Euro 7 regulation: an opportunity for improved air quality and better health?

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We are breathing cleaner air than in the past years More work to be done to meet WHO recommended guidance



Past regulations have greatly reduced tailpipe emissions of NOx and particulates – focus now on real-world high emissions



Next focus : Non-tailpipe emissions from brakes, tires (latter is especially a concern for EVs)

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Improving efficiency, fleet turnover and low carbon fuels will be critical to meet decarbonization goals

European Vehicle Sales by Powertrain : 2022



High-level overview of Euro 7 elements

- Fuel/technology neutral revised limits
 - For light-duty : same limits for cars and vans (so effectively tighter limits for vans)
- Inclusion of particles down to 10 nm



Measure emissions on "random and worst-case" RDE test cycles using PEMS

- Increased durability requirements to "average expected lifetime" of vehicles
- New species regulated e.g., NH₃ for light-duty, N₂O for heavy-duty
- Con-board (continuous) monitoring of criteria & CO₂ emissions, fuel & energy consumption
 - Register emission exceedances, communicate emissions sensor and exhaust flow data information over the air, trigger repair of vehicle
- "Environmental Vehicle Passport" for each vehicle with CoP, type-approval documentation



Revision to amend regulation in case vehicles running on CO₂ neutral fuels are approved post 2035

- Non-tailpipe emissions evaporative, brake and tires
- Battery state-of-health and durability requirements for passenger cars
 80% to 5 yrs/100K km and 70% beyond to 8 yrs/160K km



Euro 7 Light-Duty Proposal			<u>Units</u> mg/km #/km (PN)	Euro 6 (Pass cars) WLTP, RDE : x 1.1 NOx, x 1.34 PN		Euro 7 Limits No CFs	Budget (mg or #) Trips < 10 km	
Vehicles : M1, N1 (passenger cars & LCVs) Start date: July 1, 2025 (new vehicles)				Gasoline	Diesel	Tech/fuel neutral		
			NOx	60	80	60	600	
Test conditions Normal		Extended	PM	4.	.5	4.5	45	
Ambient T (°C)	0 – 35	- 10 to +45	PN (#/km)	6x10 ¹¹ > 23 nm GDI only	6x10 ¹¹ > 23 nm	6x10 ¹¹ > 10 nm	6x10 ¹² > 10 nm	
Max. Altitude (m)	< 700	< 1,800	СО	1000	500	500	5000	
Max. Speed (km/h)	≤ 145	≤ 160	ТНС	100	HC+NOx=170	100	1000	
Max. avg. P < 2km after cold start	< 20% P _{max}	> 20% P _{max}	NMHC	68	-	68	680	
Trip composition	Any		NH ₃	-		20	200	
Min. mileage	>10,000	> 3,000						
(km)			Lifetime / Durability	160,000 km / 5 yrs.		160,000 km / 8 yrs. Ext. : 200,000 km / 10 yrs. Limits x 1.2		

Euro 6 has significantly reduced on-road emissions Next regulations will address severe boundary conditions and high emitters

NOx from Diesel cars

74 diesels, model years 2012 - 2019



Particulate emissions from gasoline vehicles



Natl. Institute of Env. Res. (NIER), Korea Science of the Total Env. 767, 2021, 144250 https://doi.org/10.1016/j.scitotenv.2020.144250 EU Commission, JRC Catalysts 2022, 12, 70 https://doi.org/10.3390/catal12010070

Potential solutions for meeting Euro 7 standards – Light-Duty



DIESEL



- TWC = Three-way catalyst
- GPF = Gasoline particulate filter
- HCT = Hydrocarbon trap
- p-SCR = passive SCR



- LNT = Lean NOx Trap
- DOC = Diesel oxidation catalyst
- SCR = Selective catalytic reduction (of NOx)
- SCRF = SCR on filter
- ASC = Ammonia slip catalyst
- EHC = Electrically heated catalyst

Euro 7 He	<u>Units</u> mg/kWh (gas) #/kWh (PN)	Euro VI	Euro 7 HD proposal				
Vehicles : M2, M3			Cold 100 th percentile	Hot 90 th percentile	Budget Trips < 3xWHTC		
Start date: July 1, 2027 (new vehicles)			NOx	460	350	90	150
Test conditions	NOIMAI	Extended Emissions / 2	PM	10	12	8	10
Ambient T (°C)	-7 – 35	- 10 to +45	PN (#/kWh)	6x10 ¹¹	5x10 ¹¹	2x10 ¹¹	3x10 ¹¹
Max. Altitude (m)	< 1600	< 1,800	Euro VI : PN ₂₃ Euro VII : PN ₁₀				
Max. Speed (km/h)	≤ 145	≤ 160	СО	4000	3500	200	2700
Payload	≥ 10%	< 10%	NMOG	160 _{тнс}	200	50	75
Trip composition	As per usua	al use	NH ₃	10 ppm	65	65	70
Min. mileage (km)	5,000 for < 16t 10,000 for > 16t	> 3,000	CH ₄	500	500	350	500
<u>Lifetime</u> :	N ₂ O	-	160	100	140		
300,000 km / 8 yrs. For N2, N3 < 16t 875,000 km (ext.) / 15 yrs for N3>16t, M3>7.5t			НСНО	-	30	30	-

Technologies for Euro 7 Heavy-SCR SCR ASC DOC DPF **Ref. Euro VI Duty standards** System **Engine calibration** Heated dosine C.SCR Cylinder deactivation Engine ooc opt * SCR SCR ASC EGR pump, SuperTurbo, ... **Opposed** piston 200.22 CC-SCR DOC DRF SCR SCR ASC Hybridization Euro 7 Increase SCR volume and catalyst loadings SCR (example Added cc-SCR w/ twin dosing CC-SCR DOC DPF SCR SCR ASC configurations) Added + cc-DOC for NO₂ SCR on filter + Model based A/T controls, NH₃ storage cc.DOC CC-SCR DOC DPF SCR SCR ASC OPF Late & multiple injections Heat Heated urea dosing + Advanced technologies Electrical heater / EHC Close-coupled SCR / DOC with dual dosing Diesel \rightarrow CNG / LPG / Gasoline / H2-ICE / ... Fuel

Low S, low impurity fuels

CORNING

Active thermal management High filtration DPFs | Second DPF