The 62nd Asia Expert Meeting on; Exhaust emission Euro4 for motorcycle

February 25th, 2020

@VTCC Indonesia

JAPAN AUTOMOBILE STANDARDS INTERNATIONALIZATION CENTER

1. United nation：UN-R40
   - UNR40-01 is not revised after 1988.
   - The regulation level of the exhaust emission is EURO 0.
2. United nation：the latest situation of GTR/UNR
   - GTR2 revision (WMTC emission test, EURO5 is included)：discussion concludes, GTR is approved in WP29 in November, 2019.
3. EU regulation outline
   - Changes in emission regulation values
   - Regulation for Euro 3 and Euro 4
   - Difference between Euro4 and Euro3 requirements.
4. Test requirement item (Type 1~ Type 8) .
5. Type I test procedure for hybrid L-category vehicles

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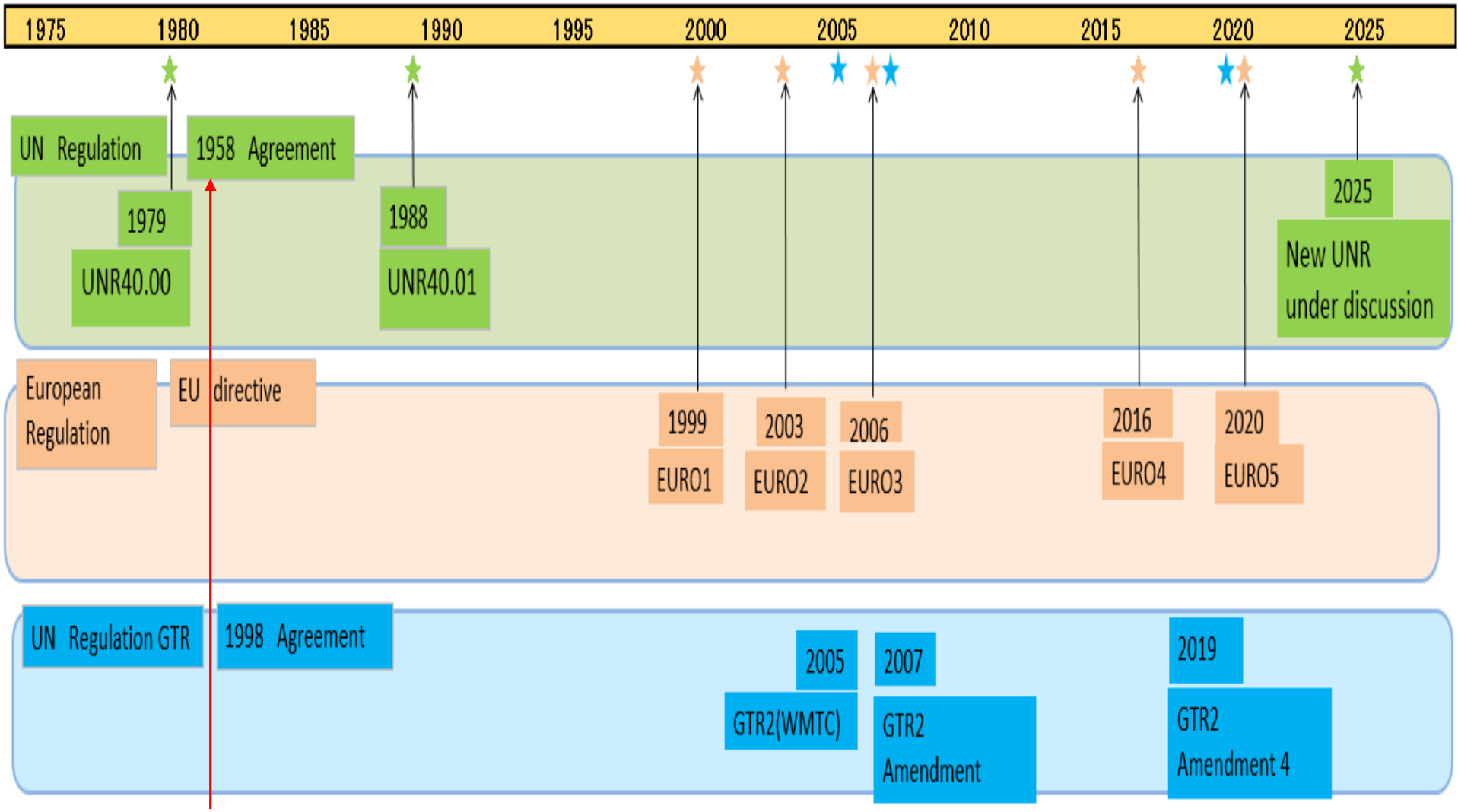
1. United nation : UN-R40

Tailpipe emission



New UN-R40-** based on GTR2 is under discussion.

1. United nation： UN-R40

Year	Regulation	Driving Cycle	Cold start	Running Resistance	Limit Value (g/km)			Remarks	Reference Fuel		
					CO	THC	NOx		Sulphur (mg/kg)	Oxgen %	Ethanol %
1979	UN R40.00	UDC	-	UN R40	25-50	7-70	-	4stroke	max 400	-	-
					16-40	10-15	-	2stroke	max 400	-	-
1988	UN R40.01	UDC	-	UN R40	17.5-35	4.2-6.0	-	4stroke	max 400	-	-
					12.8-32	8-12	-	2stroke	max 400	-	-
1999	EURO1	UDC	-	UN R40	13	3	0.3		max 400	-	-
2003	EURO2	UDC	-	UN R40	5.5	1.2(1.0)	0.3	without 40sec idling ():capacity≧150cc	max 100	max 2.3	-
2006	EURO3	UDC+EUDC		ISO11486	2	0.3(0.8)	0.15		max 400/ max 10(*) (*)2014~New	max 2.3/ report(*)	-/ 4.3-5.3(*)
2007		WMTC		ISO11486	2.62	0.75(0.33)	0.17(0.22)	():Vmax≧130km/h			
2016	EURO4	WMTC		ISO11486	1.14	0.38(0.17)	0.07(0.09)	():Vmax≧130km/h	max 10	report	4.3-5.3
2020	EURO5	WMTC		ISO11486	1	0.1	0.06				
2005	GTR2(EU, altanative)	WMTC		ISO11486	2.62	0.75(0.33)	0.17(0.22)	():Vmax≧130km/h	max 400	max 2.3	-
2007	GTR2(JAPAN)	WMTC		ISO11486	2.62	0.45(0.27)	0.16(0.21)	():Vmax≧130km/h	max 10Wtppm	not to be detected	-
2020	GTR2 rev, (EURO5)	WMTC		ISO11486	1	0.1	0.06		max 10	report	4.3-5.3

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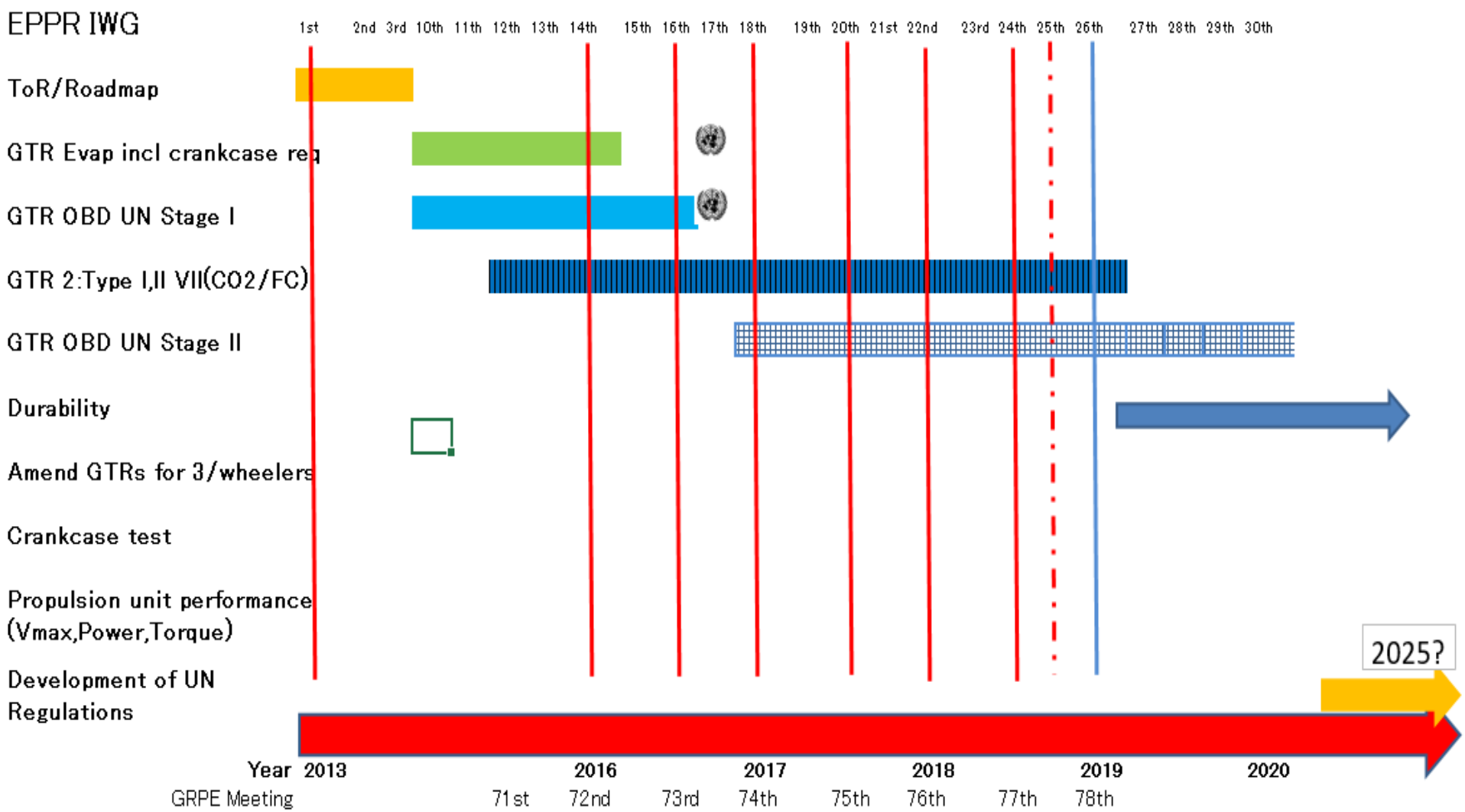
United nation： latest situation of GTR



Schedule GTR2: approved in WP29 in November, 2019

OBD2・GTR: Under the discussion, by the mid of 2020,

Remaining GTRs: by the end of 2022, UNR: by 2025?

2.United nation： latest situation of GTR/UNR

Test type	GTR	Situation
Type I Tailpipe emissions after cold start Type II Tailpipe emissions at (increased) idle and free acceleration Type VII CO 2 emissions, fuel consumption electric energy consumption and electric range	GTR2	Revised from now on Basic policy ・Based on EURO5 ・EURO 4 requirements are defined as alternative. Progress ・Type I is almost ended. ・Type II and VII has been discussed.
Type III Emissions of crankcase gases Type IV Evaporative emissions	GTR 17	Adopted at WP 29 and already issued 8 March 2017 (ECE/TRANS/180/Add.17)
Type V Durability of pollution-control devices	NEW GTR **	Created from now on
Type VIII OBD environmental tests	GTR 18	OBD1 Already issued 8 March 2017 (ECE/TRANS/180/Add.18) OBD2 Revised from now on

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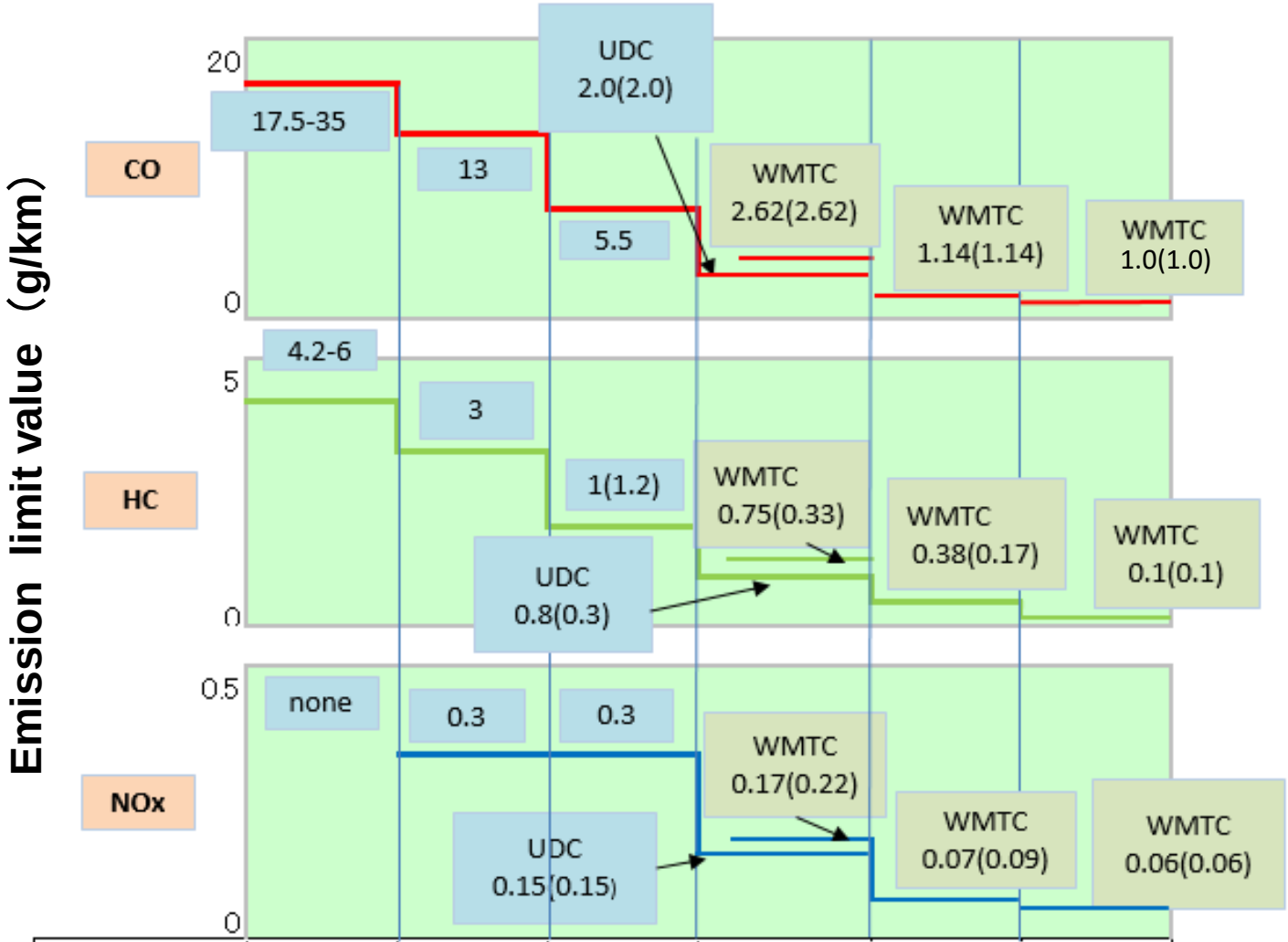
3. EU regulation



	UNR 40	EURO 1	EURO 2	EURO 3	EURO 4	EURO 5
Test method	UDC	UDC	UDC	UDC+EUDC or WMTC	WMTC	WMTC
Enforcement date		1999	2003	2006(UDC) 2007(WMTC)	2016	2020

3.EU regulation

REGULATION (EU) No 168/2013

- **RVFSR** COMMISSION DELEGATED REGULATION (EU) No 3/2014
- **RVCR** COMMISSION DELEGATED REGULATION (EU) No 44/2014
- **REPPR** COMMISSION DELEGATED REGULATION (EU) No 134/2014
- **RAR** COMMISSION IMPLEMENTING REGULATION (EU) No 901/2014

Amendment

- REGULATION (EU) 2019/129 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
- COMMISSION DELEGATED REGULATION (EU) 2018/295
- COMMISSION DELEGATED REGULATION (EU) 2016/1824

…

3.EU regulation

REGULATION (EU) No 168/2013

Annex 1	Vehicle classification
Annex 2	Exhaustive list of requirements for the purposes of EU vehicle type-approval
Annex 3	Limits for small series
Annex 4	Timetable for the application of this Regulation in respect of type-approval
Annex 5	(A) — Environmental tests and requirements
	(B) — Application of environmental performance test requirements for approval and extensions
Annex 6	Pollutant emission limit values, OBD thresholds and sound-level limit values for type-approval and conformity of production
	(A) Tailpipe emission limits after cold start
	(B) On-board diagnostics emission thresholds
	(C) Evaporative emission limits
	(D) Sound-level limits — Euro 4 and Euro 5
Annex 7	Durability of pollution control devices
Annex 8	Enhanced functional safety requirements
Annex 9	Correlation tableEN 2.3.2013 Official Journal of the European Union L 60/93

3.EU regulation

RVCR COMMISSION DELEGATED REGULATION (EU) No 44/2014

Annex 1	List of UNECE regulations which apply on a compulsory basis
Annex 2	Requirements applying to powertrain tampering prevention (anti-tampering) measures
Annex 3	Requirements applying to arrangements for type-approval procedures
Annex 4	Requirements applying to conformity of production (CoP)
Annex 5	Requirements applying to coupling devices and attachments
Annex 6	Requirements applying to devices to prevent unauthorised use
Annex 7	Requirements applying to electromagnetic compatibility (EMC)
Annex 8	Requirements applying to external projections
Annex 9	Requirements applying to fuel storage
Annex 10	Requirements applying to load platforms
Annex 11	Requirements applying to masses and dimensions
Annex 12	Requirements applying to functional on-board diagnostics (OBD)
Annex 13	Requirements applying to passenger handholds and footrests
Annex 14	Requirements applying to the registration plate space
Annex 15	Requirements applying to access to repair and maintenance information
Annex 16	Requirements applying to stands
Annex 17	Performance standards and assessment of technical services

3.EU regulation

REPPR COMMISSION DELEGATED REGULATION (EU) No 134/2014

Annex 1	List of UNECE regulations which apply on a compulsory basis
Annex 2	Test type I requirements: tailpipe emissions after cold start
Annex 3	Test type II requirements: tailpipe emissions at (increased) idle and free acceleration
Annex 4	Test type III requirements: emissions of crankcase gases
Annex 5	Test type IV requirements: evaporative emissions
Annex 6	Test type V requirements: durability of pollution-control devices
Annex 7	Test type VII requirements; CO 2 emissions, fuel consumption, electric energy consumption and electric range
Annex 8	Test type VIII requirements: OBD environmental tests
Annex 9	Test type IX requirements: sound level
Annex 10	Testing procedures and technical requirements as regards propulsion unit performance
Annex 11	Vehicle propulsion family with regard to environmental performance demonstration testing
Annex 12	Amendment of Part A of Annex V to Regulation (EU) No 168/2013

3. EU regulation

Requirement comparison

Test Type	Requirement	Euro3	Euro4	Euro5
Type I	Tailpipe emissions after cold start	✓	✓	✓
Type II	Tailpipe emissions at (increased) idle and free acceleration		✓	✓
Type III	Emissions of crankcase gases		✓	✓
Type IV	Evaporative emissions		✓	✓
Type V	Durability of pollution-control devices		✓	✓
Type VII	CO 2 emissions, fuel consumption, electric energy consumption and electric range		✓	✓
Type VIII	OBD environmental tests		✓ OBD1	✓ OBD2

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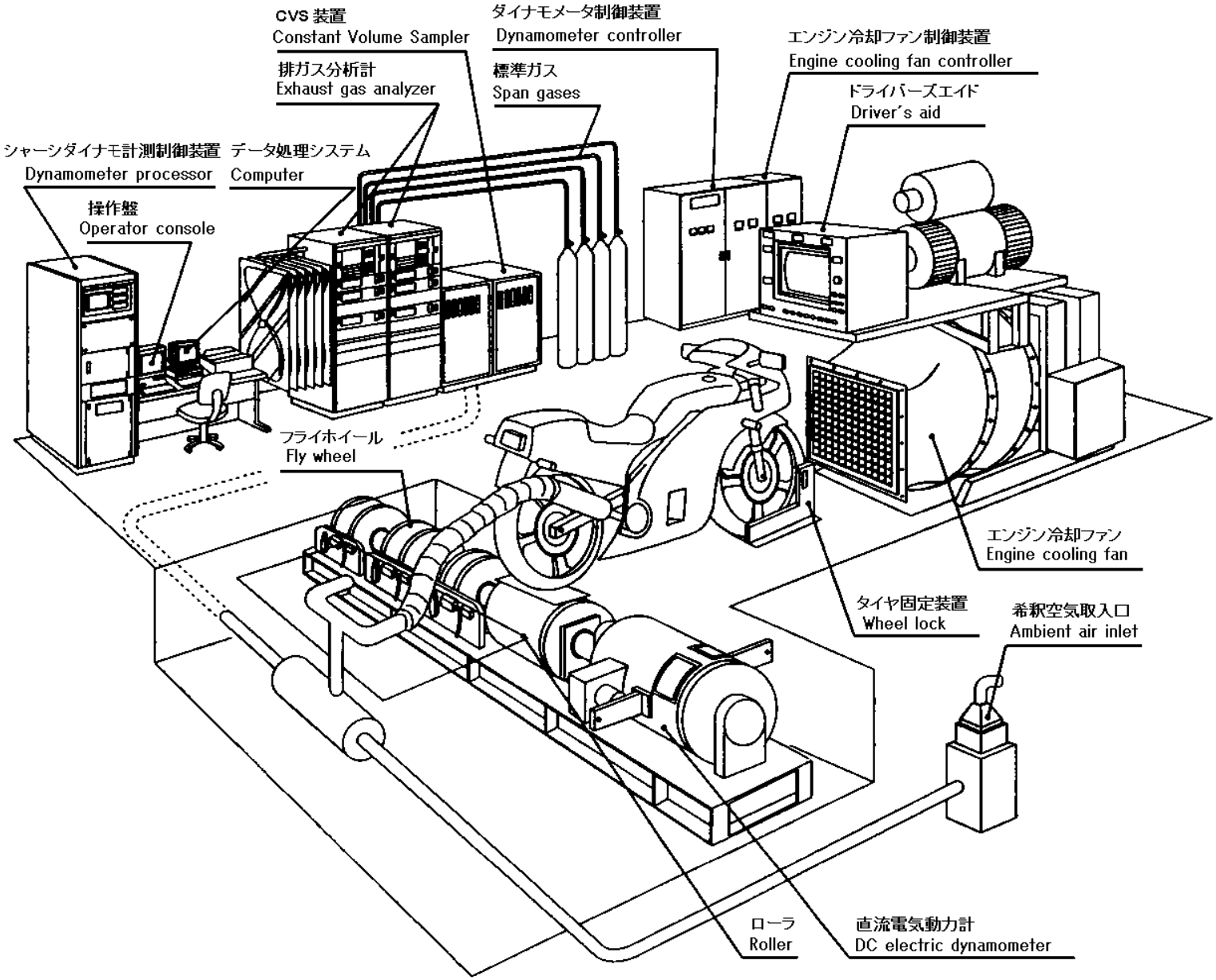
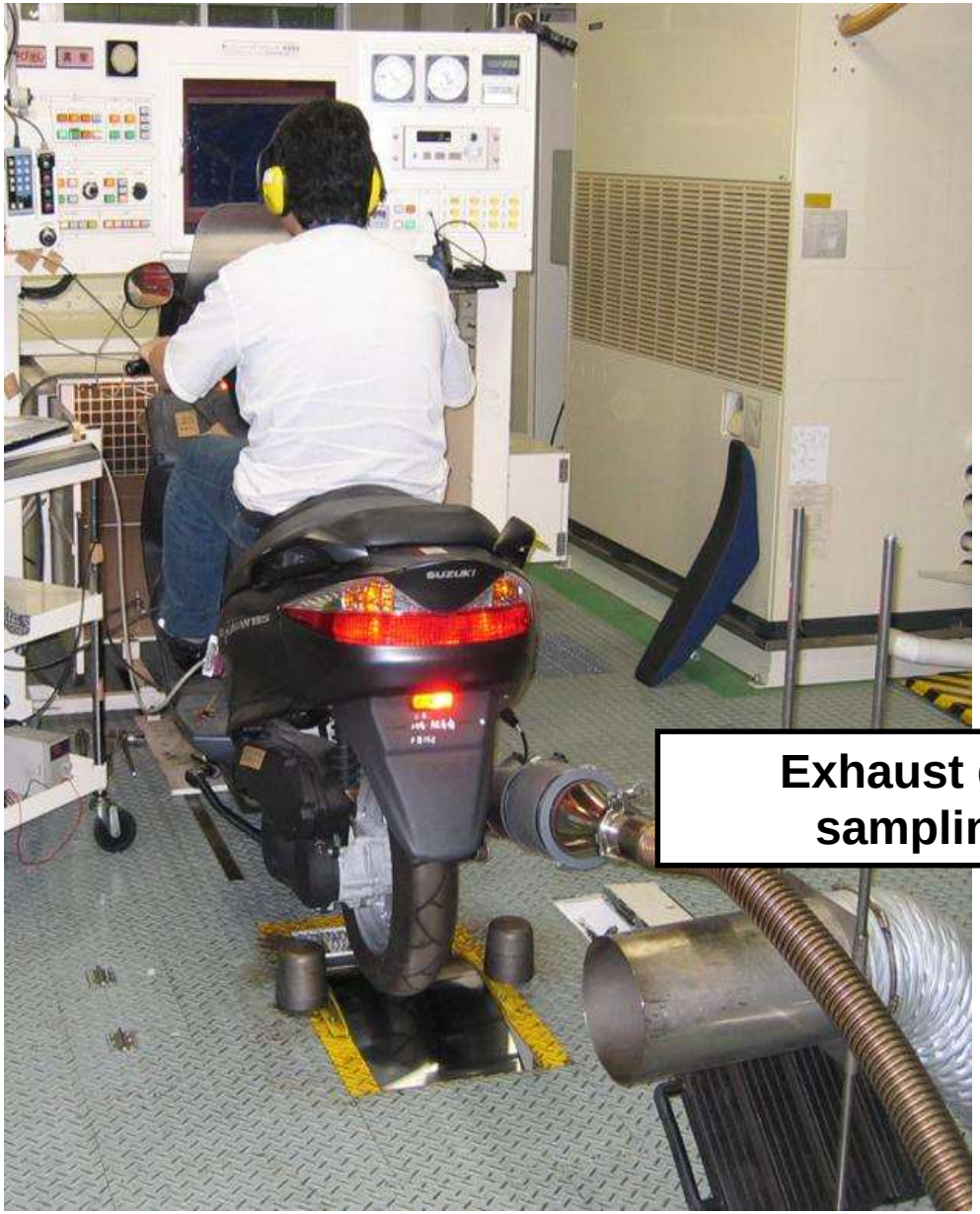
Test requirement

Test type	Requirement
Type I	Tailpipe emissions after cold start
Type II	Tailpipe emissions at (increased) idle and free acceleration
Type III	Emissions of crankcase gases
Type IV	Evaporative emissions
Type V	Durability of pollution-control devices
Type VII	CO 2 emissions, fuel consumption, electric energy consumption and electric range
Type VIII	OBD environmental tests

Type I. Emission test lab

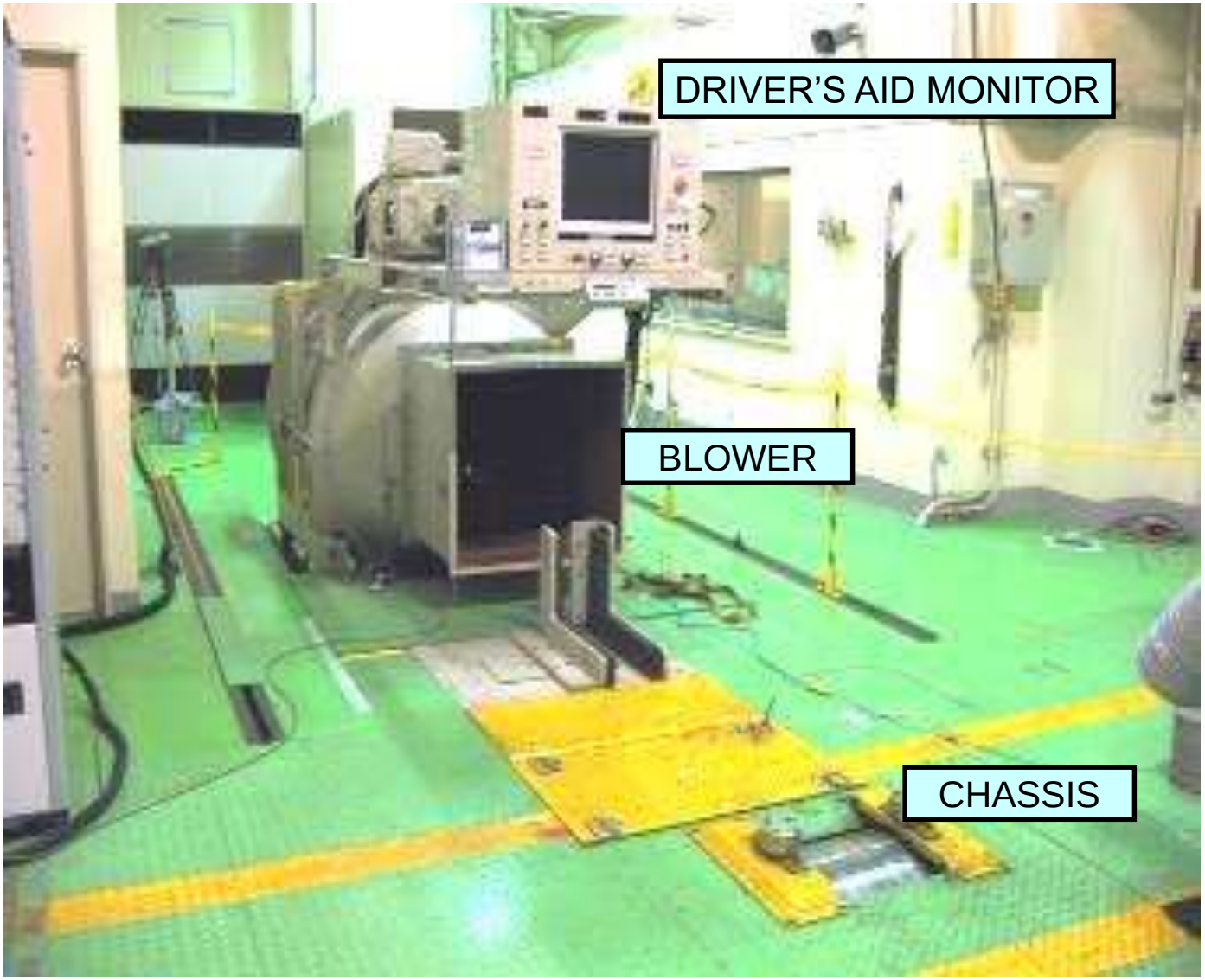


Type I. Chassis dynamometer



Exhaust gas sampling

Type I. Chassis dynamometer

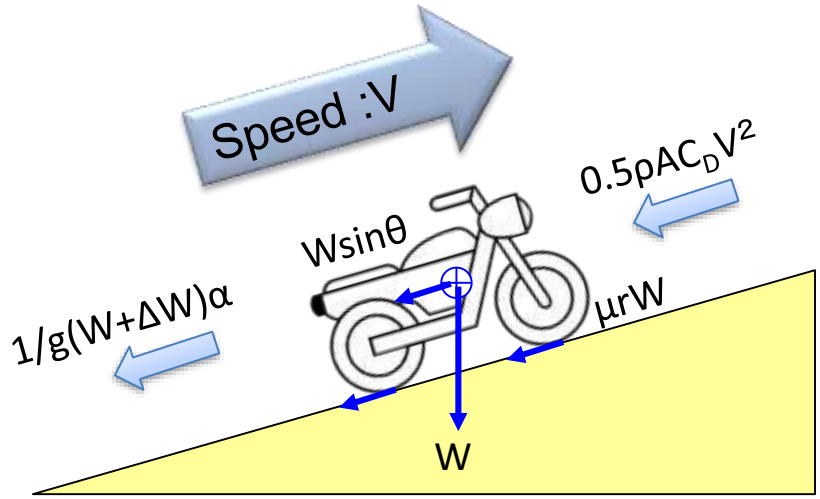


Type I. Running resistance

Running resistance acting on a motorcycle during actual running

Total running resistance	=	**Rolling** resistance	+	**Air** resistance	+	**Gradient** resistance	+	**Acceleration** resistance
Rtotal	=	**R**r	+	**R**a	+	**R**g	+	**R**cc
	=	μrW		$0.5\rho AC_DV^2$		$W\sin\theta$		$1/g(W+\Delta W)\alpha$

μr: rolling resistance coefficient
W: Total weight of vehicle weight kg
ρ: Air density
A: Front projected area m2
C_D: Air resistance coefficient
θ: gradient angle deg
α: acceleration m / s2
ΔW : Inertial mass of rotating body equivalent.



Setting running resistance on a chassis dynamometer

A, Coast-down Method

B, Running resistance table

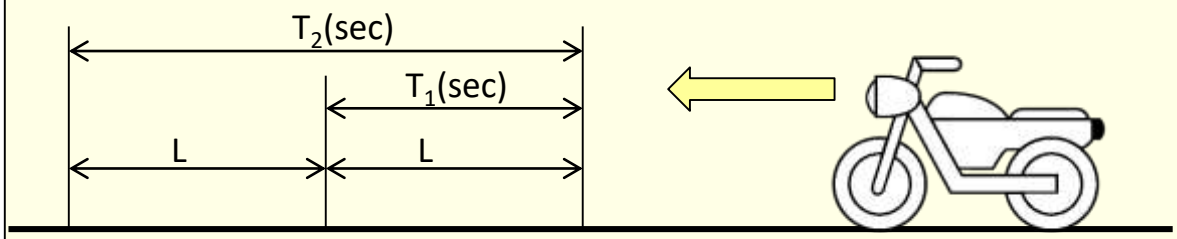
Coast-down Method

Set running resistance curve based on running resistance obtained from actual running

〇: The unique elements of the vehicle can be reproduced

×: It takes time and effort to perform the actual running test

A method that measures the transit time when a vehicle is coasted for a certain distance to determine the running resistance.



$$R = 9.8 \times \left[\frac{W + \Delta W}{g} \times \frac{L / T_1 - L / (T_2 - T_2)}{T_2 / 2} \right]$$

Appendix 7
Road tests of L-category vehicles equipped with one wheel on the driven axle or with twinned wheels for the determination of test bench settings

Type I. Running resistance

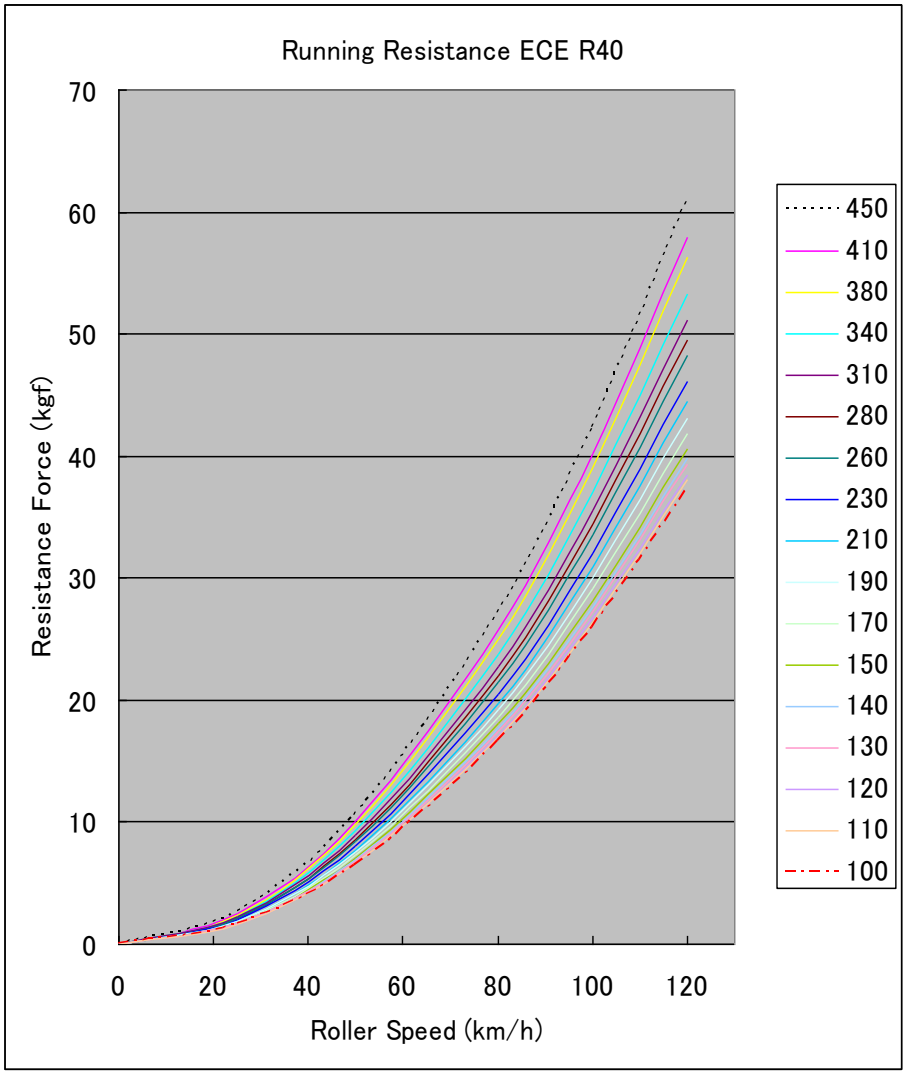
Running resistance force derived from a running resistance table

The chassis dynamometer may be set by the use of the running resistance table instead of the running resistance force obtained by the coast-down method. In this table method, the chassis dynamometer shall be set by the mass in running order regardless of particular L-category vehicle characteristics.

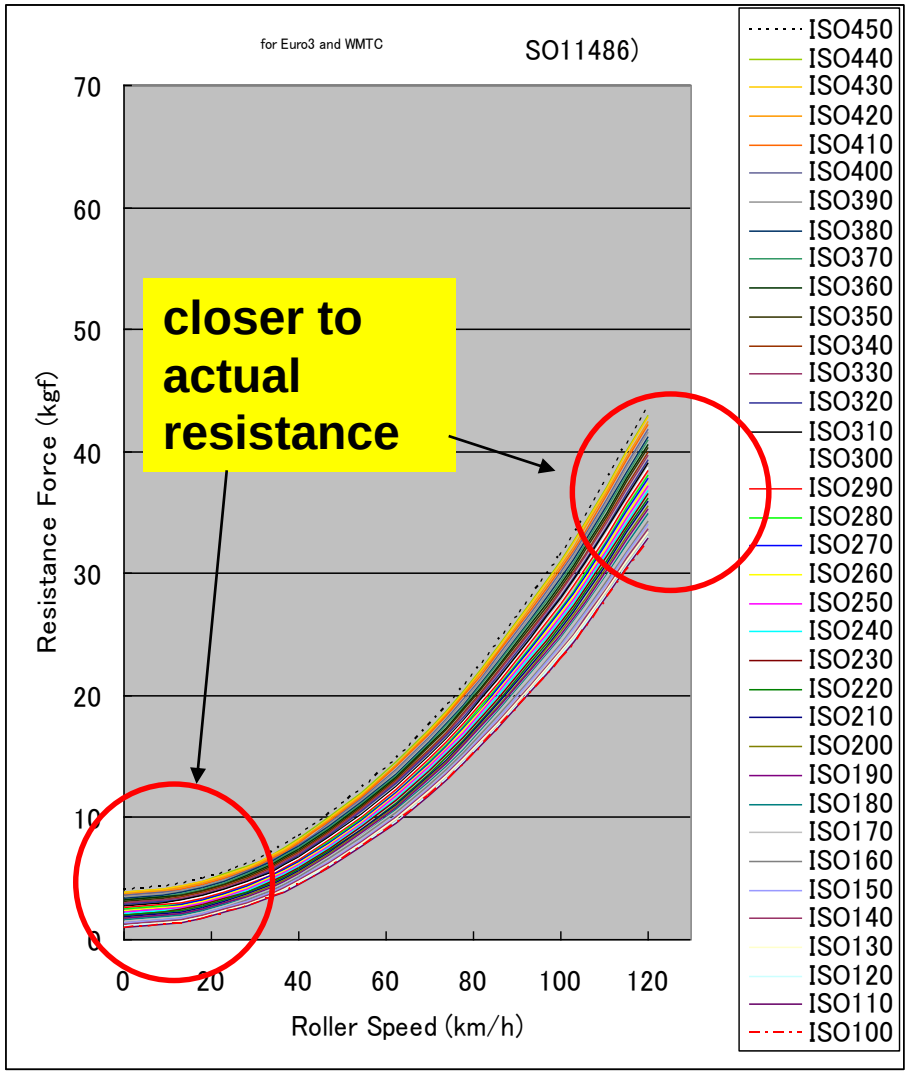
Reference mass mref (kg)	Equivalent inertia mass mi (kg)	Rolling resistance of front wheel a (N)	Aero drag coefficient b (N/(km/h)^2)
0 < mref ≤ 25	20	1.8	0.0203
25 < mref ≤ 35	30	2.6	0.0205
35 < mref ≤ 45	40	3.5	0.0206
45 < mref ≤ 55	50	4.4	0.0208
55 < mref ≤ 65	60	5.3	0.0209
65 < mref ≤ 75	70	6.8	0.0211
75 < mref ≤ 85	80	7.0	0.0212
85 < mref ≤ 95	90	7.9	0.0214
95 < mref ≤ 105	100	8.8	0.0215
105 < mref ≤ 115	110	9.7	0.0217
115 < mref ≤ 125	120	10.6	0.0218
125 < mref ≤ 135	130	11.4	0.0220
135 < mref ≤ 145	140	12.3	0.0221
145 < mref ≤ 155	150	13.2	0.0223
155 < mref ≤ 165	160	14.1	0.0224
165 < mref ≤ 175	170	15.0	0.0226
175 < mref ≤ 185	180	15.8	0.0227
185 < mref ≤ 195	190	16.7	0.0229
At every 10 kg	At every 10 kg	a = 0.088 × m i (*)	b = 0.000015 × mi +0.02

Type I.Road Load setting

UN R40-01 / EURO1 / EURO2



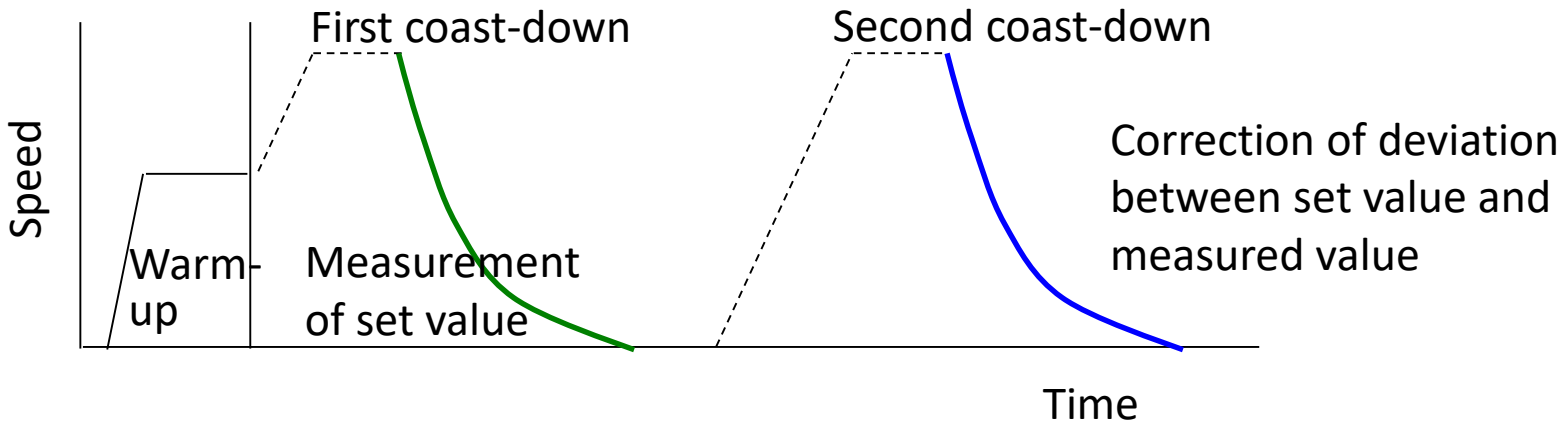
EURO3/4/5 (ISO11486),GTR

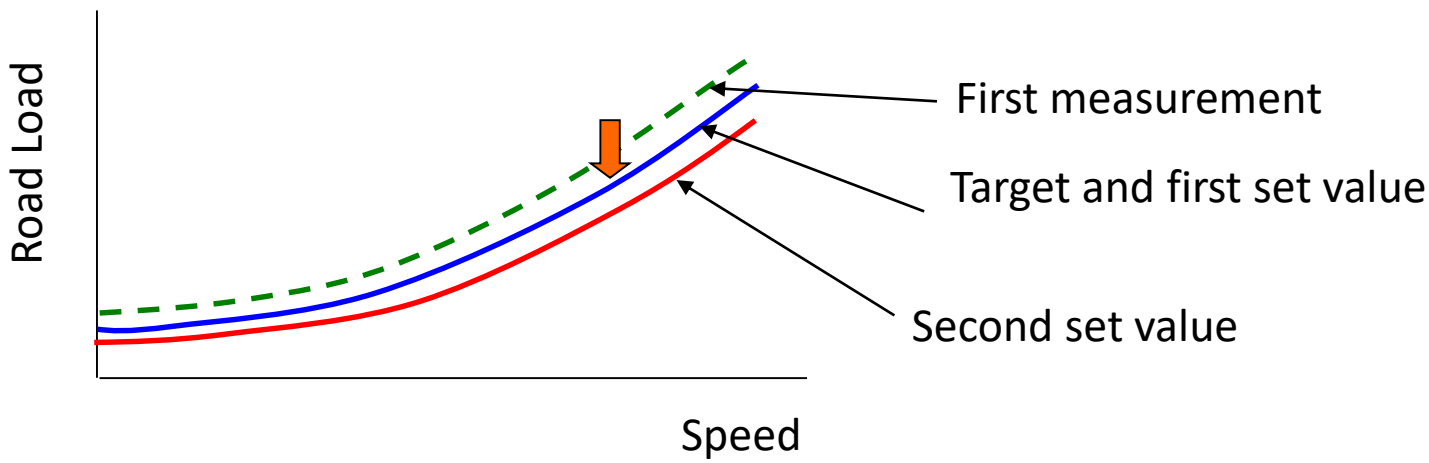


Type I Road Load setting

Method of verification

The set running resistance is verified by coast down.





Type I. Exhaust emission analyzer

Type I. Configuration of CVS

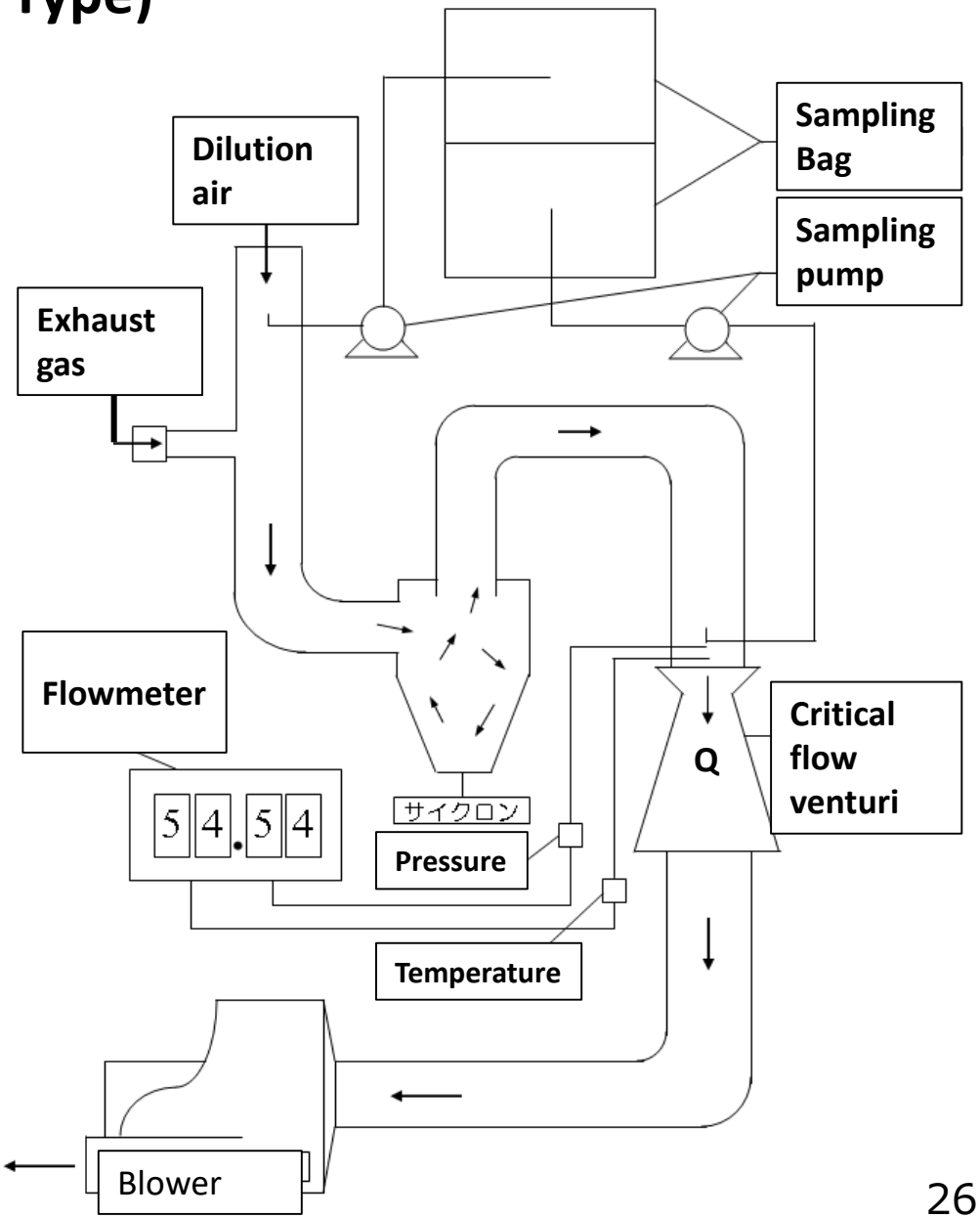
Constant Volume Sampler (CFV Type)

Measurement principle

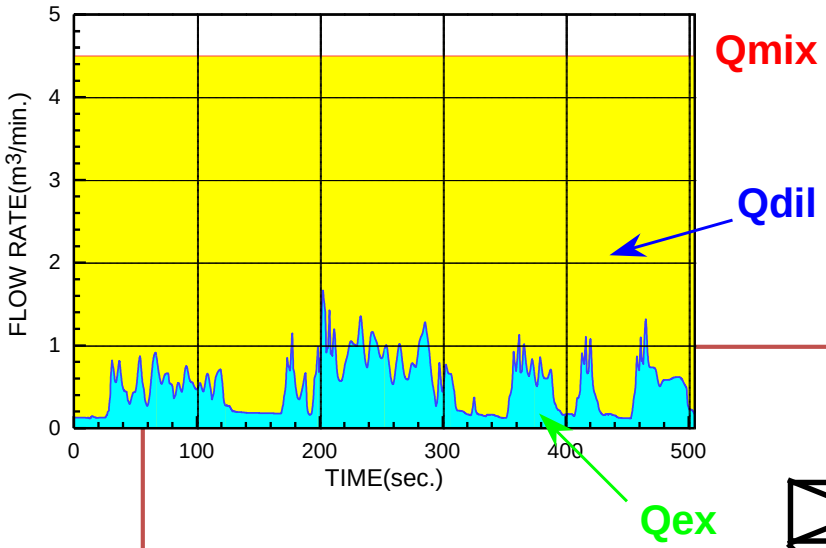
Using the critical flow venturi, the principle that the flow velocity is saturated when the gas is made sonic and the flow rate is constant if the opening area is constant.

The flow rate of the gas passing through the venturi is represented by a function of the pressure and the temperature immediately before the venturi in a specific flow coefficient, and is calculated by integrating the flow rate every minute time.

In CVS, there is a PDP type in addition to the CFV type.



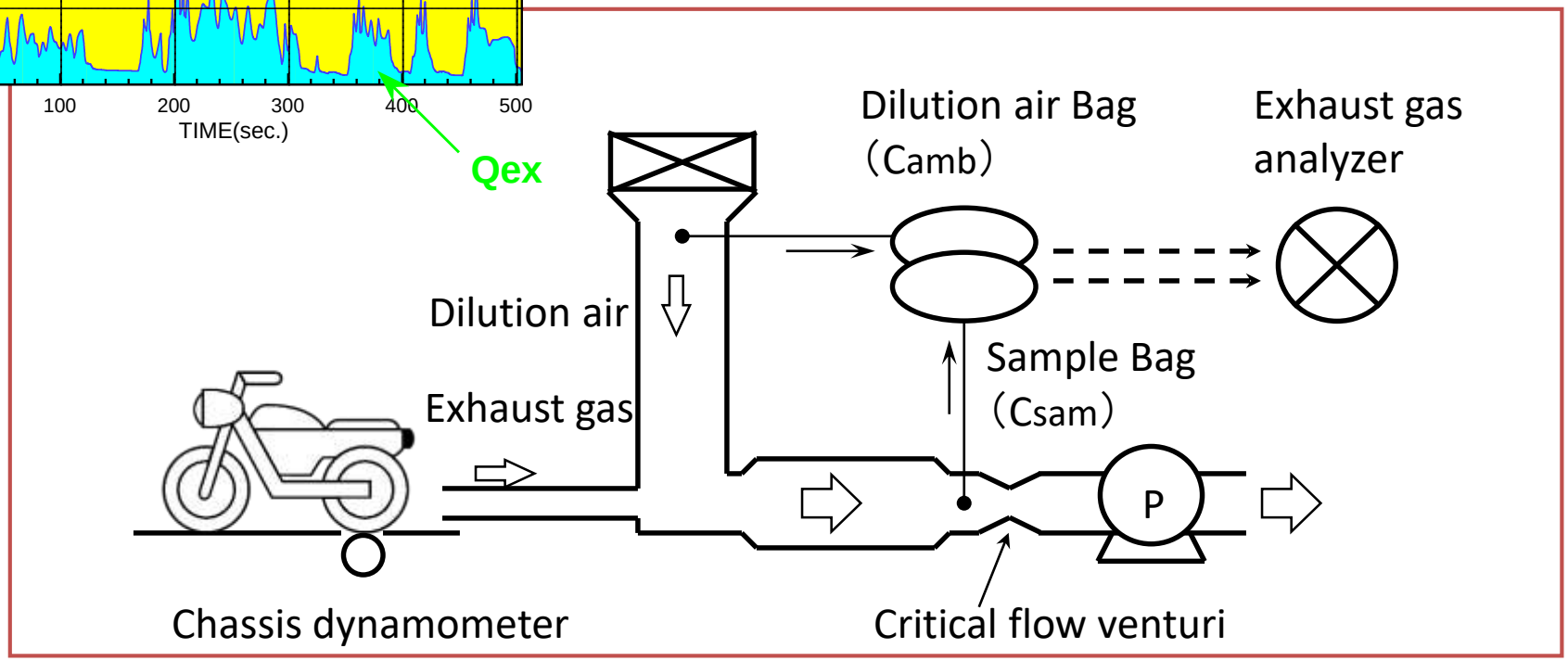
Type I. Principle of CVS method



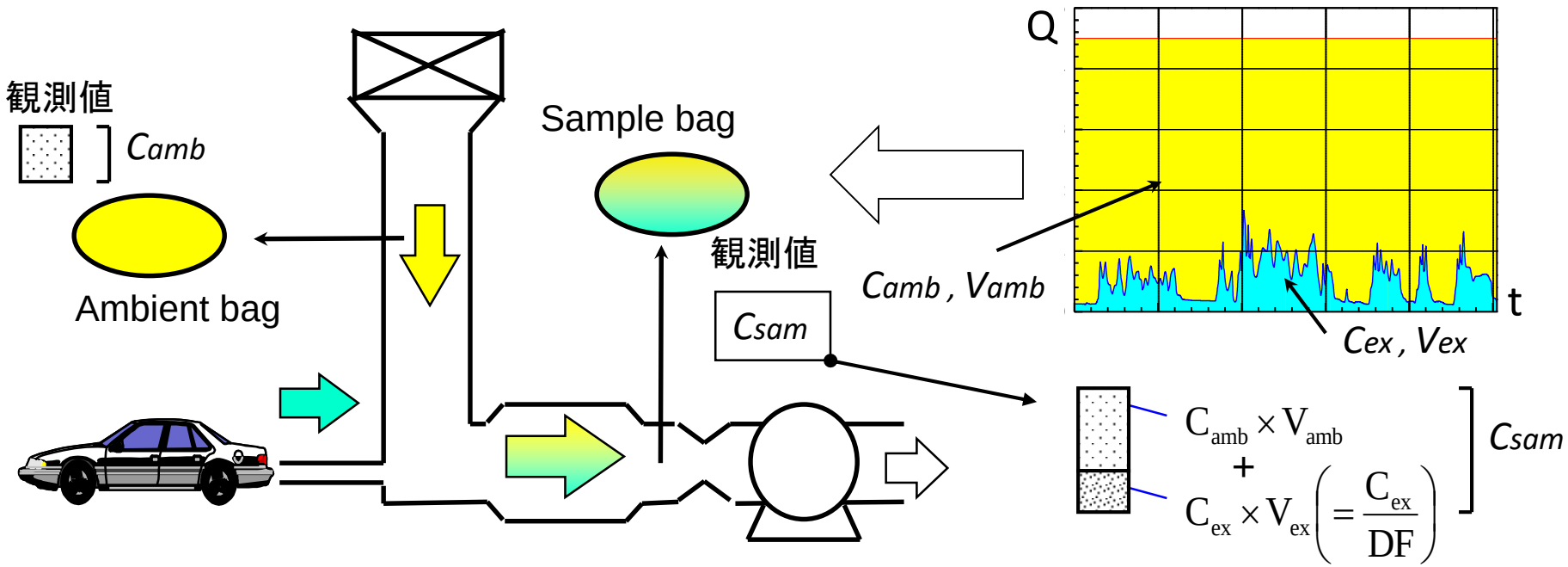
CVS method

Exhaust gas is diluted to a constant flow rate in the atmosphere and bag sampling

- -No need to measure exhaust gas flow
- -Prevent condensation



Type I. Background correction



$$V_{amb} + V_{ex} = 1$$

$$C_{amb} \times V_{amb} + C_{ex} \times V_{ex} = C_{sam}$$

$$DF \equiv \frac{V_{ex} + V_{amb}}{V_{ex}} = \frac{1}{V_{ex}}, \quad V_{ex} = \frac{1}{DF}$$

$$\begin{aligned} C_{ex} \cdot V_{ex} &= C_{sam} - C_{amb} \times V_{amb} \\ &= C_{sam} - C_{amb} \times (1 - V_{ex}) \\ &= C_{sam} - C_{amb} \times \left(1 - \frac{1}{DF}\right) \end{aligned}$$

Type I. Formula for emission mass

Mass emission formula in CVS method

$$M = \rho \times \left(C_{sam.bag} - C_{amb.bag} \times \left(1 - \frac{1}{DF} \right) \right) \times V_{mix}$$

ρ	Density of target gas
CO :	1.16
CO2 :	1.83
HC (gas) :	0.577（g/L)
$C_{sam.bag}$:	Concentration of target gas in sample bag（ppm）
$C_{amb.bag}$:	Concentration of target gas in diluted air bag（ppm）
Vmix:	total volume
DF:	Dilution factor

Type I. Calculating Dilution Factor

Exhaust gas and dilution air volume measurement is difficult
→ theoretically calculated from stoichiometry

$$C_8H_{15} + 11.75O_2 + 44.19N_2 \rightarrow 8CO_2 + 7.5H_2O + 44.19N_2$$

$$[CO_2]_{tp.ideal} = \frac{8}{8 + 7.5 + 44.19} = 13.4[\%]$$

Theoretical value

$$DF = \frac{13.4[\%]}{[CO_2]_{sam.bag} + [CO]_{sam.bag} + [THC]_{sam.bag}}$$

measured value

- Prerequisites for DF definition
  - Dilution air does not contain measurement target components
  - Engine always runs at stoichiometric
  - No condensation of water in any part of exhaust pipe

Type I. Typical analysis principle

① *Non-dispersive Infrared Detector: NDIR*

非分散赤外吸収法（NDIR法）

CO, CO_2, H_2O ・・・

② *Flame Ionization Detector: FID*

水素炎イオン化法（FID法）

THC

③ *Chemiluminescent Detector: CLD*

化学発光法（CLD法）

NO（NOx）

④ *Paramagnetic Detector: MPD*

磁気圧法（MPD法）

O_2

Type I 校正

NMHC : Regulations added from EURO5

CH4 is said to have a low contribution to photochemical smog generation, and THC in the exhaust gas excluding CH4, that is, non-methane hydrocarbons were added as a control item in EURO5

How to determine NMHC concentration

・Subtract the CH4 concentration measured separately from the THC concentration.

• To measure only CH4 with the FID analyzer, add a unit that separates CH4 from other HC components before the detector.Gas

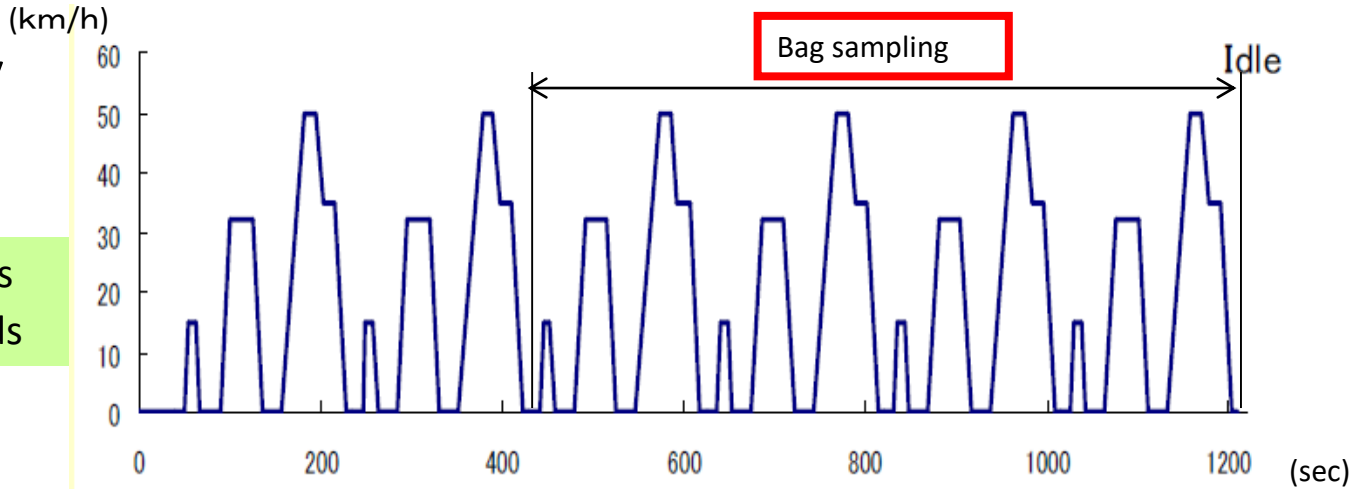
Chromatograph (GC)

Non-methane cutter (NMC)

Emission measuring methods for UN R40/Euro1/2

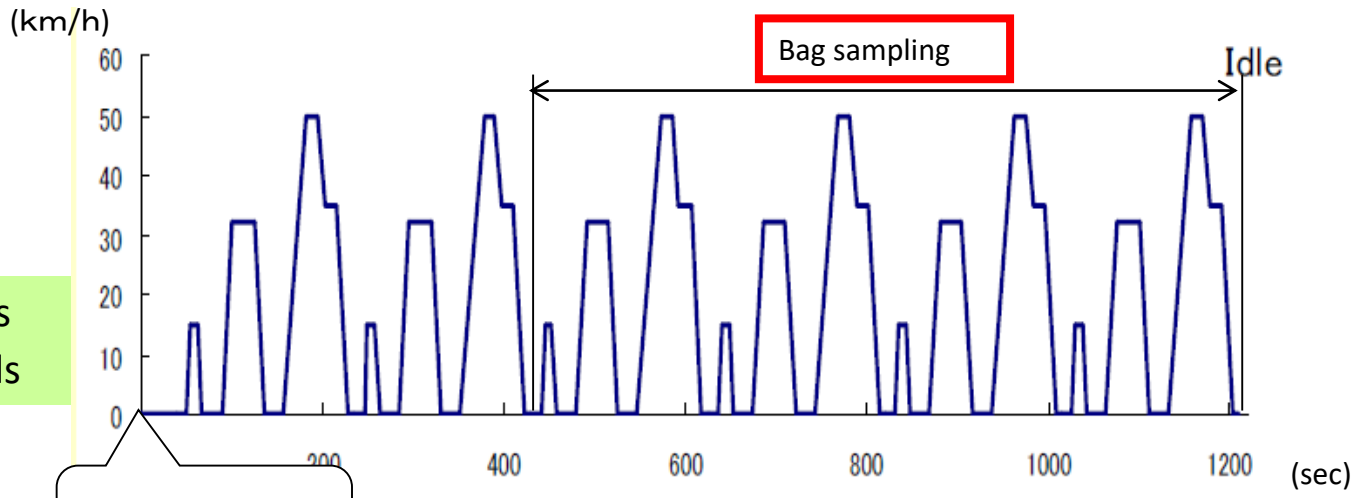
UN R40/
Euro1

All Motorcycles
except Mopeds



Euro2

All Motorcycles
except Mopeds



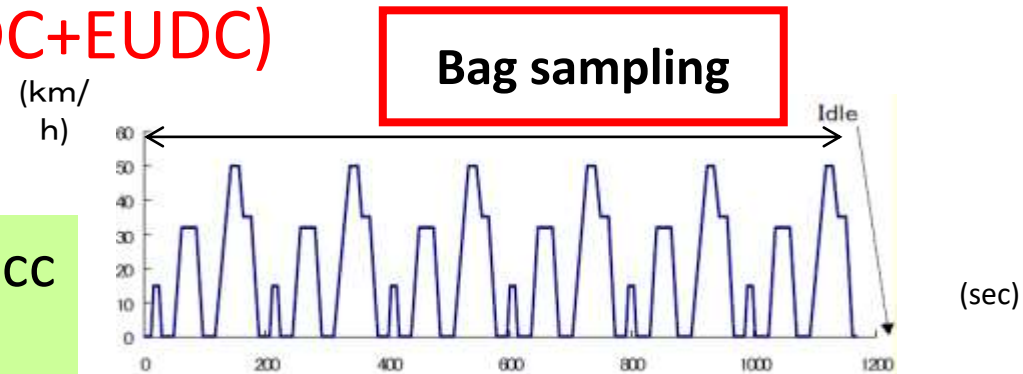
Without idling
(40sec)

Type I Test cycle

EURO3 from 2006(UDC+EUDC)

Class Ⅰ

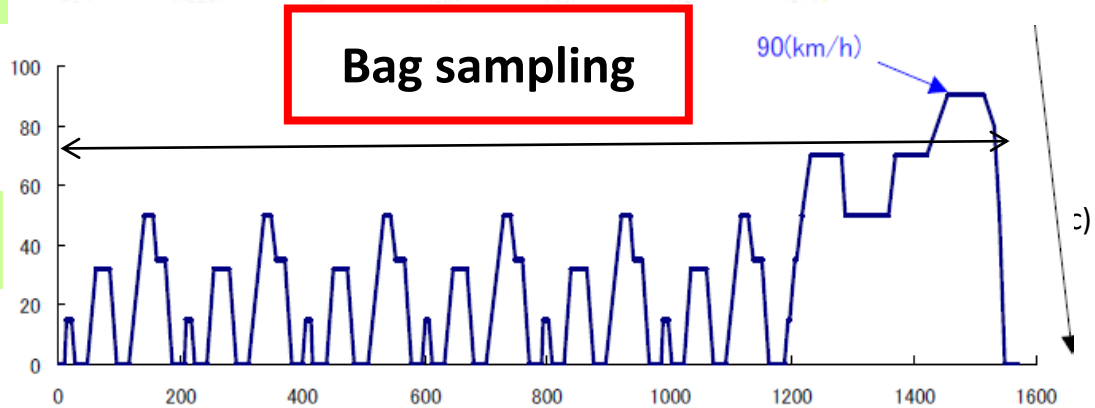
eng. displacement＜150cc
Without moped



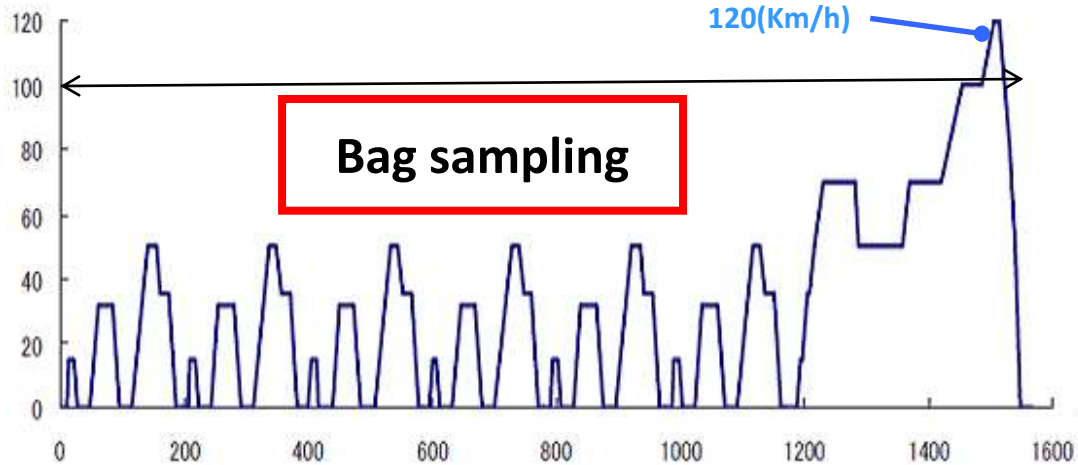
Class Ⅱ

eng. displacement ≧150cc

max. speed < 110Km/h



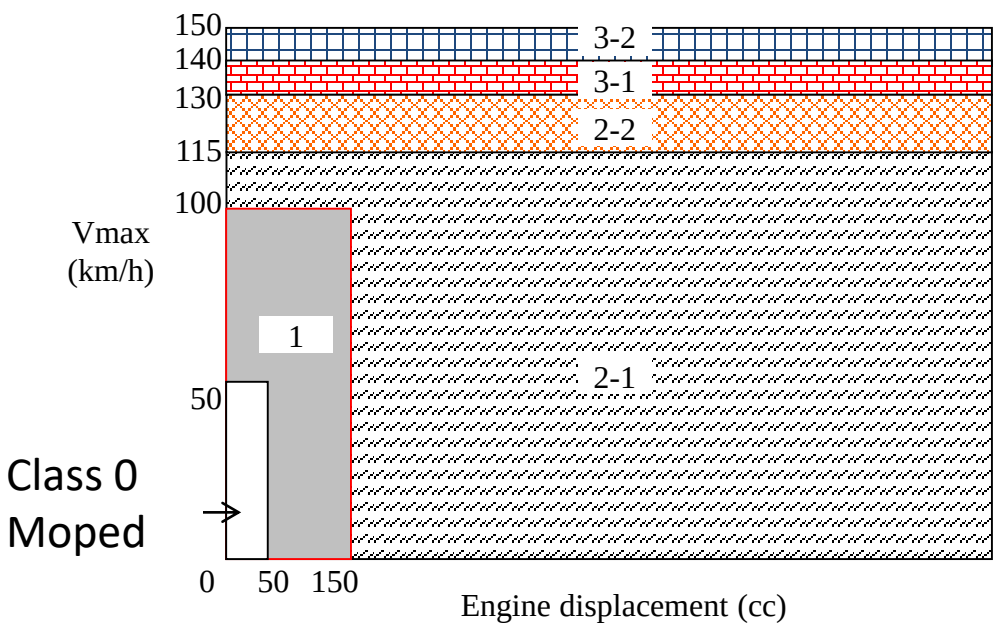
max. speed ≧ 110Km/h



Type I. Classification of WMTC

WMTC Phase2(ECE/TRANS/180/Add.2/Amend.2 of 28 October 2011) sets 5 subclasses

Class	Subclass	Definition
Class1	–	50cc<Engine displacement<150cc and Vmax>50km/h or Engine displacement<150cc, 50km/h≦Vmax<100 km/h
Class2	2-1	Engine displacement<150cc and 100km/h≦Vmax<115 km/h, or Engine displacement≧150cc and Vmax<115 km/h
	2-2	115km/h≦Vmax<130 km/h
Class3	3-1	130km/h≦Vmax<140 km/h
	3-2	Vmax≧140 km/h

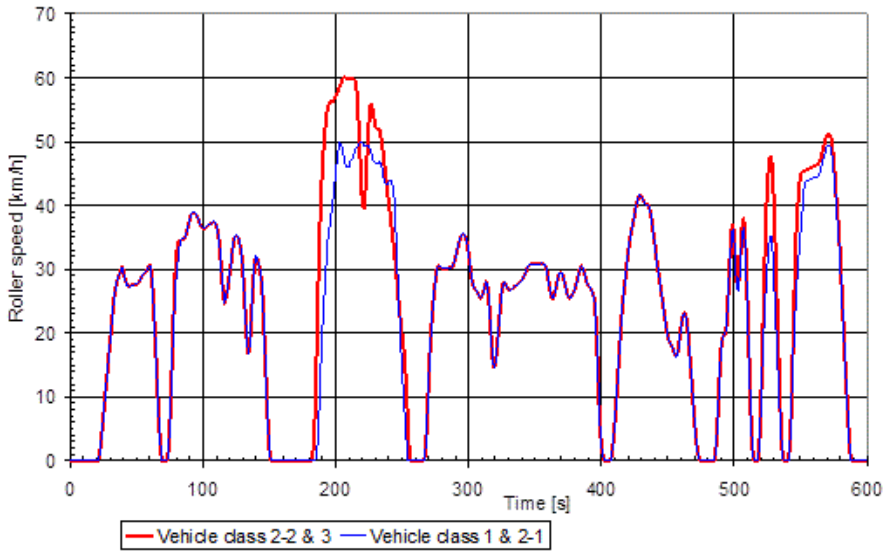


	CO	HC	NOx	(g/km)
(≧130km/h)	2.62	0.33	0.22	
(＜130km/h)	2.62	0.75	0.17	

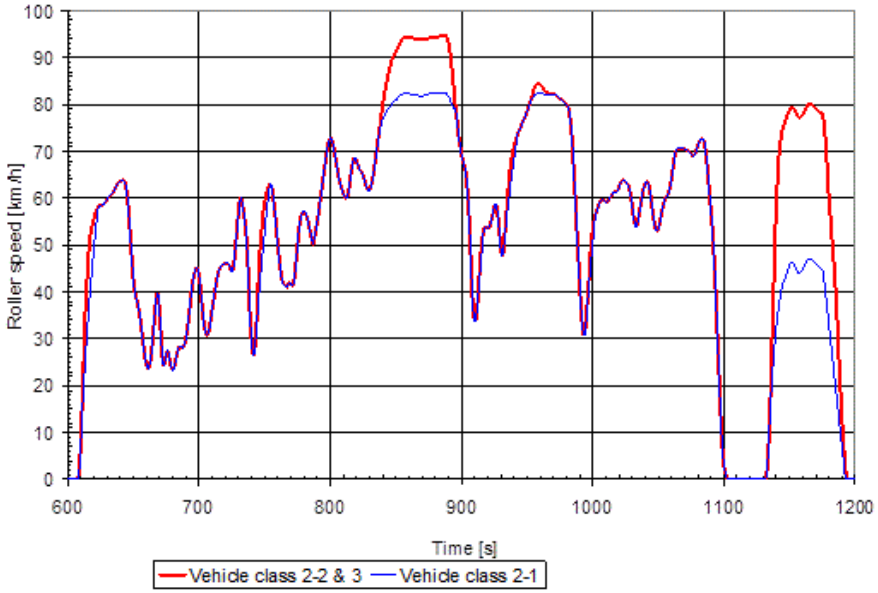
Type I. Test cycle for WMTC

WMTC Phase2 mode are as below. Each part has normal or reduced speed trace.

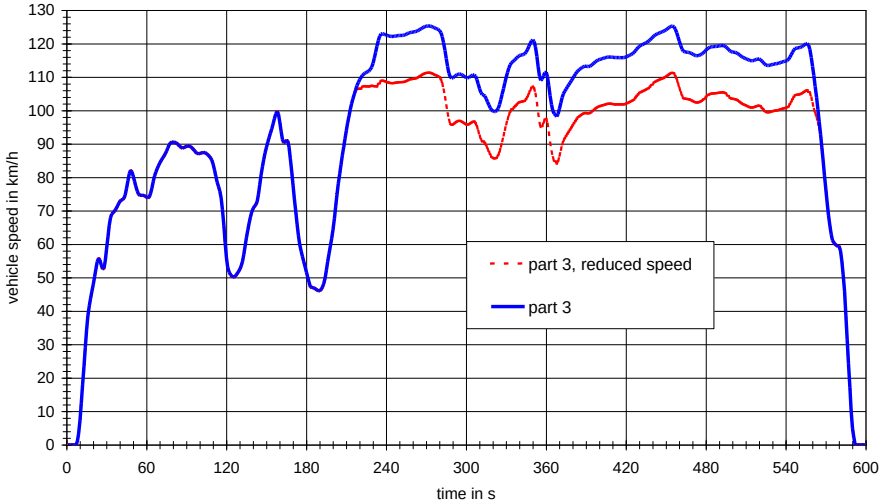
Part-1



Part-2



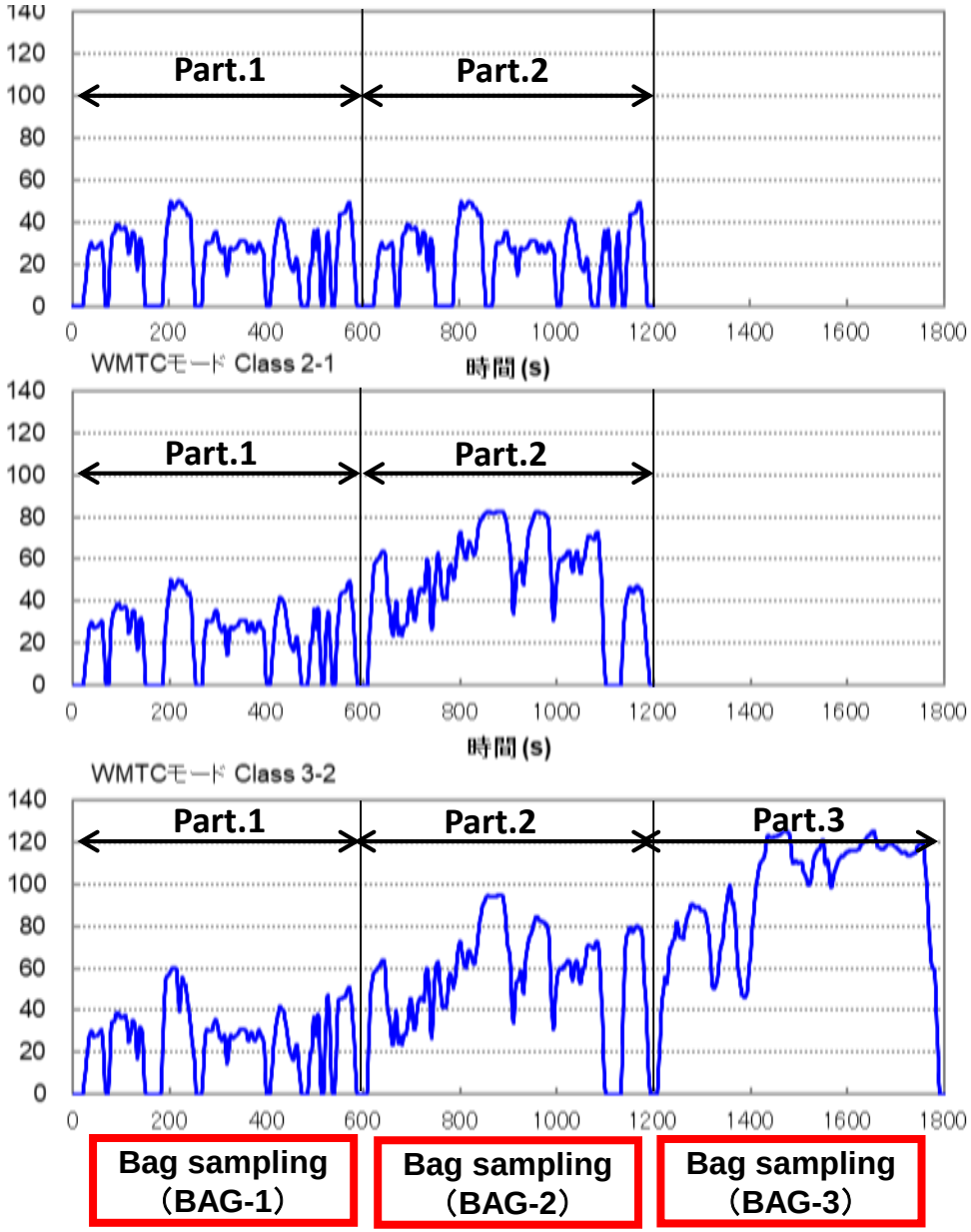
Part-3



Class	Subclass	Applicable mode (Weighting factor)
Class1	-	Part1S Cold(30%)+Part1S Hot(70%)
Class2	2-1	Part1S Cold(30%)+Part2S Hot(70%)
	2-2	Part1 Cold(30%)+Part2 Hot(70%)
Class3	3-1	Part1 Cold(25%)+Part2 Hot(50%)+Part3S Hot(25%)
	3-2	Part1 Cold(25%)+Part2 Hot(50%)+Part3 Hot(25%)

Type I. Weighting factors for WMTC

Weighting factors for WMTC



$$R_F = R_1 \cdot w_1 + R_2 \cdot w_2 + R_3 \cdot w_3$$

R_F: Final test result of pollutant emissions, carbon dioxide emission or fuel consumption

Vehicle class	Cycle		Euro 3	Euro 4/5	Gtr 2 Amd 4
Class 1	Part 1	w_1	0.5	**0.3**	**0.3**
	Part 2	w_2	0.5	**0.7**	**0.7**
Class 2	Part 1	w_1	0.3	0.3	0.3
	Part 2	w_2	0.7	0.7	0.7
Class 3	Part 1	w_1	0.25	0.25	0.25
	Part 2	w_2	0.5	0.5	0.5
	Part 3	w_3	0.25	0.25	0.25

In Euro4, CLASS1 Weight Factor has been changed

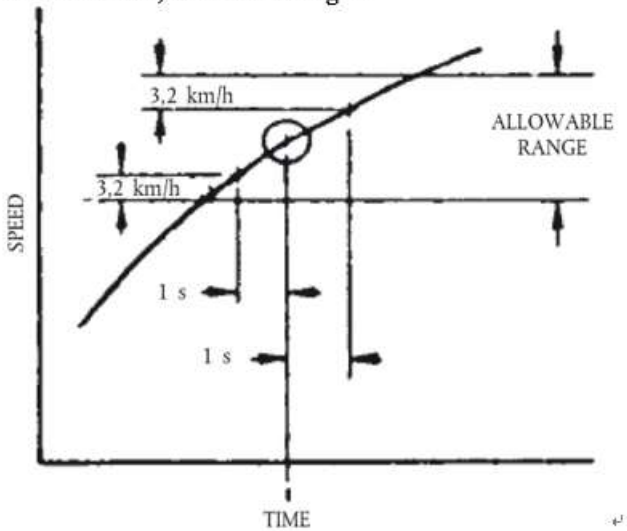
Type I Test Procedure

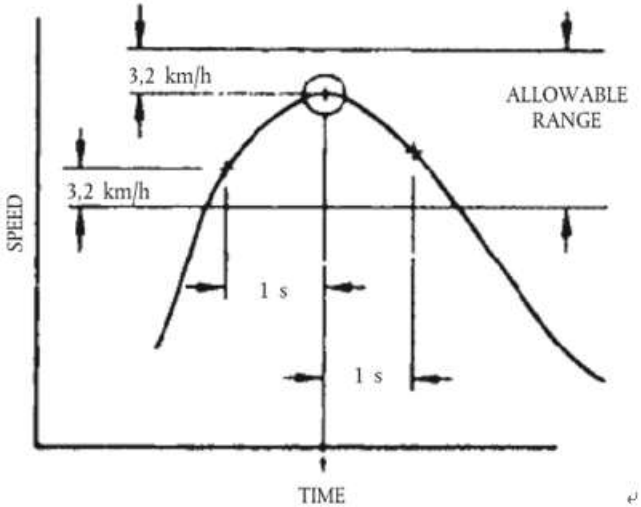
Run-in	The vehicle shall be presented in good mechanical condition, properly maintained and used. It shall have been run in and driven at least 1,000 km before the test. The engine, pollutant emission abatement equipment, drive train, and vehicle shall be properly run in, in accordance with the vehicle manufacturer's requirements.
Adjustments	The test vehicle shall be adjusted in accordance with the vehicle manufacturer's requirements, e.g. as regards the viscosity of the oils, or, if it differs from the production series, a full description shall be given in the test report.
Test mass and load distribution	The test mass, including the masses of the rider and the instruments, shall be measured before the beginning of the tests. The load shall be distributed across the wheels in conformity with the vehicle manufacturer's instructions.
Engine starting and restarting	The engine shall be started according to the manufacturer's recommended starting procedures. The test cycle run shall begin when the engine starts. The operator may use the choke, throttle, etc. where necessary to keep the engine running.
Drive instructions	The test vehicle shall be driven with minimum throttle movement to maintain the desired vehicle speed. No simultaneous use of brake and throttle shall be permitted. If the test vehicle cannot accelerate at the specified rate, it shall be operated with the throttle fully opened until the roller speed (actual vehicle speed) reaches the value prescribed for that time in the driving schedule.
Analysis	obtaining a stabilised reading of the exhaust bag sample on all analysers within 20 minutes of the end of the sample collection phase of the test;

Type I Test Procedure

Vehicle speed tolerances	The vehicle speed tolerance at any given time on the test cycles prescribed in Table A4.App12 is defined by upper and lower limits. Figure A1/-6 shows the range of acceptable vehicle speed tolerances for typical points.
	If the acceleration capability of the vehicle is not sufficient to carry out the acceleration phases or if the maximum design speed of the vehicle is lower than the prescribed cruising vehicle speed within the prescribed limits of tolerances, the vehicle shall be driven with the throttle fully open until the desired vehicle speed is reached or at the maximum design vehicle speed achievable with fully opened throttle during the time that desired vehicle speed exceeds the maximum design vehicle speed. In both cases, paragraph 3.4.4.2.1. is not applicable. The test cycle shall be carried on normally when desired vehicle speed is again lower than the maximum design speed of the vehicle.

Figure A1/-6:
Drivers trace, allowable range





Additional requirements gearshift

3.4.5.3.1.3. Step 3 — Corrections according to additional requirements

3.4.5.3.1.3.1. The gear choice shall be modified according to the following requirements:

A) no gearshift at a transition from an acceleration phase to a deceleration phase. The gear that was used for the last second of the acceleration phase shall be kept for the following deceleration phase unless the vehicle speed drops below a downshift desired vehicle speed;

B) no upshifts or downshifts by more than one gear, except from gear 2 to neutral during decelerations down to stop;

C) upshifts or downshifts for up to four seconds are replaced by the gear before, if the gears before and after are identical, e.g. 2 3 3 3 2 shall be replaced by 2 2 2 2 2, and 4 3 3 3 3 4 shall be replaced by 4 4 4 4 4 4;

In the cases of consecutive circumstances, the gear used longer takes over, e.g. 2 2 2 3 3 3 2 2 2 2 3 3 3 will be replaced by 2 2 2 2 2 2 2 2 2 2 3 3 3;

If used for the same time, a series of succeeding gears shall take precedence over a series of preceding gears, e.g. 2 2 2 3 3 3 2 2 2 3 3 3 will be replaced by 2 2 2 2 2 2 2 2 2 3 3 3;

D) no downshift during an acceleration phase.

Type I. WMTC Phase2 Gearshift

UNECE Website (WMTC Phase2 Gearshift)

UNECE
United Nations Economic Commission for Europe

Home | About UNECE | Main areas of work | Information resources

UNECE » Transport » Areas of Work » Vehicle Regulations » Agreements and Regulations » Global Regulations (1998 Agreement) » Global Technical Regulations (gtrs)

- Transport - Home
- Vehicle Regulations - Home
- About us
- Meetings and Events
- Working Parties and Documents
  - World Forum for Harmonization of Vehicle Regulations (WP 29)
  - Working Party on Noise (GRB)
  - Working Party on Lighting and Light-Signalling (GRE)
  - Working Party on Pollution and Energy (GRPE)
  - Working Party on Brakes

Global Technical Regulations (gtrs)

1998 Agreement on global technical regulations (gtr)

Registry of global technical regulations

ECE/TRANS/180 - Global Registry

English	DOC	PDF
French	DOC	PDF
Russian	DOC	PDF

http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29glob_registry.html

Addenda to the Global Registry (global technical regulations)

No.1 | No.2 | No.3 | No.4 | No.5 | No.6 | No.7 | No.8 | No.9 | No.10 | No.11 | No.12

Global Technical Regulation No.2 (WMTC)

No. 2 - Measurement procedure for two-wheeled motorcycles equipped with a positive or compression ignition engine with regard to emissions and fuel consumption (ECE/TRANS/180/Add.2)

French DOC

Appendix to Amendment 2 to gtr No. 2 - Proposal to develop Amendment 2 to gtr No. 2 and report (ECE/TRANS/180/Add.2/Amend.2/Appendix 1)

English	DOC	PDF
French	DOC	PDF

WMTC-gear selection sheets (updated version presented to GRPE at its 62nd session in June 2011)

English	-	XLS

Instruction for the use of the gearshift calculation program

English	-	PDF

Type I. Reference fuel

Parameter	Unit	Limits[1] Minimum	Maximum	Test method
Research octane number, RON		95.0	-	EN 25164 / prEN ISO 5164
Motor octane number, MON		85.0	-	EN 25163 / prEN ISO 5163
Density at 15 °C	kg/m^3	743	756	EN ISO 3675 / EN ISO 12185
Vapour pressure	kPa	56.0	60.0	EN ISO 13016-1 (DVPE)
Water content	% v/v		0.015	ASTM E 1064
Distillation:				
– Evaporated at 70 °C	% v/v	24.0	44.0	EN ISO 3405
– Evaporated at 100 °C	% v/v	48.0	60.0	EN ISO 3405
– Evaporated at 150 °C	% v/v	82.0	90.0	EN ISO 3405
– Final boiling point	°C	190	210	EN ISO 3405
Residue	% v/v	—	2.0	EN ISO 3405
Hydrocarbon analysis:				
– Olefins	% v/v	3.0	13.0	ASTM D 1319
– Aromatics	% v/v	29.0	35.0	ASTM D 1319
– Benzene	% v/v	-	1.0	EN 12177
– Saturates	% v/v		Report	ASTM 1319
Carbon/hydrogen ratio			Report	
Carbon/oxygen ratio			Report	
Induction period[2]	minutes	480	-	EN ISO 7536
Oxygen content[4]	% m/m		Report	EN 1601
Existent gum	mg/ml	-	0.04	EN ISO 6246
Sulphur content[3]	mg/kg	-	10	EN ISO 20846 / EN ISO 20884
Copper corrosion		-	Class 1	EN ISO 2160
Lead content	mg/l	-	5	EN 237
Phosphorus content	mg/l	-	1.3	ASTM D 3231
Ethanol[5]	% v/v	4.7	5.3	EN 1601 / EN 13132

Test Requirement

Test type	Requirement
Type I	Tailpipe emissions after cold start
Type II	Tailpipe emissions at (increased) idle and free acceleration
Type III	Emissions of crankcase gases
Type IV	Evaporative emissions
Type V	Durability of pollution-control devices
Type VII	CO 2 emissions, fuel consumption, electric energy consumption and electric range
Type VIII	OBD environmental tests

Type II. Emissions test(Idle/Hi Idle)

- Type II – emissions test (idle/high idle)

Type II. Emissions test(Idle/Hi Idle)

Type II – emissions test (idle/high idle)

	EURO4/5	**GTR2 rev.**
Limits Value	(a) Either, gaseous emissions exceed the specific levels given by the manufacturer;	gaseous emissions exceed the specific levels given by the vehicle manufacturer;
	(b) Or, if this information is not available, the CO emissions exceed, for vehicles not controlled by an advanced emission control system, — 4,5 %, or, — 3,5 %, according to the date of first registration or use specified in requirements (a). for vehicles controlled by an advanced emission control system, — at engine idle: 0,5 %, — at high idle: 0,3 %, or — at engine idle: 0,3 % (6) — at high idle: 0,2 %, according to the date of first registration or use specified in requirements (a).	if the information from the vehicle manufacturer is not made available and for vehicles without closed-loop fuel delivery control; CO emissions > 3.5%; if the information from the vehicle manufacturer is not available and for vehicles equipped with a closed-loop fuel delivery control system; $CO_{normal\ idle\ emissions} > 0.5\%$; or $CO_{high\ idle\ emissions} > 0.3\%$
	(c) Lambda outside the range 1 ± 0,03 or not in accordance with the manufacturer's specification	lambda outside the range 1 ± 0.03 or not in accordance with the manufacturer's specification;
	(d) OBD readout indicating significant malfunction	OBD readout indicating significant emission relevant malfunction

Type II: Test Overview

ISO 14749

Warming-up

Oil drain bolt shall be achieved **between 55℃ and 70℃**

Equip revolution counter

Equip extension pipe, (if necessary)

If the exhaust pipe shape does not allow such **insertion (<600mm)**, an extension exhaust pipe shall be provided.

Check Idling speed

Check that the engine speed measured at **idling condition is within the manufacturer's specification range** (i.e. idling speed). If the engine speed is different from idling speed, adjust the engine speed to idling speed.

Analyzer in measurement mode

Select the highest analyzer scale and put the analyzer in measurement mode.

Insert Probe

The sampling probe shall be inserted **at least 600 mm** into the exhaust outlet pipe.

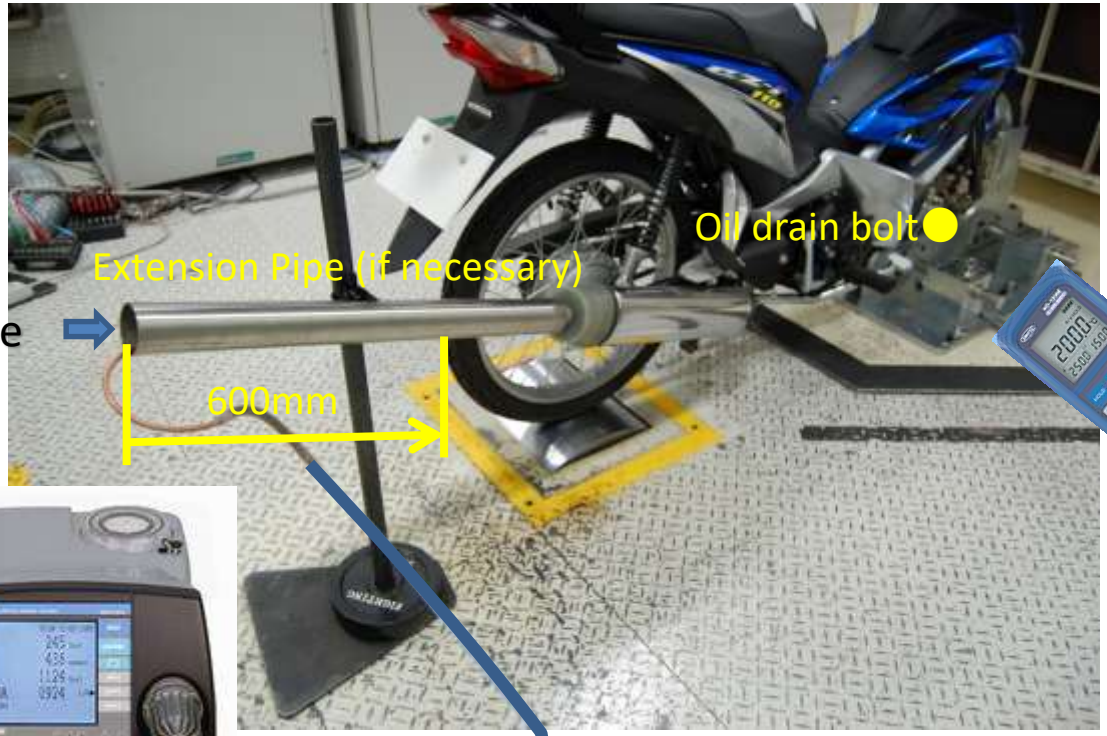
Measurement Result

After **at least 15 s** from insertion of the probe, carry out the measurements over sufficient time but not **exceeding 30 s** to obtain minimum and maximum values. Calculate the arithmetic mean of these two values.

Type II:Test Overview

The working area shall not be directly exposed to
- rain, snow or sunlight,
- interfering vibration,
- a corrosive and/or polluted atmosphere that might influence the measurement results, or
- electromagnetic interference that might influence measurement results.

Revolution Counter



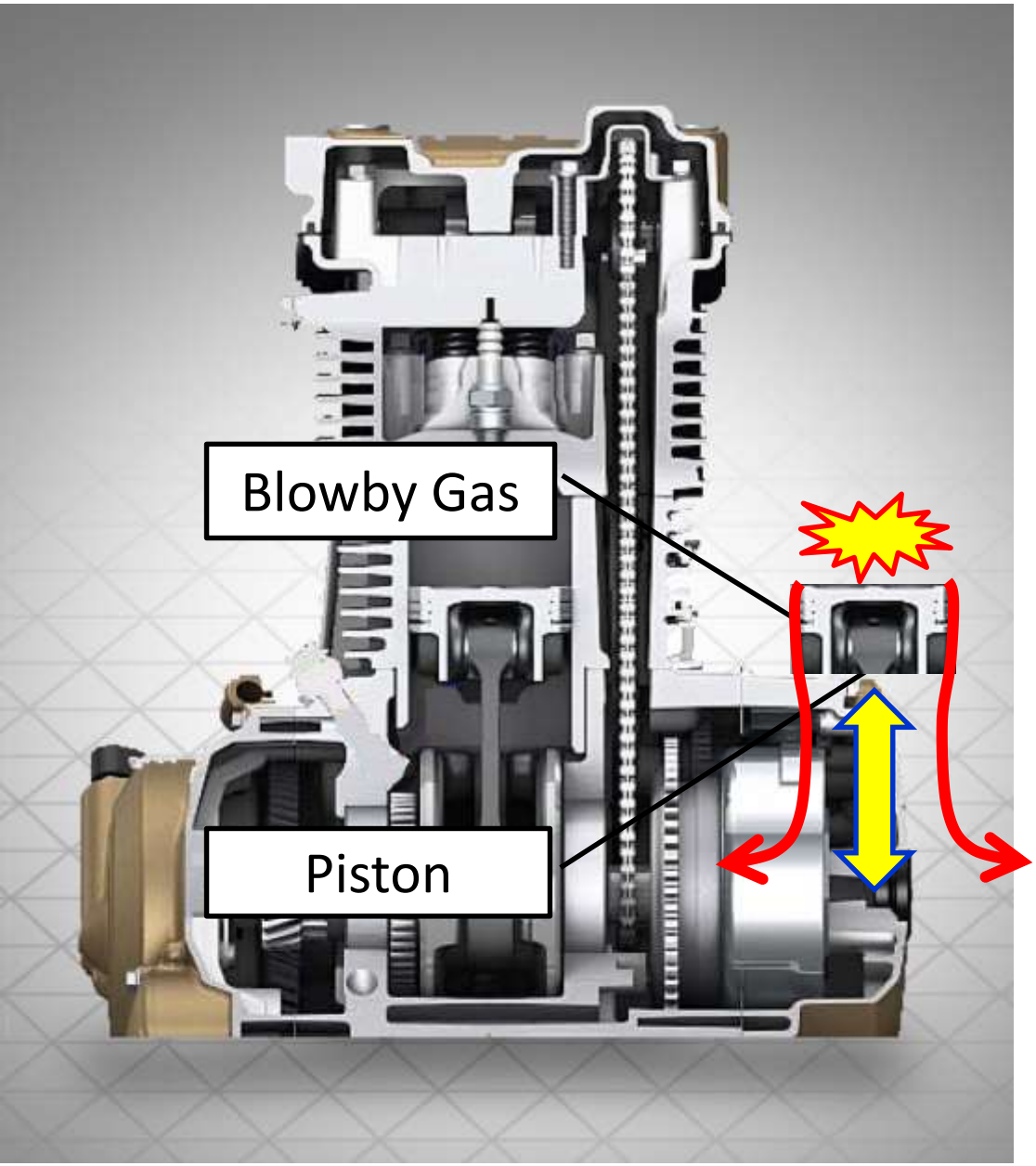
Surface temperature meter

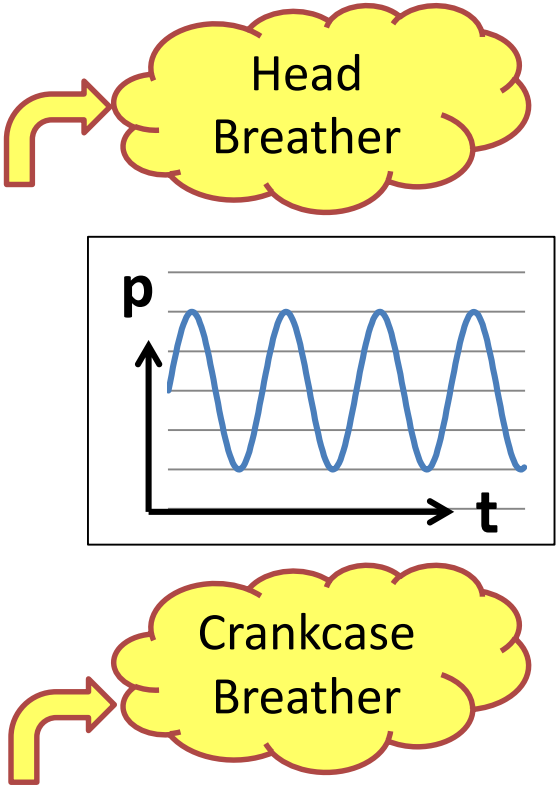
Analyzer

Test requirement

Test type	Requirement
Type I	Tailpipe emissions after cold start
Type II	Tailpipe emissions at (increased) idle and free acceleration
Type III	Emissions of crankcase gases
Type IV	Evaporative emissions
Type V	Durability of pollution-control devices
Type VII	CO 2 emissions, fuel consumption, electric energy consumption and electric range
Type VIII	OBD environmental tests

Type III. Emissions of crankcase gases

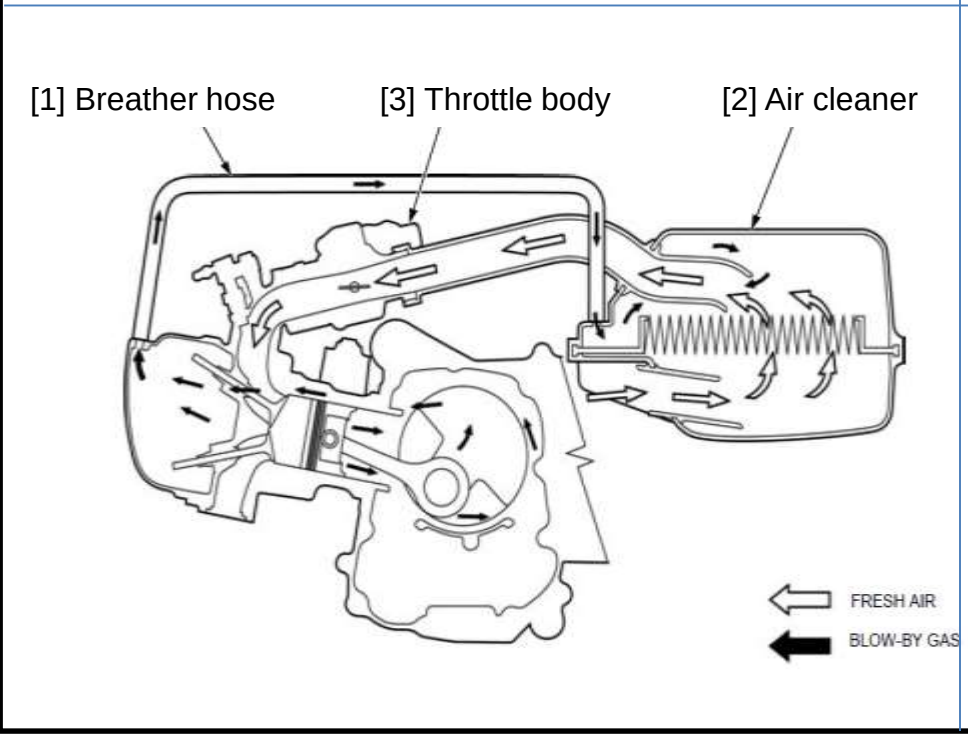
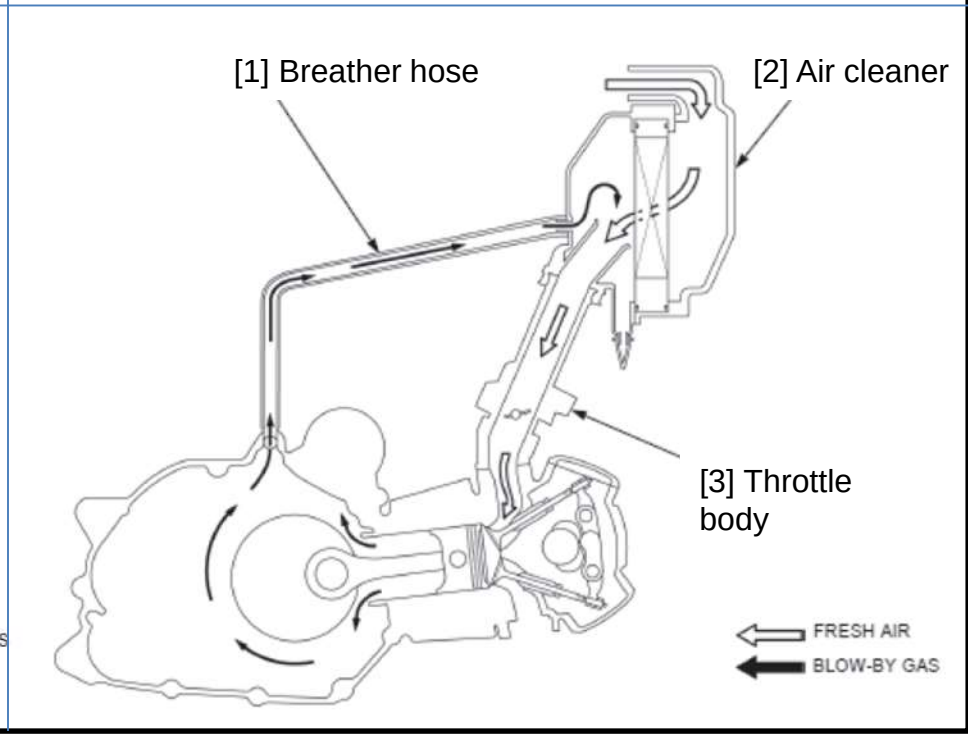




Type III. Emissions of crankcase gases

CRANKCASE EMISSION CONTROL SYSTEM

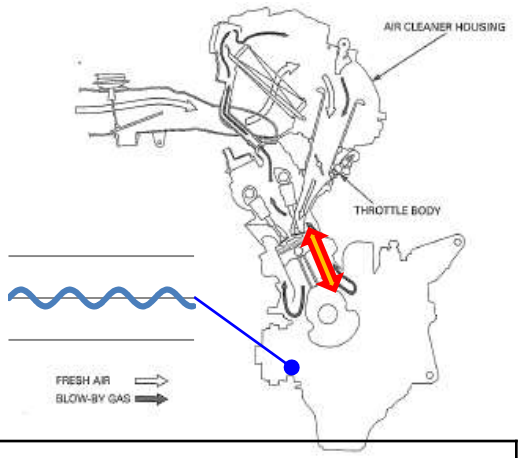
The engine is equipped with a closed crankcase system to prevent discharging crankcase emissions into the atmosphere. Blow-by gas is returned to the combustion chamber through the crankcase breather hose [1], air cleaner [2] and throttle body [3].

Head Breather	Case Breather
	

By adopting a closed crankcase system, there is no release of the emissions into the atmosphere

Type III. Emissions of crankcase gases

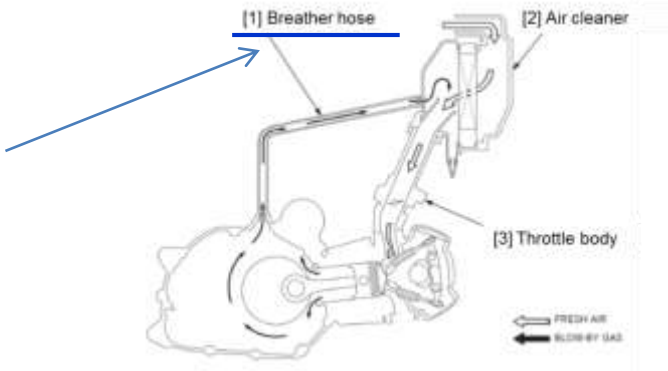
Zero emission, closed crankcase. Crankcase emissions shall not be discharged directly into the ambient atmosphere from any vehicle throughout its useful life.



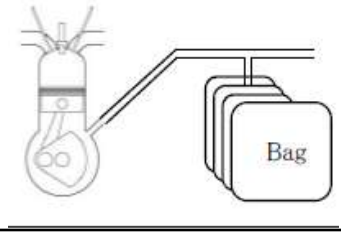
EURO4/5	GTR17
Test method -Base test – at 3 steady states, ensure crankcase pressure does not exceed atmospheric pressure. If failed then: -Additional test, option 1 – fit a bag to a suitable take-off and check it does not inflate during the 3 steady state tests. -Additional test, option 2 – pressurize the crankcase to 5 kPa and monitor for 300 seconds.	**Structure Requirement** -Option Test method

Type III. Emissions of crankcase gases

Requirements



Euro4

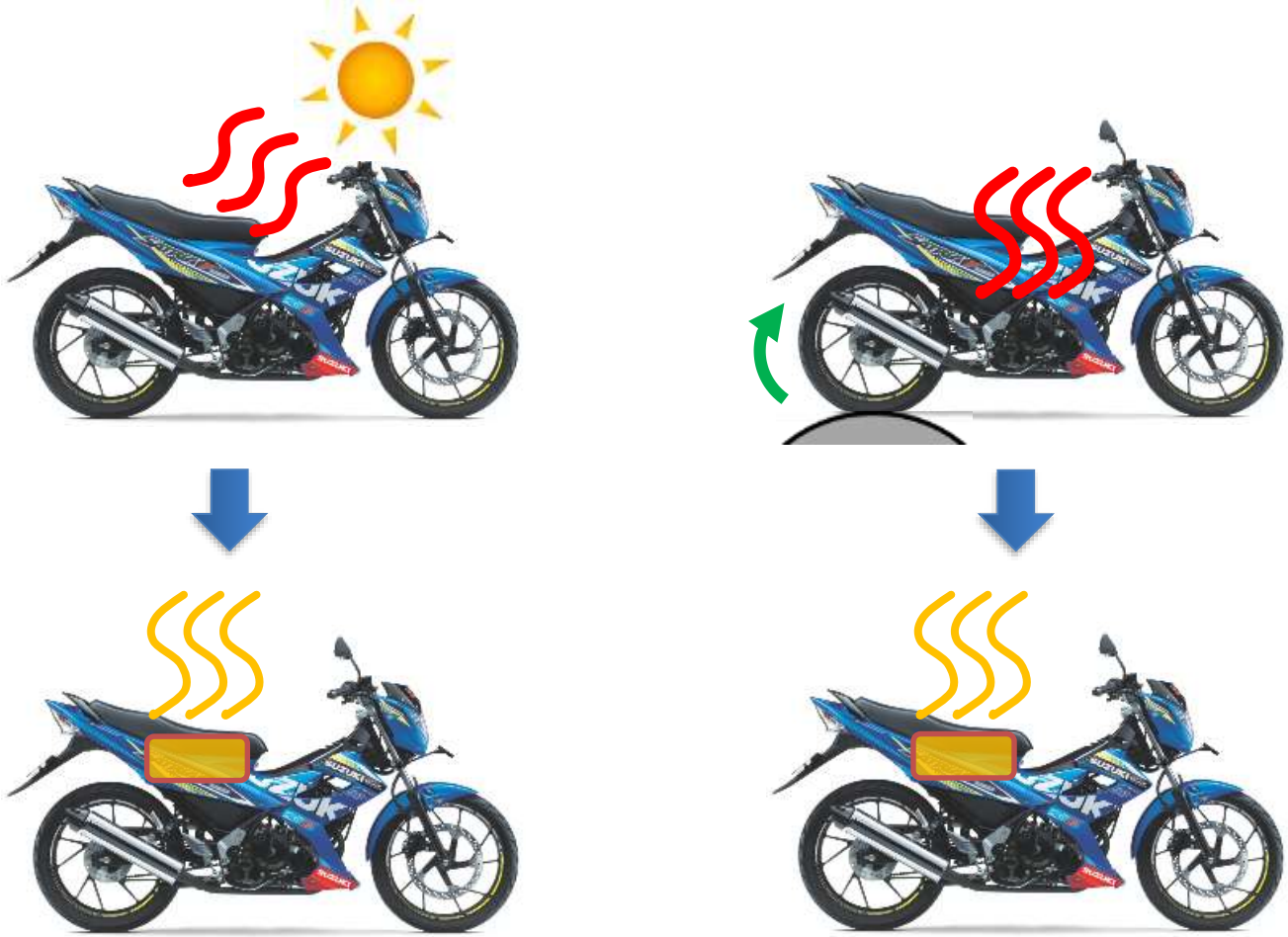
	Base Test	Option1	Option2
Test Method			
Test Condition			pressurize the crankcase to 5 kPa and monitor for 300 seconds
Requirements	Pressure does not exceed atmospheric pressure.	Bag does not inflate during the 3 steady state tests.	Crankcase pressure ≥ 0.95 times the initial overpressure for 300 seconds

	Vehicle speed (km/h)	Power absorbed by the brake
1	Idling	Nil
2	Highest of: (a) 50 ±2 (in 3rd gear or 'drive') or (b) if (a) not achievable, 50 % of max. design vehicle speed.	That corresponding to the setting for type I test at 50 km/h or if not achievable type I test at 50 % of max. design vehicle speed.
3		As for condition 2, multiplied by a factor of 1,7

Test Requirement

Test type	Requirement
Type I	Tailpipe emissions after cold start
Type II	Tailpipe emissions at (increased) idle and free acceleration
Type III	Emissions of crankcase gases
Type IV	Evaporative emissions
Type V	Durability of pollution-control devices
Type VII	CO 2 emissions, fuel consumption, electric energy consumption and electric range
Type VIII	OBD environmental tests

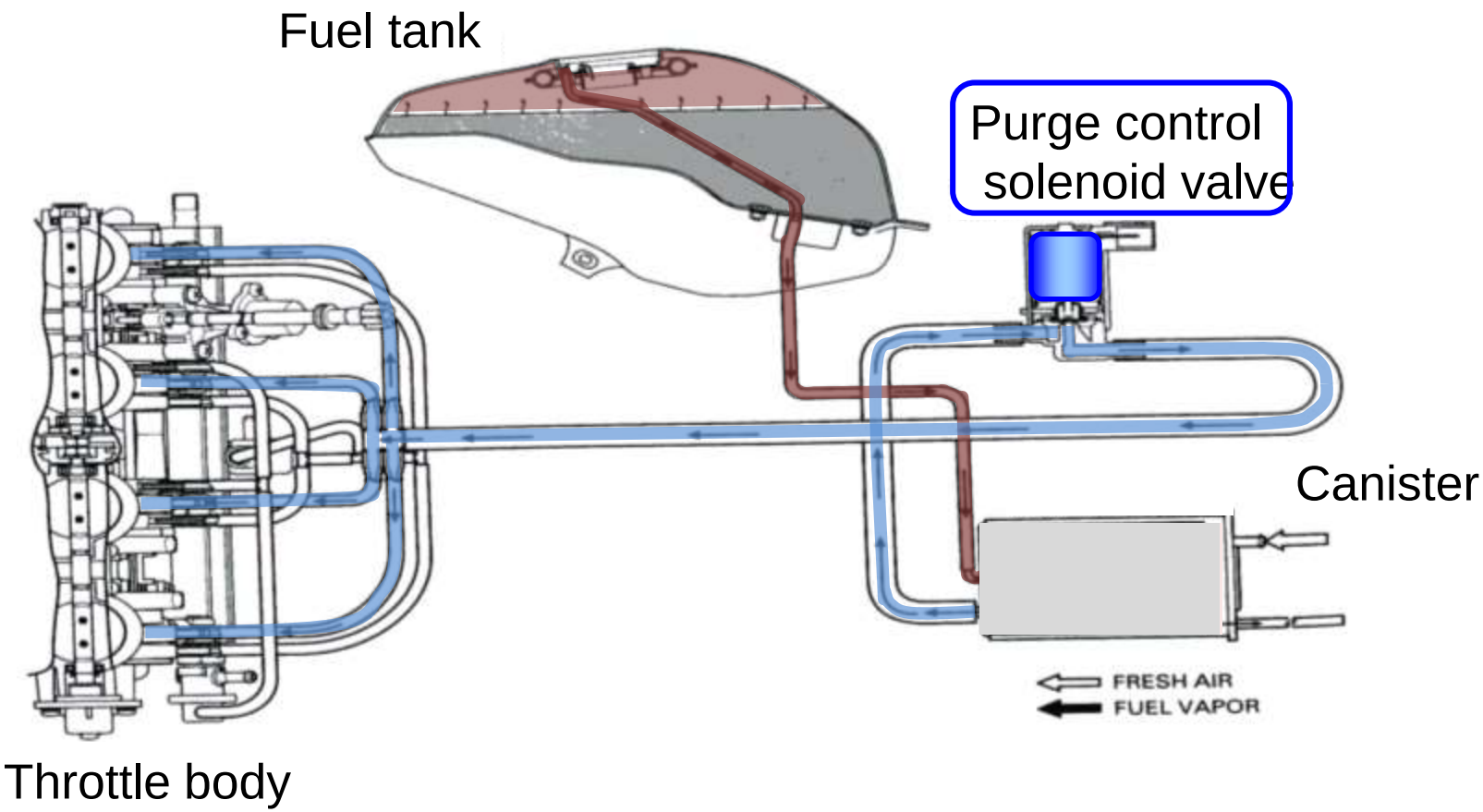
Type IV. Evaporative emissions



① Diurnal Breathing Loss ＋ ② Hot soak Loss

＝ Evaporative Emissions

Evaporative control devices

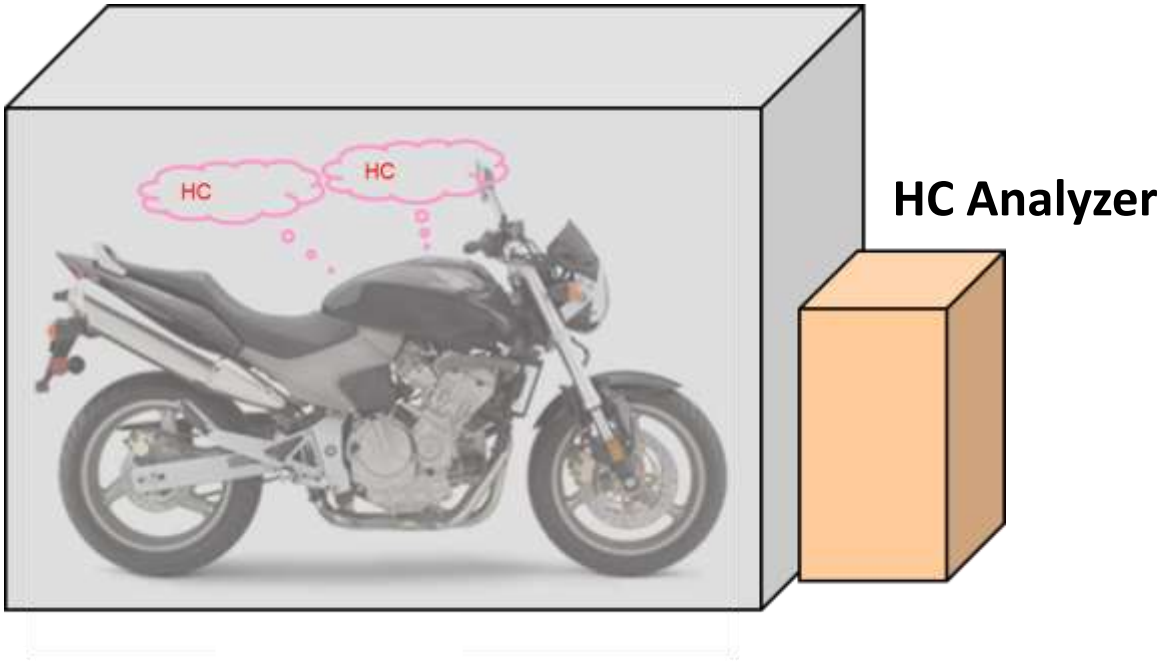


Type IV. Evaporative emissions

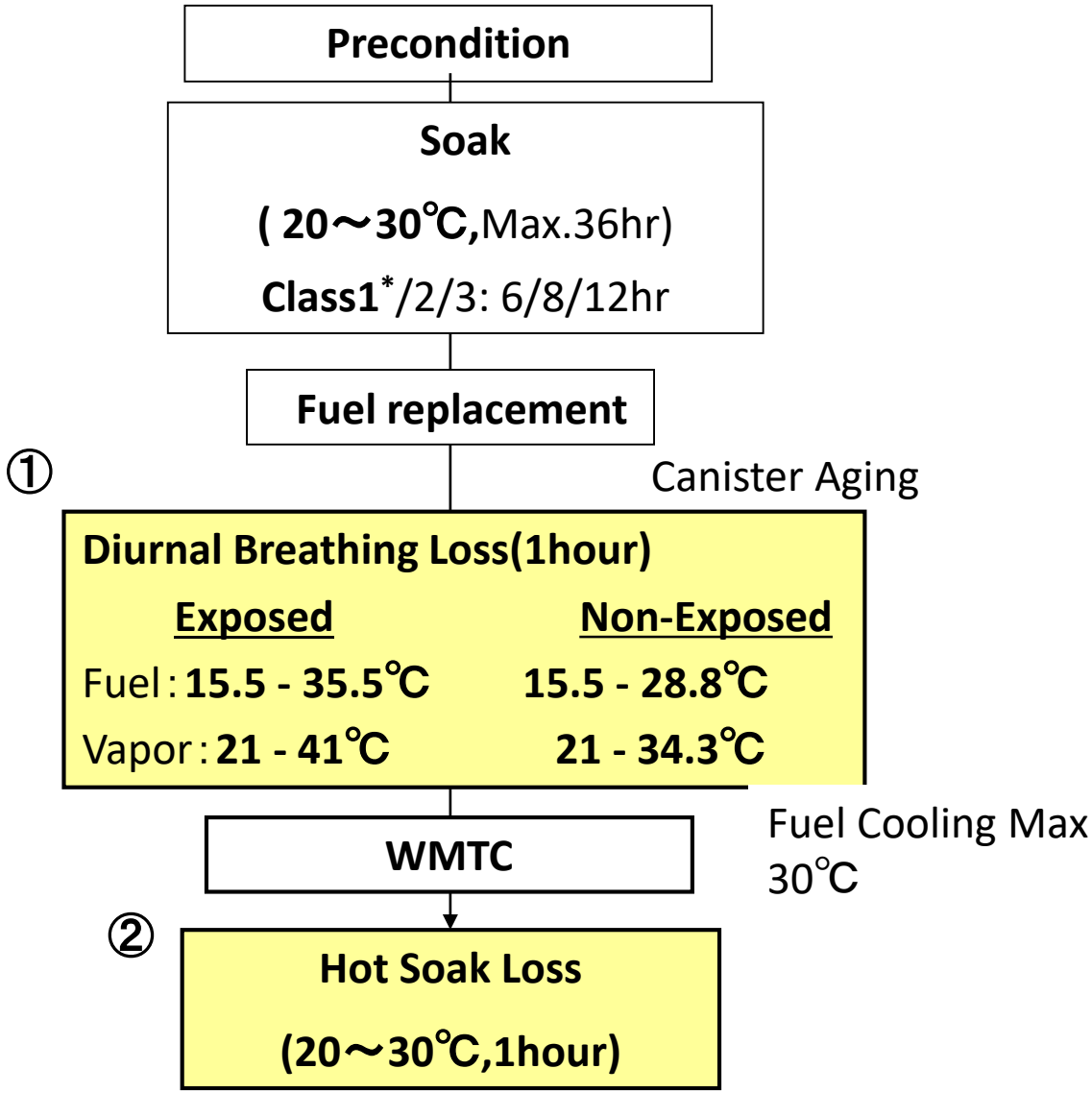
Evaporative emissions limit value

	THC g/test
EURO4	2.0
GTR 17	2.0
EURO5	1.5

SHED（**S**hield **H**ousing for **E**vaporative **D**eterminations）

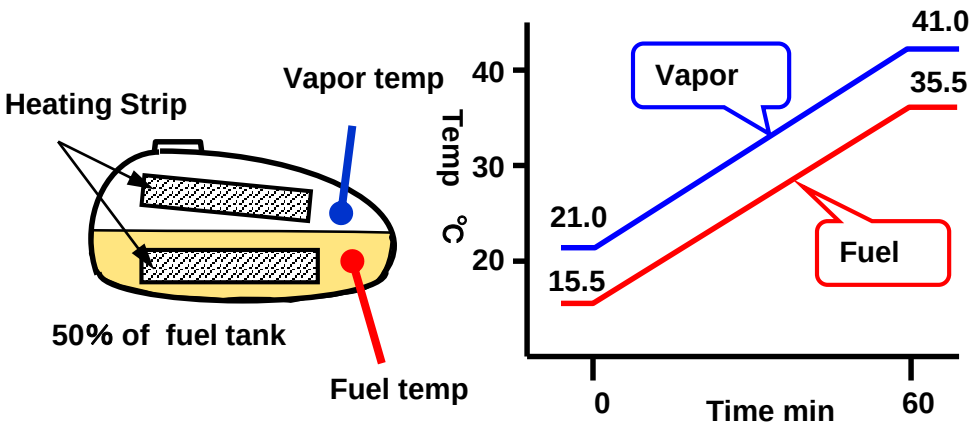


Type IV. Evaporative emissions



Limit ：①＋②＋Fixed DF ≦ 2．0g(1.5g)/Test

Type IV. Evaporative emissions



Exposed tank

Fuel: 15.5 - 35.5℃

Vapor: 21 - 41℃

Non-Exposed tank

Fuel: 15.5 - 28.8℃

Vapor: 21 - 34.3℃

Heating Strip

SHED

Type IV. Evaporative emissions

Test preparation

Attach
Temperature sensor
Heating strip

Driving cycle

WMTC mode

Soak

Ambient temperature
20－30℃

Engine capacity	Minimum (hours)	Maximum (hours)
$\leq 169\ cm^3$	6	36
$170\ cm^3 <$ engine capacity $\leq 279\ cm^3$	8	36
$> 280\ cm^3$	12	36

Type IV. Evaporative emissions

Fuel replacement

Fuel temperature
10-14℃

Fuel volume
50±2% of fuel tank

Bring into SHED

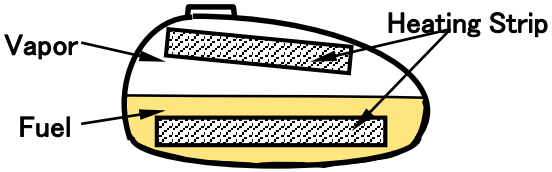
Connect
Temperature sensor
Heating strip

Diurnal breathing loss

60min

Temperature control

	start－end
Fuel	15.5－35.5℃
Vapor	21.0－41.0℃



Type IV. Evaporative emissions

SHED to Chassis

Driving cycle

WMTC mode
Start within 60min from the end of diurnal test

Chassis to SHED

Type IV. Evaporative emissions

Hot soak loss

60min

Start within 7min from the end of driving cycle

Test result

Evaporative emissions [g/test]

＝ Diurnal breathing loss ＋ Hot soak loss

Type IV. Evaporative emissions

Requirements list of evaporative emission test

	EURO4/5	GTR 17
Test Vehicle	Degreened Vehicle ① >1000km	Degreened Vehicle ① >1000km
Canister Aging	Loading & Paging ③ (REPPR)	Loading & Paging ③ （REPPR or CARB）
Control Device	Durability test 5000 ④ cycle or The parts which finished the Type V test.	Aged device ④ ・Mechanical Endurance ・Vibration Endurance ・Thermal Exposure
Fixed DF	0.3g/Test ⑤	0.3g/Test ⑤
Test Calculation method	①＋③＋④ or ①＋⑤	①＋③＋④ or ①＋⑤

Test Requirement

Test type	Requirement
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Type V	Durability of pollution-control devices
Type VII	CO 2 emissions, fuel consumption, electric energy consumption and electric range
Type VIII	OBD environmental tests

Type V. Durability of pollution-control devices

Durability requirements

Mileage requirement:

	Vmax ＜130 km/h	Vmax ≧130 km/h
EURO4/5	20,000km	35,000km
GTR	*20,000km*	*35,000km*

Under discussion!

Driving Cycles AMA、SRC-LeCV

Fixed Deterioration Factor (DF):

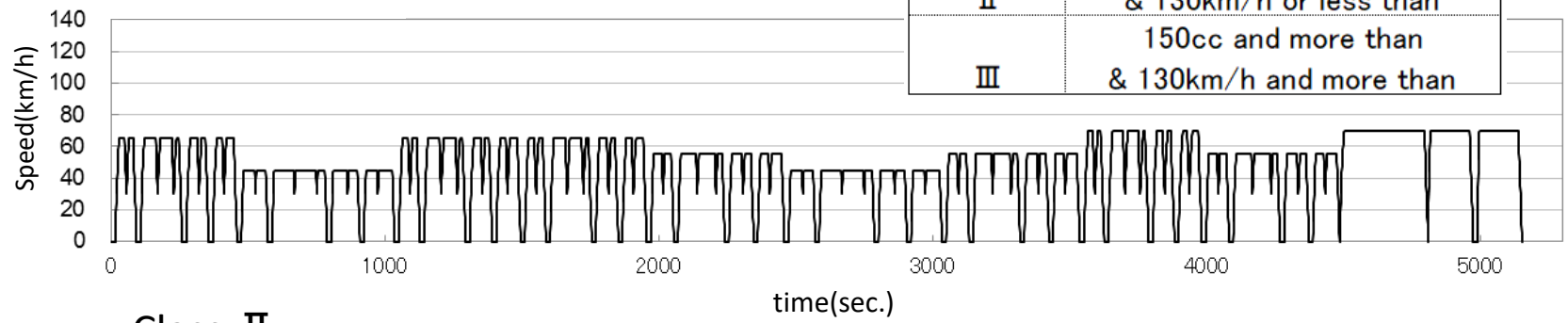
	CO	HC	NMHC	NOx
EURO4	1.3	1.2	-	1.2
EURO5	1.3	1.3	1.3	1.3
GTR	*1.3*	*1.3*	*1.3*	*1.3*

Type V. Durability of pollution-control devices

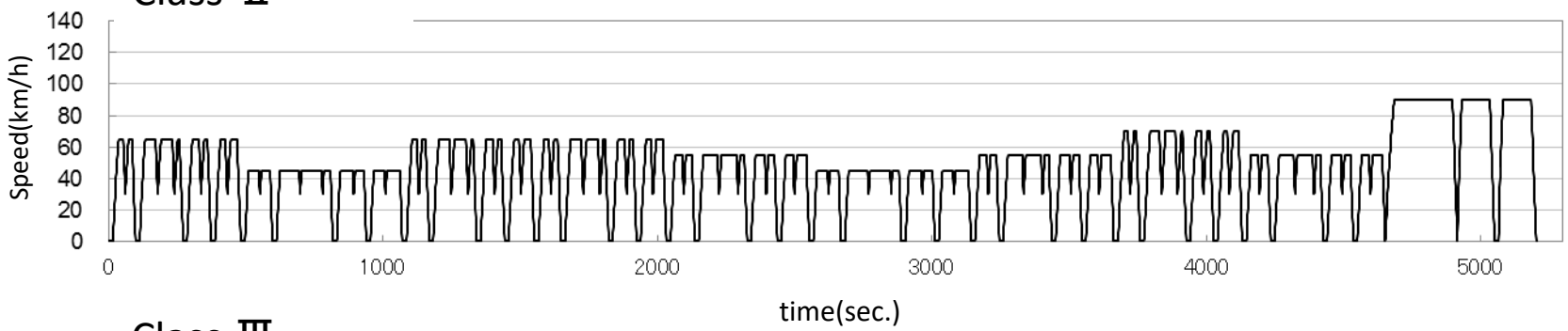
AMA mode

AMA class	engine displassment/max spped
Ⅰ	150 cc or less than
Ⅱ	150cc and more than & 130km/h or less than
Ⅲ	150cc and more than & 130km/h and more than

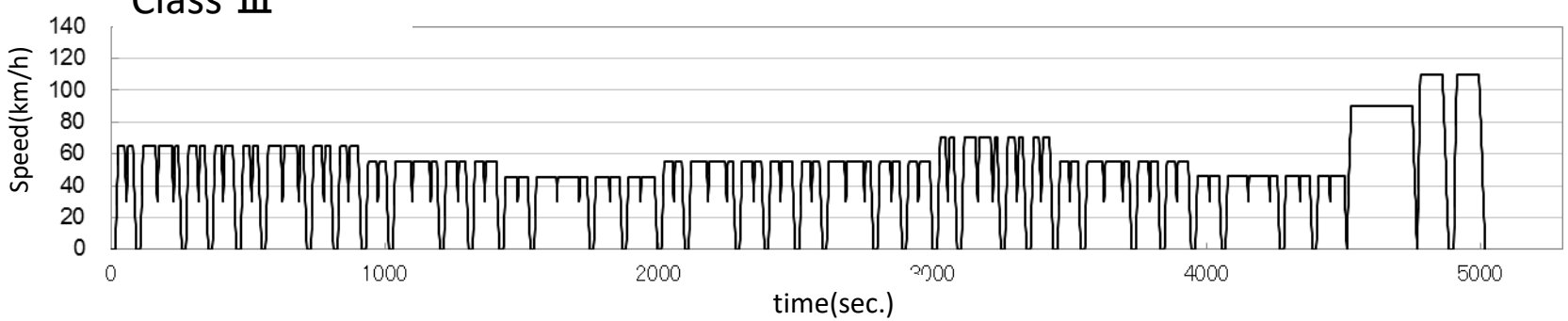
Class Ⅰ



Class Ⅱ



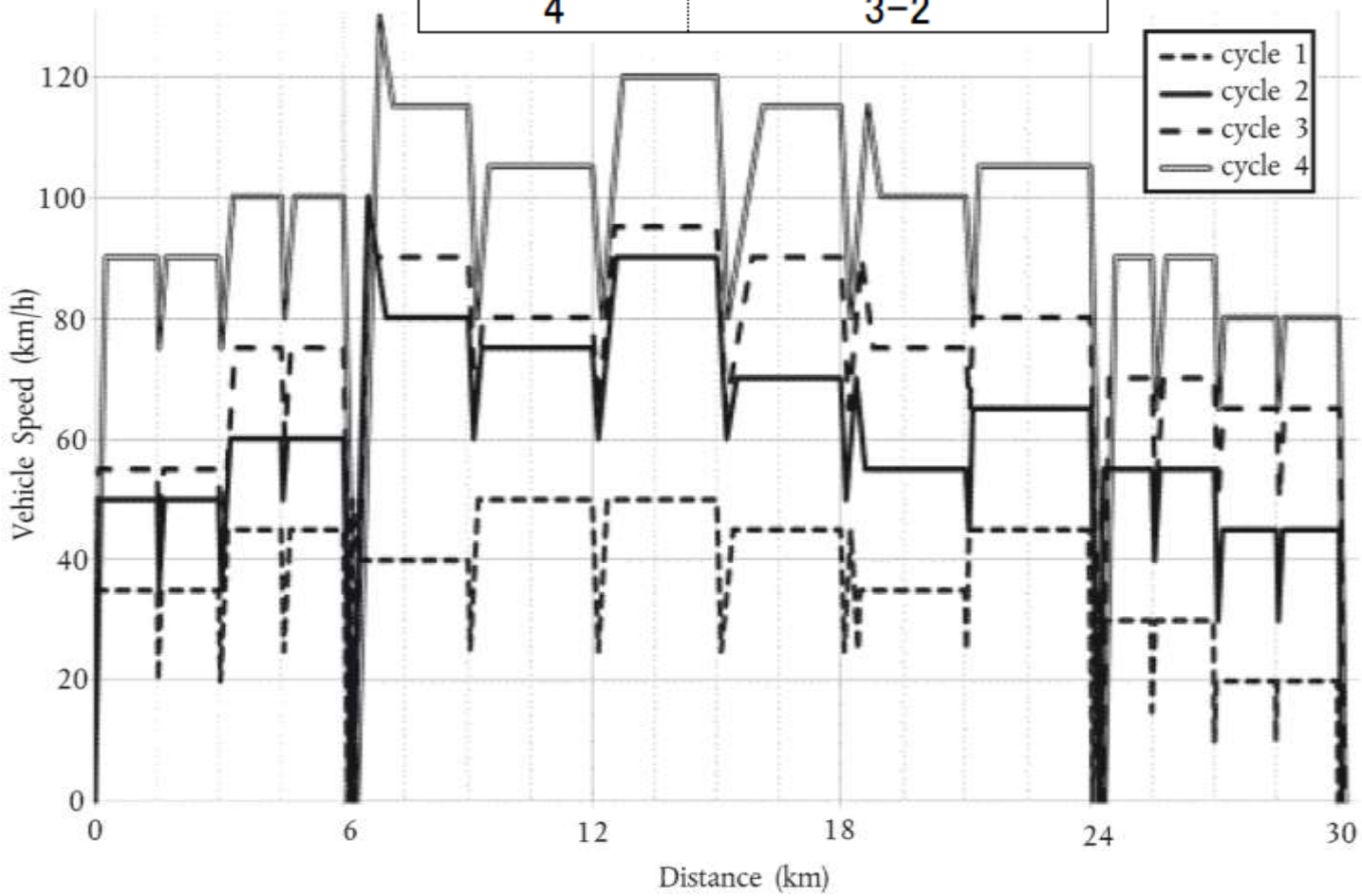
Class Ⅲ



Type V. Durability of pollution-control devices

SRC cycle

SRC cycle	WMTC class
1	1
2	2−1, 2−2
3	3−1
4	3−2



Test Requirement

Test type	Requirement
Type I	Tailpipe emissions after cold start
Type II	Tailpipe emissions at (increased) idle and free acceleration
Type III	Emissions of crankcase gases
Type IV	Evaporative emissions
Type V	Durability of pollution-control devices
Type VII	CO 2 emissions, fuel consumption, electric energy consumption and electric range
Type VIII	OBD environmental tests

Method of measuring carbon dioxide emissions and fuel consumption

Fuel consumption (FC), expressed in litres per 100 km :

- Petrol (E0) :

$$FC = (0.1155/D) \cdot ((0.866 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO2));$$

- Petrol (E5):

$$FC = (0.1180/D) \cdot ((0.848 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO2));$$

- Petrol (E10):

$$FC = (0.1206/D) \cdot ((0.829 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO2));$$

- Diesel (B5):

$$FC = (0.1163/D) \cdot ((0.860 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO2));$$

In these formulae:

FC = the fuel consumption in litres per 100 km in the case of petrol, diesel or biodiesel,

HC = the measured emission of hydrocarbons in g/km

CO = the measured emission of carbon monoxide in g/km

CO2 = the measured emission of carbon dioxide in g/km

D = the density of the test fuel.

Test requirement

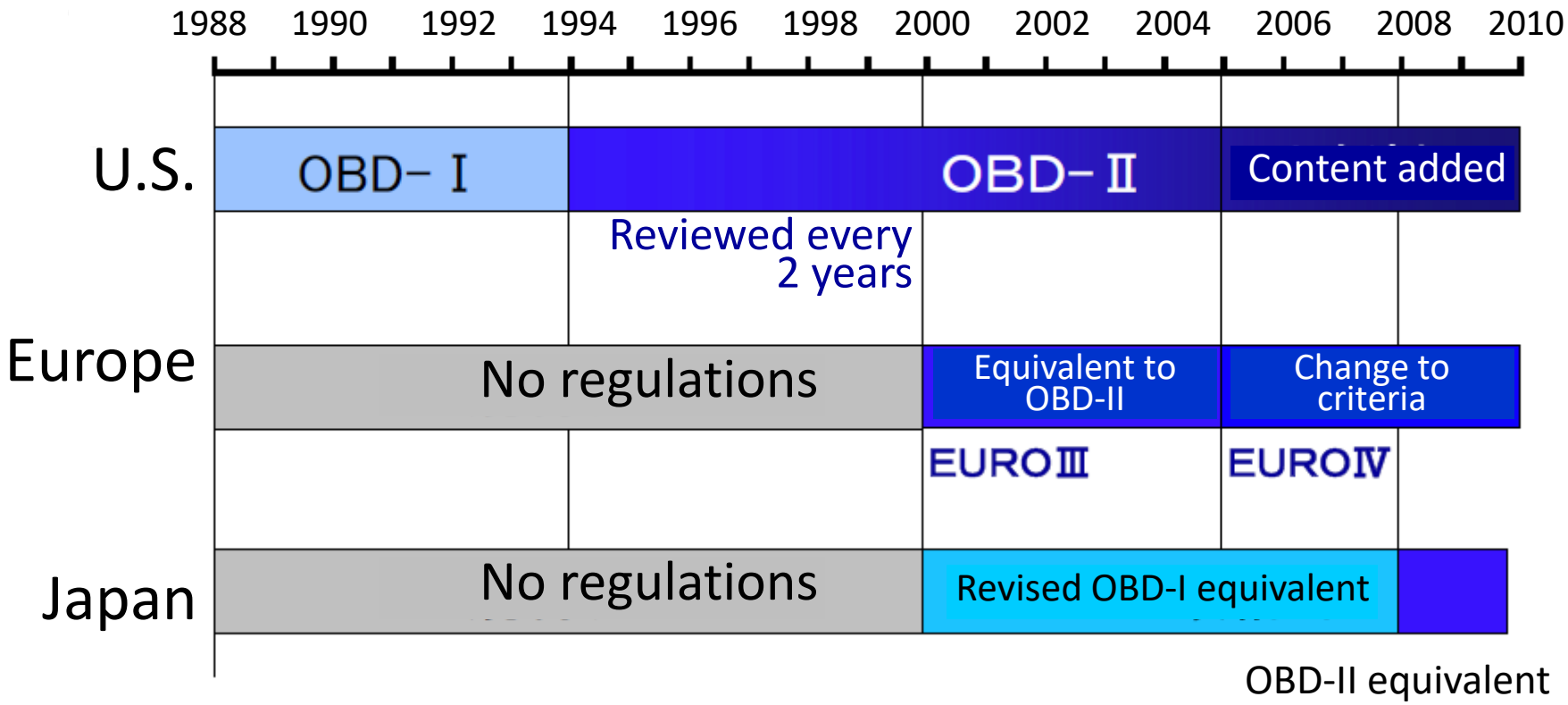
Test type	Requirement
Type I	Tailpipe emissions after cold start
Type II	Tailpipe emissions at (increased) idle and free acceleration
Type III	Emissions of crankcase gases
Type IV	Evaporative emissions
Type V	Durability of pollution-control devices
Type VII	CO 2 emissions, fuel consumption, electric energy consumption and electric range
Type VIII	OBD environmental tests

Type VIII: OBD environmental tests

- OBD Overview
  - History of automobile OBD regulations
  - Background of introduction of four wheeler OBD-I
  - Operation of the OBD system
- Technological Explanation
  - Onboard layout of system component (sensors; example)
  - Failure Diagnosis Method
    - Circuit Diagnosis
    - Functional Diagnosis
    - Threshold Diagnosis
  - Scan Tool and Diagnostic Trouble Cord
- Description of Motorcycle Laws and Regulations

History of automobile OBD regulations

OBD regulations were first implemented in North America and since then has spread to various countries



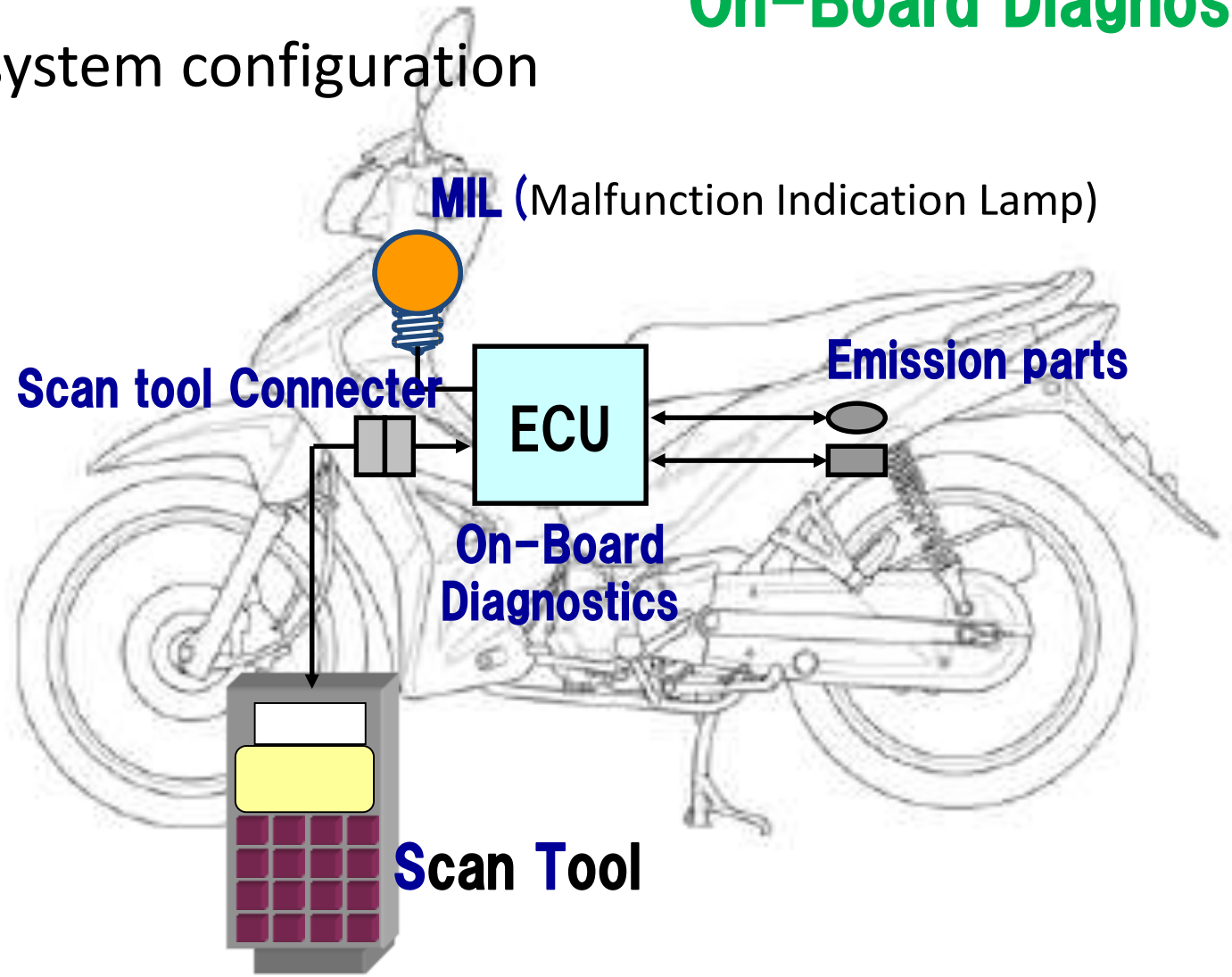
Background of introduction of four wheeler OBD-I

- Surveillances carried out in mid-1980s led to the discovery of vehicles with deteriorating emissions despite fuel being fed back. Investigations revealed that the problem lay with the 02 sensor. Subsequently, a number of vehicles with similar conditions were discovered.
- It was difficult for users to identify the failure with these vehicles, as there was no apparent impact on drivability or mileage.
- Even if strict emission restrictions were imposed, operation of vehicles installed with faulty parts and parts with insufficient maintenance can rapidly increase air pollutants

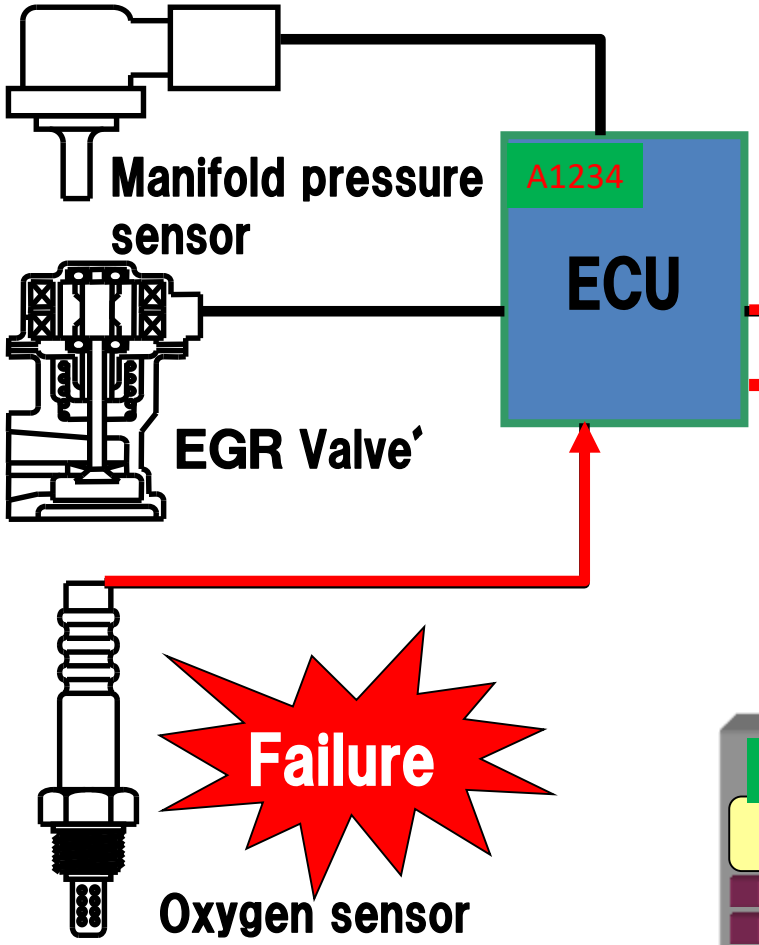
Warns the user by displaying the failure → Repair

On-Board Diagnostics

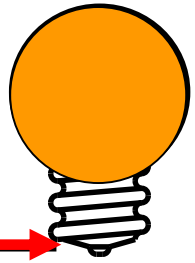
OBD system configuration



Operation of the OBD system



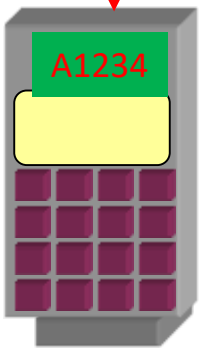
MIL turn on



On-Board Diagnostics

◆Failure code

Code indicating the failed component



Scan Tool

- OBD Overview
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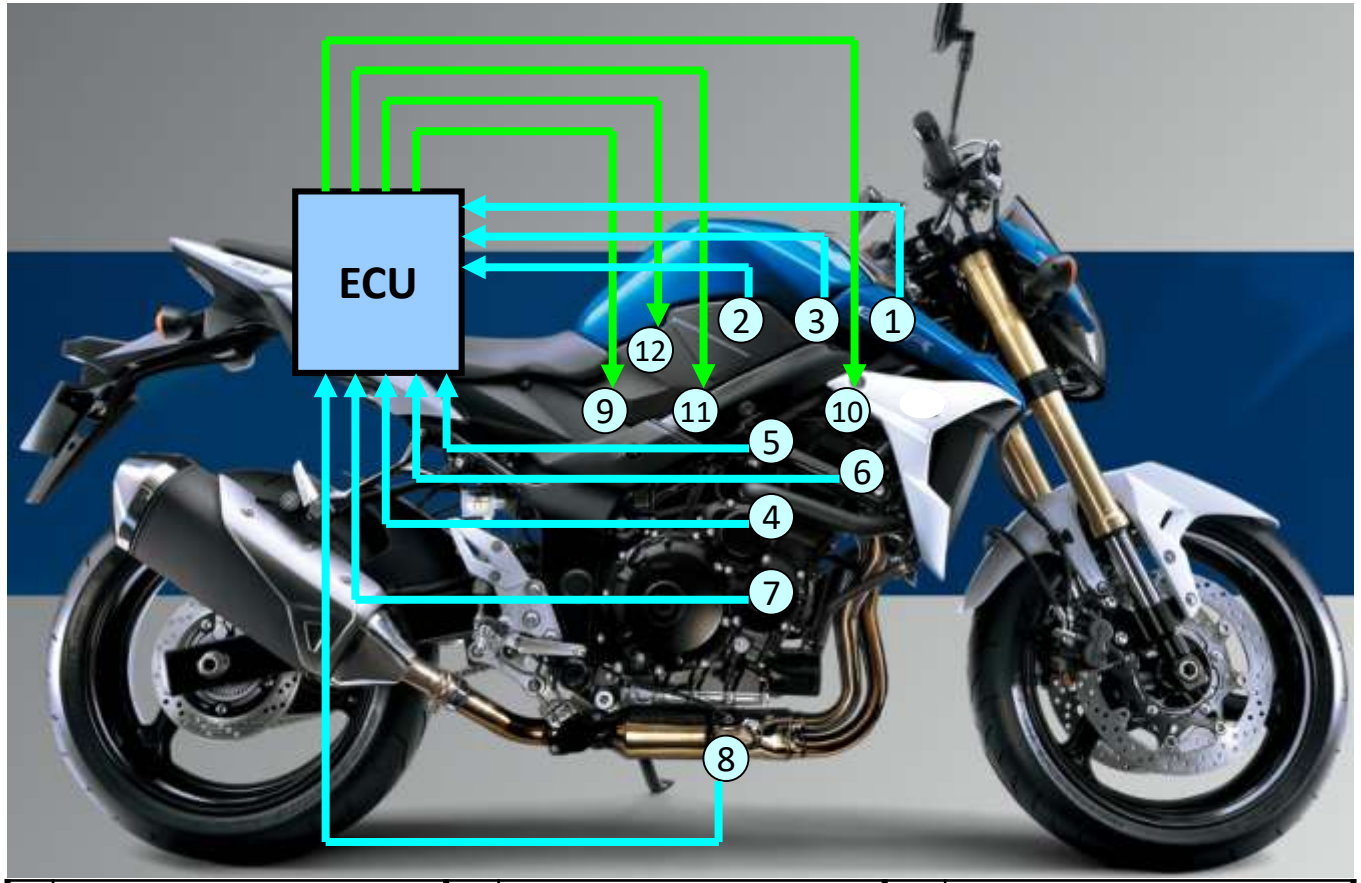
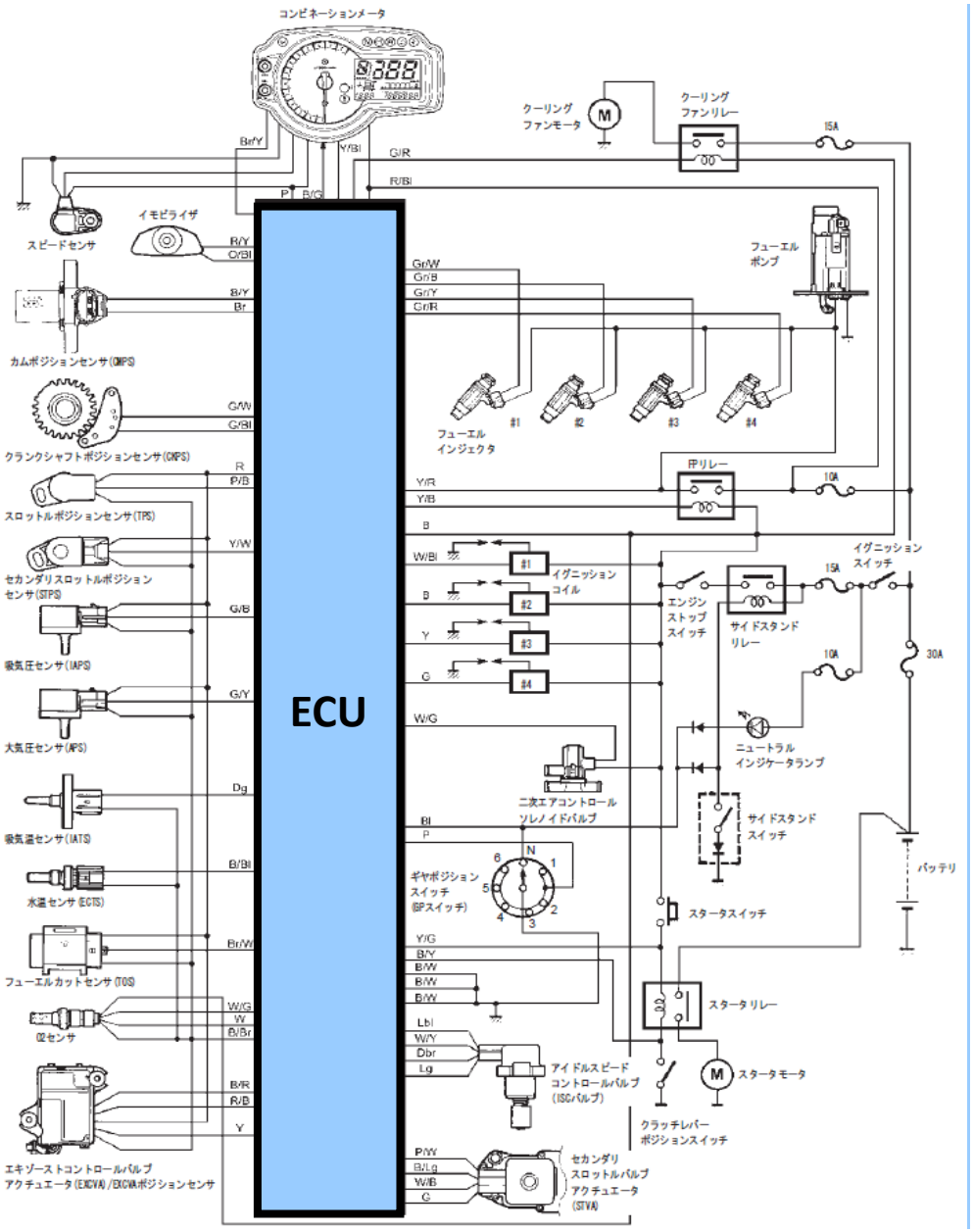
Onboard layout of system component (sensors; example)



①	Pressure sensor	⑤	Throttle opening sensor	⑨	Secondary air control valve
②	Intake pressure sensor	⑥	Cylinder identification sensor	⑩	Ignition coil
③	Intake-air temperature sensor	⑦	Crank angle sensor	⑪	Injector
④	Coolant temperature sensor	⑧	Oxygen sensor	⑫	Fuel pump

Type VIII: OBD environmental tests

Component system diagram (example)



VIII: OBD environmental tests

- OBD Overview
  - History of automobile OBD regulations
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  - Trend towards making Motorcycle OBD into regulation
  - Operation of the OBD system
- Technological Explanation
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Type VIII: OBD environmental tests

Failure Diagnosis Method

Attachment 48* of Announcement that Prescribes Details of Safety Regulations for Road Vehicles defines the followings:

Diagnosis	Diagnosis content
Circuit diagnosis	To diagnose whether or not there are open/short, etc. in the electric circuit.
Functional diagnosis	To diagnose whether or not the exhaust gas processing device satisfies the operational standards stipulated by the automobile manufacturer.
Threshold diagnosis	To diagnose each part, device and system to identify whether or not the exhaust gas value is exceeding the OBD threshold value.

Type VIII: OBD environmental tests

OBD on Motorcycle OBD-Ⅰ vs OBD-Ⅱ

In order to reduce emission, diagnosis to important system : ignition, fuel-supply system, catalyzers, is required.

	OBD-Ⅰ（**EURO4/5**）	OBD-Ⅱ（**EURO5**）
	Electric fail diagnosis	Diagnosis for emission level
Diagnostic method	Electric circuit (open/short) Functional diagnosis is optional	Introducing threshold diagnosis
Failure decision criteria	Specified	Specified
Standard ・Connector ・Fail indicator ・Fail code ・Diagnostic tool ・Diagnostic data	Unified standard (ISO, SAE)	Unified standard (ISO, SAE)

Type VIII: OBD environmental tests

VIII: OBD environmental tests

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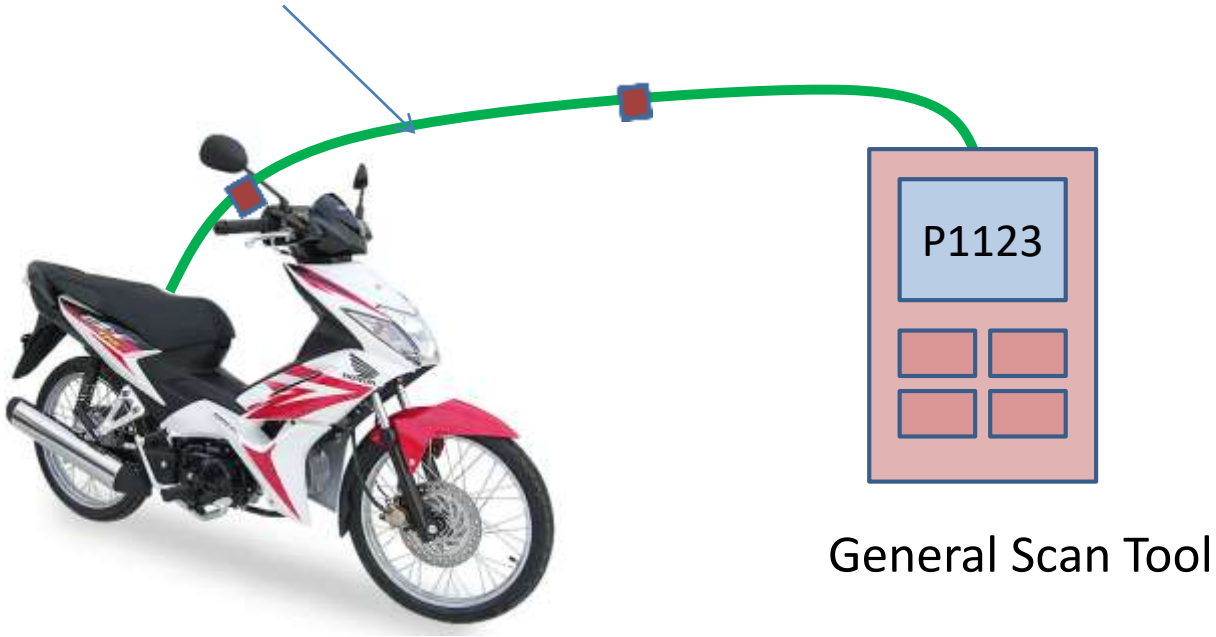
Diagnosis by general-purpose diagnostic tool

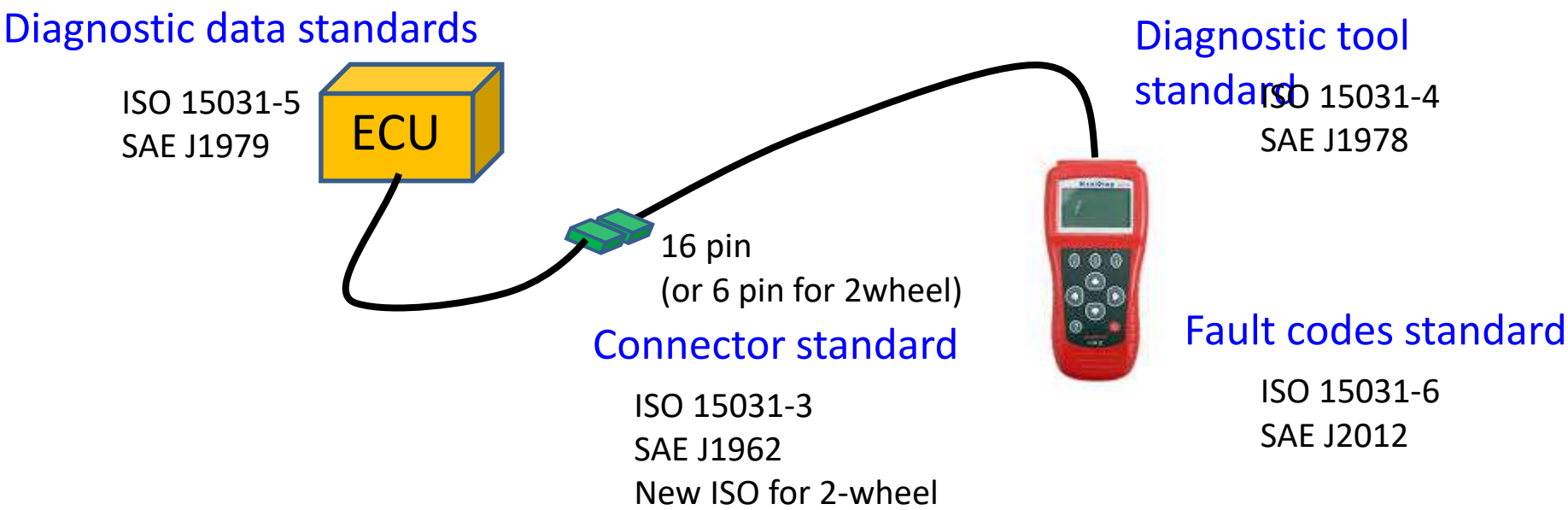
ECU diagnosis can be done by general-purpose diagnostic tool in accordance with ISO standard.

For connecting between diagnostic tool and vehicle harness wire, convert harness can be used.



Type VIII: OBD environmental tests

Standard for diagnosis has been unified by ISO and SAE.



OBD before the introduction, each company of the self-diagnostic function, communication standard, procedure to display a fault code, and meaning of the displayed fault code, was different in each manufacturer.

VIII: OBD environmental tests

General Scan-Tool

The failure of the different manufacturers of motorcycles it got to be diagnosed by a single general scan tool.

Manufacturers dedicated Scan Tools

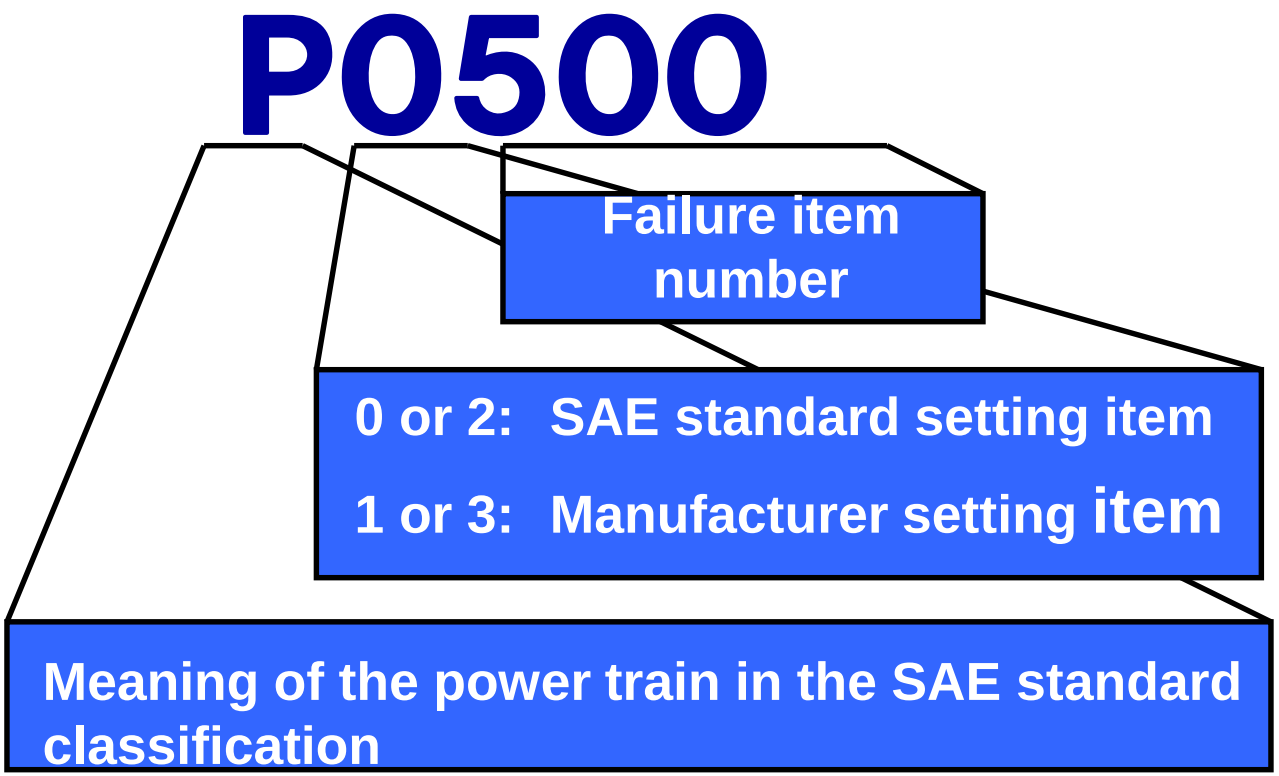
General Scan Tools

USD 122～

VIII: OBD environmental tests

DTC (Diagnostic Trouble Cord)

Example (vehicle speed sensor failure)



Type VIII: OBD environmental tests

Example of DTC (Small motorcycle)

DTC Number	DTC Naming
P0107	Manifold Absolute Pressure/Barometric Pressure Circuit Low
P0108	Manifold Absolute Pressure/Barometric Pressure Circuit High
P0117	Engine Coolant Temperature Sensor 1 Circuit Low
P0118	Engine Coolant Temperature Sensor 1 Circuit High
P0122	Throttle/Pedal Position Sensor/Switch "A" Circuit Low
P0123	Throttle/Pedal Position Sensor/Switch "A" Circuit High
P0112	Intake Air Temprature Sensor 1 Circuit Low
P0113	Intake Air Temprature Sensor 1 Circuit High
P0131	O2 Sensor Circuit Low Voltage Bank 1 Sensor 1
P0132	O2 Sensor Circuit High Voltage Bank 1 Sensor 1
P1000	Bank Angle Sensor Circuit Low
P1001	Bank Angle Sensor Circuit High
P2228	Barometric Pressure Sensor "A" Circuit Low
P2229	Barometric Pressure Sensor "A" Circuit High
P0500	Vehicle Speed Sensor "A" Circuit
P0201	Injector Circuit/Open - Cylinder 1
P0511	Idle Air Control Circuit
P0443	Evaporative Emission System Purge Control Valve Circuit
P0412	AIR System Switching Valve "A" Circuit
P0351	Ignition Coil "A" Primary/Secondary Circuit
P0135	O2 Sensor Heater Circuit

Summary

regulation	Limit Value (g/km)			Type I		Type II	Type III	Type IV	Type V	Type VII	Type VIII
	CO	THC	NOx	UDC	WMTC						
Euro 3	2.0	0.8/ 0.3	0.15/ 0.15	○							
	2.62	0.75/ 0.33	0.17/ 0.22		○						
Euro 4	1.14	0.38/ 0.17	0.07/ 0.09		○	○	○	○	○	○	○ OBD1
Euro 5	1.00	0.10	0.06		○	○	○	○	○	○	○ OBD2

For EURO4 introduction, please examine introduction in each country situation which regulation is performed.

1. United nation：UN-R40
   - UNR40-01 is not revised after 1988.
   - The regulation level of the exhaust emission is EURO 0.
2. United nation：the latest situation of GTR/UNR
   - GTR2 revision (WMTC emission test, EURO5 is included)：discussion concludes, GTR is approved in WP29 in November, 2019.
3. EU regulation outline
   - Changes in emission regulation values
   - Regulation for Euro 3 and Euro 4
   - Difference between Euro4 and Euro3 requirements.
4. Test requirement item (Type 1~ Type 8) .
5. Type I test procedure for hybrid L-category vehicles

Type I test procedure for hybrid vehicles

Type I test procedure for hybrid L-category vehicles

The emissions test results shall comply with the limits set-out in Regulation (EU) No 168/2013 under all test conditions specified in this Regulation.

Vehicle charging	Off-Vehicle Charging (1) (OVC)		Not-off-vehicle Charging (2) (NOVC)	
Operating mode switch	Without	With	Without	With
(1) Also known as 'externally chargeable'. (2) Also known as 'not externally chargeable'.				

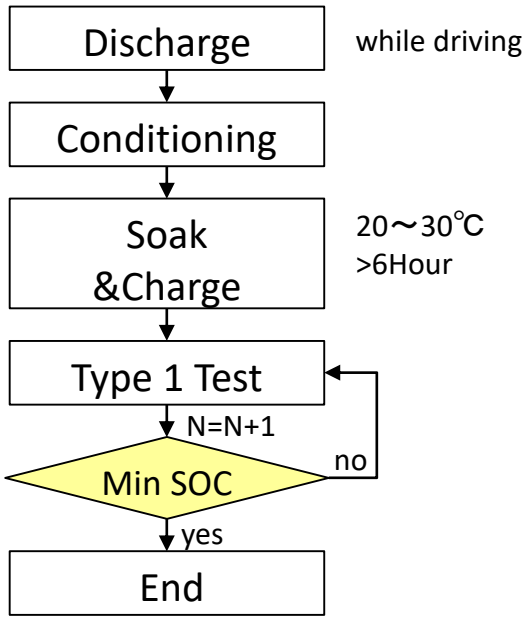
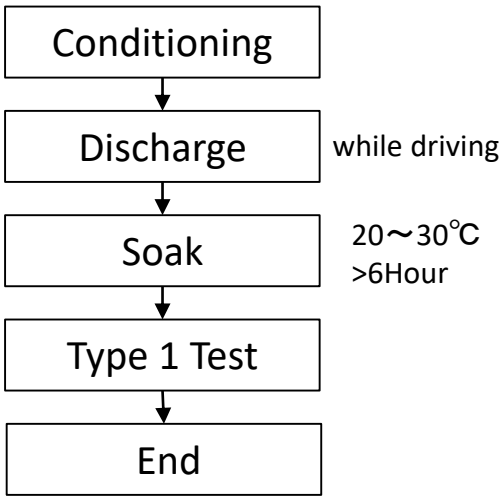
Piaggio MP3 Hybrid 300ie

Honda PCX Hybrid

Type I test procedure for hybrid vehicles

Externally chargeable vehicles (OVC HEVs) without an operating mode switch

Two tests shall be performed under the following conditions:

condition A:	condition B
Fully charged	Minimum state of charge
	
$M_{1i} = \frac{1}{N}\sum_{a=1}^{N} M_{1ia}$	M_{2i}

Type I test procedure for hybrid vehicles

Test results

For reporting, the weighted values shall be calculated as follows:

$$\mathrm{Mi} = (\mathrm{De} \cdot \mathrm{M}_{1i} + \mathrm{Dav} \cdot \mathrm{M}_{2i})/(\mathrm{De} + \mathrm{Dav})$$

M_i = mass emission of the pollutant i in mg/km;
M_{1i} = average mass emission of the pollutant i in mg/km with a fully charged electrical energy/power storage device, calculated in accordance with point 3.1.2.5.5.;
M_{2i} = average mass emission of the pollutant i in mg/km with an electrical energy/power storage device in minimum state of charge (maximum discharge of capacity), calculated in accordance with point 3.1.3.5.;
D_e = electric range of the vehicle determined according to the procedure set out in Appendix 3.3. to Annex VII, where the manufacturer shall provide the means for taking the measurement with the vehicle running in pure electric mode;
D_{av} = average distance between two battery recharges, as follows:
— 4 km for a vehicle with an engine capacity < 150 cm 3 ;
— 6 km for a vehicle with an engine capacity ≥ 150 cm 3 and v max < 130 km/h;
— 10 km for a vehicle with an engine capacity ≥ 150 cm 3 and v max ≥ 130 km/h.

Type I test procedure for hybrid vehicles

Externally chargeable vehicles (OVC HEVs) with an operating mode switch

Look-up table to determine Condition A or B depending on different hybrid vehicle concepts and on the hybrid mode selection switch position

	Hybrid-modes →	— Pure electric — Hybrid	— Pure fuel-consuming — Hybrid	— Pure electric — Pure fuel-consuming — Hybrid	— Hybrid mode n (1) — Hybrid mode m[1]
Battery state of charge		**Switch in position**	**Switch in position**	**Switch in position**	**Switch in position**
Condition A Fully charged		Hybrid	Hybrid	Most electric hybrid mode (2)	Hybrid
Condition B Min. state of charge		Fuel-consuming	Fuel-consuming	Most fuel-consuming mode (3)	Hybrid

(1) For instance: sport, economic, urban, extra-urban position, etc.
(2) Most electric hybrid mode: the hybrid mode which can be proven to have the highest electricity consumption of all selectable hybrid modes when tested in accordance with condition A of point 4 of Annex 10 to UNECE Regulation No 101, to be established based on information provided by the manufacturer and in agreement with the technical service.
(3) Most fuel-consuming mode: the hybrid mode which can be proven to have the highest fuel consumption of all selectable hybrid modes when tested in accordance with condition B of point 4 of Annex 10 to UNECE regulation No 101, to be established based on information provided by the manufacturer and in agreement with the technical service.

Since the test method varies depending on the hybrid vehicle concept and the operation mode switch, details are omitted.

Type I test procedure for hybrid vehicles

Not externally chargeable vehicles (not-OVC HEVs) without an operating mode switch

- These vehicles shall be tested according to WMTC mode.
- For preconditioning, at least **two consecutive complete driving cycles** are carried out without soak.
- The vehicle shall be driven in accordance with to the provisions of WMTC mode.

Not externally chargeable vehicles (not-OVC HEVs) with an operating mode switch

- These vehicles are preconditioned and tested in hybrid mode in accordance with Type1.
- If several hybrid modes are available, the test shall be carried out in the mode that is **automatically set after the ignition key is turned (normal mode).**
- On the basis of information provided by the manufacturer, the technical service shall ensure that the limit values are complied with in all hybrid modes.
- For preconditioning, at least **two consecutive complete applicable driving cycles** shall be carried out without soak.
- The vehicle shall be driven in accordance with the provisions of Type1.

Thank you for your attention !