VELA7

EMISSION TEST FACILITY FOR HEAVY DUTY VEHICLES

Europe's current transport system, as those of other continents, is far from being truly sustainable both, in terms of environmental impact, and in terms of energy supply. Effects on human health and on the environment represent the down side to the development driven by the ever more growing need of modern societies for mobility as vehicles are an important source of air pollution and greenhouse gas emissions. Moreover, the road transport sector depends almost totally on fossil oil, a resource that is destined to get scarce on the long run. The necessity to limit the negative impacts of road transport and to diversify the Energy resources as well as to limit the consumption is thus one of the priorities on the agenda of the European Commission, strongly engaged in developing new policy measures aiming at a solution of the above mentioned problems.

The VELA (**V**ehicle **E**mission **LA**boratory) installations at the Joint Research Centre in Ispra (Italy) have played and are playing a key role of technical and scientific support in the definition of the European policies regarding the air pollution from road transport. The activities thus include issues of CO2 and the energy efficiency of internal combustion engines. For instance, the EURO 5/6 emission standards for cars and EURO IV for heavy engines, which will enter into force from 2009 onwards for the coming years, have been developed using base-giving contributions from the VELA laboratories.

The new VELA7 Laboratory is dedicated to the measurement of emissions from real-life heavy duty vehicles. It completes the laboratories VELA already existing at the JRC, thus it becomes possible to characterise the polluting emissions of all types of road- and non-road vehicles, from small scooters to a 40-ton truck or 12m long bus.

VELA 7 has unique features in European comparison and belongs to the most advanced set-ups of its kind globally. It in fact allows to reveal the complete picture - quantitatively and qualitatively - of the emissions of a whole range of heavier vehicles, from delivery vans of medium size to busses and heavy duty trucks of a single or double driven axis.

One of the main advantages of VELA7 is the possibility to also perform tests on vehicles using different fuels, including gaseous ones like LPG, methane or even hydrogen. The latter aspect required specific safety systems to be included already at projecting stage, in order to eliminate risks from potential gas leakages during vehicle testing.

The VELA7 lab consists of three main parts:

- A climatised test cell
- A dynamic roller bench
- The instrumentation for measuring the chemo-physical characteristics of the polluting, respectively climate-relevant emissions.

Climatic Test Cell

The internal dimensions of the test cell are 22m (length) by 8m (width) by 6.7 m (hight).
One of the base prerequisites for an accurate and reproducible measurement of emissions from vehicles is the control of the environmental conditions, specifically the temperature and the relative humidity of the air.
The climatised test cell of VELA7 is projected for controlling both these parameters, which can be varied in a wide band and then kept constant during testing, thus largely covering the whole range of European climatic conditions:

- The temperature in the test cell can be chosen between - 30 °C and + 50°C with a tolerance of ± 1 °C.
- The relative humidity in the cell can be varied between 30% and 80% with a tolerance of ± 5%.

The possibility to perform emission measurements at different temperatures permits to study a range of problematic effects e.g., the influence of atmospheric temperature on correct functioning of pollution abatement systems or on the overall energy efficiency of a vehicle.
The European standards on vehicle emissions as currently in place prescribe for petrol cars already one test to be performed at -7 °C, in order to assure the good functioning of the catalytic converter also in cold climates. An extension of this test to other vehicles is under scientific consideration.

Dynamic Roller Bench

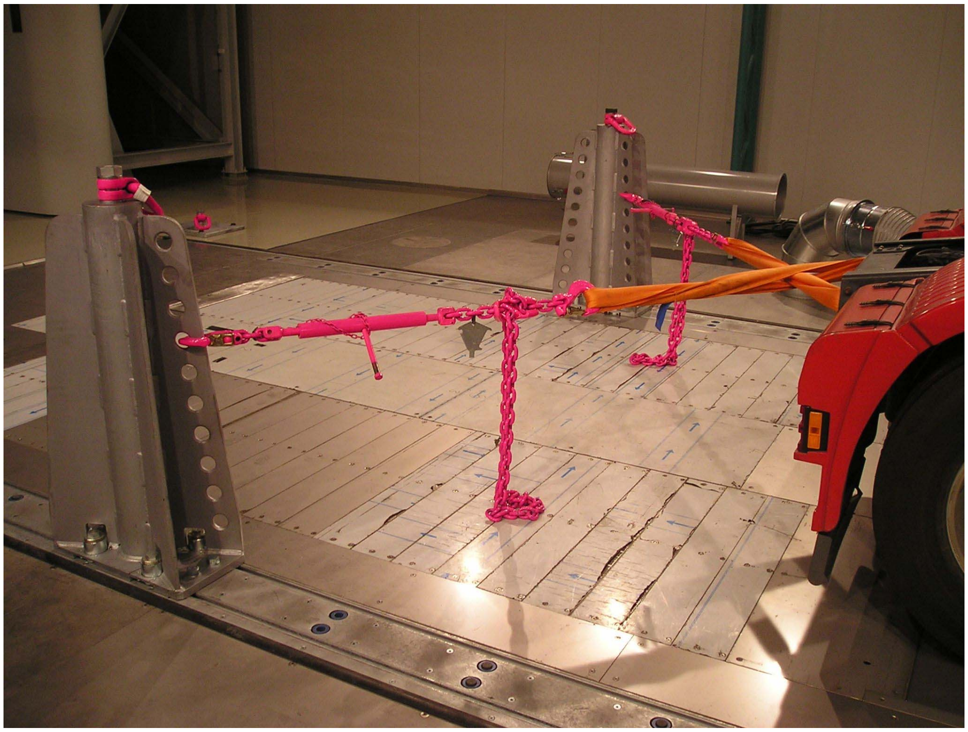
The function of a dynamic roller bench in an emission test lab is that of simulating the resistance forces active when the vehicle is in auto-motion, stemming from air resistance, rolling friction between tires and road and the flexing resistance within the tires.

Once the vehicle is positioned on the roller bench and the control parameters for the resistance forces are correctly set, it is possible to simulate with great precision the straight driving of the vehicle on road.
It is possible moreover, to simulate different drive cycles in function of the needs of any study to undertake. In fact standard cycles can be run as already defined in existing legislation or also real-life drive-cycles can be re-produced on the roller bench as recorded with appropriate instrumentation on road.

The dynamic roller bench of VELA7 has the following main technical characteristics:

Diametre of roller	1828.8 mm (72“)
Total roller width (external edge to external edge)	3000 mm
Distance between the internal edges of the roller	900 mm
Maximum load to axis	13000 kg
Maximum test speed	160 km/h
Intervallo di inerzia simulabile	800 – 30000 kg
Surface roughness	$R_a \leq 5 \pm 2\ \mu m$[3]

Vehicles under test are anchored to ground with special systems, making use of chains of adequate dimensions:



A special accessory permits to simulate up to 10 tons of additional load of a vehicle (100000 Newton).

Instrumentation for measuring the chemo-physical characteristics of the emissions

VELA is equipped with advanced instrumentation for the quantitative and qualitative measurement of polluting and climatically relevant emissions.

The system consists of a ***total dilution tunnel*** and an ***analysis system*** of the exhaust gases.

- The dilution tunnel, which has a total through-put of 150 m^3/min, permits to dilute the exhaust gases of the vehicle with appropriately pre-treated air. This is done for two reasons: First, in order to avoid the condensation of the contained water vapour which would influence the measurements of the other contained substances and secondly, to simulate the processes which in fact happen, once the exhaust gases are released to the atmosphere in real life. This second aspect is of fundamental importance for measuring the *particulate emissions*, because the processes of seeding, condensation and aggregation of the exhausted particles happen in fact after the emission from the vehicle into the atmosphere and determine the chemo-physical character of the final exhaust products.

- The analysis system of the VELA7 lab is consisting of two lines of analysers that can be operated in parallel, which are capable of continuously monitoring the gaseous pollutants *before* and *after* a system of exhaust gas post-treatment (filter, catalyst), with a time resolution of one second. This set-up permits to study in detail the efficiency of pollutant abatement in such systems.

The gaseous pollutants which are measured are the following:

- Total unburned hydrocarbons (THC)
- Methane (CH_4)
- Nitrogen Oxides (NOx)
- Carbon-monoxide (CO)
- Carbon-dioxide (CO_2)

Particulate emissions are measured gravimetrically, using standard filters as prescribed by current legislation. A sample of the diluted exhaust gas is conducted through such a filter and the difference between its weight measurements before and after the test gives the overall final result. Additionally, by advanced laser technology, it is possible to count the total number of particles emitted by the vehicle and also their granulometric weight distribution.

Moreover, instrumentation based on infrared spectroscopy enables to measure – again every second by the second - the concentration of specific compounds of which the emission is currently not regulated by legislation. For instance, it is possible to quantify the specific emissions of hydrocarbons like benzene, toxic substances like aldehydes or also evaluate the emissions of ammonia from those exhaust gas post-treatment systems, which use urea (see example graph – the black line represents the driving cycle).