



EMISSION STANDARDS

Emission standards are the legal requirements governing air pollutants released into the atmosphere. Emission standards set quantitative limits on the permissible amount of specific air pollutants that may be released from specific sources over specific timeframes. They are generally designed to achieve air quality standards and to protect human life. Different regions and countries have different standards for vehicle emissions.

Many emissions standards focus on regulating pollutants released by automobiles (motor cars) and other powered vehicles. Others regulate emissions from industry, power plants, small equipment such as lawn mowers and diesel generators, and other sources of air pollution.

The first automobile emissions standards were enacted in 1963 in the United States, mainly as a response to Los Angeles' smog problems. Three years later Japan enacted their first emissions rules, followed between 1970 and 1972 by Canada, Australia, and several European nations. The early standards mainly concerned carbon monoxide (CO) and hydrocarbons (HC). Regulations on nitrogen oxide emissions (NO_x) were introduced in the United States, Japan, and Canada in 1973 and 1974, with Sweden following in 1976 and the European Economic Community in 1977. These standards gradually grew more and more stringent but have never been unified.

There are largely three main sets of standards: United States, Japanese, and European, with various markets mostly using these as their base. Sweden, Switzerland, and Australia had separate emissions standards for many years but have since adopted the European standards. India, China, and other newer markets have also begun enforcing vehicle emissions standards (derived from the European requirements) in the twenty-first century, as growing vehicle fleets have given rise to severe air quality problems there, too.

Since the early 1990s, new car models have had to meet increasingly stringent exhaust pollution limits, known as the Euro emissions standards, before they can be put on sale. The first European exhaust emissions standard for passenger cars was introduced in 1970. 22 years passed before the next big change when, in 1992 the 'Euro 1' standard heralded the fitting of catalytic converters to petrol cars to reduce carbon monoxide (CO) emissions.

The latest standard, 'Euro 6', applies to new type approvals from September 2014 and all new cars from September 2015 and reduces some pollutants by 96% compared to the 1992 limits. The Euro 6 test became more stringent from September 2017 with the addition of an extended on-road emission test known as Real Driving Emissions or RDE.

Abbreviations: CO = Carbon Monoxide
NO_x = Oxides of Nitrogen
HC = Hydrocarbons
PM = Particulate Matter
PN = Particulate Number

Euro 1 (EC93) - July 1992 (January 1993)

The introduction of the Euro 1 standard in 1992 required the switch to unleaded petrol and the universal fitting of catalytic converters to petrol cars to reduce carbon monoxide (CO) emissions.

Euro 1 emission limits

- CO — 2.72 g/km (petrol and diesel)
- HC+ NO_x — 0.97 g/km (petrol and diesel)
- PM — 0.14 g/km (diesel only)

Euro 2 (EC96) - January 1996 (January 1997)

The Euro 2 standard further reduced the limit for carbon monoxide emissions and also reduced the combined limit for unburned hydrocarbons and oxides of nitrogen for both petrol and diesel vehicles. Euro 2 introduced different emissions limits for petrol and diesel.

Euro 2 emission limits (petrol)

- CO — 2.2 g/km
- HC+ NO_x — 0.5 g/km
- PM — no limit

Euro 2 emission limits (diesel)

- CO — 1.0 g/km
- HC+ NO_x — 0.7 g/km
- PM — 0.08 g/km

Euro 3 (EC2000) - January 2000 (January 2001)

Euro 3 modified the test procedure to eliminate the engine warm-up period and further reduced permitted carbon monoxide and diesel particulate limits. Euro 3 also added a separate NO_x limit for diesel engines and introduced separate HC and NO_x limits for petrol engines.

Euro 3 emission limits (petrol)

- • CO — 2.3 g/km
- • HC — 0.20 g/km
- • NO_x - 0.15
- • PM — no

limit Euro 3 emission limits
(diesel)

- • CO — 0.64 g/km
- • HC+ NO_x — 0.56 g/km
- • NO_x — 0.50 g/km
- • PM — 0.05 g/km

Euro 4 (EC2005) - January 2005 (January 2006)

Euro 4 (January 2005) and the later Euro 5 (September 2009) concentrated on cleaning up emissions from diesel cars, especially reducing particulate matter (PM) and oxides of nitrogen (NO_x). Some Euro 4 diesel cars were fitted with particulate filters.

Euro 4 emission limits (petrol)

- CO — 1.0 g/km
- HC — 0.10 g/km
- NO_x — 0.08
- PM — no limit

Euro 4 emission limits
(diesel)

- CO — 0.50 g/km
- HC+ NO_x — 0.30 g/km
- NO_x — 0.25 g/km
- PM — 0.025 g/km

Euro 5 - September 2009 (January 2011)

Euro 5 further tightened the limits on particulate emissions from diesel engines and all diesel cars needed particulate filters to meet the new requirements. There was some tightening of NO_x limits too (28% reduction compared to Euro 4) as well as, for

the first time, a particulates limit for petrol engines — applicable to direct injection engines only. Addressing the effects of very fine particle emissions, Euro 5 introduced a limit on particle numbers for diesel engines in addition to the particle weight limit. This applied to new type approvals from September 2011 and to all new diesel cars from January 2013.

Euro 5 emission limits (petrol)

- CO — 1.0 g/km
- HC - 0.10 g/km
- NO_x — 0.06 g/km
- PM — 0.005 g/km (direct injection

only)Euro 5 emission limits (diesel)

- • CO — 0.50 g/km
- • HC+ NO_x — 0.23 g/km
- • NO_x — 0.18 g/km
- • PM — 0.005 g/km
- • PN — 6.0×10^{11} /km

Euro 6September 2014 (September 2015)

The Euro 6 standard imposes a further, significant reduction in NO_x emissions from diesel engines (a 67% reduction compared to Euro 5) and establishes similar standards for petrol and diesel. Exhaust Gas Recirculation (EGR) — replacing some of the intake air (containing 80% nitrogen) with recycled exhaust gas — reduces the amount of nitrogen available to be oxidised to NO_x during combustion but further exhaust after treatment may be required in addition to the Diesel Particulate Filters required to meet Euro 5.

Euro 6 diesel cars may also be fitted with: A NO_x adsorber (Lean NO_x Trap) which stores NO_x and reduces it to Nitrogen over a catalyst Selective Catalytic Reduction (SCR) which uses an additive (Diesel Exhaust Fluid (DEF) or AdBlue) containing urea injected into the exhaust to convert NO_x into Nitrogen and water. The use of Cerium, a fluid injected into the fuel tank each time the vehicle is refuelled which assists the DPF regeneration by lowering the temperature needed for regeneration.

Euro 6 emission limits (petrol)

- CO — 1.0 g/km
- HC — 0.10 g/km
- NO_x — 0.06 g/km
- PM — 0.005 g/km (direct injection only)
- PN — 6.0×10^{11} /km (direct

injectiononly)Euro 6 emission limits (diesel)

- CO — 0.50 g/km
- HC+ NO_x — 0.17 g/km
- NO_x — 0.08 g/km

- PM — 0.005 g/km
- PN — 6.0×10^{-11} /km

Euro 6d-Temp, Euro 6d and RealDriving Emissions (RDE)

From 1 September 2017, more stringent and realistic tests will be used to certify new car models against the Euro 6 emission limits. A new laboratory test cycle known as WLTP (the Worldwide harmonised Light duty Test Procedure) will apply to all newtype approvals and a year later, from 1 September 2018, will apply to all new car registrations. An additional, on road, emissions test known as the Real Driving Emissions or RDE test has been introduced alongside the WLTP laboratory test to help make sure that cars meet emissions limits in a much wider range of driving conditions. An RDE test will last between 90 and 120 minutes and take in a mix of 'normal' urban, rural and motorway driving.

RDE is being introduced in two steps:

RDE step 1 — applies to new type approvals from 1 September 2017 and to all new registrations from 1 September 2019. For RDE1 a NO_x conformity factor of 2.1 will apply meaning that NO_x emissions in the RDE1 test can be up to 2.1 times the Euro 6 laboratory limit of 80mg/km. Cars type approved during this period will be described as meeting Euro 6d-temp.

RDE step 2 — applies to new type approvals from 1 January 2020 and to all new registrations from 1 January 2021. For RDE2 the NO_x conformity factor is 1.0 but with an error margin of 0.5 meaning that NO_x emissions in the RDE2 test can be up to 1.5 times the Euro 6 laboratory limit of 80mg/km. Cars type approved during this period will be described as meeting Euro 6d.