## WORKSHOP ON HEAVY-DUTY FUEL EFFICIENCY REGULATIONS April 29th, 2015.

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## **An Overview**



Establishment	: 1966	
Location	: Pune, INDIA (150 km from Mumbai)	
Manpower	: 600+	
Facilities	: 12 Laboratories – Powertrain, Emissions, Safety & Homologation, Passive Safety, Vehicle Evaluation, Materials, Automotive Electronics, NVH, CAE, Structural Dynamics, Calibration, Post Graduate Academy, Forging Industry Division	У
Our Offices	: China, Korea and Chennai	
Investments	: USD \$ 60 Million	
Accreditations	: ISO 9001, 14001, OHSAS 18001 & NABL ( ISO/IEC 17025)	



# **Upcoming Facilities at Chakan**

Progress through Research



#### **Emission Facilities & Overview**



#### Chassis Dynamometer test facility for Buses & Trucks at ARAI



Parameter	Details
Make	Froude Consine Ltd., U.K.
Туре	DC Machine (Single Roller)
Maximum power	155 kW absorption / motoring
Maximum Speed	100 km/h
Maximum tractive effort	14000 N
Vehicle inertia range	Up to 32000 Kg.
Roller diameter	2500 mm



Transient Engine Dynamometers with Full Flow Dilution Tunnel (220 kW & 500 kW)



- Broad Specifications :
  - Heavy Duty Transient Dynamometer : 500kW @ 1600 to 3200rm, 3000 Nm @ 800 to 1600 rpm.
  - Heavy Duty Transient Dynamometer : 220kW @ 2200 to 4500rm, 960 Nm @ 1000 to 2200 rpm.
  - Emission Analyser : Suitable for measurement up to Euro V.

#### Useful for :

- Automotive BSIV, BSIII
- Tractor Trem IIIA
- CEV BSIII
- Export Homologation
- High Altitude Simulation
- Friction Mapping testing
- Vehicle Simulation



Full Flow Emission Measurement facility for Transient Engine Dynamometers



Emission & Particulate Measurement Details

CO (L) NDIR Analyser Range	50 to 5000 ppm
THC HFID Analyser Range	10 to 5000 ppmC
CH4/ THC HFID Analyser Range	10 to 5000 ppmC
NO/ NOx HCLD Analyser Range	10 to 5000 ppm
CO2 NDIR Analyser Range	0.5 to 6 % Vol
NH3 HCLD Analyser Range	10 to 1000 ppm
Model	Full Flow Particulate Measurement
Make	HORIBA, Japan
Full flow dilution tunnel diameter	ф 18"
Secondary dilution tunnel diameter	φ 5"
Filter Holder Size	ф47mm & ф70mm
Suitability	BSIII & BSIV ESC as well as Transient testing



#### **Weighing Balance**

Make :- Saurtourius Model MSU 2.7S-000-DF Range = 0-2100 mgResolution =  $0.1 \ \mu g$ Precision = 20 mg



Buoyancy correction for 40CFR1065 requirer

### Weighing Chamber

Make Horiba Model CHAM 1000 Accuracy : Temperature 22 +/- 1 Deg. C Dew Point 9.5 +/- 1 Deg. C





#### FTIR Emission system:



This is stand-alone system and meets the requirements of Euro VI for ammonia measurement and EPA 40 CFR part 1065 for N2O nitrous Oxide. With wide range of component measurement capability and good correlation with conventional system, same system can be used for measurement of NO, NO2, CO, CO2, CH4 as well as alcohols, carbonyls during development trial.

 Ammonia slip and Nitrous Oxide.
 Standard components like CO, CO2, NO NO2, Nox, HC, NMHC, CH4 and H2O
 Extended components like HCD,HCM, C2H2, C2H4, C2H6, n-Pentane, n-Octane, AHC, CH3OH, SO2, N2O, CH2O, CH3CHO, HCN.



#### Fuel Economy status in India:

#### Vehicle classification in India:

Vehicle Category	Category Name	Category Details (GVW in Tons)			
Buses (Carrying Passengers)	Buses (Carrying Passengers)				
Category – M1	Car	< 3.5 T			
Category – M2	Bus	< 5 T			
Category –M3	Bus	> 5 T			
Trucks (Carrying Goods)					
Category – N1	LCV	$\leq$ 3.5 T			
Category – N2	MCV	$> 3.5 \text{ T} \le 12 \text{ T}$			
Category – N3	HCV	> 12 T			



#### Fuel Economy status in India:

Vehicle Category	Category Name	Category Details (GVW in Tons)		Fuel Economy norm	
Category – M1	Ca	ar	< 3.5 T	Measurement on Chassis dynamometer	
Category – M2	Βι	IS	< 5 T	Constant Speed Fuel Consumption measurement at 50 km/h on track	
Category –M3	-M3 Bus > 5 T		> 5 T	Constant Speed Fuel Consumption measurement at 40 km/h and 60 km/h. for GVW above 7.5 tons and at 50 km/h for GVW less than 7.5 tons on track	
Trucks (Carrying Goods)					
Category – N1	LC	CV	≤3.5 T	Measurement on Chassis dynamometer	
Category – N2	M	CV	> 3.5 T ≤ 12 T	Constant Speed Fuel Consumption measurement at 40 km/h and 60 km/h. for vehicle GVW above 7.5 tons and at 50 km/h for vehicle GVW less than 7.5 tons on track.	
Category – N3	НО	CV	>12 T	Constant Speed Fuel Consumption measurement at 40 km/h and 60 km/h on track.	



#### Global FE regulation status

	Proposed schedule	<b>Regulatory Categories</b>	Certification Test Procedures	Metric		
Japan	The FC standards for commercial vehicles to be effective from 2015	Other Truck (11 subcategories) Tractor (2 subcategories) Route Bus (5 subcategories) Other Bus (8 subcategories)	Simulation modelling +engine dynamometer testing	Fuel econo (km/L)	omy	
N. America	A. AmericaCO2 and FC standards begin in 2015.Tractors Vocational vehicles HD pickup trucks and vans Engines (tractors, voc. vehicles)Vehicles simulation model Engines dynamometer testing	Tractors, Vocation al	HD Pickups	Engines		
			dynamometer testing	gal/1,000 ton-mi	gal/100 mi	gal/100 bhp-hr
				g/ton-mi	g/mi	g/kWh
China	The FC standard has been implemented from 2014.	Tractors, dump trucks, rigid trucks, city buses, other buses	"Base" vehicles chassis dynamometer Variant" vehicles simulation modelling	Fuel consu (L/100 km)	mption )	

European Union Development of simulation method on going.



#### **European union regulation Fuel Economy regulation status**

#### As pre R49 Rev 6

CO2 emissions and fuel consumption shall be determined over the WHTC and WHSC test cycles.

> The test results shall be reported as cycle averaged brake specific values and expressed in the unit of g/kWh.

The European Commission has developed a computer simulation tool, VECTO, to measure CO2 emissions from new vehicles.

VECTO (Vehicle Energy consumption Calculation TOol) is based on an approach that covers emissions from the entire vehicle, including key components such as the engine, transmission and auxiliary elements like air compressors as well as properties such as aerodynamic drag and rolling resistance



FEATURES OF TEST TRACK	<ol> <li>The test track shall be straight, level paved road, covered with asphalt, concrete or similar material, dry, clean and smooth and shall have sufficient length on either side for the vehicle to attain and stabilise the test speed and also for stopping the vehicle at the end of test.</li> <li>The longitudinal and lateral slope of the test track shall not be more than 0.5 percent and 2 percent respectively. The altitude difference between any two points 1 000 m apart shall not be more than one metre.</li> </ol>
Preparation of Vehicle	The tyres shall be run in at the same time as the vehicle or shall have a tread depth not less than 90 percent of the tread depth of a new tyre and should have operated for at least 500 km or the distance recommended for the running-in of the vehicle, whichever is lower, on the road prior to the test.



Accessories	All power consuming accessories and equipments such as lighting and illuminating devices, windshield wiper and washing system, record player, air climatizer, etc, shall be switched off. However, the drive for the air climatizer compressor shall not be disconnected.
WEIGHTS	The unladen weight shall be the complete vehicle kerb weight as per IS 9211 : 1979, where applicable. The vehicle shall be loaded to a gross weight required for that particular test and shall be recorded in the test report



AMBIENT	<ul> <li>Standard reference conditions.</li> <li>a) Temperature : 300 K ( 27°C ) b) Pressure : 100 kPa</li> <li>The ambient conditions at the test site shall be:</li></ul>
CONDITIONS	Temperature : 288 to 308 K ( 15 to 35°C) <li>Relative humidity : Not more than 75 Percent Air density when calculated as described below shall not differ by more than 7.5 percent from the air density under the reference conditions:</li> <li>The wind velocity in any direction shall not exceed 3 m/set. The measurement of wind velocity shall be done at a height of 1 to 1-5 m above road surface.</li>
TEST	The vehicle shall be tested at the constant speed/speeds required for the test. The vehicle shall be run in top gear or in the gear as recommended by the manufacturer. The test shall be conducted over a distance of not less than 1000 m. Two consecutive test runs in the opposite directions shall constitute a pass The test shall be conducted sufficient number of times such that the readings for at least 5 passes ( one pass comprising consecutive readings in the opposite directions ), whose variation of S ( Fuel consumption) for that pass in not more than +/- 2.5 percent of mean and the average speed not varying by more than +/- 1 km/h from the specified speed can be selected. These readings shall be selected such that the variation S and Fuel consumption is minimum.



#### National Centre for Automotive Testing (NCAT, Ahmednagar)





For following changes CSFC test needs to be perform.

- For change in GVW in excess of 10%
- Change in swept volume in excess of 10, number and arrangement of cylinder.
- Change in engine power or torque in excess of 5%.
- Change in fuel system.
- Change in type of transmission.
- Change in radial ply to cross ply or vice versa.
- Change in overall transmission ratio.
- Change in body shape with increases the frontal area.
- Change of fuel type ( petrol/diesel etc)
- $\succ$  no. of axles
- Change in injection / injection timing in excess of 2 deg.
- $\succ$  No. of tyres
- Change in tyre size
- Air intake system (NA, TC etc)
- Change in Engine Control Unit, including calibration

The above criteria may be reviewed



Propose road map for HDV fuel economy norms in INDIA

- 1) Sub-categorization of vehicle classification for FE norm.
- 2) Development of test methodology for entire vehicle FE measurement.
- 3) Development of simulation tool for CO2 and fuel measurement from the entire vehicle, including key components such as the engine, transmission and auxiliary elements like air compressors as well as properties such as aerodynamic drag and rolling resistance .
- 4) Till development of simulation tool measurement of
- Constant speed fuel consumption as per IS 11921:1993 i.e. "Automotive Vehicles - Method of evaluation & fuel consumption" to be continued.
- CO2 emissions and fuel consumption shall be determined over the ESC and ETC test cycles for all BSIV engine.
- The test results shall be reported as cycle averaged brake specific values and expressed in the unit of g/kWh.



#### Existing test facility in India for HDV testing

	Facility for Engine Dynamometer( Transient)	Facility for Chassis Dynamometer (HDV vehicle)
ARAI	YES	YES
VRDE	YES	NO
ICAT	YES	NO
M/s. Tata Motors Ltd.	YES	YES
M/s. Ashok Leyland Ltd.	YES	NO
M/s. VE Commercial Vehicles Ltd. (A Volvo Group & Eicher Motors Joint Venture)	YES	NO
M/s Mahindra & Mahindra Limited. Truck and Bus Division	YES	NO
M/s. Daimler India Commercial Vehicles Pvt. Ltd.	NO (Available at overseas)	NO (Available at overseas)
M/s. Mahindra Navistar Automotives Ltd.	NO	NO
M/s. MAN Trucks India Pvt. Ltd.	NO (Available at overseas)	NO (Available at overseas)
M/s. Scania Commercial Vehicles India Pvt. Ltd.	NO (Available at overseas)	NO (Available at overseas)
M/s. SML ISUZU LTD.	YES	NO
M/s. Force Motors Ltd.	YES	NO
M/s. AMW Motors Ltd.	NO	NO



#### Existing test facility in India for HDV testing

#### Chassis Dynamometer test facility for Buses & Trucks at IOCL

Parameter	Details
Make	AVL and Brush Inc (2Nos)
Туре	DC Machine (Single Roller)
Maximum power	191/196 kW absorption / motoring
Maximum Speed	200 km/h
Maximum tractive effort	10500 N
Vehicle inertia range	Up to 16000 Kg.
Roller diameter	1219 mm



#### Existing test facility in India for HDV testing

#### Chassis Dynamometer test facility for Buses & Trucks at TML

Parameter	Pune	Pune	Jamshedpur
Make	BEP,USA	BEP,USA	BEP,USA
Туре	DC Machine (Single Roller)	DC Machine (Single Roller)	DC Machine (Single Roller)
Maximum Speed	130 km/h	130 km/h	130 km/h
Maximum tractive effort	32,388 N	140,428 N	270,280 N
Vehicle inertia range	3.5-25 T	3.5-50 T	3.5-50 T
Roller diameter	1905 mm	1905 mm	1905 mm



	Vehicle inertia simulation	Fuel consumption measurement	Emission measurement capability
ARAI	32 tons	Yes	Yes
TML Pune	25 tons / 50 tons	Yes	No
TML Jamshedpur	50 tons	Yes	No
IOCL	16 tons	Yes	Yes



# Thanks

