

Gear shift analysis

Proposed by Japan

DHC group
under GRPE/WLTP informal group
6-7 July 2011
Stockholm, Sweden

How to define the gear shift point

- In case of manual gear shift, the equation for the vehicle speed would be the following if the clutch was engaged.

$$\frac{i_t \cdot i_f}{2\pi r} = \frac{N_e}{V}$$

where,

V: Vehicle speed (m/s)

N_e : Engine speed (1/s)

r: radius of tire (m)

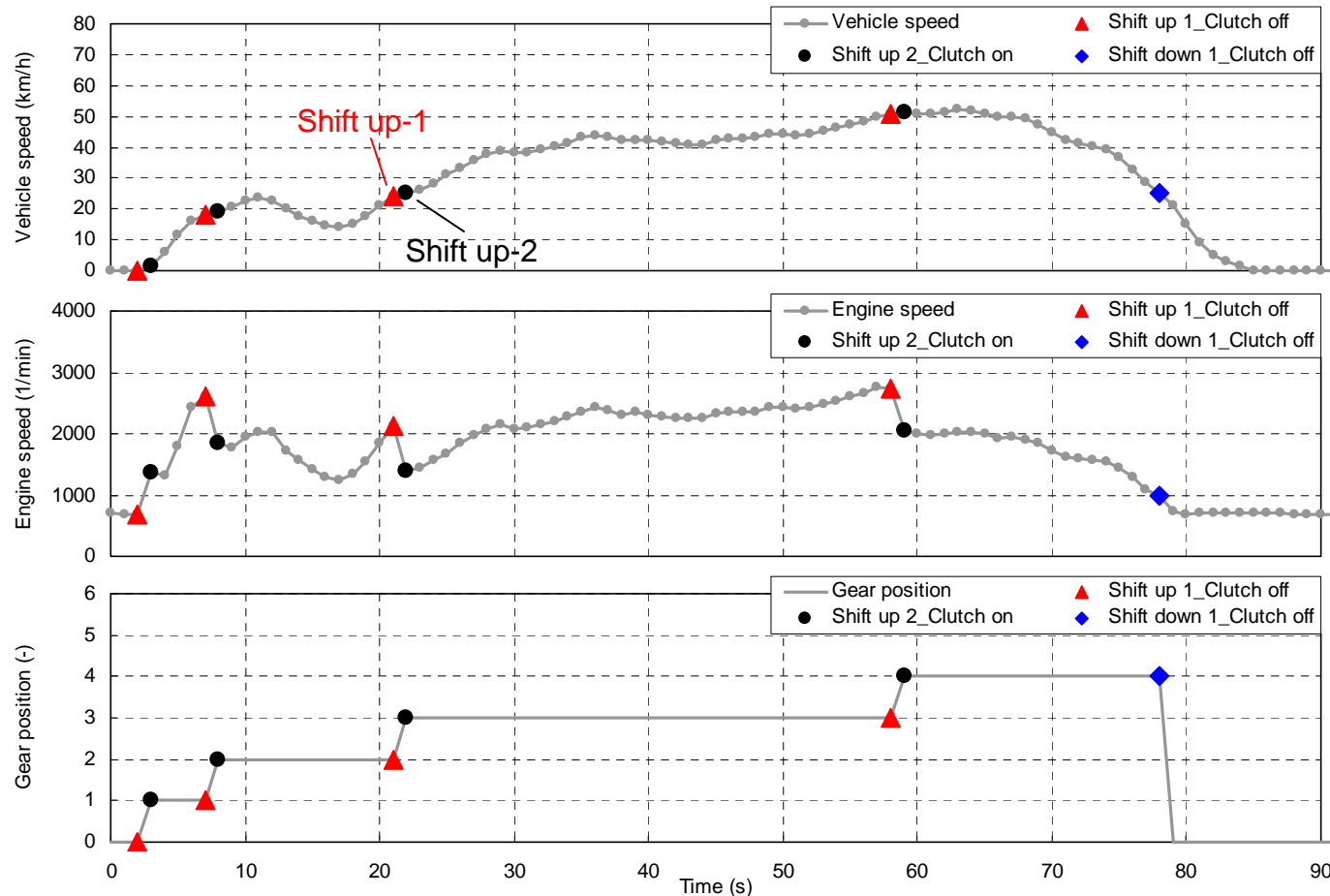
i_t : Gear ratio

i_f : final reduction ratio

- Consequently, gear position can be defined by calculating gear ratio during driving

Definition of the gear shift point

- Shift up-1: Clutch disengaged point for up-shifting
- Shift up-2: Clutch engage point after putting in higher gear
- Shift down-1: Clutch disengaged point for down-shifting or neutral



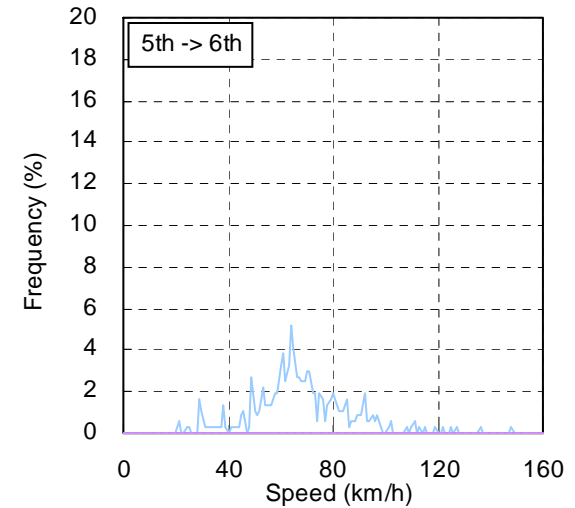
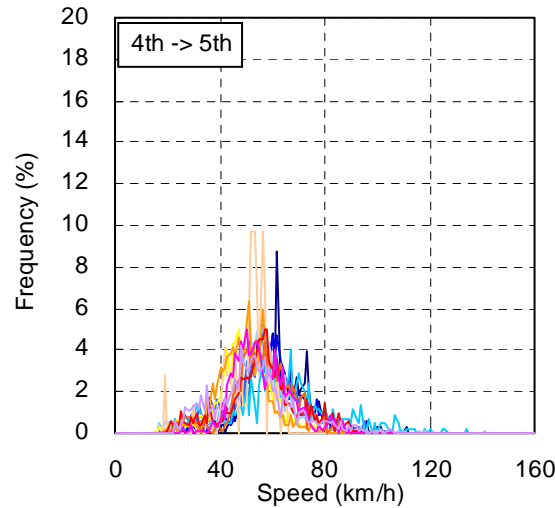
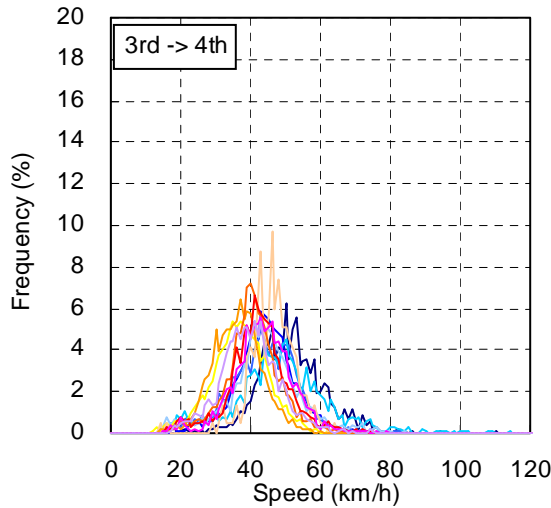
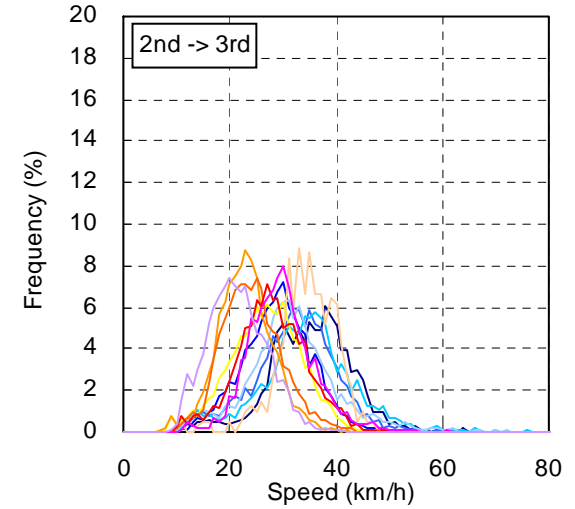
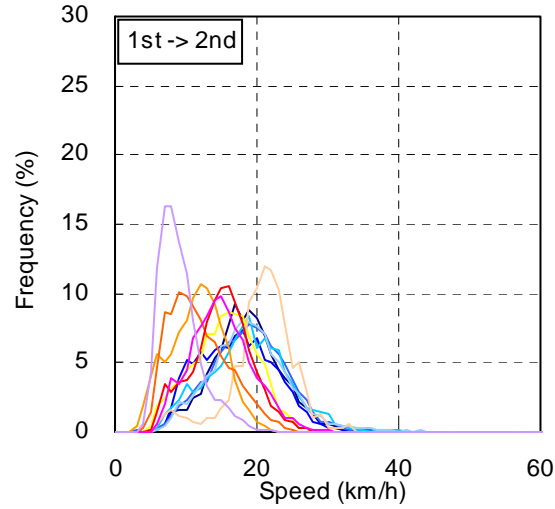
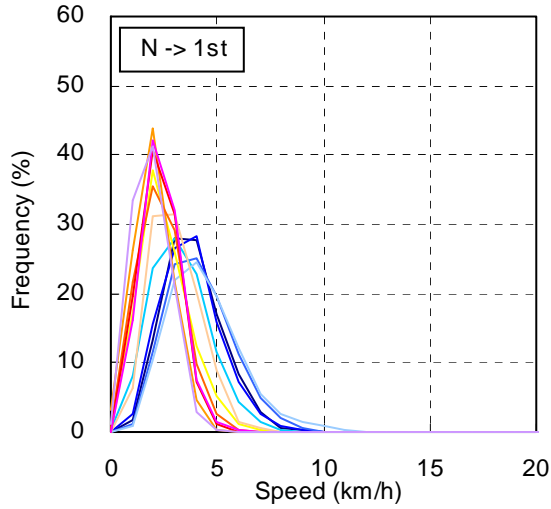
Extract driving condition at the shift up-1, shift up-2 and shift down-1

Factorial analysis and Frequency distribution

- Calculate the vehicle speed in each gear position (both up-shift and down-shift), then generate various frequency distribution by each vehicle category and analyze the factors that effect shift operation.
 - Vehicle speed frequency distribution
($0 \leq V \leq 100$ km/h, 1km/h step)
 - Vehicle acceleration frequency distribution
($-10 \leq a \leq 10$ km/h/s, 1km/h/s step)
 - Engine speed frequency distribution
($600 \leq r \leq 6000$ rpm, 100rpm step)
 - Standardized engine speed frequency distribution
($0 \leq r \leq 100$ %, 10 % step)

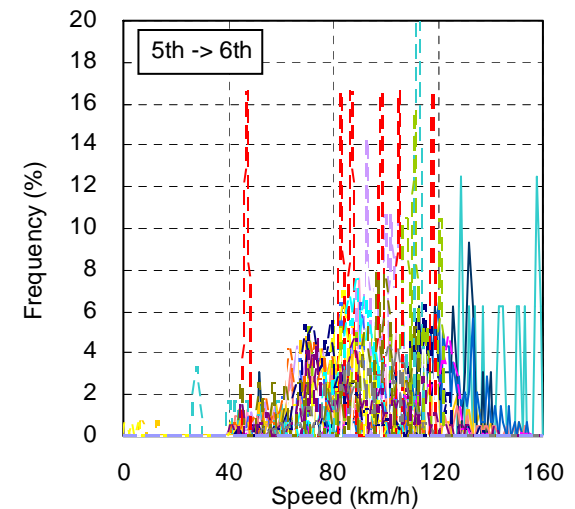
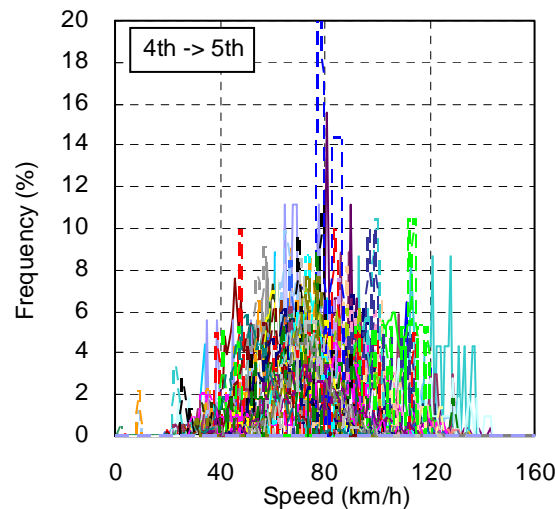
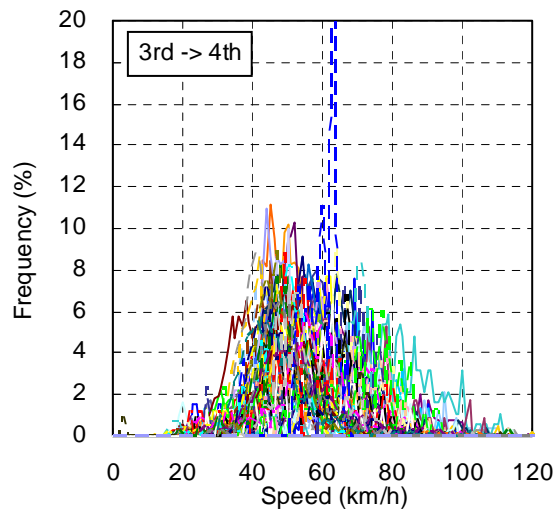
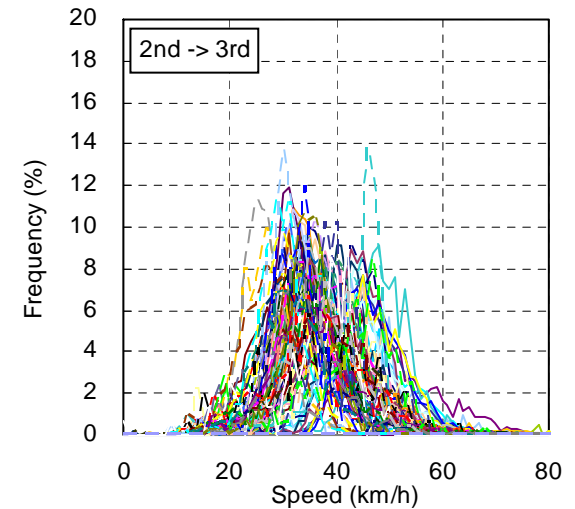
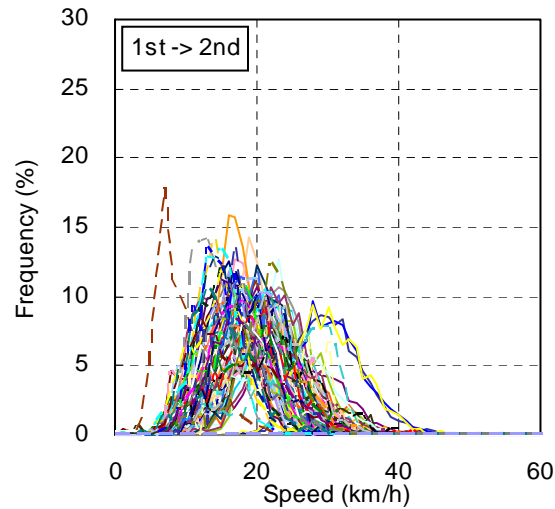
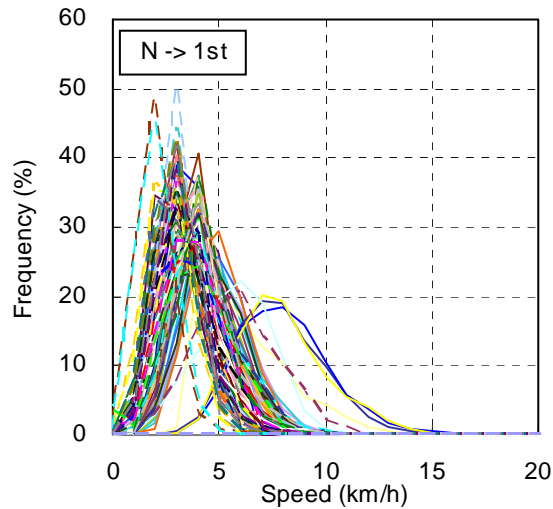
Speed frequency distribution at shift up-1

◇ Shift up-1 speed in Japan



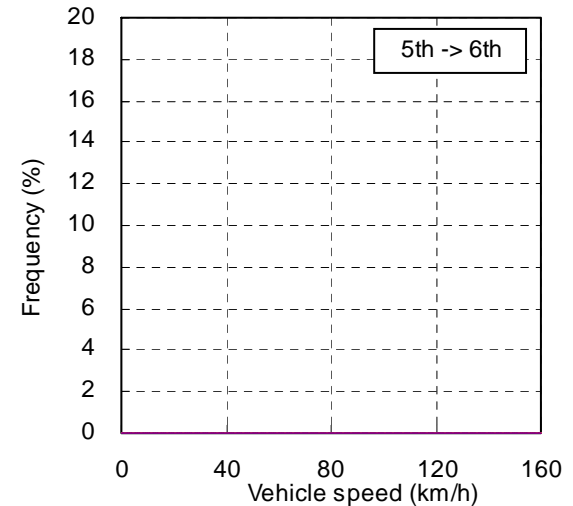
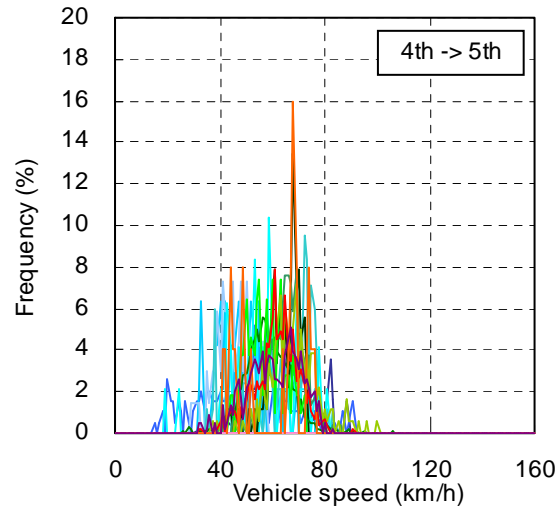
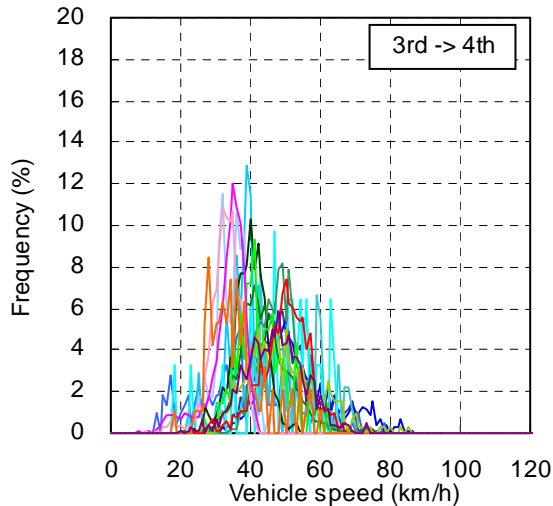
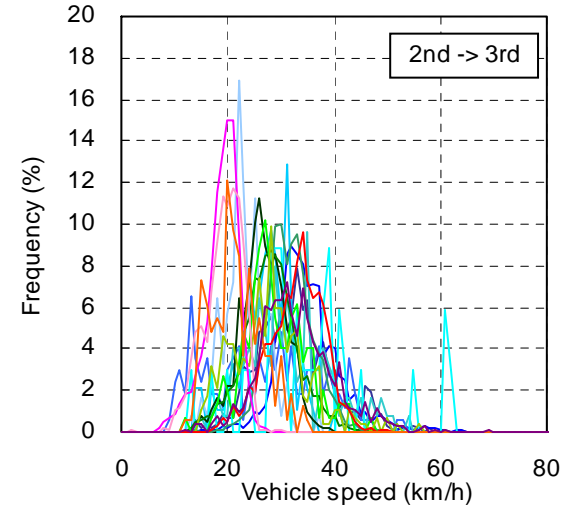
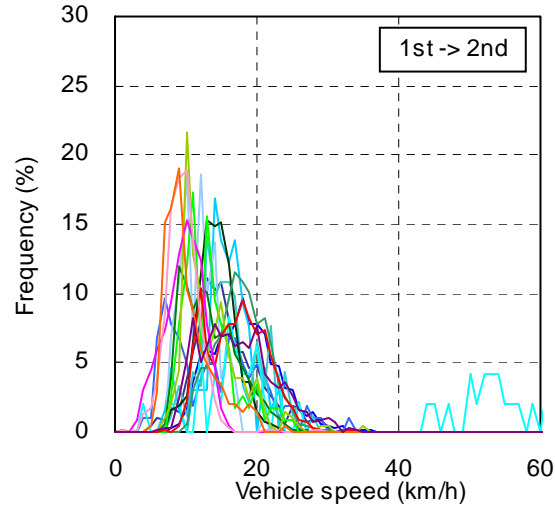
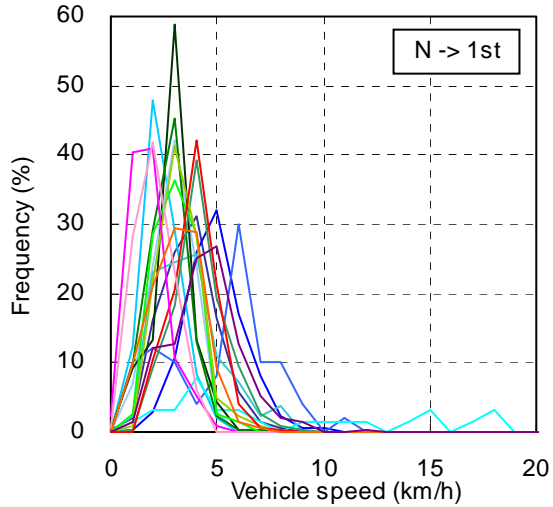
Speed frequency distribution at shift up-1

◇ Shift up-1 speed in Europe



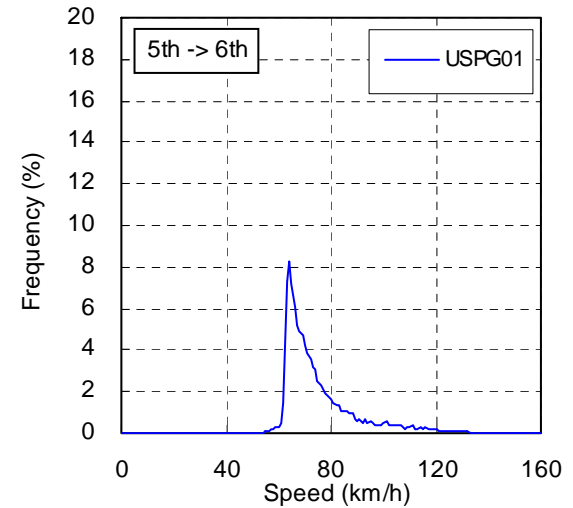
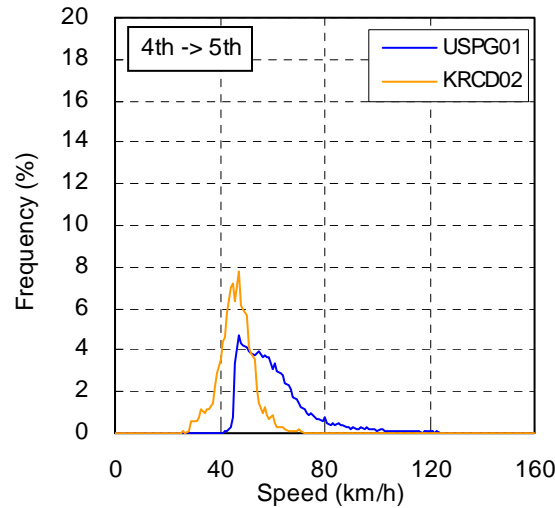
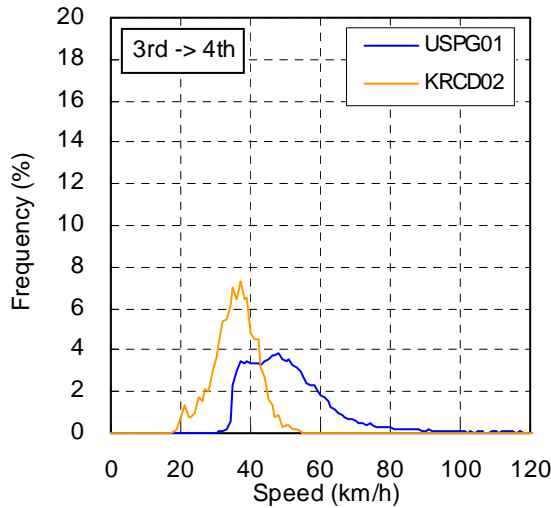
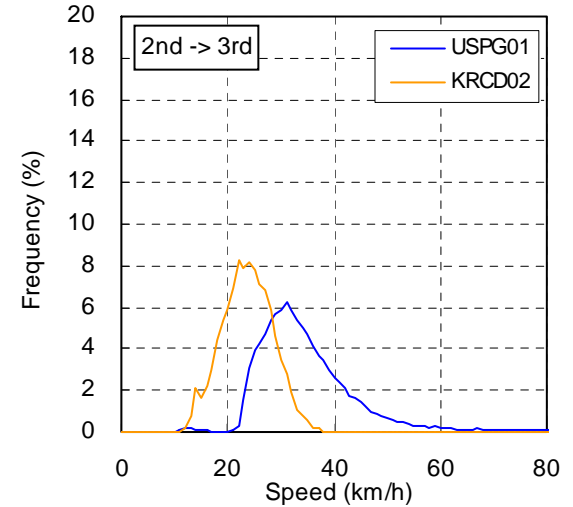
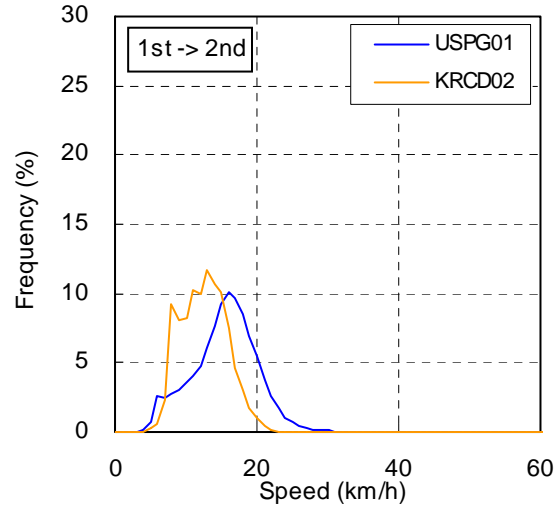
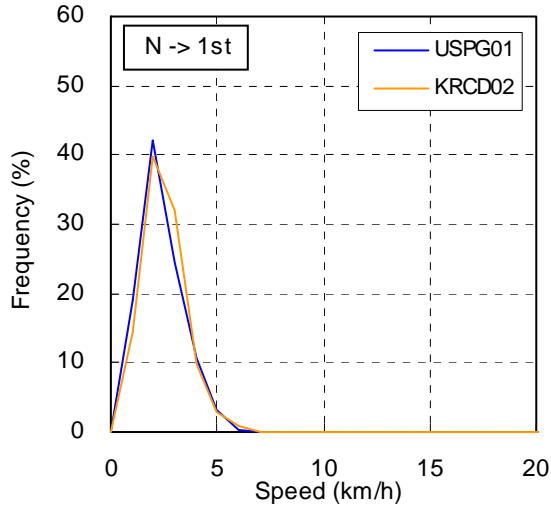
Speed frequency distribution at shift up-1

◇ Shift up-1 speed in India



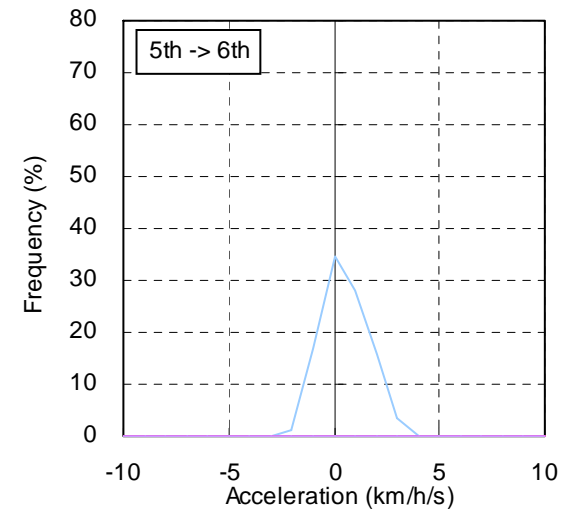
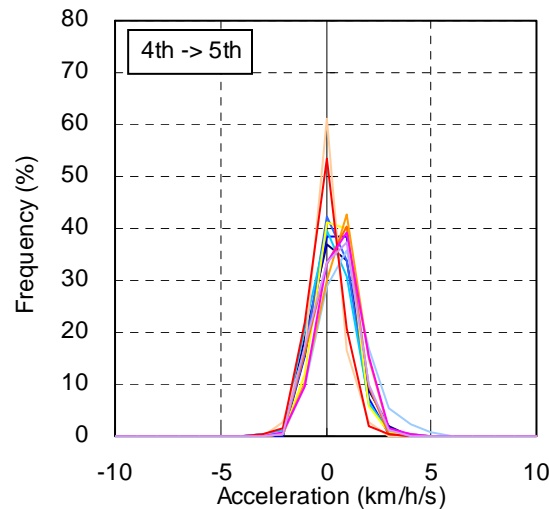
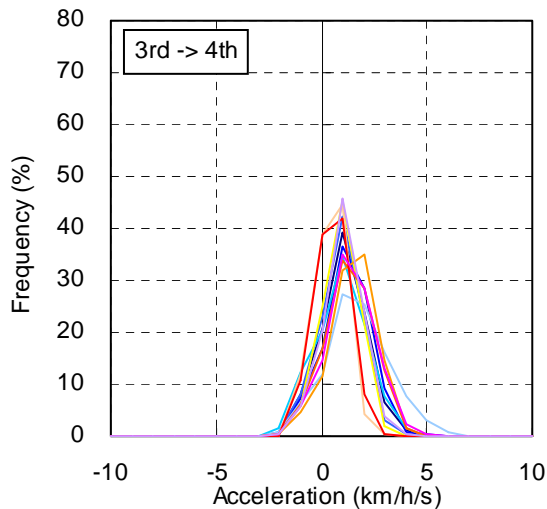
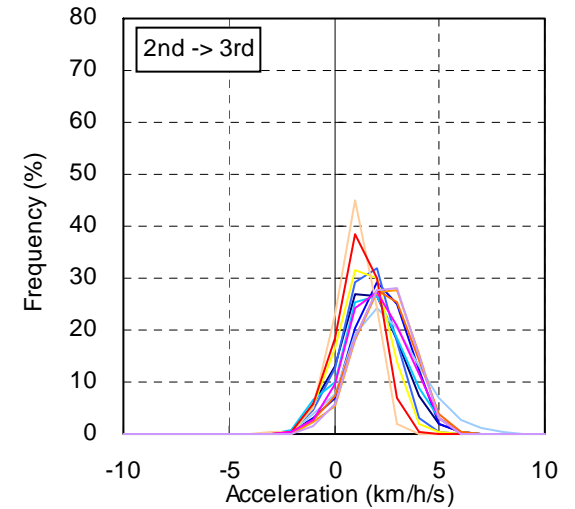
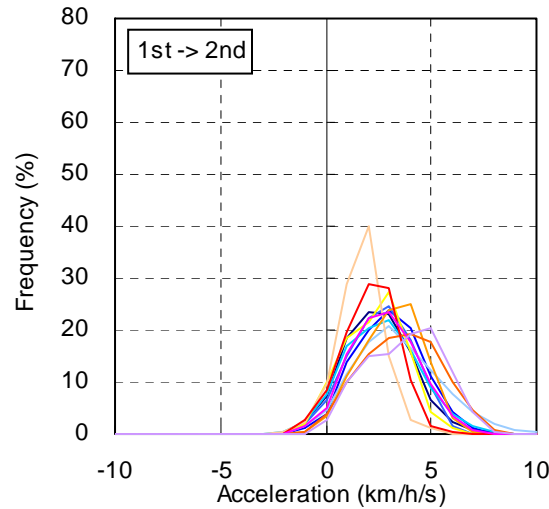
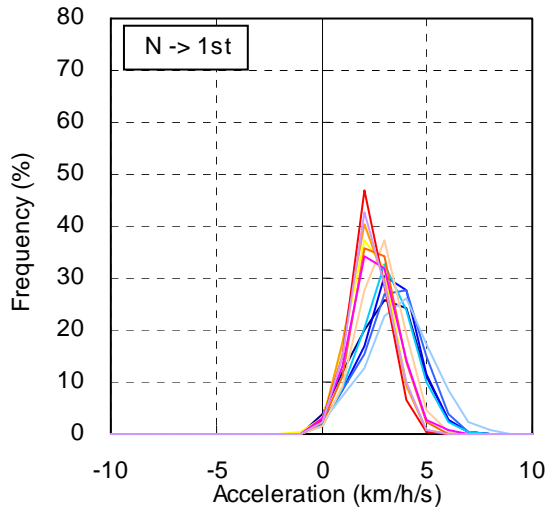
Speed frequency distribution at shift up-1

◇ Shift up-1 speed in US & Korea



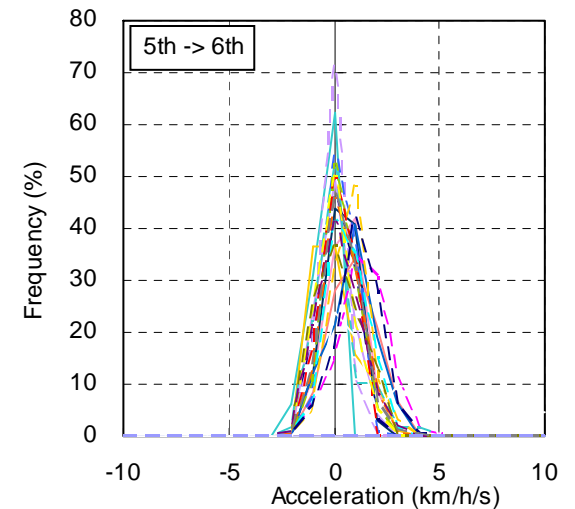
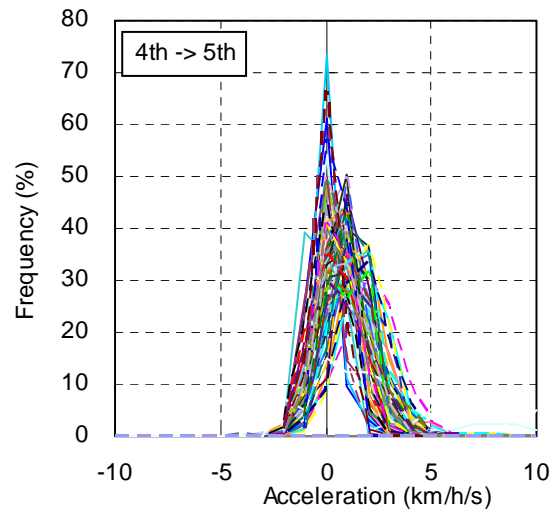
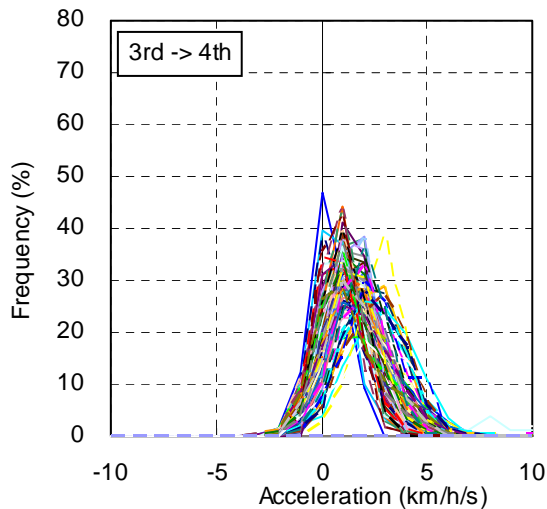
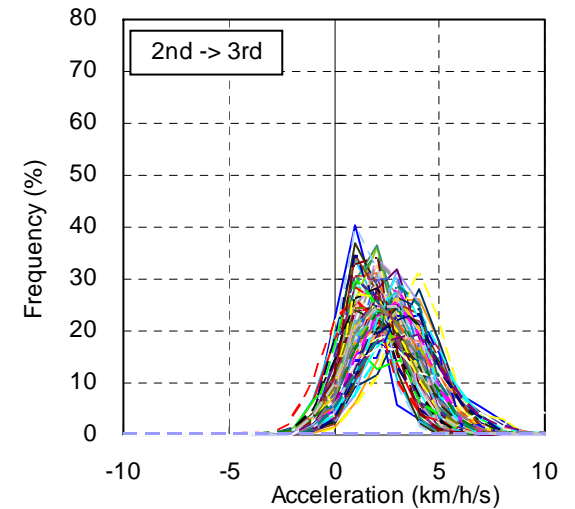
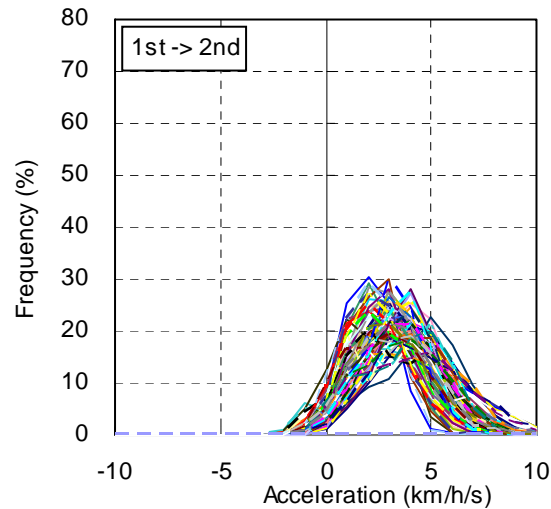
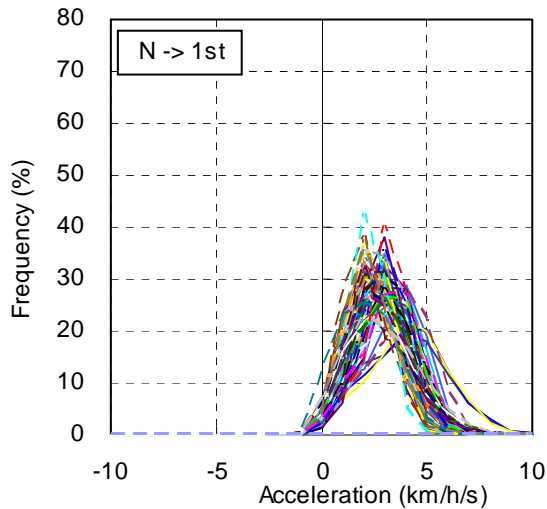
Acceleration frequency distribution at shift up-1

◇ Shift up-1 acceleration in Japan



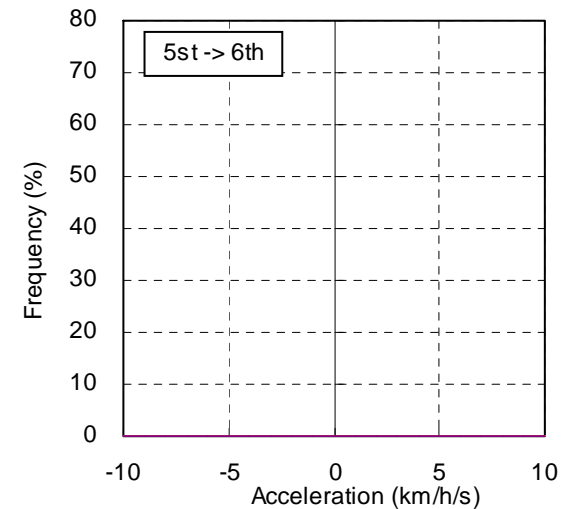
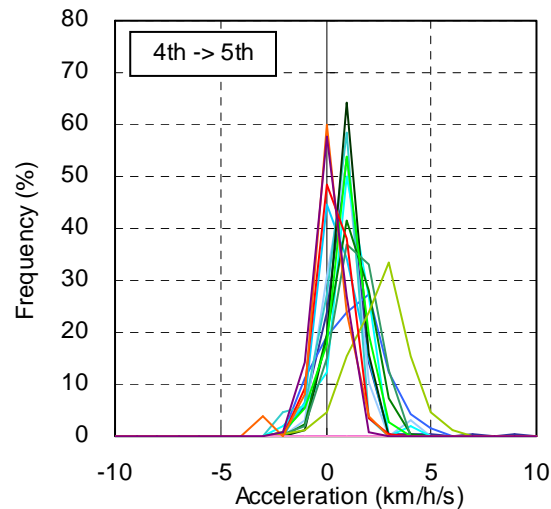
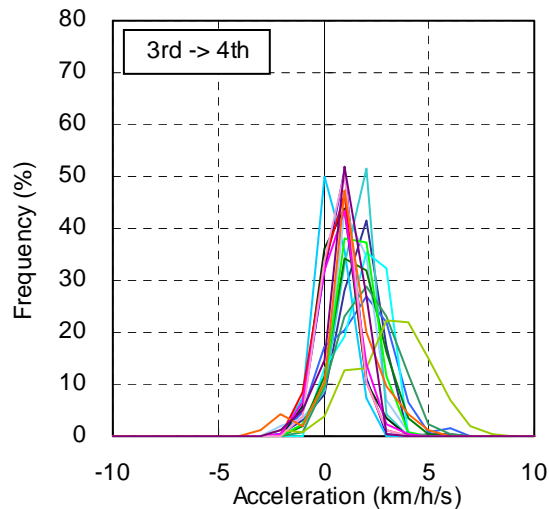
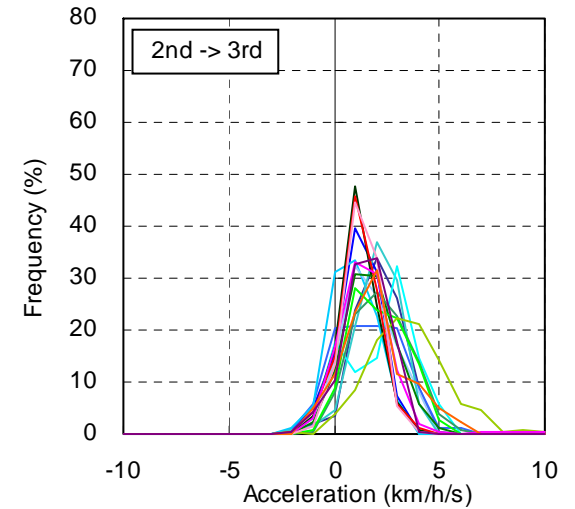
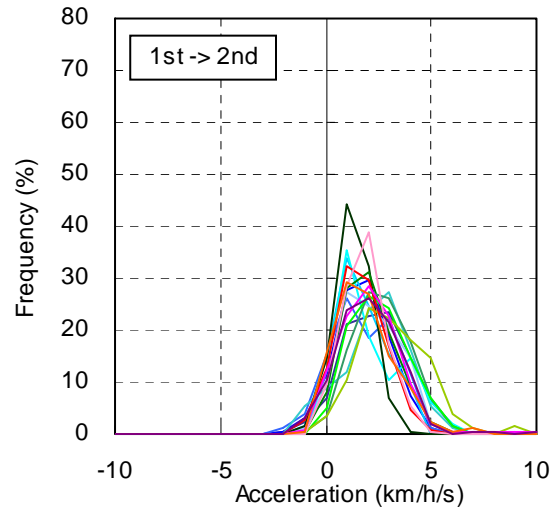
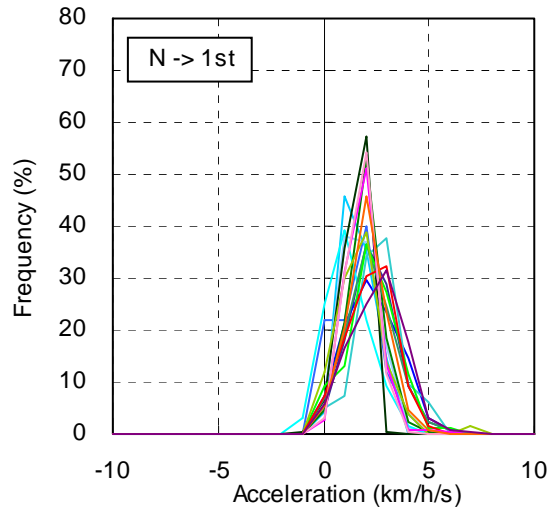
Acceleration frequency distribution at shift up-1

◇ Shift up-1 acceleration in EU



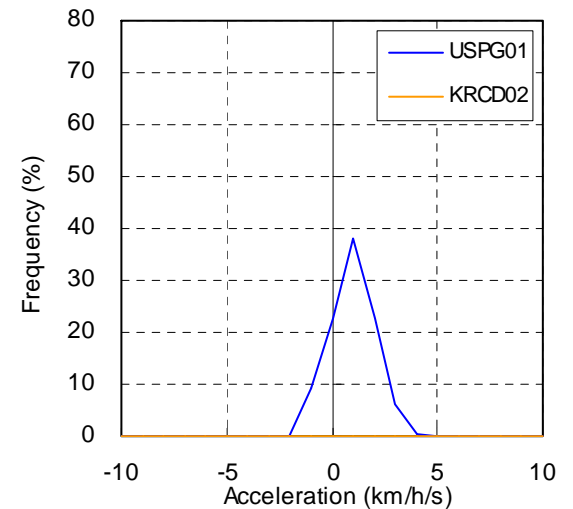
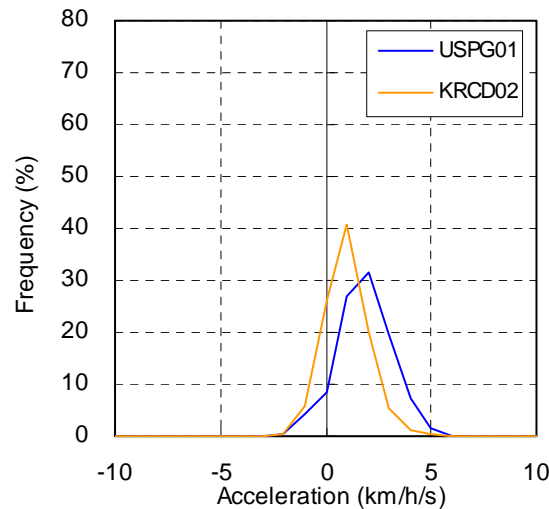
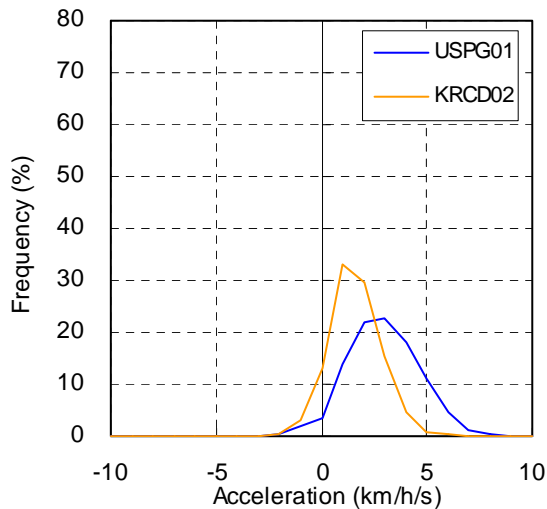
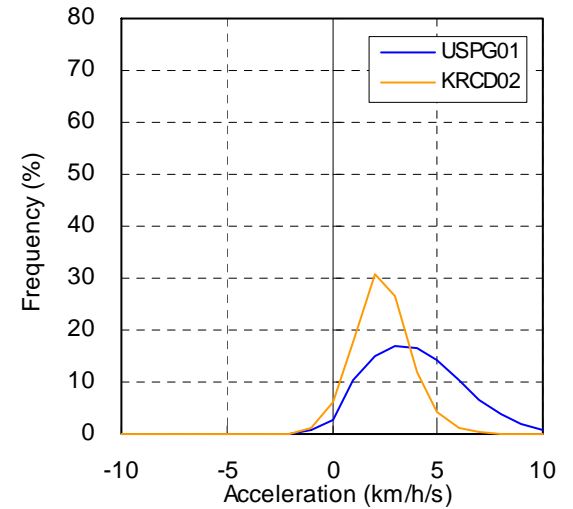
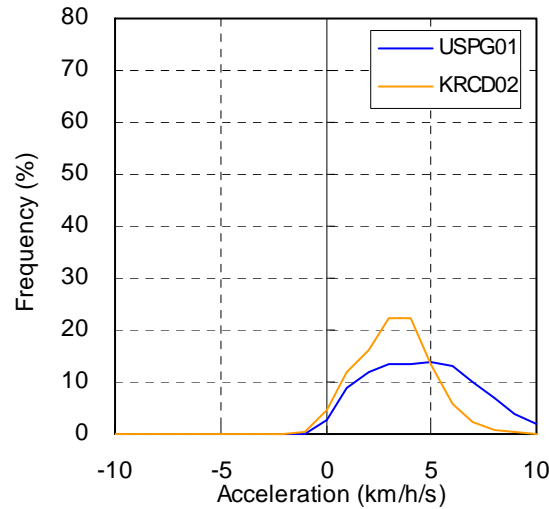
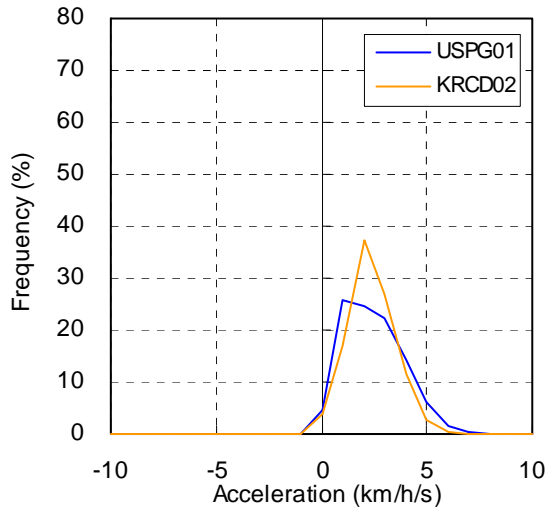
Acceleration frequency distribution at shift up-1

◇ Shift up-1 acceleration in India



Acceleration frequency distribution at shift up-1

◇ Shift up-1 acceleration in US & Korea

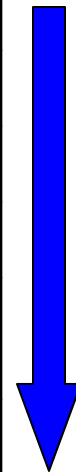


Multiple regression analysis

Investigate Influence between shift up point and each factor

■ Dependent variable: Gear position after shift up

Explanatory variable	Standard partial regression coefficient β	correlation coefficient γ
Vehicle speed @shift up-1	0.852	0.826
Acceleration @shift up-1	-0.214	-0.222
Vehicle category (PC: 0, LDCV: 1)	0.163	0.010
Engine displacement	-0.045	0.013
Fuel type (0: Petrol, 1: Diesel, 3: LPG)	-0.036	0.052
Power to mass ratio	0.030	-0.018
No. of gears	0.011	0.017



less impact

It was observed that vehicle category have impact on gear shift point. Therefore the gearshift equations were developed according to vehicle category by Stepwise selection method.

Shift up equation for PC

Model	R ²	Explanatory variable						Constant
		Regression coefficient Standard partial regression coefficient						
1	0.848	Vehicle speed						1.057
		5.11E-02						
		0.921						
2	0.862	Vehicle speed	Acceleration					1.323
		4.95E-02	-8.65E-02					
		0.893	-0.123					
3	0.863	Vehicle speed	Acceleration	Power to mass ratio				1.229
		4.96E-02	-8.64E-02	1.50E-03				
		0.893	-0.123	0.020				
4	0.863	Vehicle speed	Acceleration	Power to mass ratio	Engine Displacement			1.312
		4.97E-02	-8.54E-02	1.59E-03	-5.27E-05			
		0.895	-0.122	0.021	-0.020			
5	0.863	Vehicle speed	Acceleration	Power to mass ratio	Engine Displacement	Fuel type		1.303
		4.96E-02	-8.59E-02	1.99E-03	-7.23E-05	3.34E-02		
		0.894	-0.122	0.026	-0.027	0.013		
6	0.863	Vehicle speed	Acceleration	Power to mass ratio	Engine Displacement	Fuel type	V*A	1.314
		4.93E-02	-9.03E-02	2.00E-03	-7.27E-05	3.33E-02	1.43E-04	
		0.889	-0.129	0.027	-0.027	0.013	0.008	

N: 700,717 points

Shift up equation for LDCV

Model	R ²	Explanatory variable						Constant
		Regression coefficient Standard partial regression coefficient						
1	0.822	Vehicle speed						1.170
		6.47E-02						
		0.907						
2	0.837	Vehicle speed	Acceleration					1.441
		6.21E-02	-1.04E-01					
		0.870	-0.127					
3	0.843	Vehicle speed	Acceleration	No. of gears				2.950
		6.28E-02	-9.39E-02	-3.06E-01				
		0.880	-0.114	-0.083				
4	0.844	Vehicle speed	Acceleration	No. of gears	Engine Displacement			2.864
		6.29E-02	-9.17E-02	-2.74E-01	-4.62E-05			
		0.882	-0.112	-0.074	-0.029			
5	0.846	Vehicle speed	Acceleration	No. of gears	Engine Displacement	Power to mass ratio		2.790
		6.29E-02	-9.54E-02	-2.80E-01	-8.15E-05	4.09E-03		
		0.880	-0.116	-0.076	-0.052	0.049		
6	0.846	Vehicle speed	Acceleration	No. of gears	Engine Displacement	Power to mass ratio	Fuel type	2.724
		6.29E-02	-9.47E-02	-2.74E-01	-1.18E-04	5.22E-03	7.21E-02	
		0.880	-0.115	-0.074	-0.075	0.062	0.027	

N: 158,698 points

Gearshift equation

The gearshift equations were developed by Stepwise selection method for PC and LDCV.

$$G(x)_{PC} = 1.32 + 0.0495 \cdot V - 0.0865 \cdot A$$

$$G(x)_{LDCV} = 1.44 + 0.0621 \cdot V - 0.104 \cdot A$$

$G(x)$: Gear position

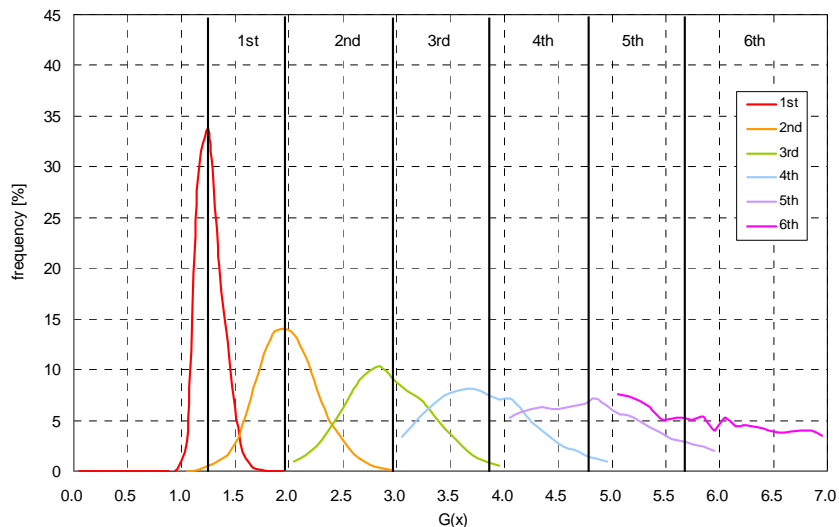
V : Vehicle Speed @shift up-1 (km/h)

A : Acceleration @shift-up-1(km/h/s)

The boundary condition

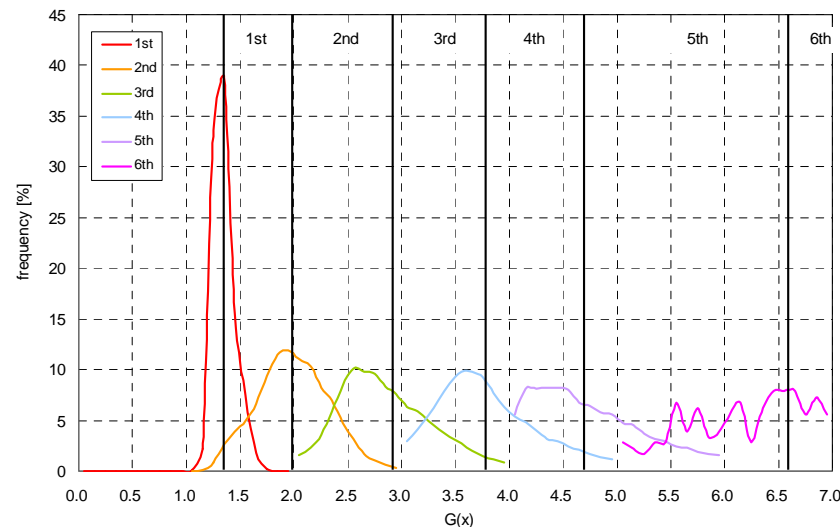
The boundary condition was set based on an average of the estimated gear position in each operation.

[PC]



Boundary condition	1st	2nd	3rd	4th	5th	6th
$G(x)_{PC}$	1.27	1.99	2.92	3.79	4.74	5.61

[LDCV]



Boundary condition	1st	2nd	3rd	4th	5th	6th
$G(x)_{LDCV}$	1.35	1.99	2.85	3.79	4.70	6.70

Clutch off speed

In order to avoid engine stall, Clutch OFF speed should be determined based on V1000 in each gear position of data collection vehicles

Gear	Average of V_{1000} (km/h)	Average of V_{idling} (km/h)
1	7.5	6.2
2	15.0	12.4
3	22.5	18.6
4	29.9	24.8
5	37.6	31.0
6	46.7	37.7

(*) V1000: Vehicle speed @ engine speed of 1000 rpm

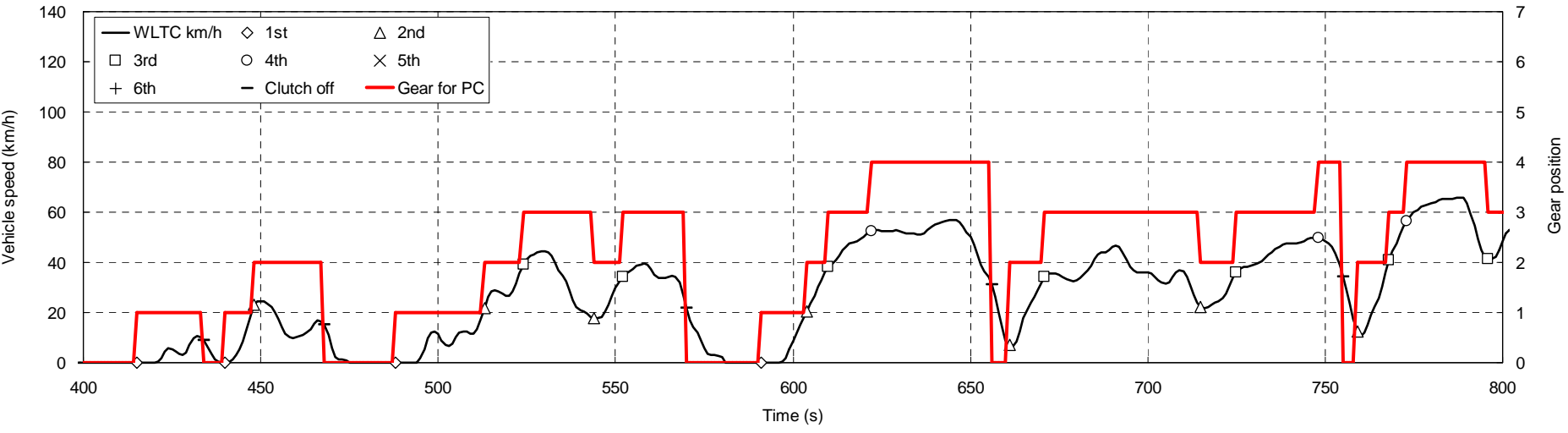
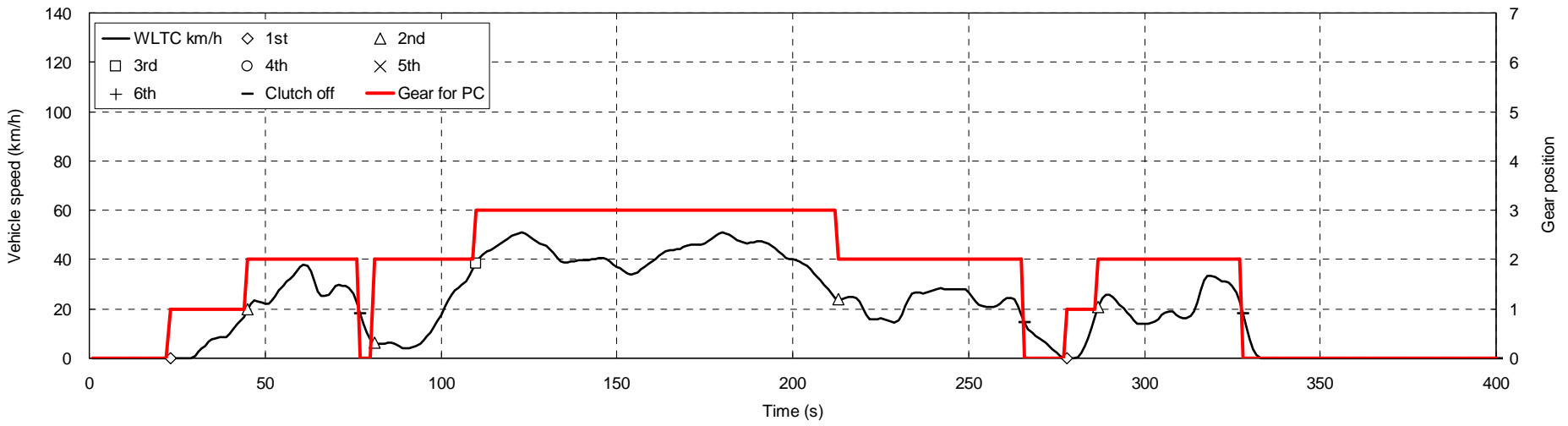
Additional condition

In order to make the shift change event natural and stable, the following additional condition were applied.

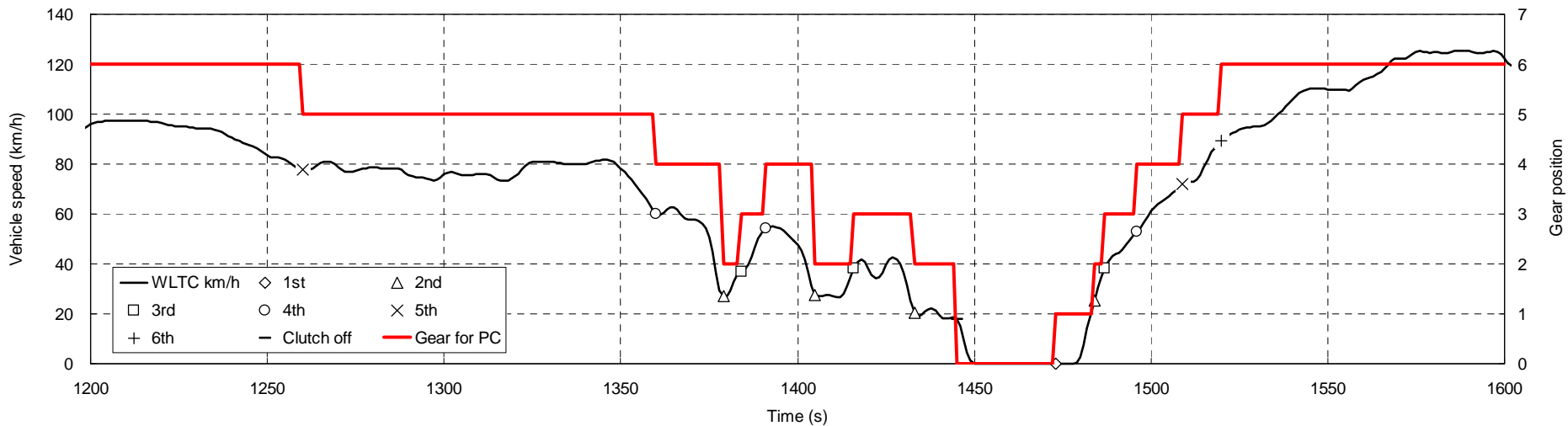
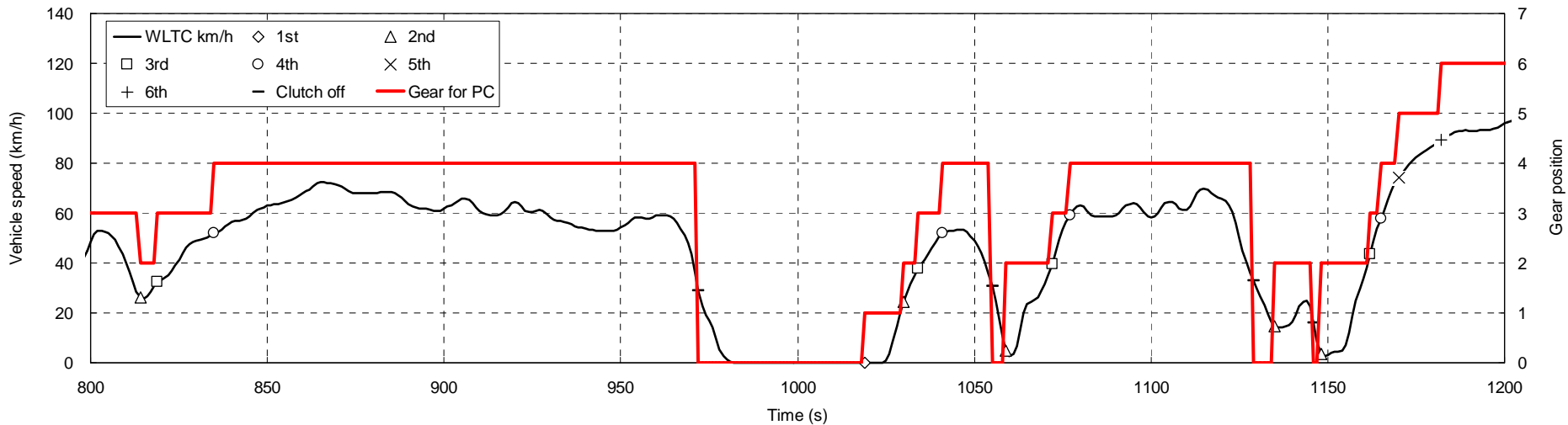
- ✓ Avoid to use 1st gear except take-off phase
- ✓ Avoid the downshift event to get higher deceleration during deceleration phase
- ✓ Avoid shift up at the top of hill (when shift to deceleration phase)
- ✓ Keep same gear position at least 2 second
- ✓ Put in 1st gear with the clutch disengaged 5 seconds before each take-off event.

The following criteria is necessary from viewpoint of operation.

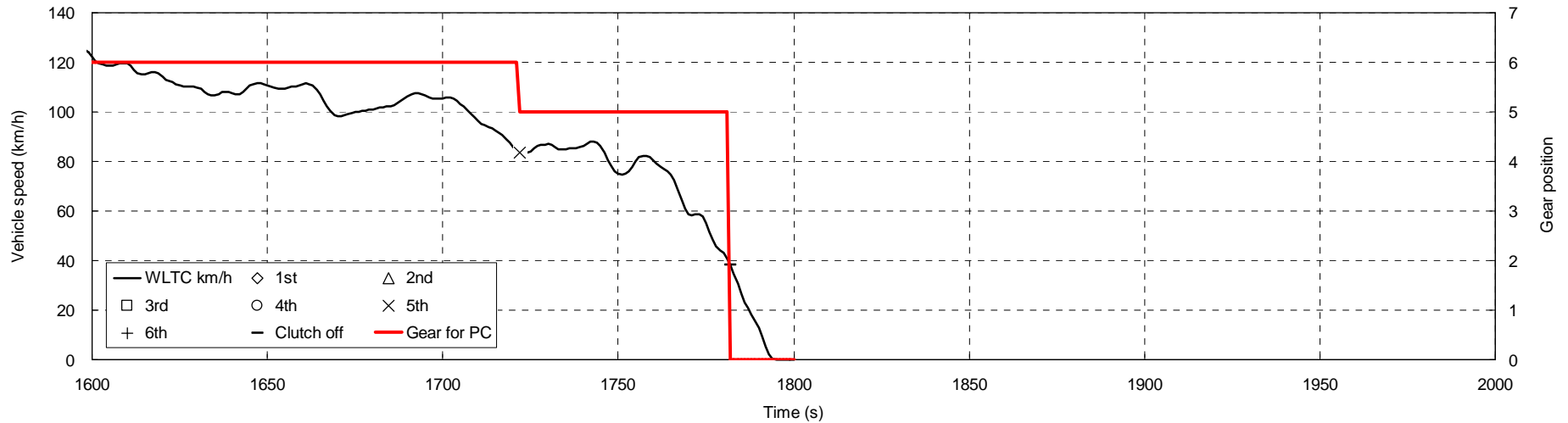
- ✓ Shall be driven in the range of idling engine speed and 90% of maximum rated engine speed.
 - ✓ When engine speed exceed 90% of maximum rated speed, it is necessary to shift up gear
 - ✓ When engine speed below the idling speed, it is necessary to disengage clutch and shift down gear



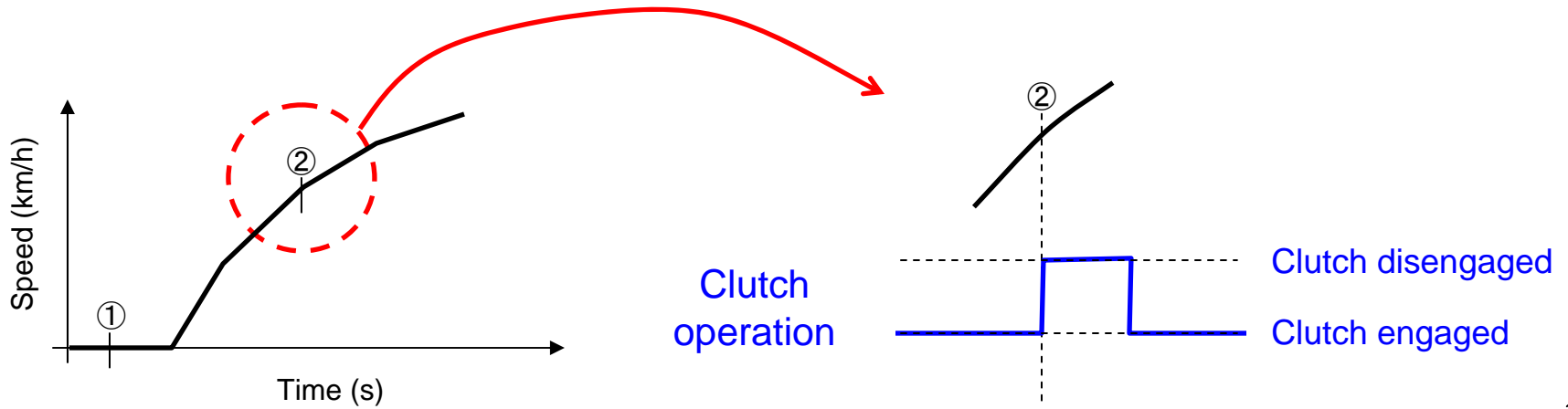
Gear for PC



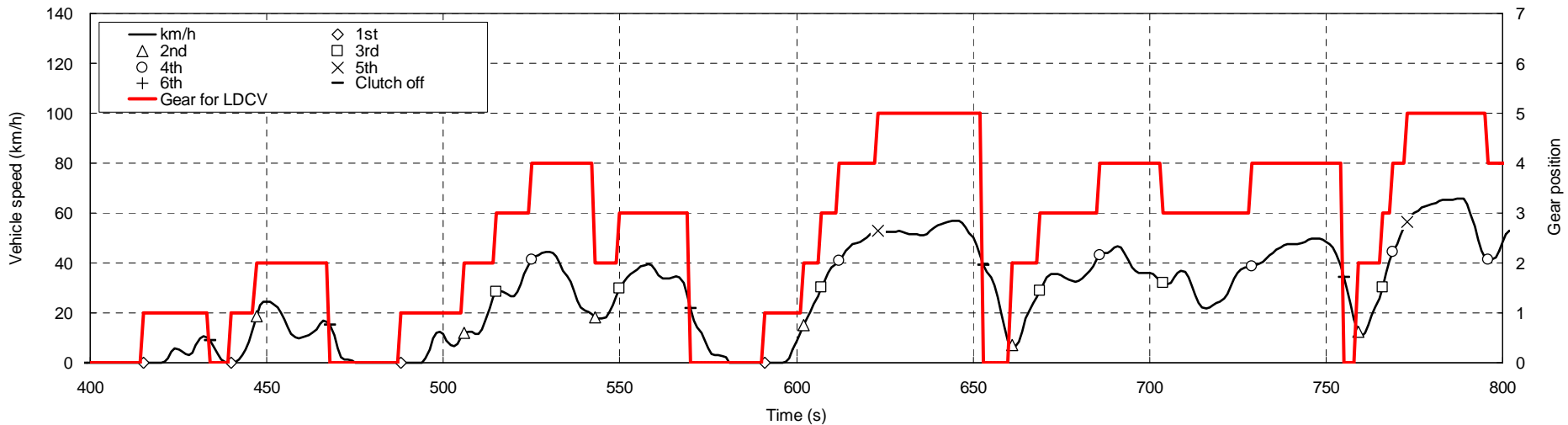
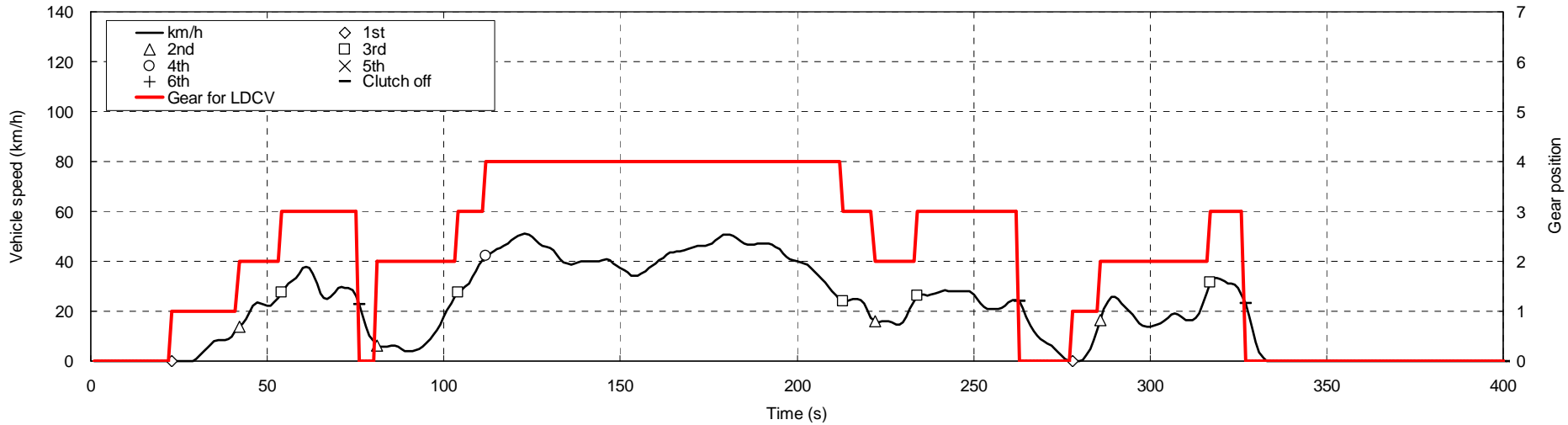
Gear for PC



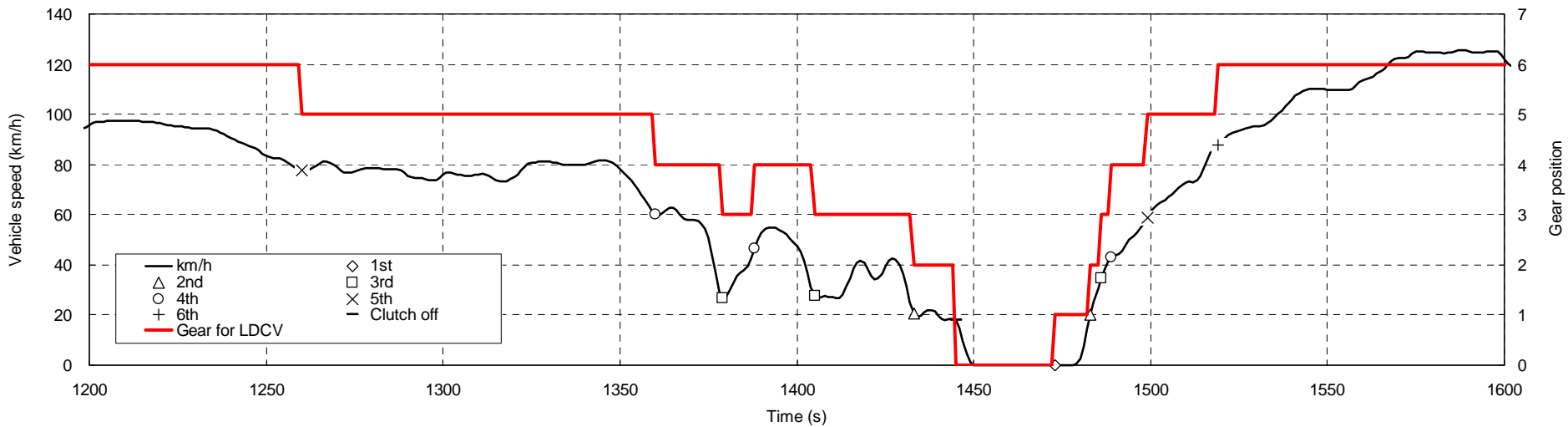
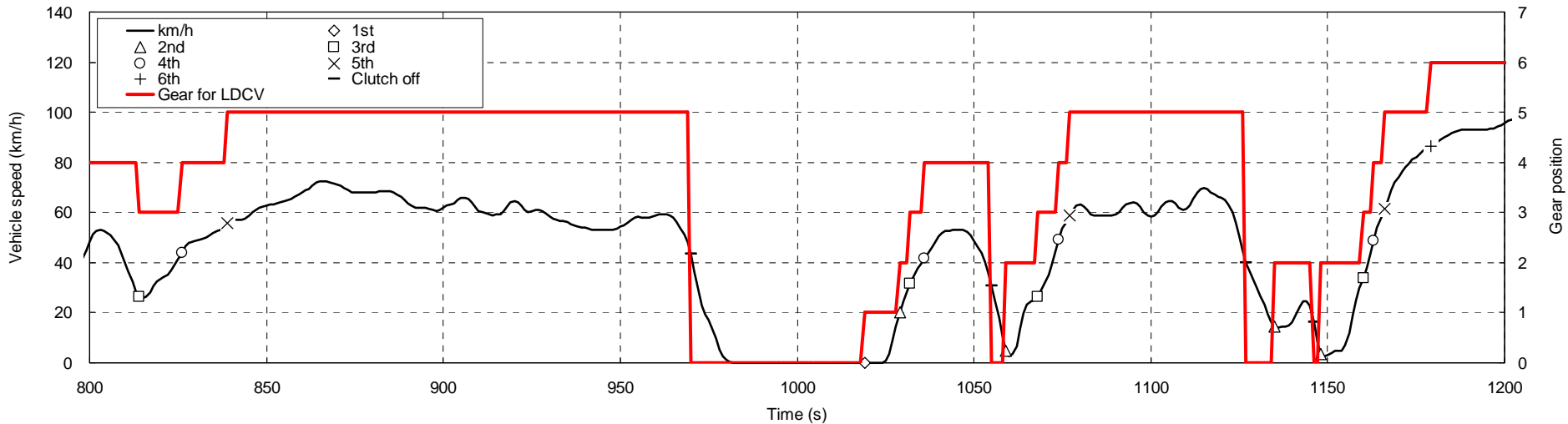
Definition



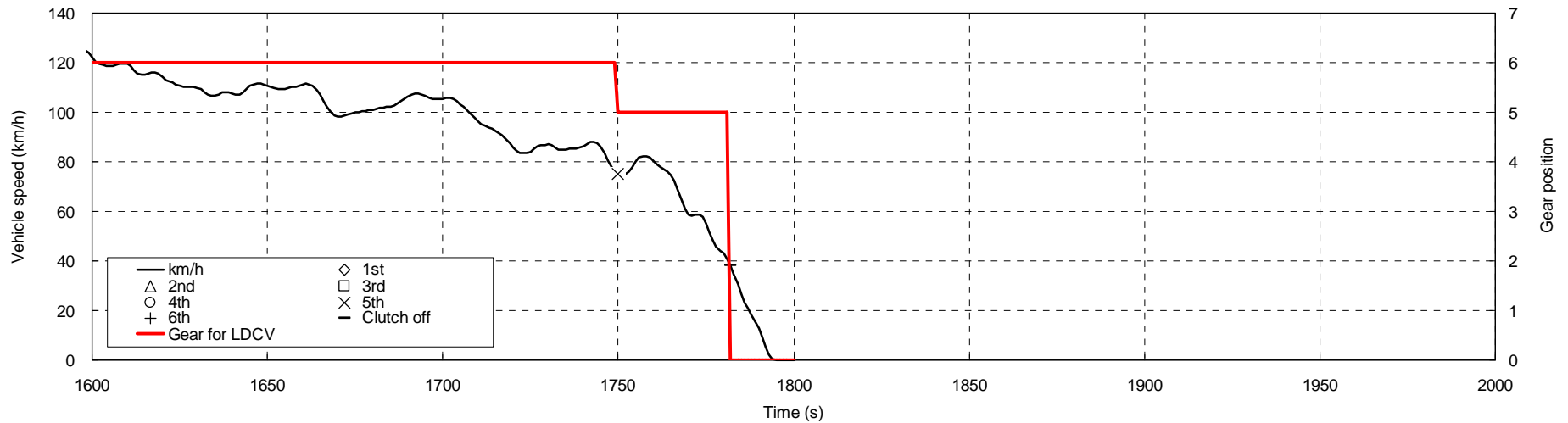
Gear for LDCV



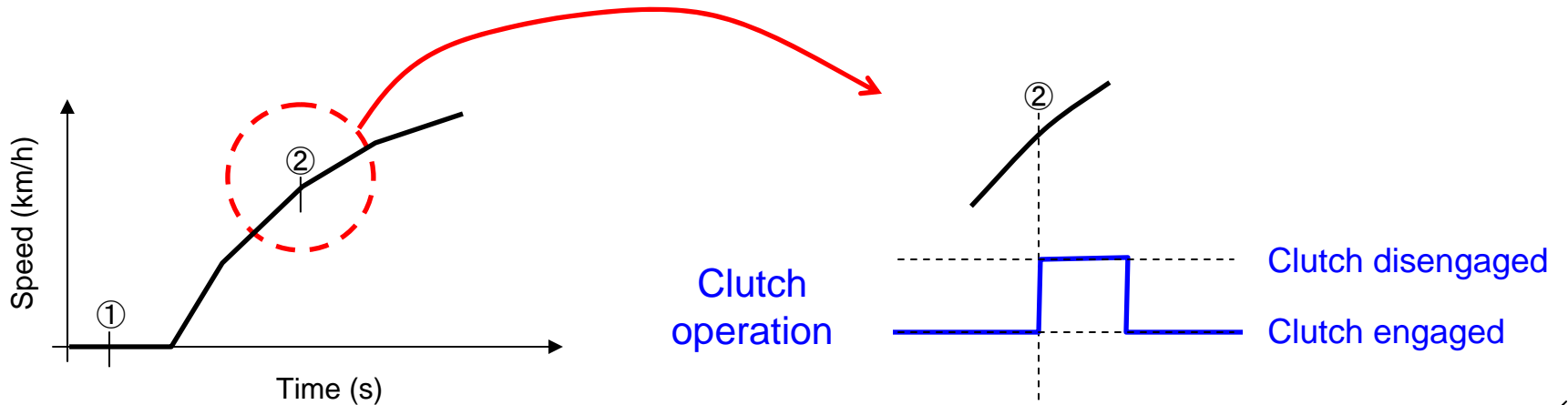
Gear for LDCV



Gear for LDCV



Definition



Vehicle information

Region	Vehicle ID	Vehicle Category	Engine type	Engine displacement	Curb mass	Gross Vehicle Weight	Transmission	Number of gears	Maximum rated power	Maximum rated engine speed	idling engine speed	Normalized vehicle weight	Power to mass ratio @ curb mass	Power to mass ratio @ GVW	Drive Traine Coefficient	Vehicle make	Vehicle model
			-	cm3	kg	kg	-	#	kW	min-1		-	kW/t	kW/t		-	-
BE	BEPD01	M1	Diesel	2188	1660	-	Manual	5	85	4000	850	-	51.2	-	0.146	Renault	Vel Satis 2.2 cdi
BE	BEPD02	M1	Diesel	1896	1121	-	Manual	5	50	4000	900	-	44.6	-	0.127	Volkswagen	Golf 1.9 sdi
BE	BEPD03	M1	Diesel	1896	1320	-	Manual	5	77	4000	750	-	58.3	-	0.158	Audi	A3 1.9 tdi
BE	BEPD05	M1	Diesel	1398	960	-	Manual	-	50	4000	850	-	52.1	-	0.140	peugeot	206 1.4HDI
BE	BEPD06	M1	Diesel	1998	1431	-	Manual	-	85	4000	800	-	59.4	-	0.163	Ford	Mondeo 2.0 tdc
BE	BEPD07	M1	Diesel	1997	1125	-	Manual	-	66	4000	850	-	58.7	-	0.149	Citroen	Xsara 2.0 hdi
BE	BEPD08	M1	Diesel	1997	1423	-	Manual	-	66	4000	900	-	46.4	-	0.159	Citroën	C5 Break 2.0 hdi
BE	BEPD09	M1	Diesel	2231	1585	-	Manual	-	130	3600	1050	-	82.0	-	0.165	Lexus	is220d
BE	BEPG01	M1	Petrol	1360	925	-	Manual	-	55	5500	950	-	59.5	-	0.127	Peugeot	206 1.4 gasoline
BE	BEPG02	M1	Petrol	1149	1090	-	Manual	-	55	5000	900	-	50.5	-	0.118	Renault	Clio III 1.2 16V
DE	DEPD01	M1	Diesel	2993	1635	-	Manual	5	200	4000	700	-	122.3	-	-	BMW	535 D
DE	DEPD02	M1	Diesel	1560	1180	-	Manual	5	66	4000	800	-	55.9	-	0.156	Peugeot	207
DE	DEPD03	M1	Diesel	1896	1452	-	Manual	5	77	4000	850	-	53.0	-	0.148	VW	Passat
DE	DEPD04	M1	Diesel	1364	905	-	Manual	5	55	4000	800	-	60.8	-	-	Toyota	Yaris
DE	DEPG03	M1	Petrol	1998	1177	-	Manual	5	100	6000	700	-	85.0	-	0.113	Peugeot	307
DE	DEPG04	M1	Petrol	1598	1250	-	Manual	5	64	5400	800	-	51.2	-	0.105	Opel	Meriva
ES	ESCD01	N	Diesel	1560	-	-	Manual	5	66	4000	750	-	-	-	0.137	Peugeot	Partner
ES	ESCD02	N	Diesel	2402	2620	-	Manual	6	85	-	800	-	32.4	-	0.097	Ford	Transit 350
ES	ESCD03	N	Diesel	1753	1392	-	Manual	5	55	-	850	-	39.5	-	0.128	Ford	Connect
ES	ESCD04	N	Diesel	2402	1865	-	Manual	6	85	-	800	-	45.6	-	0.101	Ford	Transit 350I
ES	ESPD01	M1	Diesel	1896	1125	-	Manual	5	77	4000	850	-	68.4	-	0.173	Seat	Ibiza
ES	ESPD02	M1	Diesel	1995	1310	-	Manual	6	105	4000	750	-	80.2	-	0.152	BMW	1.18D
ES	ESPD03	M1	Diesel	1995	1560	-	Manual	5	74	4000	900	-	47.4	-	-	Opel	Zafira
ES	ESPD04	M1	Diesel	1560	1417	-	Manual	5	80	4000	750	-	56.5	-	0.146	Peugeot	307 SW
ES	ESPG01	M1	Petrol	1364	920	-	Manual	6	103	4900	800	-	112.0	-	0.127	Opel	Astra
ES	ESPG02	M1	Petrol	1390	1403	-	Manual	6	92	5000	700	-	65.6	-	0.123	Seat	Altea 1.3 XL
FR	FRPD01	M1	Diesel	1868	1023	-	Manual	5	51	4600	950	-	49.9	-	0.137	Peugeot	Peugeot 206
FR	FRPD02	M1	Diesel	1997	1300	-	Manual	5	66	4000	800	-	50.8	-	0.156	Citroën	Citroën Xsara
FR	FRPD03	M2	Diesel	1997	1485	-	Manual	5	80	4000	800	-	53.9	-	0.145	Citroën	Citroën Evasion
FR	FRPD04	M1	Diesel	1560	1235	-	Manual	5	80	4000	800	-	64.8	-	0.155	Peugeot	Peugeot 307
FR	FRPD05	M1	Diesel	1997	1410	-	Manual	6	100	4000	800	-	70.9	-	0.144	Peugeot	Peugeot 308
FR	FRPD10	M1	Diesel	1997	1505	-	Manual	6	100	4000	750	-	66.4	-	0.152	Peugeot	Peugeot 407
FR	FRPD11	M1	Diesel	1997	1505	-	Manual	6	100	4000	800	-	66.4	-	0.149	Peugeot	Peugeot 407
FR	FRPD12	M1	Diesel	1997	1380	-	Manual	6	100	4000	800	-	72.5	-	0.150	Citroën	Citroën C4
FR	FRPD13	M1	Diesel	1560	1235	-	Manual	5	80	4000	800	-	64.8	-	0.154	Peugeot	Peugeot 307
FR	FRPD14	M1	Diesel	1560	1235	-	Manual	5	80	4000	800	-	64.8	-	0.153	Peugeot	Peugeot 307
FR	FRPD15	M1	Diesel	1997	1505	-	Manual	6	100	4000	800	-	66.4	-	0.144	Peugeot	Peugeot 407
FR	FRPD16	M1	Diesel	1997	1505	-	Manual	6	100	4000	800	-	66.4	-	-	Peugeot	Peugeot 407
FR	FRPD17	M1	Diesel	1560	1235	-	Manual	5	80	4000	800	-	64.8	-	0.150	Peugeot	Peugeot 307
FR	FRPD18	M1	Diesel	1560	1125	-	Manual	5	80	4000	750	-	71.1	-	-	Citroën	Citroën C3
FR	FRPD19	M1	Diesel	1560	1125	-	Manual	5	80	4000	800	-	71.1	-	-	Citroën	Citroën C3
FR	FRPD20	M1	Diesel	1560	1125	-	Manual	5	80	4000	800	-	71.1	-	-	Citroën	Citroën C3
FR	FRPD21	M1	Diesel	1560	1125	-	Manual	5	80	4000	-	-	71.1	-	-	Citroën	Citroën C3
FR	FRPD22	M1	Diesel	1560	1125	-	Manual	5	80	4000	-	-	71.1	-	-	Citroën	Citroën C3
FR	FRPD23	M1	Diesel	1560	1125	-	Manual	5	80	4000	-	-	71.1	-	-	Citroën	Citroën C3
FR	FRPG01	M1	Petrol	1361	860	-	Manual	5	55	5500	950	-	64.0	-	0.119	Peugeot	Peugeot 206
FR	FRPG02	M1	Petrol	1361	860	-	Manual	5	55	5500	850	-	64.0	-	0.125	Citroën	Citroën Saxo
FR	FRPG03	M1	Petrol	1124	825	-	Manual	5	44	6200	850	-	53.3	-	0.108	Citroën	Citroën Saxo
FR	FRPG04	M1	Petrol	1360	860	-	Manual	5	55	5500	900	-	64.0	-	0.108	Citroën	Citroën Berlingo
FR	FRPG05	M1	Petrol	1762	1170	-	Manual	5	66	5500	800	-	56.4	-	0.131	Peugeot	Peugeot Partner
FR	FRPG06	M1	Petrol	1997	1595	-	Manual	5	100	6000	700	-	62.7	-	0.130	Citroën	Citroën Xsara
FR	FRPG08	M1	Petrol	1587	1145	-	Manual	5	80	5750	750	-	69.9	-	0.110	Peugeot	Peugeot 1007
FR	FRPG09	M1	Petrol	1997	1240	-	Manual	5	103	6000	700	-	83.1	-	0.118	Peugeot	Peugeot 307

Vehicle information

Region	Vehicle ID	Vehicle Category	Engine type	Engine displacement	Curb mass	Gross Vehicle Weight	Transmission	Number of gears	Maximum rated power	Maximum rated engine speed	idling engine speed	Normalized vehicle weight	Power to mass ratio @ curb mass	Power to mass ratio @ GVW	Drive Traine Coefficient	Vehicle make	Vehicle model
			-	cm3	kg	kg	-	#	kW	min-1		-	kW/t	kW/t		-	-
FR	FRPG10	M1	Petrol	1360	1045	-	Manual	5	65	5250	750	-	62.2	-	0.116	Citroën	Citroën C3
FR	FRPG11	M1	Petrol	1360	1045	-	Manual	5	65	5250	800	-	62.2	-	0.122	Citroën	Citroën C3
FR	FRPG12	M1	Petrol	1587	1145	-	Manual	5	80	5750	800	-	69.9	-	0.115	Peugeot	Peugeot 1007
FR	FRPG13	M1	Petrol	1360	1045	-	Manual	5	65	5250	800	-	62.2	-	-	Citroën	Citroën C3
FR	FRPG14	M1	Petrol	1587	1145	-	Manual	5	80	5750	800	-	69.9	-	0.112	Peugeot	Peugeot 1007
FR	FRPG15	M1	Petrol	1360	1045	-	Manual	5	65	5250	800	-	62.2	-	-	Citroën	Citroën C3
FR	FRPG16	M1	Petrol	1360	1045	-	Manual	5	65	5250	800	-	62.2	-	0.119	Citroën	Citroën C3
FR	FRPG17	M1	Petrol	1587	1145	-	Manual	5	80	5750	750	-	69.9	-	0.111	Peugeot	Peugeot 1007
FR	FRPG18	M1	Petrol	1997	1240	-	Manual	5	103	6000	750	-	83.1	-	-	Peugeot	Peugeot 307
FR	FRPG19	M1	Petrol	1997	1240	-	Manual	5	103	6000	-	-	83.1	-	-	Peugeot	Peugeot 307
IN	INCD01	N1	Diesel	2523	1725	2750	Manual	5	46	3200	850	0.627	26.8	16.8	0.150	Mahindra	Bolero Camper
IN	INCD02	N1	Diesel	702	815	1550	Manual	5	11	3200	900	0.526	13.9	7.3	0.079	TATA	Ace
IN	INCD03	N1	Diesel	442	670	1250	Manual	4	7	3600	1050	0.536	10.1	5.4	0.062	Mahindra	GIO
IN	INCD04	N1	Diesel	1500	1250	2500	Manual	5	65	3700	850	0.500	52.0	26.0	0.107	ASHOK	LT
IN	INPC01	M1	CNG	796	795	1140	Manual	5	35	6200	1050	0.697	44.0	30.7	0.097	Maruti Suzuki	Alto
IN	INPD01	M1	Diesel	1248	1130	1572	Manual	5	56	5150	900	0.719	49.5	35.6	0.112	FIAT INDIA	G.PUNTO
IN	INPD02	M1	Diesel	2498	1830	2475	Manual	5	83	3800	800	0.739	45.5	33.6	0.126	Mahindra	Xylo
IN	INPD03	M1	Diesel	2179	2225	2850	Manual	5	103	5500	850	0.781	46.3	36.1	0.131	Tata	ARIA
IN	INPD04	M1	Diesel	1248	1210	1670	Manual	5	68	4000	850	0.725	56.4	40.8	-	FIAT LINEA	EMOTION
IN	INPD05	M1	Diesel	1248	1080	1505	Manual	5	55	4000	850	0.718	51.1	36.7	0.131	Maruti Suzuki	SWIFT
IN	INPD06	M1	Diesel	1598	1220	1760	Manual	5	77	4400	650	0.693	63.1	43.8	0.134	VW	Vento
IN	INPG01	M1	Petrol	998	880	1320	Manual	5	49	6200	950	0.667	55.7	37.1	0.103	Maruti Suzuki	A-Star
IN	INPG02	M1	Petrol	624	635	935	Manual	4	35	5500	1250	0.679	55.8	37.9	0.105	Tata	NANO
IN	INPG03	M1	Petrol	1368	1180	1619	Manual	5	66	6000	850	0.729	55.8	40.7	-	FIAT LINEA	EMOTION
IN	INPG04	M1	Petrol	1198	1055	1430	Manual	5	66	6200	1400	0.738	62.6	46.2	0.123	HONDA	JAZZ
IN	INPG05	M1	Petrol	1086	895	1360	Manual	5	49	5500	800	0.658	54.7	36.0	0.099	Hyundai	i10
IN	INPG06	M1	Petrol	1197	1033	1515	Manual	5	59	5200	700	0.682	56.9	38.8	0.112	Hyundai	i20
IN	INPG07	M1	Petrol	996	870	1275	Manual	5	50	6200	950	0.682	57.5	39.2	0.101	Maruti Suzuki	WAGON R
IN	INPG08	M1	Petrol	1496	930	1430	Manual	5	66	5600	1050	0.650	71.0	46.2	0.124	TOYOTA	ETIOS
IN	INPG09	M1	Petrol	1172	1090	1520	Manual	5	60	6000	1050	0.717	46.0	33.0	-	G.PUNTO	EMOTION
IT	ITPD01	M1	Diesel	2900	1978	-	Manual	5	106	3800	850	-	53.6	-	0.175	KIA	Carnival
IT	ITPD02	M1	Diesel	2497	2027	-	Manual	5	100	4400	900	-	49.3	-	0.103	L. Rower	R.Rower
IT	ITPD03	M1	Diesel	1968	1227	-	Manual	5	55	4200	850	-	44.8	-	0.172	VW	Golf
IT	ITPD04	M1	Diesel	1896	1335	-	Manual	5	77	4000	850	-	57.7	-	0.175	Audi	A3
IT	ITPD05	M1	Diesel	2148	1530	-	Manual	5	125	3800	750	-	81.7	-	-	Mercedes	Class C
IT	ITPD06	M1	Diesel	1968	1227	-	Manual	5	55	4200	-	-	44.8	-	-	VW	Golf
IT	ITPD07	M1	Diesel	1422	1103	-	Manual	5	51	4000	900	-	46.2	-	0.136	VW	Polo
IT	ITPG01	M1	Petrol	1600	1205	-	Manual	5	75	5600	750	-	62.2	-	0.112	Audi	A3
JP	JPCD01	N1	Diesel	2180	1350	2265	Manual	5	57	4250	700	0.596	42.2	25.2	0.098	MAZDA	BONGO
JP	JPCD02	N1	Diesel	1998	1160	1570	Manual	5	54	4500	750	0.739	46.6	34.4	0.107	MITSUBISHI	LIBERO
JP	JPCD03	N1	Diesel	2835	1790	3455	Manual	5	69	4000	800	0.518	38.5	20.0	0.111	MITSUBISHI	CANTER
JP	JPCG01	N1	Petrol	650	800	1260	Manual	5	31	5500	1200	0.635	38.8	24.6	0.080	SUZUKI	EVERY
JP	JPCG02	N1	Petrol	1990	1550	2965	Manual	5	88	5200	700	0.523	56.8	29.7	0.106	NISSAN	CARAVAN
JP	JPCG03	N1	Petrol	657	880	1340	Manual	5	37	6000	950	0.657	42.0	27.6	0.056	SUZUKI	EVERY
JP	JPCG04	N1	Petrol	1789	1210	2225	Manual	5	66	5000	800	0.544	54.5	29.7	0.102	MAZDA	BONGO TRUCK
JP	JPPG01	M1	Petrol	1496	1020	1295	Manual	5	81	6000	700	0.788	79.4	62.5	0.125	TOYOTA	COROLLA
JP	JPPG02	M1	Petrol	658	700	920	Manual	5	40	6500	1000	0.761	57.1	43.5	0.076	SUZUKI	ALTO
JP	JPPG03	M1	Petrol	997	840	1115	Manual	5	51	6000	700	0.753	60.7	45.7	0.114	TOYOTA	VITZ
JP	JPPG04	M1	Petrol	1998	1440	1715	Manual	5	116	6500	650	0.840	80.6	67.6	0.119	HONDA	CR-V
JP	JPPG05	M1	Petrol	1998	1180	1400	Manual	6	162	8000	800	0.843	137.3	115.7	0.088	HONDA	INTEGRA TYPE-R
KR	KRCD01	N1	Diesel	2497	1755	2950	Manual	5	126	3800	750	0.595	71.8	42.7	0.114	Hyundai	Porter

Vehicle information

Region	Vehicle ID	Vehicle Category	Engine type	Engine displacement	Curb mass	Gross Vehicle Weight	Transmission	Number of gears	Maximum rated power	Maximum rated engine speed	idling engine speed	Normalized vehicle weight	Power to mass ratio @ curb mass	Power to mass ratio @ GVW	Drive Traine Coefficient	Vehicle make	Vehicle model
			-	cm3	kg	kg	-	#	kW	min-1		-	kW/t	kW/t		-	-
PL	PLPD01	M1	Diesel	1248	1310	-	Manual	6	66	4000	850	-	50.4	-	0.142	Opel	Astra 1.3 CDTI
PL	PLPD02	M1	Diesel	1896	1270	-	Manual	5	66	4000	900	-	52.0	-	0.141	Skoda	Octavia 1.9 TDI
PL	PLPD03	M1	Diesel	1560	1489	-	Manual	5	80	4000	800	-	53.7	-	0.142	Citroen	C4 Picasso
PL	PLPD04	M1	Diesel	1910	1410	-	Manual	5	84	4000	800	-	59.6	-	0.143	Fiat	Stilo
PL	PLPD05	M1	Diesel	2494	1750	-	Manual	5	86	3600	700	-	49.1	-	0.124	Toyota	Hiace
PL	PLPG01	M1	Petrol	1362	1155	-	Manual	5	66	5600	800	-	57.1	-	0.116	Opel	Astra 1.4 Twin
PL	PLPG02	M1	Petrol	998	790	-	Manual	5	50	6000	950	-	63.3	-	0.115	Citroen	C1
PL	PLPG03	M1	Petrol	1598	1055	-	Manual	5	81	6000	950	-	76.8	-	0.115	Toyota	Corolla
PL	PLPG04	M1	Petrol	1149	950	-	Manual	5	55	5500	800	-	57.9	-	0.109	Renault	Twingo
SI	SIPD01	M1	Diesel	2204	1473	-	Manual	5	102	4000	-	-	69.2	-	-	Honda	Accord
SI	SIPD02	M1	Diesel	1968	1454	-	Manual	5	103	4000	800	-	70.8	-	0.144	VW	Passat
SI	SIPD03	M1	Diesel	1500	1255	-	Manual	5	85	3750	850	-	67.7	-	0.138	Renault	Modus
SI	SIPD04	M1	Diesel	1800	1280	-	Manual	5	66	3800	900	-	51.6	-	0.145	Ford	Focus
SI	SIPD05	M1	Diesel	1995	1560	-	Manual	5	74	4300	800	-	47.4	-	0.131	Opel	Zafira
SI	SIPD06	M1	Diesel	1995	1435	-	Manual	6	130	4000	850	-	90.6	-	0.149	BMW	320D
SI	SIPD07	M1	Diesel	2200	1502	-	Manual	6	114	3500	800	-	75.9	-	0.141	Jaguar	X Type
SI	SIPD08	M1	Diesel	1896	1396	-	Manual	5	95	4000	-	-	68.1	-	-	VW	Passat
SI	SIPD09	M1	Diesel	1461	1205	-	Manual	5	60	4000	800	-	49.8	-	0.133	Renault	Megane
SI	SIPD10	M1	Diesel	1910	1568	-	Manual	6	89	3500	850	-	56.8	-	0.144	Opel	Zafira
SI	SIPG01	M1	Petrol	1596	1226	-	Manual	5	74	5500	-	-	60.4	-	-	Ford	Focus
SI	SIPG02	M1	Petrol	1400	1156	-	Manual	5	55	5400	800	-	47.6	-	0.109	Peugeot	207
SI	SIPG03	M1	Petrol	1598	1234	-	Manual	5	78	5750	800	-	63.2	-	0.114	Renault	Megane
SI	SIPG04	M1	Petrol	1598	1215	-	Manual	5	83	6000	750	-	68.3	-	0.113	Renault	Megane
SI	SIPG05	M1	Petrol	1332	955	-	Manual	5	70	6000	-	-	73.3	-	-	Mitsubishi	Colt
SI	SIPG06	M1	Petrol	1149	1090	-	Manual	5	55	5500	750	-	50.5	-	0.108	Renault	Clio
SI	SIPG07	M1	Petrol	1596	1226	-	Manual	5	74	5500	1000	-	60.4	-	0.118	Ford	Focus
SE	SEPD01	M1	Diesel	1560	1394	-	Manual	-	80	-	750	-	57.4	-	0.161	Volvo	Volvo V50
SE	SEPD02	M1	Diesel	1560	1394	-	Manual	-	80	-	750	-	57.4	-	0.166	Volvo	Volvo V50
SE	SEPG01	M1	Petrol	1999	1574	-	Manual	-	107	-	750	-	68.0	-	0.121	Volvo	Volvo V70
UK	UKCD01	N1	Diesel	2200	1580	2600	Manual	5	63	3500	750	0.608	39.9	24.2	0.126	Ford	Transit 85T 260
UK	UKCD02	N1	Diesel	2198	1800	2800	Manual	5	63	3500	800	0.643	34.7	22.3	0.137	Ford	Transit 85 T280M
UK	UKCD03	N1	Diesel	2200	1580	2600	Manual	5	63	3500	800	0.608	39.9	24.2	0.129	Ford	Transit 85T 260
UK	UKCD04	N1	Diesel	2200	1580	2600	Manual	5	63	3500	800	0.608	39.9	24.2	0.124	Ford	Transit 85T 260
UK	UKCD05	N1	Diesel	2200	1580	2600	Manual	5	63	3500	800	0.608	39.9	24.2	0.133	Ford	Transit 85T 260
UK	UKCD06	N1	Diesel	2000	1877	2900	Manual	6	84	3500	750	0.647	44.8	29.0	0.116	Renault	Traffic SL29 dCI 115
UK	UKCD07	N1	Diesel	2148	2015	3500	Manual	6	80	3800	850	0.576	39.7	22.9	0.106	Mercedes	Sprinter 311 CDI MWB
UK	UKCD08	N1	Diesel	2400	2034	3600	Manual	6	85	3500	800	0.565	41.5	23.5	0.122	Ford	Transit 115 T350L
UK	UKCD09	N1	Diesel	2400	2034	3600	Manual	6	85	3500	750	0.565	41.5	23.5	0.101	Ford	Transit 115 T350L
UK	UKCD10	N1	Diesel	1750	1415	2040	Manual	5	55	4000	700	0.694	38.9	27.0	0.133	Ford	Transit Connect 200 L75
UK	UKPD01	M1	Diesel	1870	1350	-	Manual	6	80	4000	900	-	59.3	-	0.145	Renault	Laguna
UK	UKPD02	M1	Diesel	1997	1557	-	Manual	6	85	3750	800	-	54.6	-	0.146	Ford	Mondeo
UK	UKPD03	M1	Diesel	1753	1391	-	Manual	5	85	3800	900	-	61.1	-	0.150	Ford	Focus SW
UK	UKPD04	M1	Diesel	1995	1680	-	Manual	6	110	4000	800	-	65.5	-	0.147	BMW	320 CD
UK	UKPG01	M1	Petrol	1108	840	-	Manual	5	40	5000	900	-	47.6	-	0.109	Fiat	Panda 1.1
UK	UKPG02	M1	Petrol	1798	1309	-	Manual	5	88	6000	1000	-	67.2	-	0.110	Ford	C Max
UK	UKPG03	M1	Petrol	2522	1392	-	Manual	6	165	6000	900	-	118.5	-	0.112	Ford	Focus ST2
UK	UKPG04	M1	Petrol	1242	966	-	Manual	5	80	5800	950	-	82.8	-	0.111	Ford	Fiesta 1.2
US	USPG01	M1	Petrol	4511	2200	2880	Manual	6	250	6500	750	0.764	113.6	86.8	0.132	-	-
US	USPG05	M1	Petrol	3189	2160	2880	Manual	6	184	6300	-	0.750	85.2	63.9	0.113	-	-

Total: 153 vehicles