

**Study on Pass-by Noise Testing Methods Incorporating
Urban Driving Conditions
Test method of N2 category**

Transmitted by JAPAN

1. Introduction

In Japan, urban running conditions have been investigated by using various types of road vehicles with different power to mass ratios, and new acceleration noise test methods have been studied. These studies found that, concerning N2 category vehicles, the noise levels measured by the test methods did not correspond well with the noise levels generated by urban running^{1),2)}.

Therefore, field measurements concerning urban running conditions and the acceleration noise test according to the ISO proposal were performed by using 4 vehicles of N2 category including a CNG vehicle. In this report, these results are described.

2. Running conditions on urban roads

The running conditions were investigated by using 4 vehicles with maximum payload from 2 tons to 4 tons (gross vehicle weight from 4 tons to 8 tons). Table 1 shows the specifications of the test vehicles used in this investigation. Vehicle N2-B is a CNG vehicle and the others are diesel engine vehicles.

Figure 1 shows the distribution of the cumulative frequency of the engine speeds when the N2 category vehicles ran on the urban roads. The 95 percentile value of the cumulative frequency of each vehicle is between 0.67 S and 0.77 S (S : rated engine speed), and the average value is 0.71 S. Figure 2 shows the relationships between power to mass ratio and engine speed, and between power to mass ratio and acceleration. In the figure, the data of

all vehicles including the data reported in the 36th GRB meeting are indicated. The blue squares indicate the data of the N2 vehicles added at this time. The engine speed and acceleration data of the N2 vehicles are almost on the same curve as the vehicles in the other categories, and this fact also corresponds to the CNG vehicle.

3. Test method of N2 category based on the ISO proposal

In this study, as the representative values of the noise generated from running vehicles on urban roads, the maximum noise levels in the start and the acceleration running condition were adopted. The calculation method of the maximum noise level has already been reported in the 35th GRB meeting. Figure 3 shows the example of the estimation results of the vehicle speed, the engine speed and the noise levels. From the results, the maximum noise levels have been extracted.

The engine speed at line BB (the end of the acceleration period) described in the ISO proposal is 0.65 S to 0.75 S for N2 category vehicles. In this study, the engine speed of 0.71 S at line BB was adopted on the basis of the data obtained from the urban road running. Table 2 shows the test method of each proposal. To examine the relationship between the noise level in the acceleration tests and that in the urban running, the acceleration noise test was conducted on the test track by using 7 vehicles of the N2 category. Table 3 shows the specifications of the test vehicles.

Figure 4 shows the relationships between the noise levels measured by the test methods and the maximum noise levels under the start and the acceleration condition on urban roads. Figure (a) shows the results of ECE R51/02 method, and Figure (b) shows those of the ISO proposal in which the engine speed of 0.71S at line BB was adopted for N2 category vehicles. The levels measured by the ECE R51/02 method show poor correspondence with the maximum noise levels at the start and the acceleration running condition on urban roads in all categories.

On the other hand, the noise levels measured by the ISO method show good correspondence with the maximum noise levels on urban roads. In the figure, the blue squares indicate the data of N2 category vehicles in which the engine speeds at line BB have been adjusted to 0.71S. Therefore, this method can be applied to the N2 vehicles as well as others.

4. Conclusions

Noise test method of the N2 category vehicles was studied based on the investigation result of the running conditions on urban roads. From the results, the following conclusions have been obtained.

- (1) For the N2 category vehicles, the average value of 95 percentile values of the cumulative frequency distributions of the engine speeds on urban roads was 0.71 S.
- (2) The engine speed of 0.71 S at the line BB was introduced into the ISO proposal. As a result, it was found that the noise levels measured by the ISO test method show good correspondence with the maximum noise levels at the start and the acceleration condition on urban roads.
- (3) We therefore agree with the German/ISO proposal³⁾ in which the engine speed of 0.70 S to 0.74 S was adopted as engine speed at line BB.
- (4) The German/ISO test method can be also applied to the CNG vehicle.

References

- 1) Informal document No.6, WP29/35thGRB, 2001
- 2) Informal document No.2, WP29/36thGRB, 2002
- 3) TRANS/WP.29/GRB/2002/4 10 July 2002

Table 1 Vehicles used in urban running test

Test Vehicle	No.	Engine	Displacement (cc)	Maximum power (kW/rpm)	Transmission	Vehicle mass (t)	Loading conditions	Power to mass ratio (kW/t)
Medium commercial vehicle-1 (2t Truck)	N2-A	Diesel	4214	92 / 3200	5M/T	2.18	Unladen	42.3
						4.27	Rated load	21.6
Medium commercial vehicle-2 (2t Truck)	N2-B	CNG	3907	88 / 3200	5M/T	2.99	Unladen	29.6
						5.08	Rated load	17.4
Medium commercial vehicle-3 (4t Truck)	N2-C	Diesel	8226	154 / 2850	6M/T	8.50	Rated load	18.1
Medium commercial vehicle-4 (4t Truck)	N2-D	Diesel	8226	129 / 2800	5A/T	3.76	Unladen	34.3
						7.89	Rated load	16.3

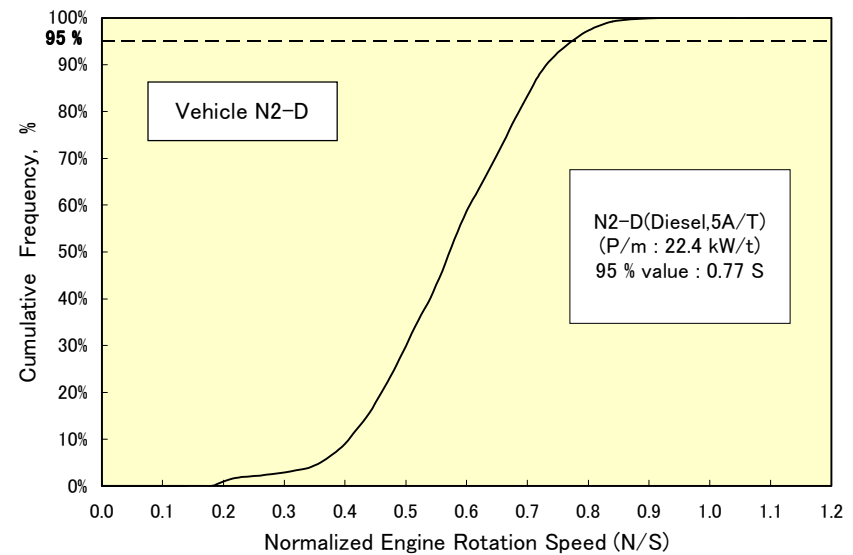
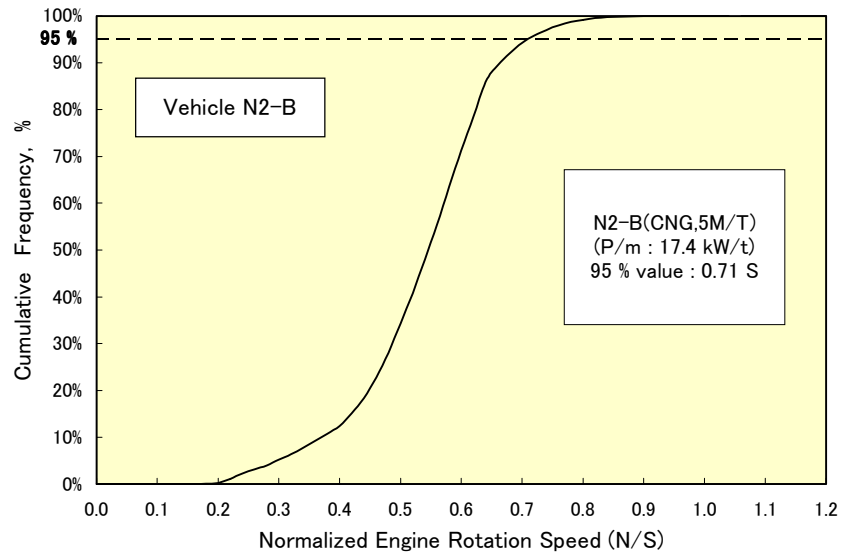
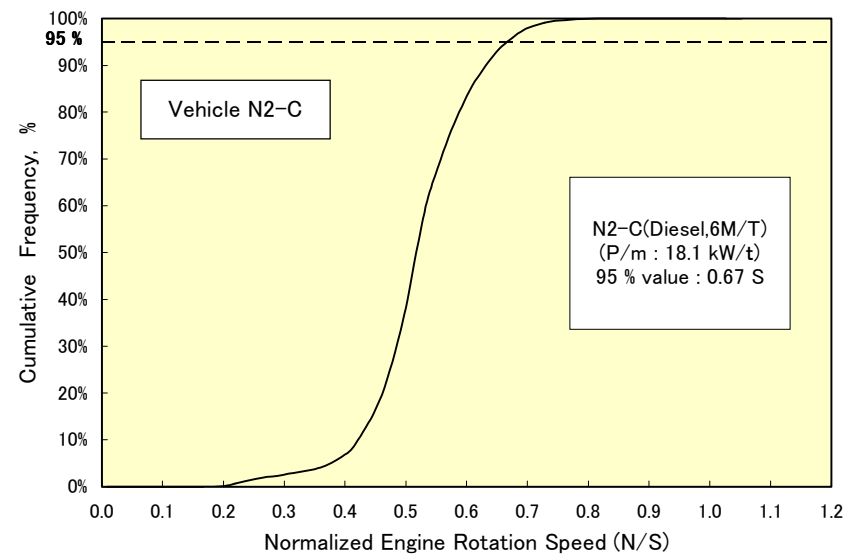
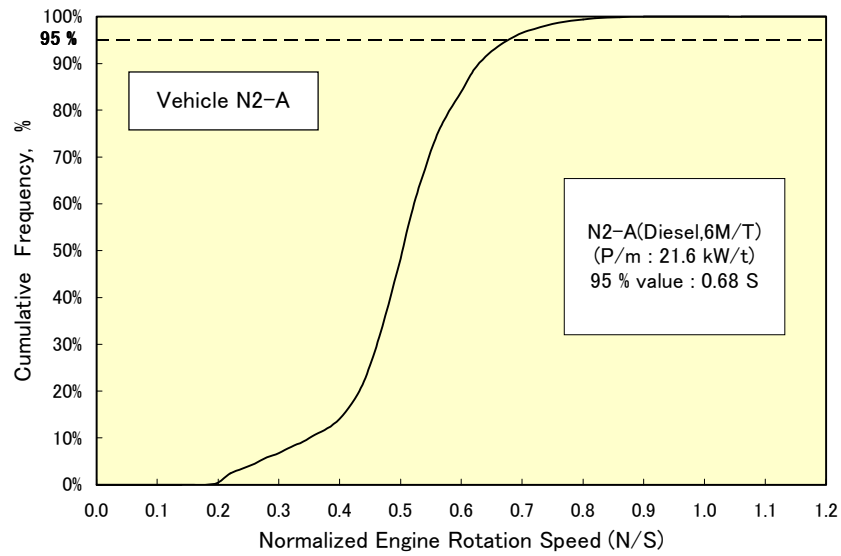
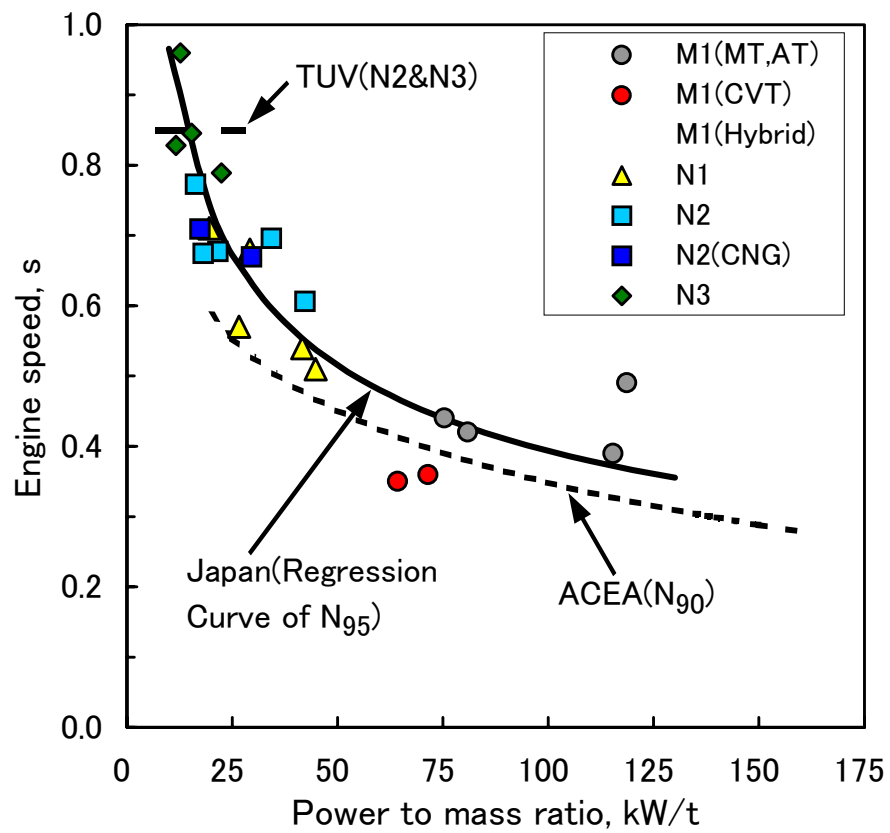
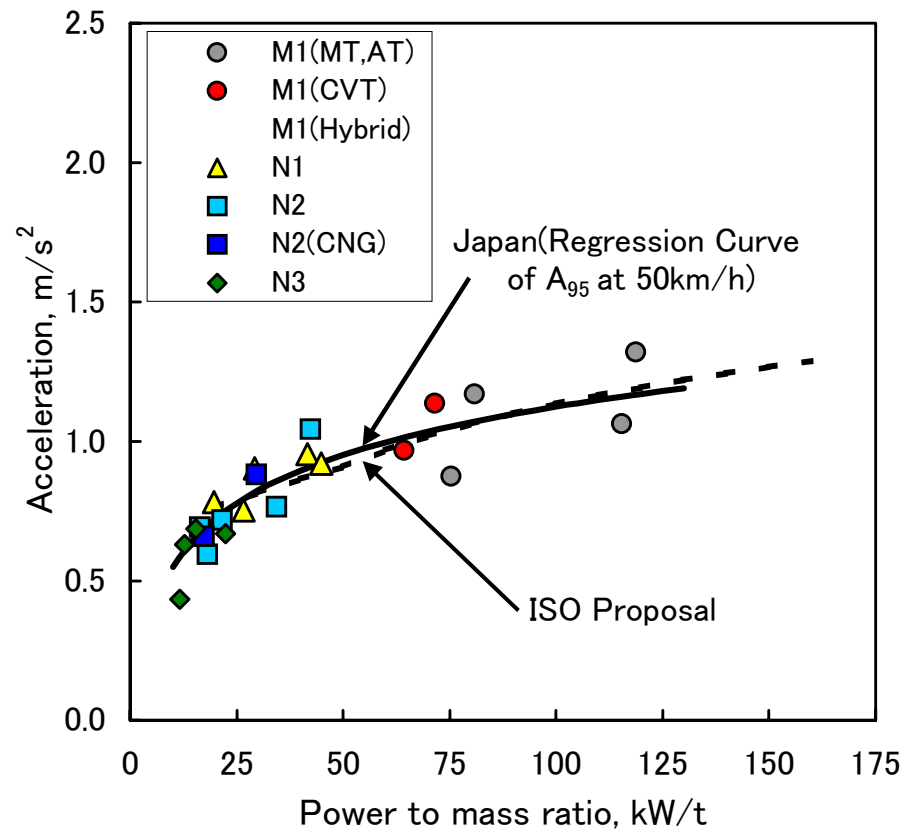


Figure 1 Cumulative frequency distributions of engine speed during acceleration



(a) Engine Speed



(b) Acceleration

Figure 2 Engine speed and acceleration in urban running (The 95 percentile values)

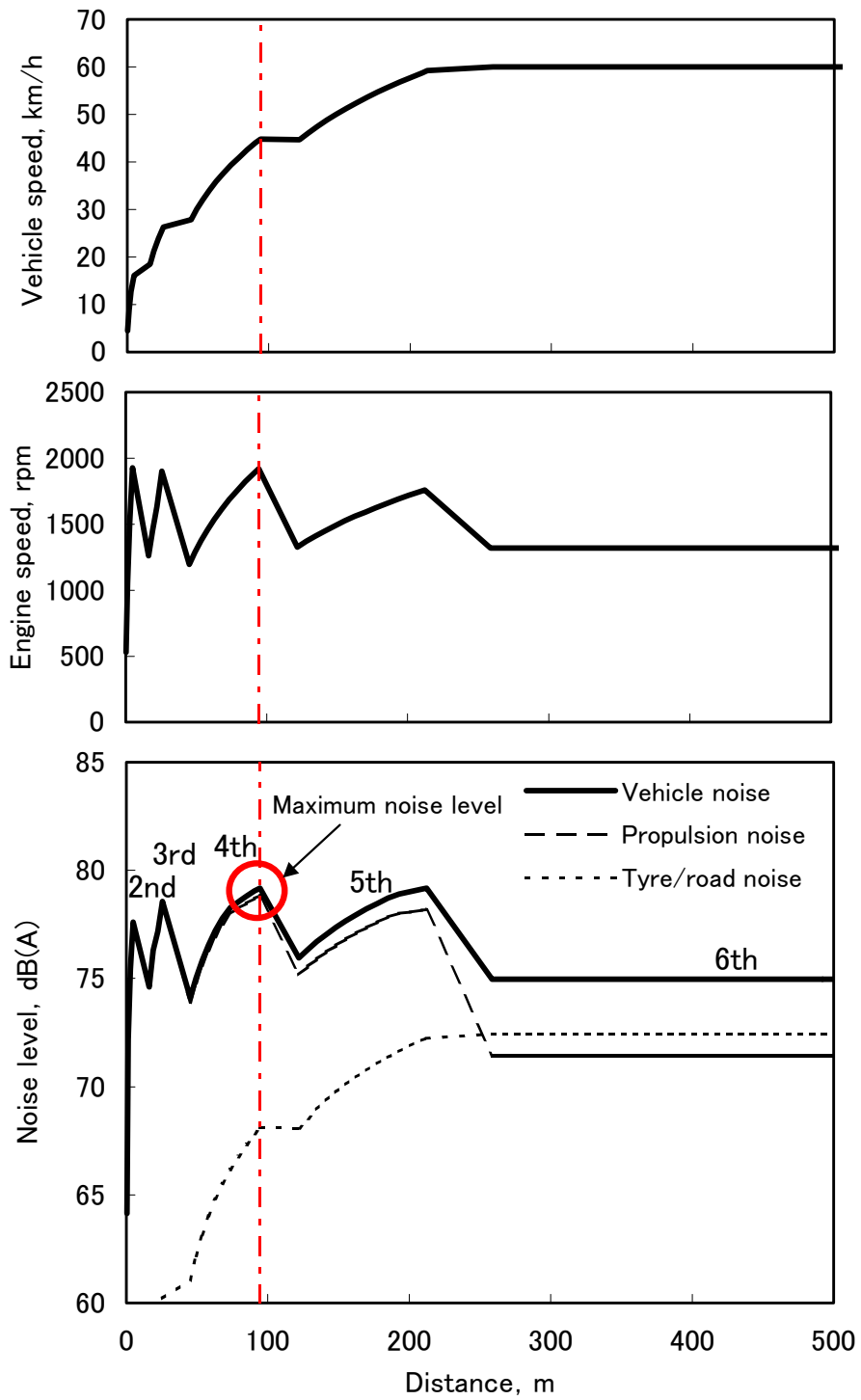


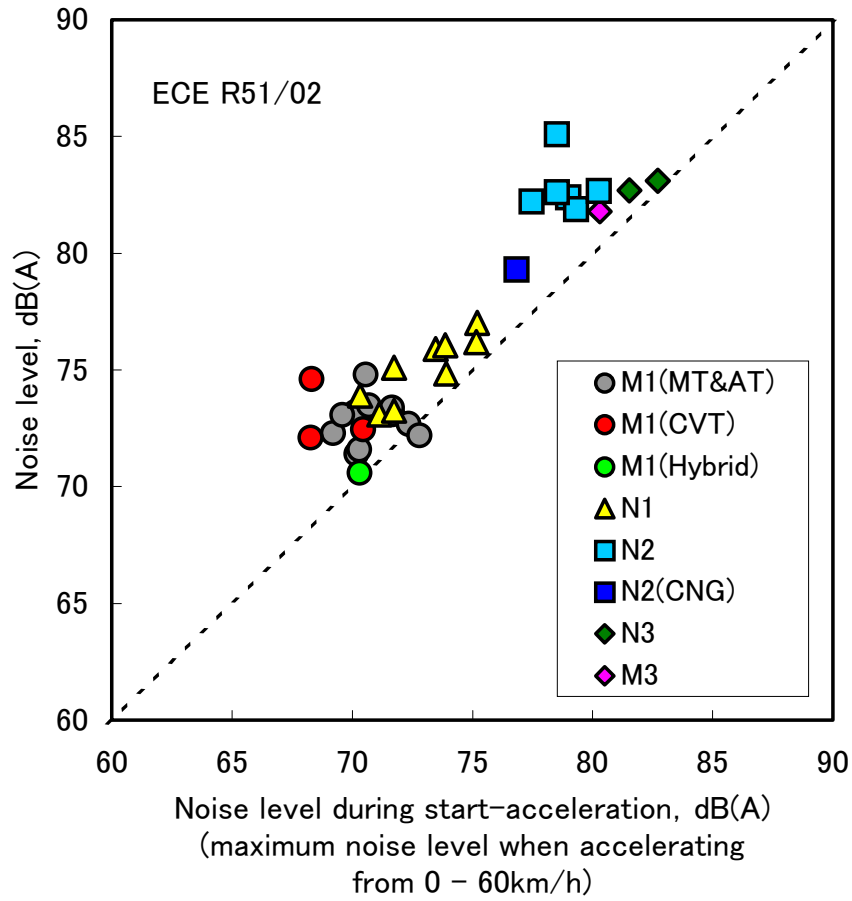
Figure 3 Estimation results of the vehicle speeds, the engine speeds and the noise levels during the start and the acceleration

Table 2 Outline of each test method

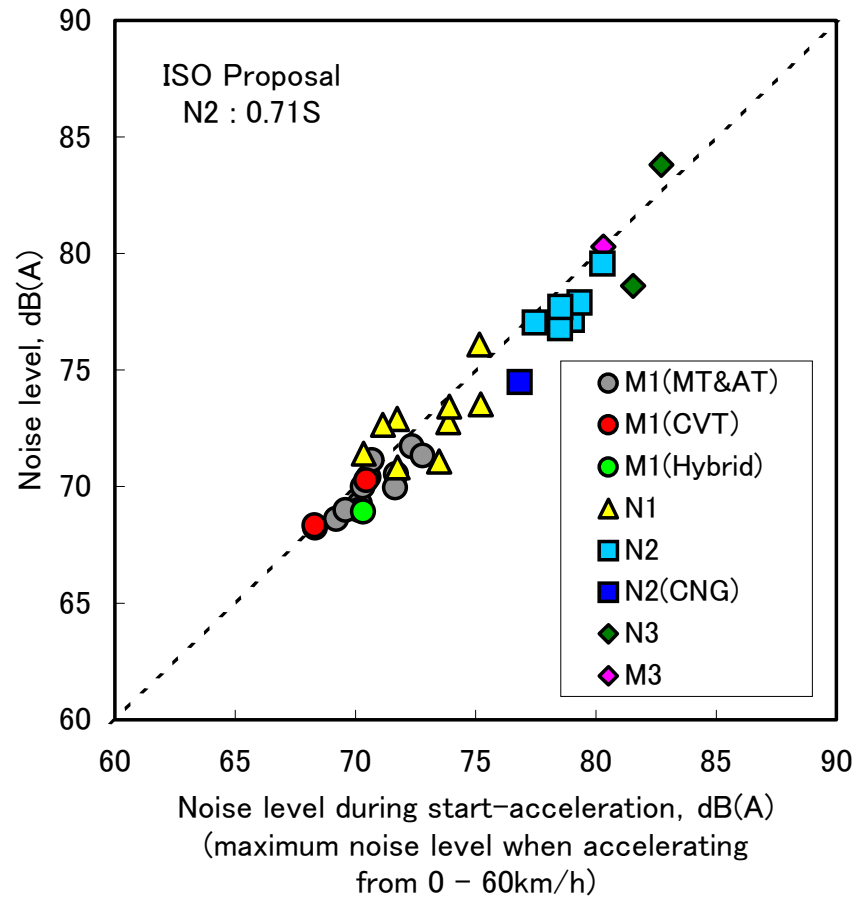
	ECE R51/02	ISO Proposal	This study
	Medium and heavy vehicles	Medium and heavy vehicles	Medium vehicles
Driving method	Full-throttle acceleration	Full-throttle acceleration	Full-throttle acceleration
Reference point	Vehicle front and rear	Engine front	Engine front
Loading conditions	Unladen	N2,N3: 50 x maximum power (kg) (the extra loading is limited to 75% of the max. weight allowed for the rear axle) M2,M3: unladen weight + 75kg	N2: 50 x maximum power (kg) (the extra loading is limited to 75% of the max. weight allowed for the rear axle) M2: unladen weight + 75kg
Acceleration start	Vehicle front: AA' line	Engine front: AA' line	Engine front: AA' line
Acceleration end	Vehicle rear: BB' line	Engine front: DD' line (15m behind microphone)	Engine front: DD' line (15m behind microphone)
Approach speed (V_A)	50km/h or 0.75S, whichever is less		
Vehicle speed at BB' line (V_B) Engine speed at BB' line (N_B)		Medium vehicles(N2,M2) N _B : 0.65S-0.75S Heavy vehicles(N3,M3) N _B : 0.85S-0.89S	N _B : 0.71S
Gear selection	When power is less than 225kW, n/2 or higher gear. When power is more than 225kW, n/3 or higher gear (n: total number of gears)	Gear nearest 35km/h at 0.65S (N2,M2), 0.85S (N3,M3) When gear is more than 5km/h off target speed: two gears on either side of 35km/h When approach engine rotation speed is less than 1000rpm: higher gear	Gear nearest 35km/h at 0.71S When gear is more than 5km/h off target speed: two gears on either side of 35km/h When approach engine rotation speed is less than 1000rpm: higher gear
Reported values (L_R)	L _R = measured value	L _R = measured value When measurement is taken in two gears: L _R =(L ₁ +L ₂)/2	L _R = measured value When measurement is taken in two gears: L _R =(L ₁ +L ₂)/2

Table 3 Vehicles used in the acceleration tests

No.	Category	Engine type	Displacement (cc)	Maximum power (kW/rpm)	Transmission	Vehicle mass (maximum payload) (kg)	Loading conditions	Power to mass ratio (kW/t)
N2-1	N2	Diesel	4104	91.9 / 3200	5M/T	2170 (2000)	Unladen 50 x maximum power (kW)	41.0 21.2
N2-2		Diesel	4334	90.5 / 3100	5M/T	2610 (2000)	Unladen 50 x maximum power (kW)	18.7 20.0
N2-3		Diesel	5249	103.0 / 3200	5M/T	2582 (2000)	Unladen 50 x maximum power (kW)	38.8 21.7
N2-4		Diesel	6925	177.0 / 2700	6M/T	3630 (4100)	Unladen 50 x maximum power (kW)	47.8 22.4
N2-5		CNG	3907	88.3 / 3200	5M/T	2910 (2000)	Unladen 50 x maximum power (kW)	29.6 20.0
N2-6		Diesel	4104	91.9 / 3200	5M/T	2100 (2000)	Unladen 50 x maximum power (kW)	42.3 21.6
N2-7		Diesel	8226	128.7 / 2800	5A/T	3680 (4100)	Unladen 50 x maximum power (kW)	47.8 22.4



(a) ECE R51/02



(b) ISO Proposal (N2 : 0.71S)

Figure 4 Relationships between the noise levels measured by the test methods and the maximum noise level under the start and the acceleration condition