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agenda item 2)

Research on Measurement Methods for LDV & HDV in Multiple Driving Mode Conditions

- CATC Data Study and Measurement Methods Research -

5-7th September 2022, GRBP 76th Session

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Review

- January, 2018, the project GB/T “Measurement Methods for Noise Emitted by Light-duty Vehicles in Multiple Driving Mode Conditions” launched.
- June, 2020, China introduced “Measurement Methods for Noise Emitted by Light-duty Vehicles in Multiple Driving Mode Conditions” in the 16th ASEP IWG meeting.
- August, 2021, the project GB/T “Measurement Methods for Noise Emitted by Heavy-duty Vehicles in Multiple Driving Mode Conditions” launched.
- October, 2021, GB/T 40578-2021 “Measurement Methods for Noise Emitted by Light-duty Vehicles in Multiple Driving Mode Conditions” published.
- September, 2022, HDV working condition survey for the measurement methods based on CATC data.

GB/T 40578-2021 for LDV (Two questions are still remained)

Acceleration noise

Test speeds (km/h)	$V_{PP'}$=30±1	$V_{PP'}$=50±1	$V_{PP'}$=70±2
Engine speeds (r/min)	$n_{BB'}$=Idle to 80%S		
Acceleration (m/s^2)	$0.5 \le a_{test} \le 3.5$	$0.5 \le a_{test} \le 3.0$	$0.3 \le a_{test} \le 2.5$
Test Gears	(1+X/2)/2+1	(1+X/2)	(X+X/2)/2+1
	D for unlockable		
Accelerator Position	POT or WOT (Both are possible)		
Noise Tested	L_{max} per run for left side and right side separately		
No. of Runs*	2		
Intermediate Result	Average of per side		
Final result	Higher of averages		
*M_1 (PMR≥90 kW/t), 2 runs can add at different acceleration.			

Cruise noise

Test speeds (km/h)	$V_{PP'}$=80±2	$V_{PP'}$=110±2 for M_1 $V_{PP'}$=90±2 for others
Engine speeds (r/min)	$n_{BB'}$=Idle to 80%S	
Acceleration (m/s^2)	$a_{test} \le 0.15$	
Test Gears	Highest lockable gear or D for unlockable	
Accelerator Position	POT (Cruise)	
Noise Tested (dB(A))	L_{max} per run for left side and right side separately	
No. of Runs	2	
Intermediate Result	Average of per side	
Final result	Higher of averages	

Data Survey for HDV

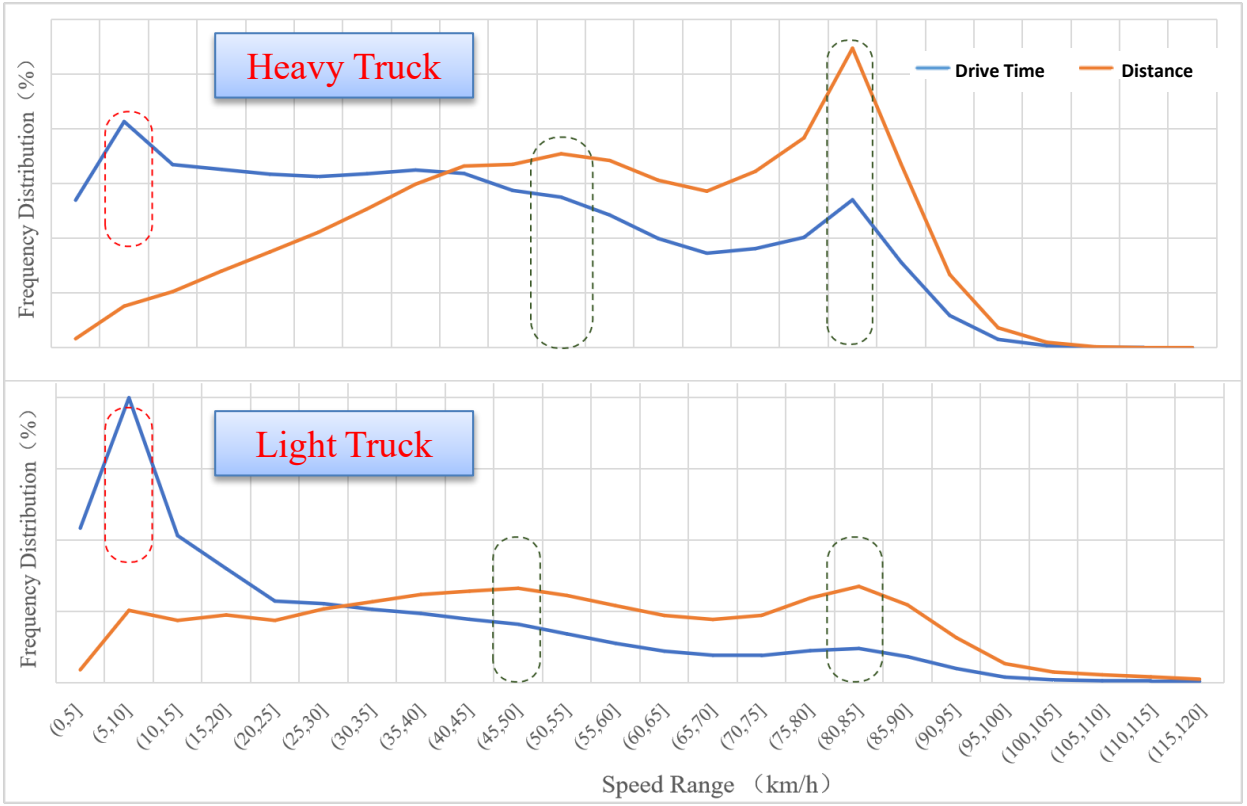
- **Established a fleet composed of 76 heavy-duty vehicles, covering typical vehicle types, vocations and cities all over China.**
- **Collected 1hz real-time data including vehicle speed, engine speed and other parameters by free driving operation.**
- **Collected about 1.5 million kilometer's real-road data by 3-6 months of stable driving.**

	Bus	Coach	Heavy Truck	Light Truck	Dumper	Tractor
Fleet Size	13	12	15	12	10	14
Distance (10000 km)	43.74	28.14	23.22	13.23	13.46	29.63
City	16 cities covered (Harbin, Changchun, Hangzhou, Changsha, Guiyang, Fuzhou, Kunming, Nanning, Shuangliao, Xining, Linfen, Xiangyang, Huzhou, Nanchang, Xiamen)					
Vocation	Intercity Long Haul 、Local Delivery、City Construction、Passenger Transportion…					

- **Based on collected data, determine typical scenes that are prone to generate noise. Establish corresponding test projects in the standard system.**
- **Based on scene information, calculate statistical characteristics to design specific test methods and conditions.**

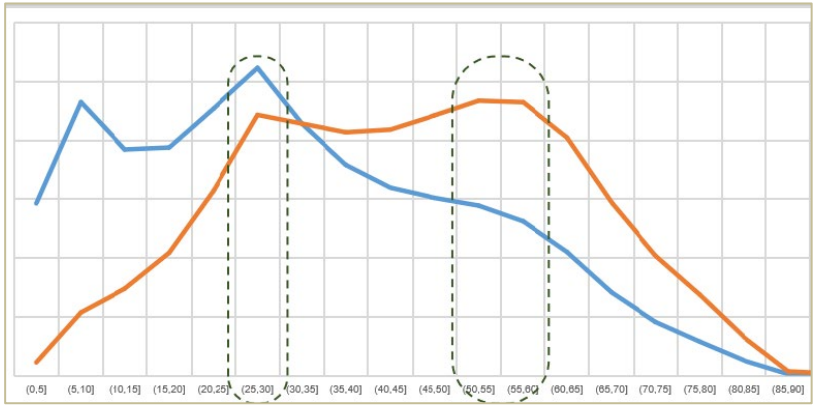
Data Survey for HDV (Speed)

For defferent vehicle types, locate high frequency speed distribution zones based on drive time and distance.

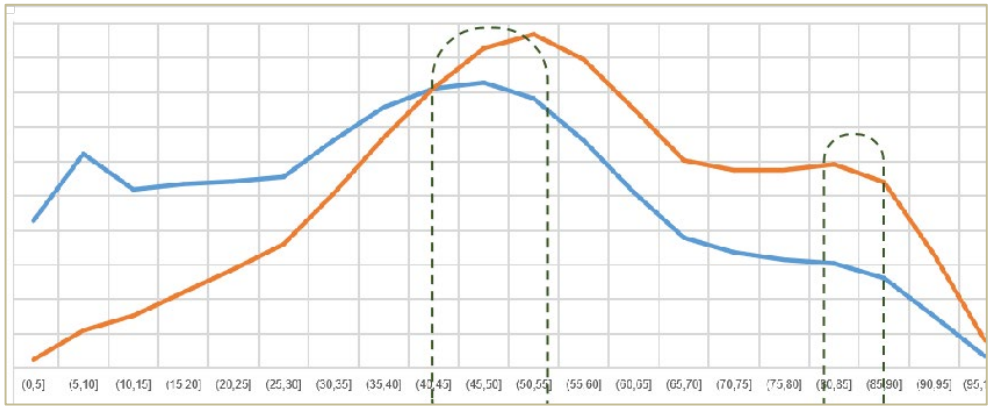


Data Survey for HDV (Speed)

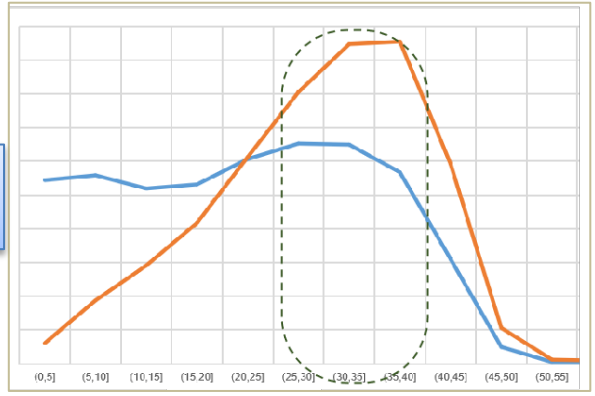
Dumper



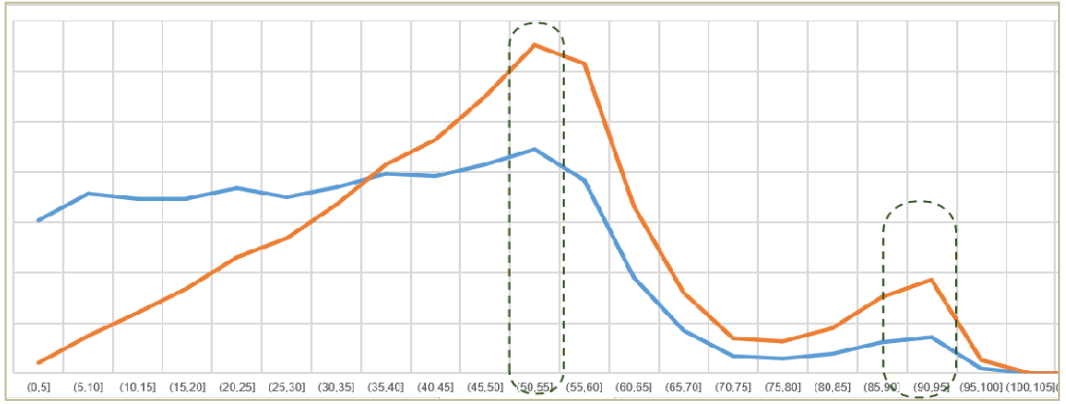
Tractor



Bus



Coach



Data Survey for HDV (Speed)

Vehicle Type	Speed Range	LOW	MID	HIGH
Bus	Time	25-35	——	——
	Distance	30-40	——	——
Coach	Time	——	50-55	90-95
	Distance	——	50-55	90-95
Heavy Truck	Time	5-10	——	80-85
	Distance	——	50-55	80-85
Light Truck	Time	5-10	——	80-85
	Distance	——	45-50	80-85
Dumper	Time	5-10 25-30	——	——
	Distance	25-30	50-60	——
Tractor	Time	5-10	45-50	——
	Distance	——	50-55	80-85
Test Speed Point		Starting + 30	50	80

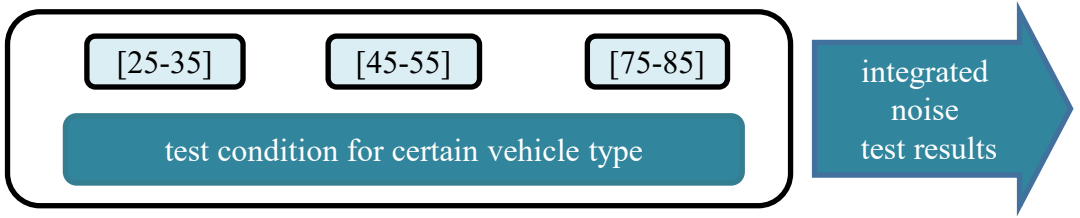
Data Survey for HDV (Engine speed + Accelaration)

Heavy-Truck

Engine Speed Percentile(Rated：2500rpm）					
Speed	50%	80%	90%	95%	99%
50	1449	1918	2019	2098	2236
80	1698	1781	2100	2169	2263
Acceleration Percentile(m/s2)					
50	0.08	0.19	0.28	0.36	0.67
80	0.08	0.14	0.19	0.22	0.39

Engine Speed Percentile(Rated：2200rpm）					
Speed	50%	80%	90%	95%	99%
50	1259	1488	1560	1614	1863
80	1765	1783	1791.3	1801	1814
Acceleration Percentile(m/s2)					
50	0.08	0.17	0.22	0.31	0.61
80	0.08	0.14	0.17	0.19	0.28

Calculate typical percentile values of engine speed and acceleration within ± 5km/h range of test speed point.



Light Truck

Engine Speed Percentile(Rated：3200rpm）					
Speed	50%	80%	90%	95%	99%
50	1748	2107	2293	2408	2976
80	2116	2650	2736	2799	2875
Acceleration Percentile（m/s2）					
50	0.22	0.39	0.50	0.61	0.89
80	0.17	0.33	0.42	0.50	0.75

Dumper

Engine Speed Percentile(Rated：2500rpm）					
Speed	50%	80%	90%	95%	99%
30	1382	1927	2014	2075	2199
50	1329	1454	1513	1557	1997
Acceleration Percentile(m/s2)					
30	0.22	0.53	0.75	0.97	1.78
50	0.22	0.39	0.50	0.58	0.92

Data Anylasis for HDV

Tractor

Engine Speed Percentile(Rated：1900rpm）					
Speed	50%	80%	90%	95%	99%
50	1142	1300	1355	1397	1470
80	1519	1575	1615	1637	1683
Acceleration Percentile(m/s2)					
50	0.14	0.25	0.33	0.42	0.61
80	0.08	0.14	0.19	0.25	0.44

Engine Speed Percentile(Rated：1900rpm）					
Speed	50%	80%	90%	95%	99%
50	1057	1127	1160	1377	1497
80	1649	1703	1728.2	1743	1769
Acceleration Percentile(m/s2)					
50	0.14	0.28	0.36	0.47	0.78
80	0.08	0.17	0.22	0.25	0.42

Bus

Engine Speed Percentile(Rated：2500rpm）					
Speed	50%	80%	90%	95%	99%
Overall	1014	1425	1607	1778	2147
30	1154	1670	1793	1905	2051
Acceleration Percentile（m/s2)					
Overall	0.28	0.64	0.92	1.17	1.89
30	0.28	0.64	0.89	1.14	1.81

Engine Speed Percentile(Rated：2200rpm）					
Speed	50%	80%	90%	95%	99%
Overall	1053	1195	1276	1349	1509
30	1112	1215	1309	1359	1434
Acceleration Percentile（m/s2)					
Overall	0.39	0.78	1.06	1.36	2.03
30	0.33	0.67	0.94	1.19	1.83

Coach

Engine Speed Percentile(Rated：2200rpm）					
Speed	50%	80%	90%	95%	99%
50	1339	1478	1551	1975	2188
80	1213	1469	1553	1605	1651
Acceleration Percentile(m/s2)					
50	0.33	0.64	0.83	1.08	1.61
80	0.17	0.33	0.46	0.61	0.97

Engine Speed Percentile(Rated：2300rpm）					
Speed	50%	80%	90%	95%	99%
50	1213	1334	1380	1419	1872
80	1155	1192	1203	1211	1478
Acceleration Percentile(m/s2)					
50	0.28	0.50	0.67	0.88	1.44
80	0.17	0.31	0.44	0.58	0.69

Conclusions

- Consider low- speed conditions for LDV (mixed with active sound, muffler and leisure noise problem, below 30km/h).
- More accurate acceleration range is needed.
- Emission Model and Evaluation Model for LDV are expected to be established (powertrain including engine and transmission system).

- Testing speed 25-45 km/h and engine speed range (85-89% S) in UN R51-03 reflect the real-world working conditions well.
- 30±5km/h, 50±5km/h, 80±5km/h could be the propriate test speeds for HDV, but depends on the utilities and sub-categories of HDV.
- Other conditions like the test mass need to study, and the work of HDV measurement methods will be finished next year.

Thanks for your attention!