WLTP-13-07e

Asian Round Robin Test
~ Interim report ~

13th WLTP-IWG

11-12 Jan 2016

prepared by Japan

Purposes

- to check the understanding and application of the GTR15 (based on Phase 1a text) in different labs
- to evaluate the repeatability and reproducibility of the test procedure

<V1 - Petrol>

Toyota WISH

1.8L, 105kW, CVT

<V2 - Diesel>

Mahindra & Mahindra XUV500

2.2L, 103kW, 6MT

Test schedule

- Expect to be completed by the March 2016
- Difficult to control the vehicle transportation beyond continental
- Need to coordinate the vehicle transportation between Asia and Europe

Region	Lab	Vehicle-1 (Petrol)			Vehicle-2 (Diesel)		
		date	# of test	Witness	date	# of test	Witness
JAPAN	JARI-1	22 - 24 Oct 2014	3	-	-	-	-
	NTSEL	19 - 20 Nov 2014	3	-	-	-	-
	TOYOTA	3 - 5 Dec 2014	3	-	-	-	-
	JARI-2	11 Feb 2015	1	✔	-	-	-
INDIA	ARAI-1	5 - 9 May 2015	3 (5)*	✔	23 - 27 Mar 2015	5	-
KOREA	NIER	30 Jun – 3 Jul 2015	4	-	28 - 31 Jul 2015	3	✔
	KEMCO	9 - 14 Jul 2015	3	-	-	-	-
	KATRI	24 - 29 Jul 2015	3	✔	-	-	-
CHINA	CATARC	28 - 30 Oct 2015	3	✔	19 Oct 2015 ~	3	-
	CRAES	-	-	-	-	-	-
JAPAN	JARI-3	8 Jan 2016	1	✔	13 - 15 Jan 2016	2	-
	(Internal RRT)	Jan 2016 ~	-	-	-	-	-
INDIA	ARAI-2	-	-	-	TBD (Mar 2016 ~)	TBD	TBD
EUROPE	(TBD)	-	-	-	TBD	-	-

*) 3 data were used in analysis

Test equipment-1

Participant			JARI	NTSEL	TOYOTA	ARAI
Chassis Dynamometer	Make		MEIDEN	MEIDEN	MEIDEN	Burke E. Porter
	Type		Oil floated cradle AD-DY	Oil floated cradle AD-DY	AC-DY（FC-DY)	Electric
	2WD or 4WD		2WD/4WD	2WD/4WD	2WD	2WD
	Roller type (single/twin)		single	single	single	single
	Diameter of roller (mm)		1219.2	1219.2	1591.5	1219.2
	Width of roller (mm)		800	800	700	2740
	Max. speed (km/h)		200	200	160	200
	Material and surface		Steel, sprayed surface	alloyed aluminum, sprayed surface	alloyed aluminum	Steel
	Range of Inertia weight (kg)		455~3500(2WD), 800~3500(4WD)	455~3500(2WD), 800~3500(4WD)	625~3500	120 to 5443
	max. tractive force (kW)		220(absorption), 200(drive)	350：2WD, 380：4WD(absorption), 280(drive)	150(absorption), 110(drive)	149
Cooling fan	Make		MEIDEN	SOKKEN	OOHIRO SANGYO	Burke E. Porter
	Type		centrifugal fan, v-proportional	unconfirmed	centrifugal fan, v-proportional	Axial Flow
	Outlet area (m2)		0.70	1.26	0.96	0.40
	Geometry (mm)		W1000 × H700	W1800 × H700	W1200 × H800 mm	W630 x H630
	Max. speed (km/h)		160	70	120	130
	Flow (m3/min)		1867	1600	1920	867 (52000 m3/hr)
	Hight lower edge (m)		Approx. 0.1	unconfirmed	Approx. 0.1	20 cm (adjustable)
	Distance from front of vehicle (cm)		Approx. 50	unconfirmed	Approx. 50 ~	30 cm (adjustable)
CVS	Make		HORIBA	HORIBA	HORIBA	HORIBA
	Model		CVS-7400T	CVS-7100	CVS-9300T	CVS-7400T
	CVS type		Critical flow venturi (CFV)	Critical flow venturi (CFV)	Critical flow venturi (CFV)	CFV
	flow rate (m^3/min)		5, 10, 15, 20, 25, 30	3, 4.5, 6, 9	5, 10, 15, 20, 25, 30	4.5,6,9,12 slectable max upto 31.5 m3/min
	Number of sample bags/phases		4	4	3	3
	Air dryer used (yes/no)		no	no	no	no
	Location of intake of ambient air (inside/outsi		inside	inside	inside	inside
	Bag material		PVF	PVF	unconfirmed	unconfirmed
	Bag cabinet (heated/not heated)		not heated	not heated	not heated	not heated
	Transfer hose (length, thermal insolation)		Approx. 3m, heated	unconfirmed	Approx. 5m, heated	appx 5 m, insulated
	Heat exchanger		yes	yes	yes	yes
	Air Filter Type		charcoal	charcoal	unconfirmed	HEPA & Charcoal both
DAR or BMD	Make		-	-	-	-
	Model		-	-	-	-
Gas Analyzer	Make		HORIBA	HORIBA	HORIBA	HORIBA
	Model		MEXA-7200D	MEXA-9400D	MEXA-7400H	MEXA-7200D
	Method Type	HC	FID(Gasoline) H･FID(Diesel)	FID	FID(Gasoline) H･FID(Diesel)	FID(Gasoline) H･FID(Diesel)
		CO	NDIR	NDIR	NDIR	NDIR
		CO_2	NDIR	NDIR	NDIR	NDIR
		NOx	CLD	CLD	CLD	CLD
		CH4	Gas chromatograph	Gas chromatograph	Gas chromatograph	Gas chromatograph
	Range	HC (ppmC)	10～5000	0～5000	10～5000	10 ~ 20000
		CO (ppm)	100～50000	0～100000	100～50000	50 ~ 5000
		CO_2 (%)	0.5～5	0～10	0.5～5	0.5 ~20 %
		NOx (ppm)	10～5000	0～2500	10～5000	10 ~ 10000
		CH4 (ppm)	5～25	0～50	5～25	10 ~5000
Power analyzer	Manufacturer		HIOKI	-	HIOKI	HIOKI
	Type		3390	-	3390	3334
Current sensor	Manufacturer		HIOKI	YOKOGAWA	HIOKI	-
	Type		9278 (200A range)	701930	9278 (200A range)	-
	Manufacturer		HIOKI	-	-	-
	Type		9279 (500A range)	-	-	-

Need to upgrade the equipment to meet the GTR No.15 requirements in several labs (cooling fan, # of sample bags)

Test equipment-2

Participant			NIER-TPRC		Kpetro(KEMCO)	KATRI
Chassis Dynamometer	Make		AVL		AVL Zoller GmbH	AVL Zoellner GmbH
	Type		RP 1220 / 12 C27 M17 / APM150 AC Motor		RPL1220/12C27M12/APM	RPL 1220/12C27M8/APM150
	2WD or 4WD		2WD		2WD/4WD	4WD
	Roller type (single/twin)		single		single	single
	Diameter of roller (mm)		1219.2		1219.2	1219±0.254
	Width of roller (mm)		910		915	900
	Max. speed (km/h)		200		200	250
	Material and surface		Laufrolle		Steel, sprayed surface	Metal spray chrome CR13
	Range of Inertia weight (kg)		454~5548		454~5448(2WD), 800~5448(4WD)	500~3500
	max. tractive force (kW)		10096(Max), 8000(Calbration) (Unit : N)		)N(motor operation), 5987N(generator opera	210
Cooling fan	Make		DAE SAN ENG.		DESAN	AVL
	Type		Accel Fan		centrifugal fan, v-proportional	
	Outlet area (m2)		0.48		0.48	0.43
	Geometry (mm)		W1050 x H1050		W800 × H600	W950 × H455
	Max. speed (km/h)		130		130	160
	Flow (m3/min)		1040		variable	53000(m3/h)
	Hight lower edge (m)		0.43		Approx. 0.1	Approx. 0.09
	Distance from front of vehicle (cm)		30		30.5	Approx. 30.5
CVS	Make		HORIBA	HORIBA	HORIBA	AVL
	Model		CVS-7200S(Gasoline)	CVS7400T(Diesel)	CVS-7200S	AT2328E-CVSi60
	CVS type		Critical flow venturi (CFV)	Critical flow venturi (CFV)	Critical flow venturi (CFV)	Critical flow venturi (CFV)
	flow rate (m^3/min)		4.8, 6.4, (9.6), 11.2, 12.9,16,17.6,22.4	3,9.9, 12.2 18.2, (19.8), 22.1,28.1, 30.4,32,4(	9	5, 7, 9, 10, 11, 12, 14, 15, 16, 17, 19, 21, 22,
	Number of sample bags/phases		4	4	4	4
	Air dryer used (yes/no)		no	no	no	no
	Location of intake of ambient air (inside/outsi		inside	inside	outside	inside
	Bag material				tedlar	
	Bag cabinet (heated/not heated)		not heated	not heated	not heated	heated
	Transfer hose (length, thermal insolation)					
	Heat exchanger		yes	yes	yes	yes
	Air Filter Type		charcoal	charcoal	HEPA	
DAR or BMD	Make		HORIBA			-
	Model		DAR-2200			-
Gas Analyzer	Make		HORIBA	HORIBA	HORIBA	AVL
	Model		MEXA-7400LE(Gasoline)	MEXA-7200H(Diesel)	MEXA-7200	AMA i60
	Method Type	HC	FID	H·FID	FID(Gasoline)	heated FID
		CO	NDIR	NDIR	NDIR	NDIR
		CO_2	NDIR	NDIR	NDIR	NDIR
		NOx	CLD	CLD	CLD	heated CLD
		CH4	GC	GC	GC-FID	cutter FID
	Range	HC (ppmC)	10~200	10~200	10, 50, 100, 500	10~3000
		CO (ppm)	50~1000	50~1000	10, 50, 100, 500	50~5000
		CO_2 (%)	1~6	1~6	1, 2, 3, 6	1~20
		NOx (ppm)	10~1000	10~1000	10, 50, 100, 500	10~1000
		CH4 (ppm)	10~50	10~50	10, 20, 50	10~1000 ppmC
Power analyzer	Manufacturer		xantrex		HIOKI	-
	Type		Link Pro		3390	-
Current sensor	Manufacturer		xantrex		HIOKI	-
	Type		Link Pro		9278 (200A range)	-
	Manufacturer		xantrex		HIOKI	-
	Type		Link Pro		9277 (20A range)	-

Fuel property - Petrol

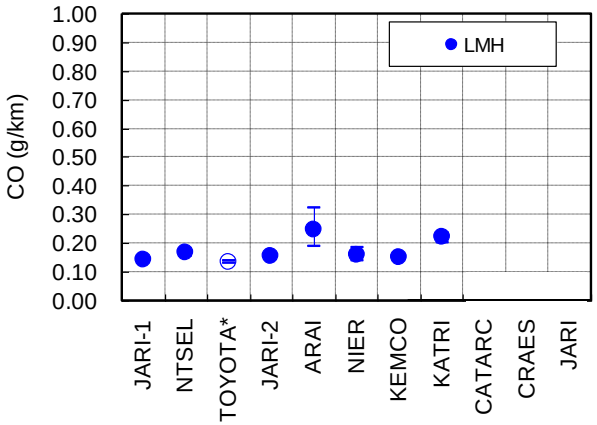
Participant		-	JARI	NTSEL	TOYOTA	ARAI	NIER	K-petro(KEMCO)	KATRI
Make		-	TOTAL	TOTAL	tonengeneral	Haltermann	Total	Total	Total
Lot number		-	PCT010006G	PCT010006G	D1618	BK280300N0	T0221099G	T0221099G	T0221099G
Octane number	RON	-	97	97	90.6	101.4	97.4	97.4	97.4
	MON	-	86.9	86.9	81.5	90.1	87.2	87.2	87.2
Density at 15 °C		kg/m3	750.7	750.7	730.0	750.6	750.0	750.0	750.0
Vapour pressure (DVPE)		kPa	58.4	58.4	59.1	60	59.1	59.1	59.1
Water content		% v/v	0.014	0.014	-	0.0092	<0.015	<0.015	<0.015
Distillation:	evaporated at 70°C	% v/v	35.5	35.5	-	30.4	36.6	36.6	36.6
	evaporated at 100°C	% v/v	52.5	52.5	-	49.3	53.5	53.5	53.5
	evaporated at 150°C	% v/v	84.5	84.5	-	86.3	85.6	85.6	85.6
	final boiling point	°C	199.3	199.3	-	193.8	195.3	195.3	195.3
	Residue	% v/v	0.6	0.6	-	1	0.6	0.6	0.6
Hydrocarbon analysis:	olefines	% v/v	5.2	5.2	19.6	4.3	6.1	6.1	6.1
	aromatics	% v/v	32.2	32.2	22	30.3	31.5	31.5	31.5
	benzene	% v/v	0.1	0.1	0.5	0.16	<0.1	<0.1	<0.1
	saturates	% v/v	57.8	57.8	-	60.8			
Carbon/hydrogen ratio		%Mass	6.375	6.375	-	0.54	6.37	6.37	6.37
Carbon/oxygen ratio		%Mass	47.619	47.619	-		0.02	0.02	0.02
Induction Period		minutes	>528	>528	-	>1200			
Oxygen content		% m/m	1.78	1.78	-	1.7	1.9	1.9	1.9
Exsistant gum		mg/ml	<0.01	<0.01	-		<0.01	<0.01	<0.01
Sulphur content		mg/kg	7.1	7.1	4	<3	<3	<3	<3
Copper corrosion			1a	1a	-	1A	1a	1a	1a
Lead content		mg/l	<5.0	<5.0	-	<3	<5	<5	<5
Phosphorus content		mg/l	<0.2	<0.2	-	<0.2	<0.2	<0.2	<0.2
Ethanol		% v/v	4.8	4.8	0.1	4.7	5	5	5

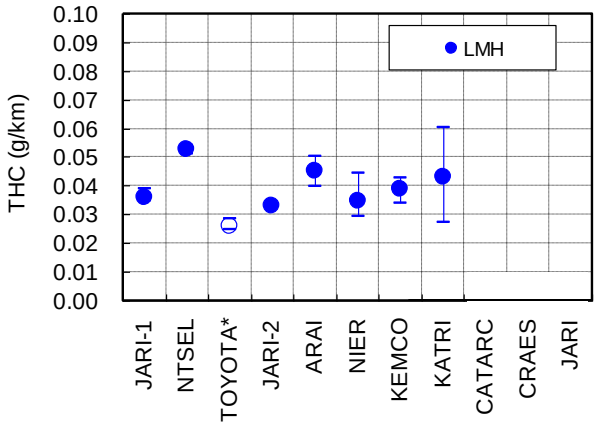
E5 petrol was used in 6 labs (except TOYOTA)

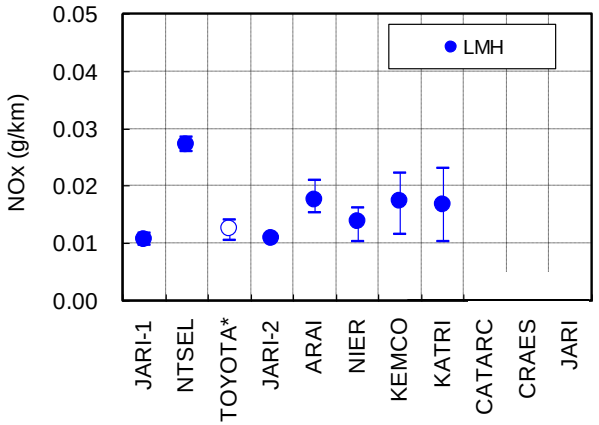
Test results (3 phase) of Vehicle-1

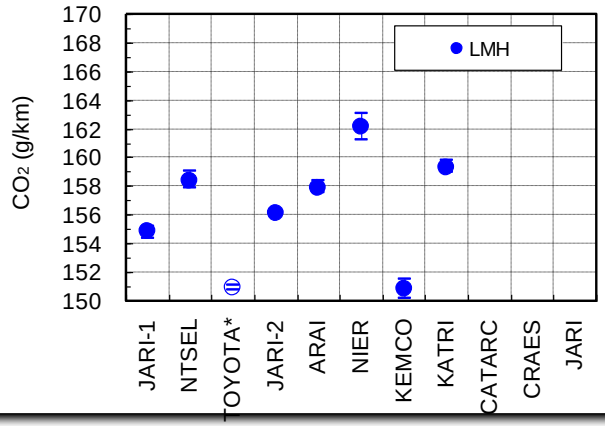
Labs	# of Test	CO (g/km)			THC (g/km)			NOx (g/km)			CO2 (g/km)			Fuel consumption (L/100km)		
		AVE	SD	RSD	AVE	SD	RSD	AVE	SD	RSD	AVE	SD	RSD	AVE	SD	RSD
JARI-1	3	0.141	0.005	3.8	0.036	0.002	5.1	0.011	0.001	8.0	154.9	0.4	0.3	6.66	0.02	0.3
NTSEL	3	0.168	0.008	5.0	0.053	0.001	2.4	0.027	0.001	3.7	158.4	0.5	0.3	6.81	0.02	0.3
TOYOTA	3	0.134	0.002	1.8	0.026	0.002	6.6	0.013	0.002	12.5	150.9	0.1	0.1	6.53	0.00	0.1
JARI-2	1	0.154	0.000	0.0	0.033	0.000	0.0	0.011	0.000	0.0	156.1	0.0	0.0	6.71	0.00	0.0
ARAI	3	0.247	0.055	22.2	0.045	0.004	9.4	0.018	0.002	13.4	157.9	0.3	0.2	6.65	0.02	0.2
NIER	4	0.160	0.019	11.7	0.035	0.006	16.6	0.014	0.002	16.0	162.2	0.6	0.4	6.98	0.03	0.4
KEMCO	3	0.149	0.004	3.0	0.039	0.004	9.9	0.017	0.004	25.0	150.9	0.6	0.4	6.49	0.02	0.4
KATRI	3	0.220	0.013	6.0	0.043	0.014	31.3	0.017	0.005	30.8	159.3	0.3	0.2	6.86	0.02	0.2
ALL*	20	0.179	0.045	25.0	0.041	0.009	21.6	0.017	0.006	35.2	157.4	3.6	2.3	6.75	0.16	2.4
Inter lab*	7 labs	0.177	0.037	21.1	0.041	0.006	15.8	0.016	0.005	32.0	157.1	3.3	2.1	6.74	0.15	2.2

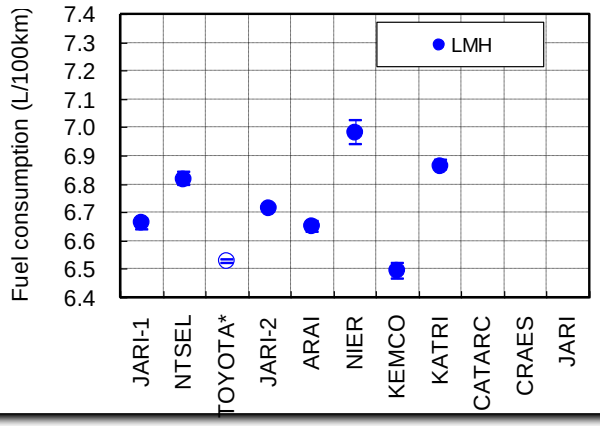
*) except TOYOTA data











<CO_2 : Inter laboratory>

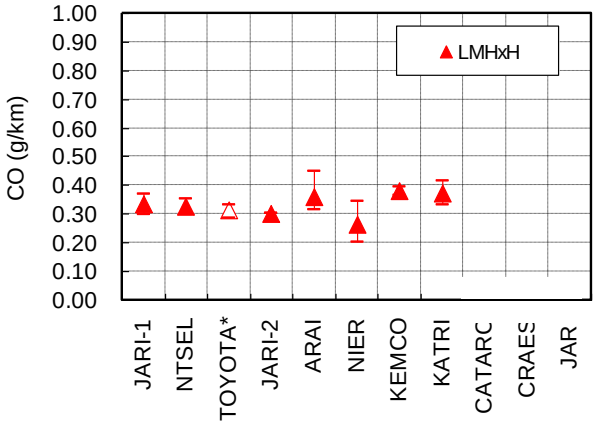
- RSD(=SD/Ave): 2.1% (SD=3.3 g/km)
- (Max-Min)/Ave: 7.2% (Δ=11.3 g/km)
- RCB correction was not applied

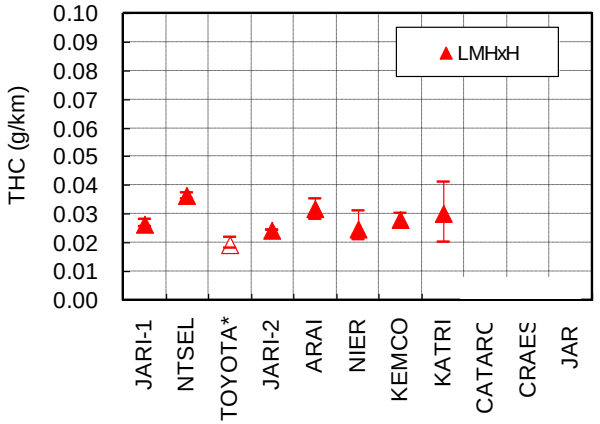
*) TOYOTA: E0 petrol, **) Error bar: MAX - MIN

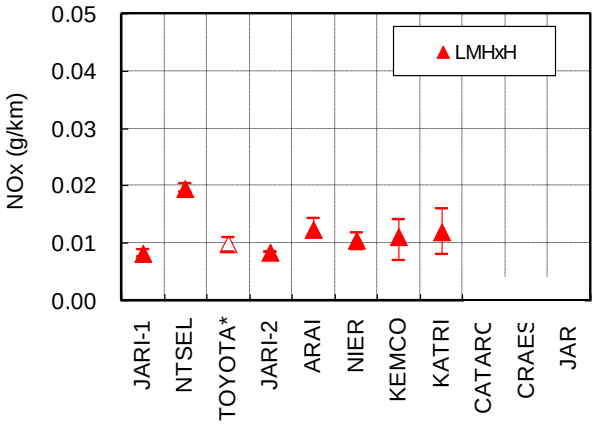
Test results (4 phase) of Vehicle-1

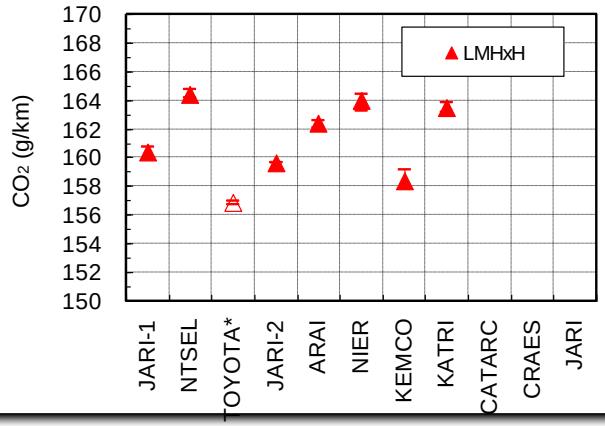
Labs	# of Test	CO (g/km)			THC (g/km)			NOx (g/km)			CO2 (g/km)			Fuel consumption (L/100km)		
		AVE	SD	RSD	AVE	SD	RSD	AVE	SD	RSD	AVE	SD	RSD	AVE	SD	RSD
JARI-1	3	0.334	0.028	8.4	0.026	0.001	4.5	0.008	0.001	6.4	160.4	0.4	0.2	6.91	0.02	0.2
NTSEL	3	0.328	0.024	7.3	0.036	0.001	2.3	0.019	0.001	3.2	164.4	0.2	0.1	7.08	0.01	0.1
TOYOTA	3	0.313	0.021	6.8	0.019	0.002	8.7	0.010	0.001	10.3	156.8	0.1	0.1	6.79	0.00	0.0
JARI-2	1	0.303	0.000	0.0	0.024	0.000	0.0	0.008	0.000	0.0	159.6	0.0	0.0	6.87	0.00	0.0
ARAI	3	0.361	0.063	17.4	0.032	0.003	8.9	0.012	0.001	11.4	162.4	0.2	0.1	6.84	0.01	0.2
NIER	4	0.263	0.052	19.9	0.025	0.004	15.2	0.010	0.001	10.7	163.9	0.5	0.3	7.06	0.02	0.3
KEMCO	3	0.382	0.012	3.1	0.028	0.002	7.7	0.011	0.003	26.8	158.3	0.6	0.4	6.83	0.02	0.3
KATRI	3	0.373	0.035	9.4	0.030	0.009	28.3	0.012	0.003	27.2	163.5	0.3	0.2	7.05	0.01	0.1
ALL*	20	0.334	0.057	17.2	0.029	0.006	19.4	0.012	0.004	32.9	162.1	2.2	1.3	6.96	0.11	1.5
Inter lab*	7 labs	0.335	0.039	11.6	0.029	0.004	14.1	0.012	0.004	30.1	161.8	2.2	1.3	6.95	0.10	1.5

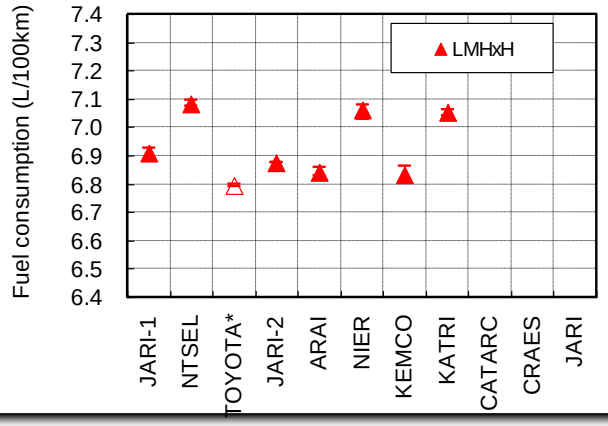
*) except TOYOTA data











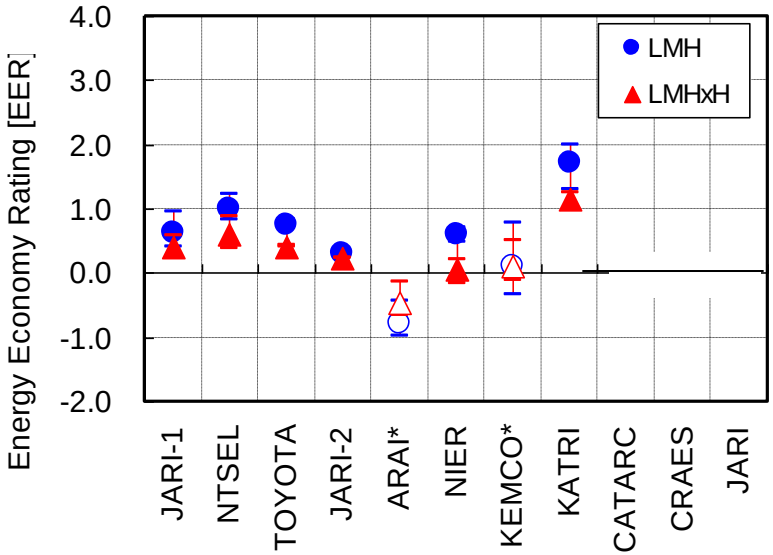
<CO_2 : Inter laboratory>

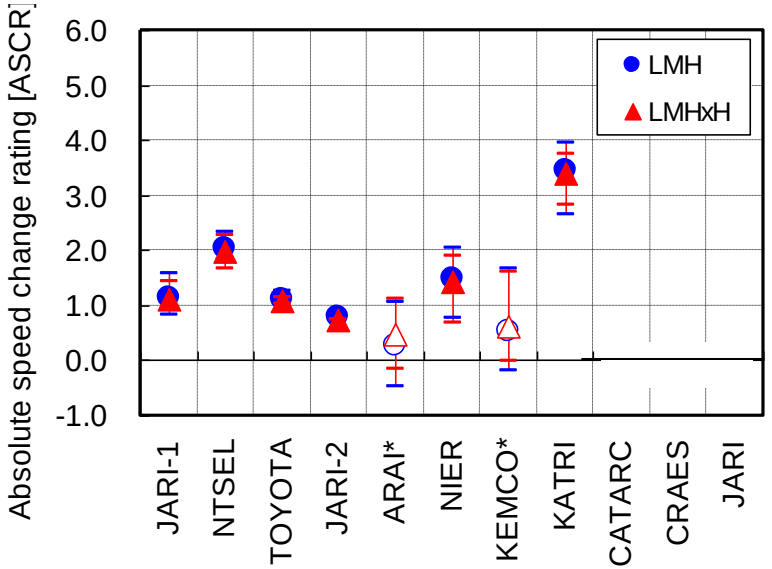
- RSD(=SD/Ave): 1.3% (SD=2.2 g/km)
- (Max-Min)/Ave: 3.7% (Δ=6.0 g/km)
- RCB correction was not applied

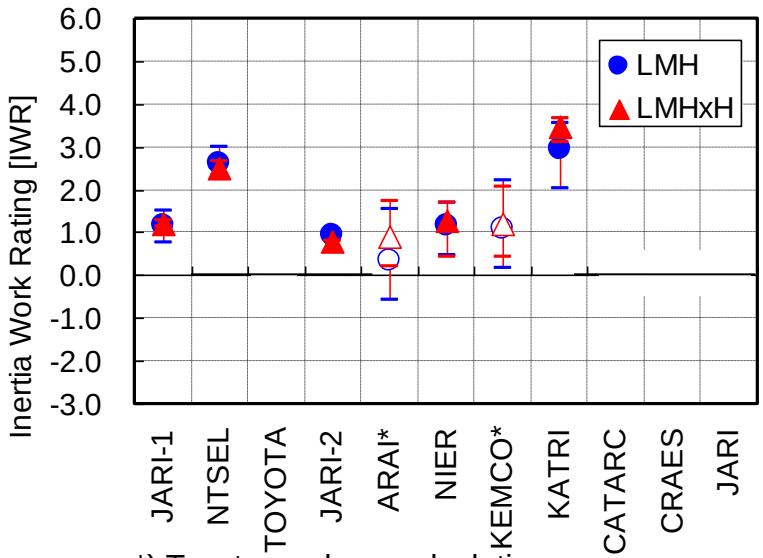
*) TOYOTA: E0 petrol, **) Error bar: MAX - MIN

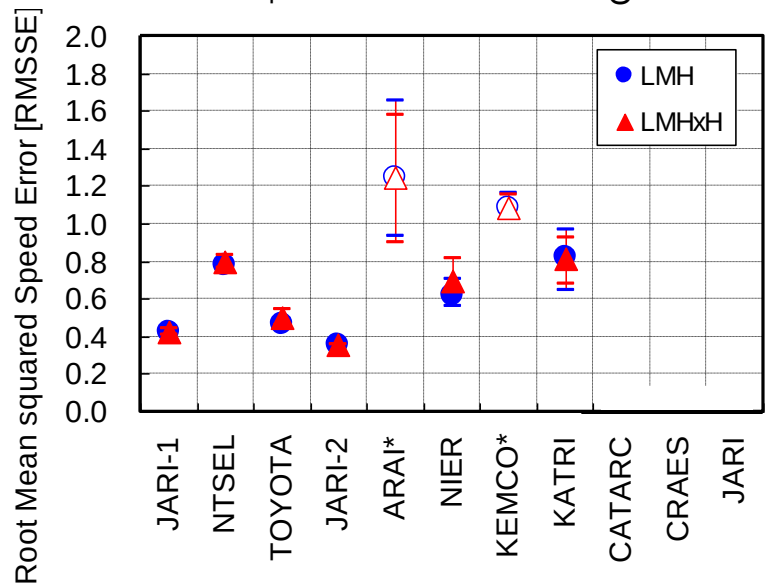
Comparison of Drive Trace Index (3 and 4 phases)

● LMH(3-phase), ▲ LMHxH (4-phase)







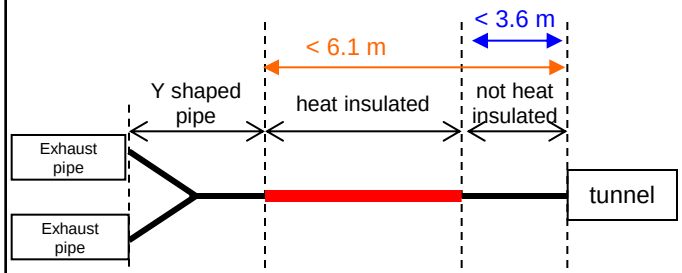
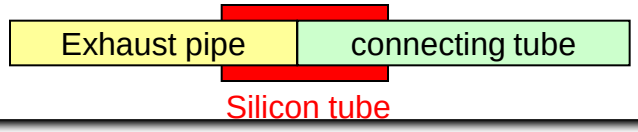


*) Toyota: under recalculation

*) ARAI & KEMCO: calculated by using 1Hz data

Confirmation on GTR-text

Questions were raised during RRT and these were confirmed to WLTP-IWG members in Tokyo meeting

Item	GTR (Phase 1a)	Confirmation point
Connecting tube (a)	Annex5, 3.3.1.3. The connecting tube shall satisfy the following requirements: (a) Be less than 3.6 metres long, or less than 6.1 metres long if heat-insulated. Its internal diameter shall not exceed 105 mm; the insulating materials shall have a thickness of at least 25 mm and thermal conductivity not exceeding 0.1 W/m-1K-1 at 673 K (400 ° C). Optionally, the tube may be heated to a temperature above the dew point. This may be assumed to be achieved if the tube is heated to 343 K (70 ° C);	If there are both heat-insulated part and not heat-insulated part (e.g. Y-shaped pipe), how long is the maximum length? ⇒ It was confirmed that Y-shaped pipe is not included in this requirement. 
Connecting tube (c)	No component of the connecting tube shall be of a material which might affect the gaseous or solid composition of the exhaust gas. To avoid generation of any particles from elastomer connectors, elastomers employed shall be as thermally stable as possible and have minimum exposure to the exhaust gas. It is recommended not to use elastomer connectors to bridge the connection between the vehicle exhaust and the connecting tube.	Is it possible to use silicon-elastomer tube as the connecting tube in the PM/PN measurement? In particular, ExHIGH phase and regeneration condition. ⇒ Horiba suggested that the exhaust gas should not contact with the silicon tube. This matter will be confirmed in PM/PN group. 

Summary (Temporary)

Variation was observed in CO_2 between labs. However, it will be reduced if the following actions are taken.

Item		Detail	Action
Lab. equipment	Temperature in the test cell and soak area	One lab could not set at 23 deg. C during RR program because of other on going programs	will be changed when WLTP is introduced
	Maximum speed of Cooling fan	Lacking the speed of cooling fan at one lab	Need to renewal the cooling fan
	Width of Cooling fan	Width of cooling fan is shorter than that of GTR requirement at on lab	Need to renewal or update/modification
	Length of Connecting tube	length of connecting tube is longer than that of GTR requirement at one lab.	Need to modification
	RCB measurement equipment	One lab doesn't have a RCB measurement system yet	Need to be introduced the equipment
	Data recording system	Two labs could not record the vehicle speed of 10Hz.	Need to renewal the data recording system
Test procedure	Warm up procedure for RL setting	Unique method was applied in the RL setting at one lab	Follow the GTR procedure
Driving trace	Driving trace index	Variation was observed in each index	Follow the trace as much as possible