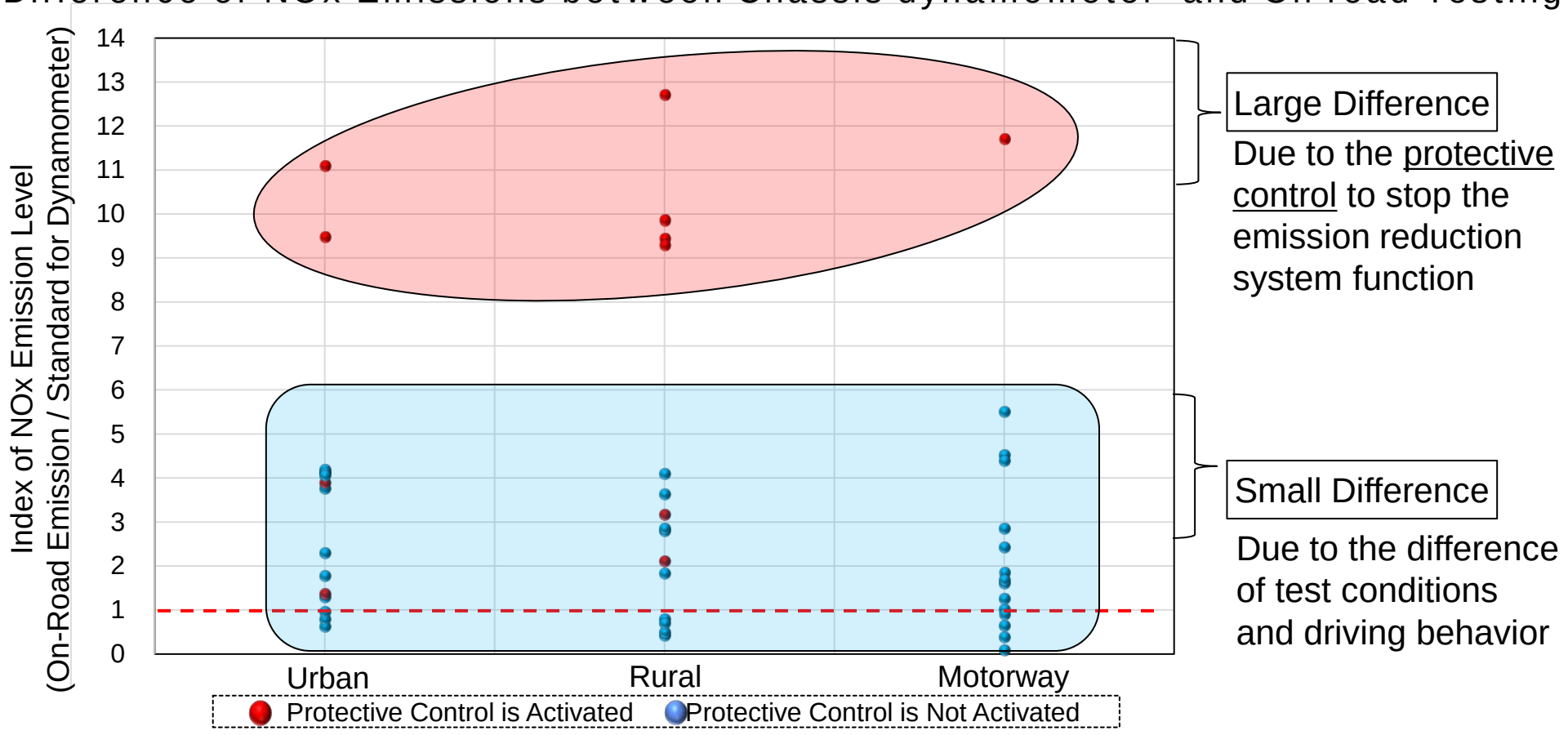
**We analyzed the differences between the result of chassis-dynamometer testing and on-road driving testing**

# Investigation for On-Road emission in Japan

**Result**

- The illegal software like the defeat device is not confirmed.
- NOx emissions of the on-road testing are higher than those of dynamometer testing from 2 to 13 times for some models.

Difference of NOx Emissions between Chassis-dynamometer and On-road Testing



# RDE Regulation in Europe (1)

## 1. History of RDE regulation

2007 Starting discussion about introduction of RDE

2011 Deciding to introduce RDE regulation

2016 Obligating to monitor on-road exhaust gas and recording it to automobile manufacturers

2017.9 Obligating to set emission standard value

2020.1 Strengthening the standard

## 2. Main Condition of RDE

**Speed (instantaneous speed in On-Road) and Distance**

| Category of speed | 1. Urban (0 – 60 km/h) | 2. Rural (60 – 90 km/h) | 3. Motorway (90 km/h - ) |
|---|---|---|---|
| Percentage of distance | 29 – 44 % | 33 ± 10% | 33 ± 10% |

**Temperature**

-7～35℃ (the emissions are divided by 1.6 during -7～0℃, 30～35℃)

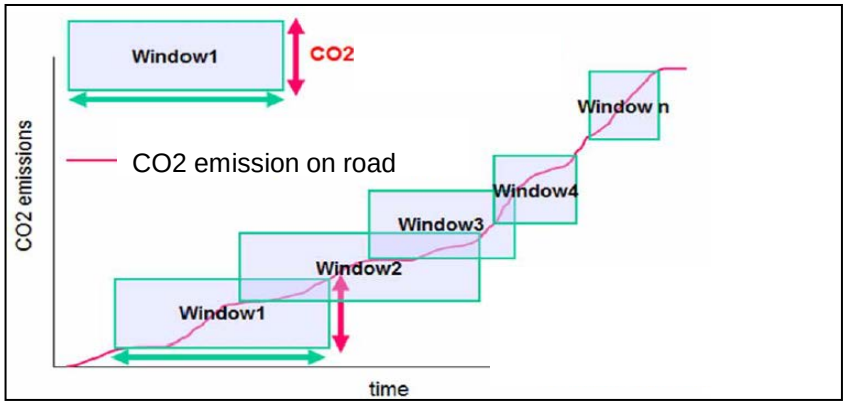
**CF*(Conformity Factor) value**

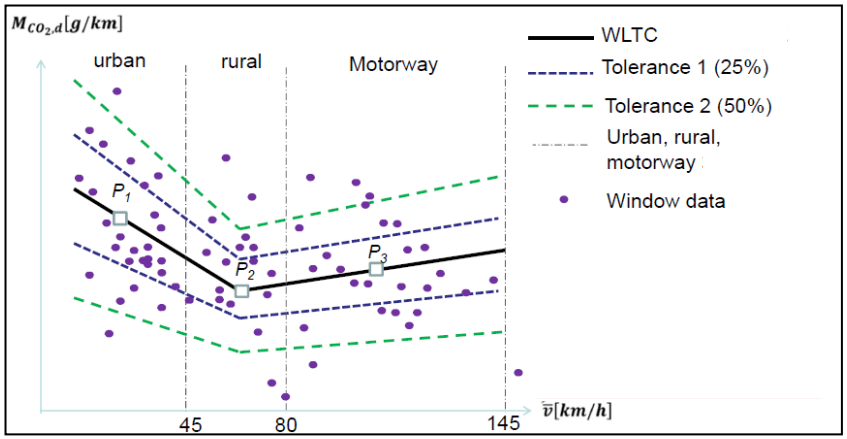
2.1(2017-), 1.5(2020-)

# RDE Regulation in Europe (2)

## 3. Evaluation method of RDE（Moving Average Window method）

1. ‘Window’ is defined as a continuous period when the cumulative amount of exhaust $CO_2$ gets the half of $CO_2$ that is emitted by driving on WLTC mode. Windows are made at every second, and average speed and exhaust gases of each Windows are calculated.
2. $CO_2$ Characteristic curve is made based on WLTC, and weighting factor(WF) of each Window is calculated.
3. NOx emissions as a weighted average of the windows are calculated.




Making of $CO_2$ Characteristic Curve

- Based on $CO_2$ emission of unit distance of WLTC mode, P1（L, M×1.2）、P2（H×1.1）、P3（Ex-H×1.05）and line P1- P2, and P2 – P3 (base line) are plotted.
- Tolerance 1（WF 1）: base line ±25% Tolerance 2（WF 0-1）:base line ±50%
- Threshold speed of Urban/Rural/Motorway: 45,80km/h

Requirement of MAW method of EC’s RDE

- Trip Completeness：each speed category include more than 15% of all Windows
- More than 50% of Window is Tolerance1 at each speed category

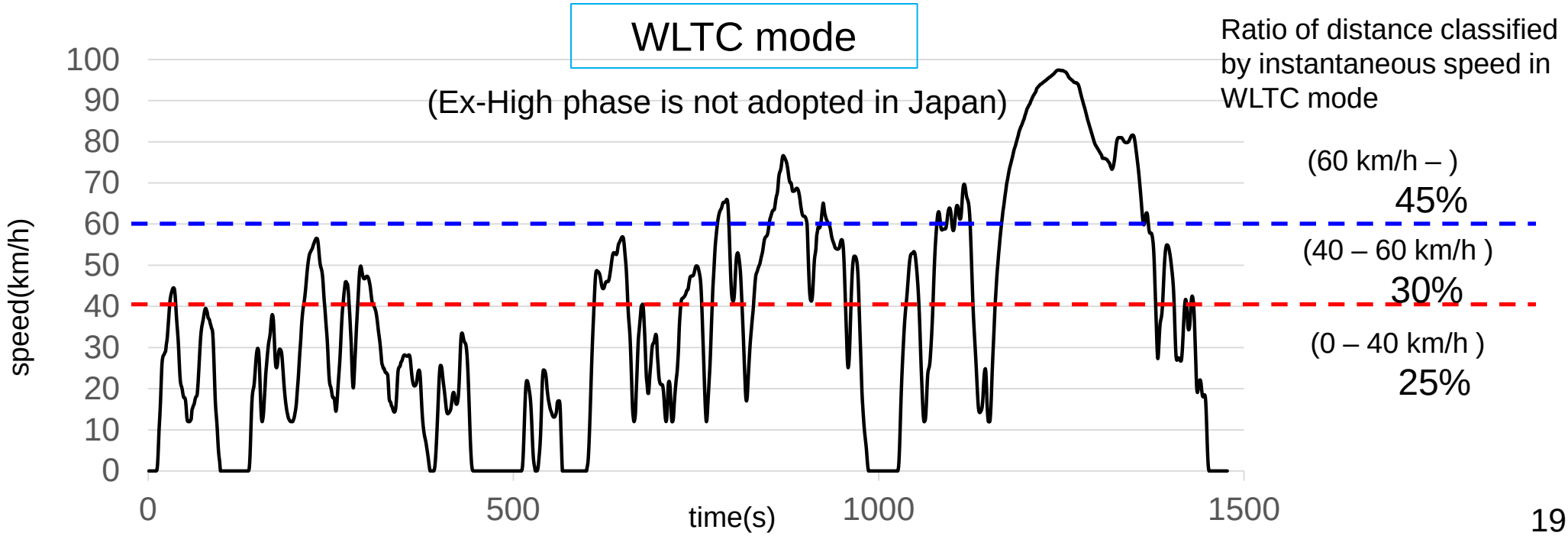
# Ratio of trip distance of instantaneous speed

## Condition of percentage of total trip distance of instantaneous speed in RDE

| Category of speed | 1. Low speed （0 – 40 km/h） | 2. Middle speed （40 – 60 km/h） | 3. High speed （60 km/h - ） |
|---|---|---|---|
| Percentage of distance | 20 – 35 % | 30 ± 10% | 45 ± 10% |

(ref) EC's RDE

| Category of speed | 1. Urban （0 – 60 km/h） | 2. Rural （60 – 90 km/h） | 3. Motorway （90 km/h - ） |
|---|---|---|---|
| Percentage of distance | 29 – 44 % | 33 ± 10% | 33 ± 10% |



# Checking the ratio of total trip distance (1)

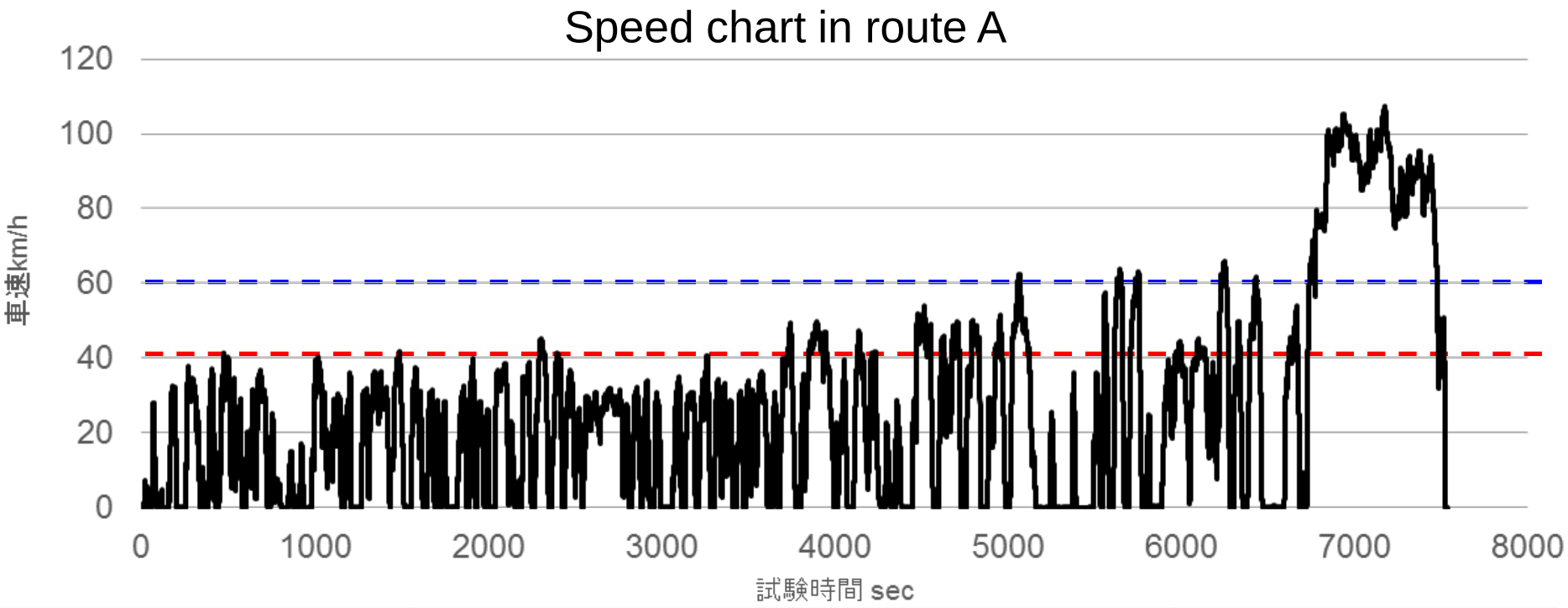
## Example of On-Road examination (route A)

| Category of Limit speed | Low (0 - 40 km/h) | Middle (40 - 60 km/h) | High (60 km/h - ) |
|---|---|---|---|
| Percentage of distance | 30.5% (16.9km) | 35.2% (19.5km) | 34.3% (19.0km) |


Note: This route is set to verify method of On-Road test procedure in Europe in early stage of investigation, not to verify method in Japan.

# Checking ratio of total trip distance (2)

**Result**
It has become clear that It needs to increase the ratio of “Low speed” trip distance in Japan.



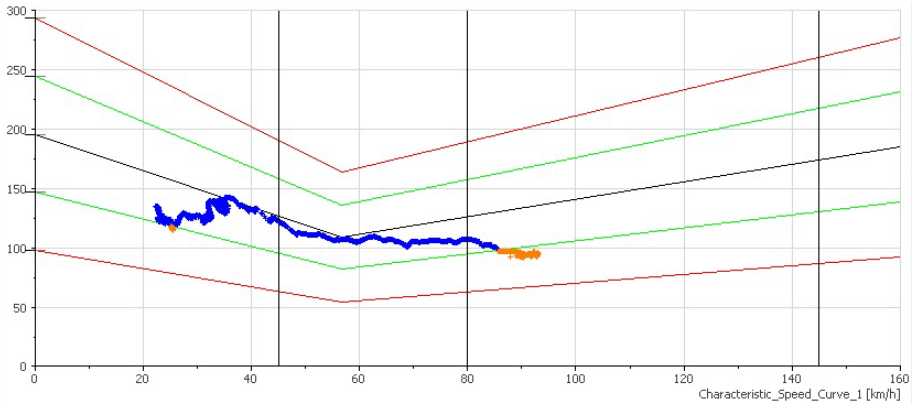

| Instantaneous speed<br>Requirement of RDE regulation in Europe | Low<br>(0 - 40 km/h)<br>20 - 35% | Middle<br>(40 - 60 km/h)<br>30 ± 10% | High<br>(60 km/h - )<br>45 ± 10% |
|---|---|---|---|
| Percentage of distance | 44.5% (24.7km) | 19.8% (11.0km) | 35.7% (19.8km) |

# Verification of Modifying MAW method

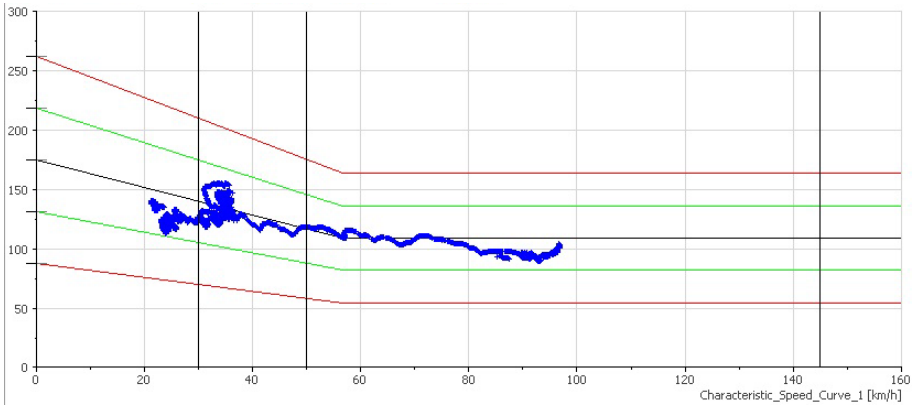
- Windows in Tolerance 1 are increased by changing Reference Point and base line.
- Window bias are reduced by changing threshold speed .

## Evaluation of route A

EC's MAW method




Modifying MAW method

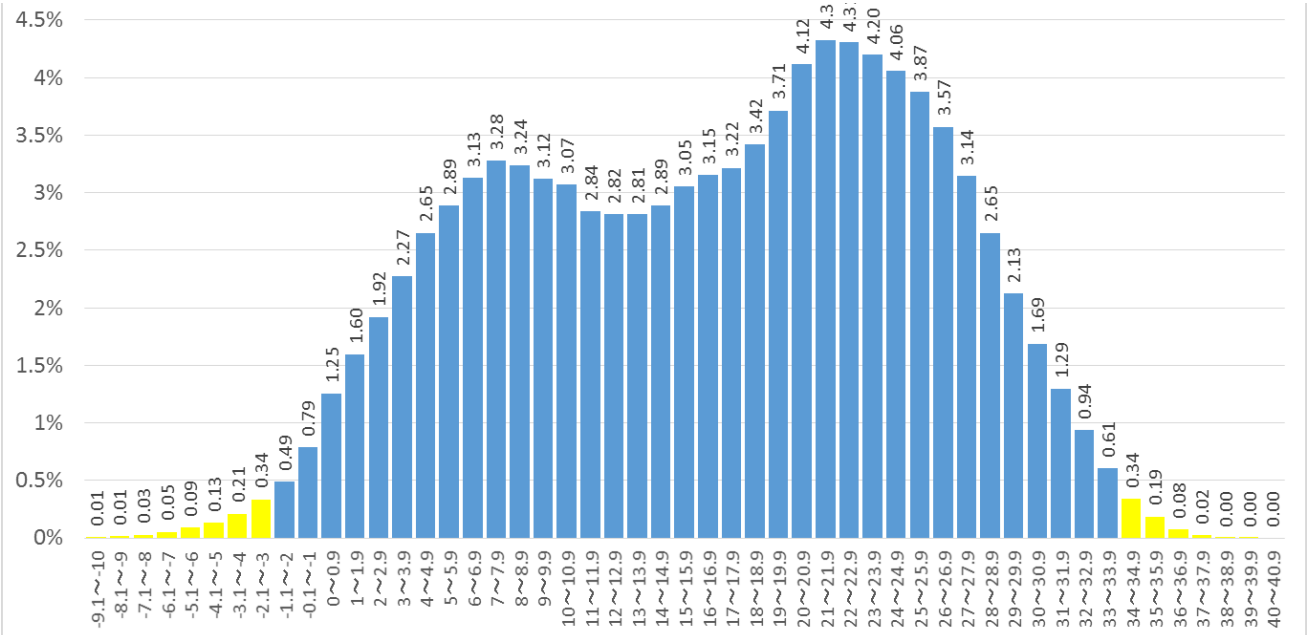



| | Urban | Rural | Motorway |
|---|---|---|---|
| Normality (requirement: more than 50%) | 97.5% | 100.0% | 44.7% |
| Result | PASS | PASS | FAIL |
| Trip Completeness (requirement: more than 15%) | 82.7% | 11.0% | 6.4% |
| Result | PASS | FAIL | FAIL |

| | Low | Middle | High |
|---|---|---|---|
| Normality (requirement: more than 50%) | 100.0% | 100.0% | 100.0% |
| Result | PASS | PASS | PASS |
| Trip Completeness (requirement: more than 10%) | 51.1% | 35.5% | 13.4% |
| Result | PASS | PASS | PASS |

# Area-mean Low Temperature in Japan

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




| Temp（℃） | Ratio（%） | Cumulative（%） |
|---|---|---|
| −9.1～−10 | 0.01 | 0.01 |
| −8.1～−9 | 0.01 | 0.02 |
| −7.1～−8 | 0.03 | 0.05 |
| −6.1～−7 | 0.05 | 0.10 |
| −5.1～−6 | 0.09 | 0.19 |
| −4.1～−5 | 0.13 | 0.32 |
| −3.1～−4 | 0.21 | 0.53 |
| −2.1～−3 | 0.34 | 0.87 |
| −1.1～−2 | 0.49 | 1.36 |
| −0.1～−1 | 0.79 | 2.15 |
| 0～0.9 | 1.25 | 3.40 |
| 1～1.9 | 1.60 | 5.00 |
| 2～2.9 | 1.92 | 6.92 |

| Temp（℃） | Ratio（%） |
|---|---|
| 3～3.9 | 2.27 |
| 4～4.9 | 2.65 |
| 5～5.9 | 2.89 |
| 6～6.9 | 3.13 |
| 7～7.9 | 3.28 |
| 8～8.9 | 3.24 |
| 9～9.9 | 3.12 |
| 10～10.9 | 3.07 |
| 11～11.9 | 2.84 |
| 12～12.9 | 2.82 |
| 13～13.9 | 2.81 |
| 14～14.9 | 2.89 |

| Temp（℃） | Ratio（%） |
|---|---|
| 15～15.9 | 3.05 |
| 16～16.9 | 3.15 |
| 17～17.9 | 3.22 |
| 18～18.9 | 3.42 |
| 19～19.9 | 3.71 |
| 20～20.9 | 4.12 |
| 21～21.9 | 4.33 |
| 22～22.9 | 4.31 |
| 23～23.9 | 4.20 |
| 24～24.9 | 4.06 |
| 25～25.9 | 3.87 |
| 26～26.9 | 3.57 |
| 27～27.9 | 3.14 |

| Temp（℃） | Ratio（%） | Cumulative（%） |
|---|---|---|
| 28～28.9 | 2.65 | 9.93 |
| 29～29.9 | 2.13 | 7.27 |
| 30～30.9 | 1.69 | 5.15 |
| 31～31.9 | 1.29 | 3.46 |
| 32～32.9 | 0.94 | 2.17 |
| 33～33.9 | 0.61 | 1.23 |
| 34～34.9 | 0.34 | 0.62 |
| 35～35.9 | 0.19 | 0.29 |
| 36～36.9 | 0.08 | 0.10 |
| 37～37.9 | 0.02 | 0.03 |
| 38～38.9 | 0.00 | 0.00 |
| 39～39.9 | 0.00 | 0.00 |
| 40～40.9 | 0.00 | 0.00 |

- Temperature data of each 47 prefectural capital (obtained by Japan Meteorological Agency) are divided into range of 1 degree, and calculated a weighing value by multiplying traffic ratio of each prefecture (obtained by road traffic census) and each time.
- Yellow area is about 1% (low temperature and high temperature, respectively)