Euro VI Heavy Duty Vehicle Emissions Regulation

Briefing note

The introduction of Euro VI heavy duty vehicle emission standards applied from 31 December 2012 for new vehicle and engine types, and applied from 31 December 2013 for all new vehicle registrations. The main elements of Euro VI were a further tightening of vehicle emission limits for particulate matter (PM) and nitrogen oxides (NO_X) from the previous Euro V limits. This briefing note gives an overview of the changes and implications for operators.

Summary of Euro VI regulation

The main elements of the regulation are as follows.

- The regulation applies to all heavy duty goods and passenger vehicles with a reference mass exceeding 2,610kg.
- A reduction of 80 per cent in oxides of nitrogen (NO_X) and a 67 per cent reduction in particulate matter (PM) emissions limits compared to the Euro V standards that it replaced .
- A 71 per cent reduction in hydrocarbon (THC) emissions limits.
- Requirements for uniform access to on-board diagnostic and repair information for heavy duty vehicles.
- A limit on the number of particles emitted to supplement the particulate mass limit.
- Emissions testing on the world harmonised test cycles, rather than on the currently-used European drive cycle.
- A number of other detailed provisions including tightening of the limit on emissions of ammonia, standardising the process for measuring fuel consumption and carbon dioxide emissions of heavy duty engines and an increase in the durability of emission control systems.

What are Euro standards?

Euro standards seek to reduce pollutant emissions released into the air from vehicles. Since 1991, the standards have progressively tightened as the European Commission has demanded emissions limits to curb the release of air pollutants such as oxides of nitrogen, particulate matter and hydrocarbons. The freight industry has therefore made massive inroads to reduce vehicle emissions. Operators, through their procurement of new vehicles, contribute to reducing the impact of air pollution. In the past, the UK Government has incentivised the purchase of Euro standard vehicles by offering Reduced Pollution Certificates (RPC) which reduced the amount of vehicle excise duty that needs to be paid. Similarly Low Emission Zone schemes across Europe have used Euro standards as determining criteria to which vehicles may travel in urban areas without being subject to financial penalties. For example, the London Ultra Low Emission Zone which replaces the T-Charge from 8 April 2019 will be based on a minimum Euro VI standard for lorries and diesel vans and Euro 4 for petrol vans.

Why was Euro VI introduced?

The introduction of Euro VI further tightened emissions from air pollutants as European Community legislation has established appropriate standards for ambient air quality, including the setting of national emission ceilings. This is to cut the number of premature deaths from poor air quality and to protect those vulnerable to daily changes in levels of air pollutants. For example, the Clean Air For Europe (CAFE) programme led to the adoption of a strategy on air pollution. One of the strategy's conclusions was that further reductions in emissions from transport, energy, agricultural and industrial sectors are required to meet EU air quality objectives. The further development of Euro standards is therefore one of the measures designed to reduce the actual in-use emissions of air pollutants from the transport sector.

In particular, a reduction in NO_X emissions from heavy duty vehicles was necessary to improve air quality and comply with limit values for pollution and national emissions ceilings. Setting limit values for NO_X at an early stage provides long-term, European Union-wide planning security for vehicle manufacturers.

Where do oxides of nitrogen (NO_X) come from?

Oxides of nitrogen are formed when air is burnt in the combustion chamber. Air is formed from approximately 20 per cent oxygen and 80 per cent nitrogen. It is this 80 per cent of nitrogen which, when subject to high temperatures and extremely high pressure within the combustion chamber, converts to oxides of nitrogen.

The Euro VI regulation also established common technical requirements for the type approval of motor vehicles, engines and replacement parts with regard to their emissions. The regulation

Euro VI emission limits and Euro emissions progress to date

European Transient Cycle limits

	Date in service	Carbon Monoxide CO g/kWh	Hydro Carbon HC g/kWh	Nitrogen Oxides NO_X g/kWh	Particles PM g/kWh
Euro III	Oct 2001	5.45	0.78	5.0	0.16
Euro IV	Oct 2006	4.0	0.55	3.5	0.3
Euro V	Oct 2009	4.0	0.55	2.0	0.03
Comparable Euro VI limits	**Dec 2013**	**4.0**	**0.16**	**0.4**	**0.01**

laid down rules for in-service conformity of vehicles and engines, durability of pollution control devices, on-board diagnostic (OBD) systems, accessibility of vehicle OBD and vehicle repair and maintenance information. It also gave recommendations for the Commission to study the feasibility and development of a definition and a methodology of energy consumption and CO_2 emissions measurement for the whole vehicle and not just the engine.

Timetable for Euro VI standards

European legislation required new engines homologated from 31 December 2012, or new vehicles first registered from 31 December 2013, to meet the Euro VI emission standard.

There was provision in the EC Whole Vehicle Type Approval legislation to cover 'end of series run out' for a few vehicles which could not meet this date.

A derogation was available for Euro V trucks which allowed Euro V vehicles built before 30 September 2013 to be registered at any time up to end December 2014, which was effectively stockpiling vehicles. However, Euro V trucks built from 1 October 2013 had to be registered by the Euro VI deadline date of 31 December 2013 and from 1 January 2014 all trucks built needed to comply with Euro VI. This allowed operators who could afford to purchase and stockpile vehicles the opportunity to buy Euro V models built before 30 September 2013 and progressively introduce them into their fleets throughout 2014.

The regulation in detail

The main aspect of Euro VI is that it required a further tightening of vehicle emission limits for PM and NO_X from the previous Euro V limits. The reductions required under the Euro VI legislation were technically challenging for vehicle manufacturers and the technological approach typically required to meet these limits included the use of diesel particulate filters and both Selective Catalytic Reduction (SCR) and Exhaust Gas recirculation (EGR).

Particulate matter (PM)

A reduction of 67 per cent in the mass of particulate emissions was needed which required the introduction of a Diesel Particulate Filter (DPF) to vehicle exhausts.

The emission limits selected for particulates could be met by using open or closed filters. Closed filters had the benefit of reducing the amount of ultra fine particles (PM 0.1 and below) that are considered most harmful to health. To prevent the possibility that in the future open filters are developed that meet the new particulate mass limit but allow a high number of ultra fine particles to pass, the Euro VI legislation introduced a new standard limiting the number of ultra fine particles that can be emitted.

Oxides of nitrogen (NO_X)

A reduction of 80 per cent in NO_X was also required. To comply with this requirement internal engine measures such as Exhaust Gas Recirculation (EGR) and after treatment devices such as Selective Catalytic Reduction (SCR) were needed. The correct functioning of these systems is a basic requirement and measures to guarantee the correct operation of such systems were included in the regulation to ensure vehicles are not operated if these systems become defective or inoperative, for example incorrect exhaust gas recirculation flow, deactivated EGR or a lack of the required reagent.

Ammonia (NH_3)

The regulation included a tightening of the limit on emissions of ammonia (NH3) from the Euro V limit of 25 parts per million (ppm) to 10ppm. The limit on ammonia emissions was set in order to prevent what is known as 'ammonia slip' due to maladjustment of systems which inject urea into vehicle exhausts to reduce oxides of nitrogen (NO_X) emissions by Selective Catalytic Reduction. Urea is broken down over the catalyst, producing ammonia which reacts with NO_X. Excess urea injection, however, which may occur at times during vehicle operation, leads to NH3 being released.

Hydrocarbons (THC)

Total hydrocarbon emissions were also required to be reduced by 71 per cent, consistent with achieving a common technical approach in both Europe and North America.

The regulation limits the application of separate emission limits for total hydrocarbons, non-methane hydrocarbons, and methane to spark ignition engines. However, the same flexibility was not extended to compression ignition engines such as 'dual-fuel' engines which use small quantities of diesel to initiate combustion and natural gas as the bulk fuel. Since the intention is to avoid barriers in the marketing of natural gas fuelled vehicles, the extension of the proposed separate emission limits to cover both spark ignition and compression ignition engines appears to be sensible.

Access to repair information

Manufacturers are required to provide to independent operators, unrestricted and standardised access to on-board diagnostic information, diagnostic and other equipment and tools including any relevant software and vehicle repair and maintenance information. They are also required to provide a standardised, secure, remote facility to enable independent repairers to complete operations which involve access to the vehicle security system.

	Limit values				
	Carbon Monoxide CO g/k Wh	Hydro Carbon HC g/kWh	Nitrogen Oxides NO_x g/kWh	Particulates PM g/kWh	Particulates PM Number/kWh
WHSC	1.5	0.13	0.4	0.01	$8{,}0 \times 10^{11}$
WHTC	4.0	0.16	0.46	0.01	$6{,}0 \times 10^{11}$

World Harmonised Heavy-Duty Test Cycles

The regulation adopted the Worldwide Harmonised Steady State Cycle (WHSC) and the Worldwide Harmonised Transient Cycle (WHTC) as alternatives to the traditionally used European cycles (European Transient Cycle (ETC) and the European Steady State Cycle (ESC)). The Euro VI legislation introduced emission limits to Worldwide test cycles for compression ignition vehicles as detailed in the table on the next page.

The primary benefit of adopting WHSC is a further step towards alignment of emission standards across global markets, which will reduce costs to industry.

Test cycles

Two test cycles had traditionally been used in European legislation for emissions testing.

The ESC test (European Steady State Cycle) reflected the engine load and speed characteristics most frequently used in heavy vehicle operation

The ETC test (European Transient Cycle) was a record of constantly varying engine load and speed, designed to give a complete picture of vehicle operation rather than a collection of specific load and speed points

The WHTC (World Harmonised Transient Cycle (WHTC) was developed in terms of normalised engine speed and load, and is capable of taking into account different engine and drive train technologies

The WHSC (World Harmonised Steady State Cycle) consists of engine speed/load combination mode points in order to represent, as closely as possible, the same speed and load distribution as the transient reference engine cycle

Fuel consumption

It was unrealistic to hope for a Euro VI standard that would be genuinely effective in reducing pollutant emissions from heavy duty vehicles without having some adverse impact on fuel consumption. The European Commission's original estimate of the fuel consumption penalty associated with achieving Euro VI emissions limits at the time the regulation was drafted was between two and three per cent using a Euro V baseline. The Department for Transport (DfT) commissioned an independent study in July 2008 which suggested that the penalty, based on the state of technology at that time, could be around eight per cent.

During the development of Euro VI, manufacturers had invested heavily not only into producing Euro VI engine technology, but also into wider vehicle design changes to offset any potential fuel consumption and weight penalties resulting from Euro VI introduction, together with improved engine cooling.

Early indications show that typically, on general haulage operations most Euro VI vehicles are no worse, or in some cases show improvements on fuel consumption compared with Euro V vehicles.

To deal with high on-road emissions from passenger vehicles, where a significant discrepancy with the laboratory testing has been confirmed in recent years, the European Commission developed the Real-Driving Emissions test procedure (RDE), which applied from 1 September 2017. This test procedure, which better reflects the actual emissions on the road and reduces the discrepancy between emissions measured in real driving to those measured in a laboratory, uses portable on-board emission analysers to measure emissions during a realistic, on-road test.

Durability of emission control systems

The regulation included an obligation for manufacturers to take technical measures to ensure that tail pipe emissions were effectively limited throughout the normal operational life of the vehicle under normal operating conditions. Increases in the durability requirements for emissions were as follows.

160,000km or five years, whichever is the sooner, in the case of engines fitted to vehicles of category M1, N1 and M2

300,000km or six years, whichever is the sooner, in the case of engines fitted to vehicles of category N2, N3 with a maximum technically permissible mass not exceeding 16 tonnes and M3 Class I, Class II and Class A, and Class B with a maximum technically permissible mass not exceeding 7.5 tonnes

700,000km or seven years, whichever is the sooner, in the case of engines fitted to vehicles of category N3 with a maximum technically permissible mass exceeding 16 tonnes and M3, Class III and Class B with a maximum technically permissible mass exceeding 7.5 tonnes

Penalties

Member states are required to impose penalties for the infringement of the provisions of the regulation. Many of the infringements outlined in the regulation apply directly to manufacturers, although operators are liable to penalties if vehicles are driven, for example, without consumable reagent or defective EGR systems.

Further information

European Commission Regulation (EU) 582/2011 implements and amends Regulation (EC) No 595/2009 with respect to emissions from heavy duty vehicles (Euro VI).

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